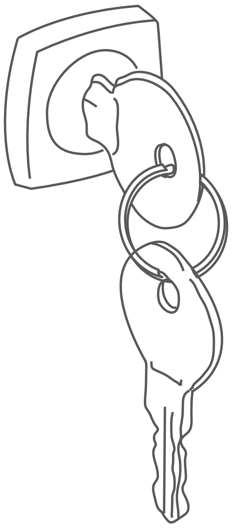
the MEDICINE CHEST



A COLLECTION OF SAFE DISPOSAL CURRICULUM, ACTIVITIES, AND SERVICE LEARNING RESOURCES

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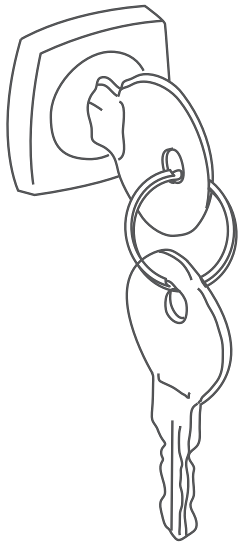
IISG-15-016

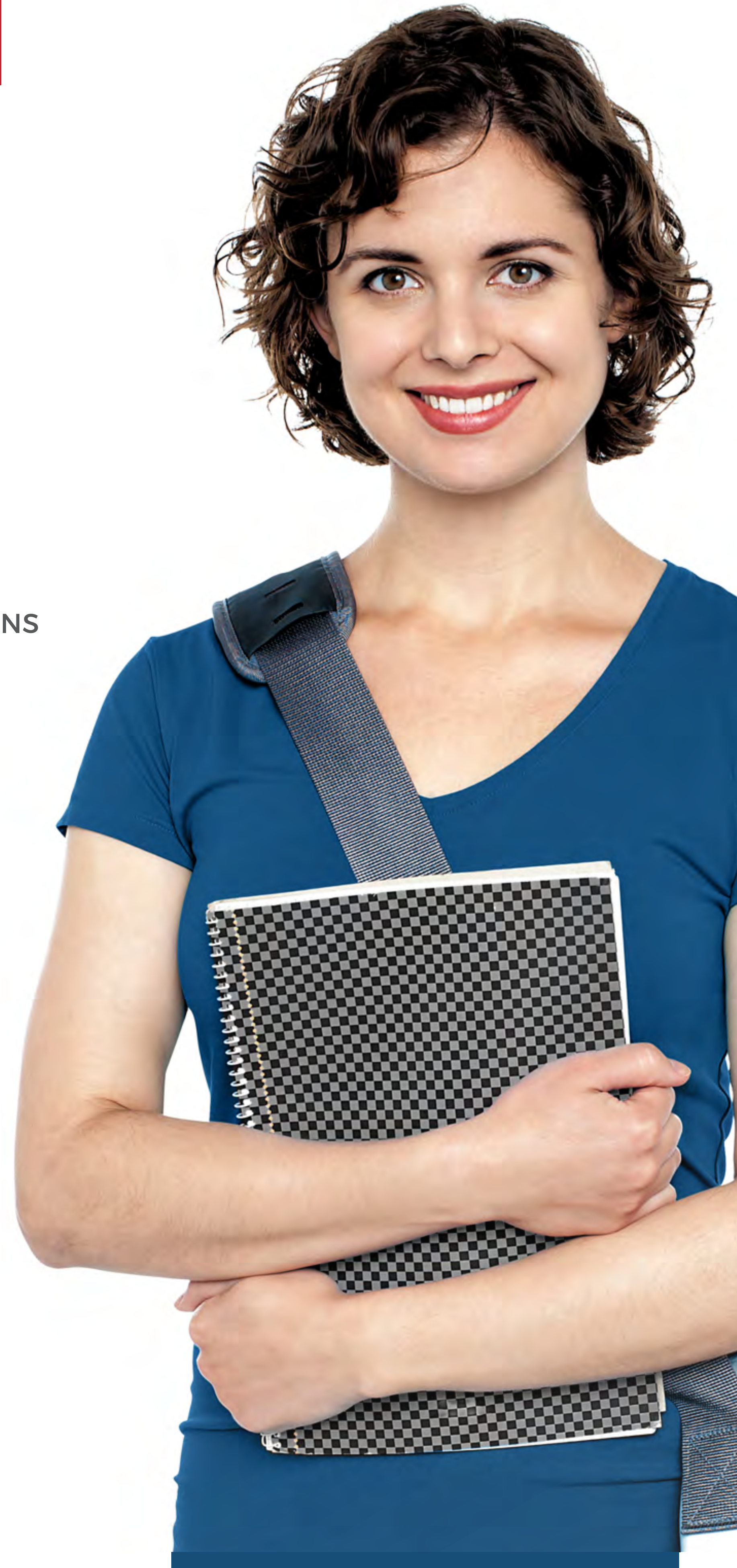
the MEDICINE CHEST



A COLLECTION OF SAFE DISPOSAL CURRICULUM, ACTIVITIES, AND SERVICE LEARNING RESOURCES

IISG-15-016

TABLE OF CONTENTS



01 INTRODUCTION

Get started with a brief overview of concerns surrounding the disposal of pharmaceuticals and personal care products and the goals of the curriculum.

Introduction: *Why you should care about pharmaceutical and personal care products disposal issues.*

Pharmaceuticals help people and animals live healthier lives, yet their use sometimes comes with unforeseen consequences. Contaminated drinking water and negative impacts on wildlife and plants have both been associated with medicines that are not disposed of properly. The problem is only growing because of the increasing use of medications.

Unused prescription medications in homes can be accidentally ingested, stolen, misused, or abused. In fact, according to the Centers for Disease Control and Prevention, 44 people in the U.S. die of prescription painkiller overdose every day.

Prescription and over-the-counter medications can cause unintended harm to pets too. The American Society for the Prevention of Cruelty to Animals reported that in 2014, they received 26,407 calls from people whose pets had gotten into medicines meant for human use, putting human medications at the top of their toxins list for the seventh straight year.

The Medicine Chest addresses these emerging issues with curriculums comprised of multidisciplinary, standards-based classroom materials. It also includes sample stewardship activities and background information for educators and high school students on how the improper disposal of unwanted medicines can be harmful to people, pets, and the environment.

Teachers also have the option to present the *Medicine Chest* materials in a traditional classroom or flipped classroom setting. The lessons are designed to be completed in approximately 45-minute periods, but can be expanded into longer sessions. Extension ideas have been added at the end of the lessons.

Through the multifaceted service-learning program presented in *The Medicine Chest*, students will be empowered to take action that will serve as a catalyst to help communities reduce the impacts from improper storage, use, and disposal of pharmaceuticals.

Our goals for *The Medicine Chest* are to:

- **Offer** comprehensive curriculums on the issues surrounding pharmaceuticals and personal care products disposal.
- **Incorporate** a variety of educational approaches for instructing high school-level students.
- **Support** community stewardship by offering creative project examples and guidance that will inform the public about appropriate disposal practices.
- **Explore** a variety of careers that work with pharmaceuticals and personal care products.

We dedicate *The Medicine Chest* to our youth who are working to make a significant difference in their communities as they develop important lifelong learning skills, including leadership and civic responsibility.

Lesson 1:

What are PPCPs and How Do They Affect Me?

9-12 Grade

45 Minutes

Subjects:
Consumer science, Life science, Mathmatics

Setting:
Home and Classroom

Pre-Homework:
Pharmaceutical and Personal Care Product Worksheet

INTRODUCTION

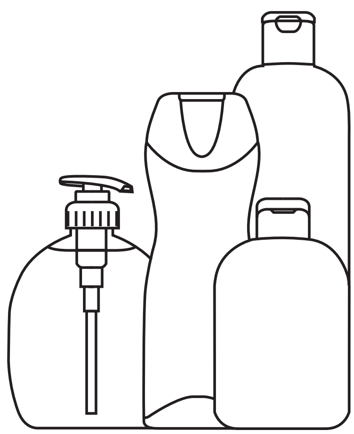
Every day you use a variety of products to improve your health or your quality of life. For example, perhaps you have to take a daily medication. That's a pharmaceutical (P). When you take a shower, you use shampoo, conditioner, soap, and maybe other products. Before you leave, you use toothpaste to brush your teeth. All of those items are considered personal care products (PCPs). The question is where do all of these substances, considered by most to be necessary to every-day life, go when they leave your body or go down the drain? What can *you* do to be an agent of change when it comes to how pharmaceuticals and personal care products (PPCPs) enter our environment?

STUDENT OBECTIVES

1. Explain, based on research, the different sources of pollution specific to pharmaceuticals and personal care products.
2. Summarize possible effects of PPCPs to the environment.
3. Design a personal (or family) action plan to reduce PPCP pollution.
4. Critically discuss the issues and challenges surrounding the issue.

DAILY ASSESSMENT

Students should have a clear understanding of the issues outlined in the PPCP worksheet as well as a feasible action plan to reduce improper disposal of PPCPs in their home.



Materials:

- ☐ Internet Access
  (for research or instruction)
- ☑ Worksheet
  (Pharmaceutical and Personal Care Products)
  [Included]
- ☑ Worksheet
  (Personal Care Plan of Action)
  [Included]

DSRP Vocabulary:

- ▹ Nonpoint-source pollution
- ▹ Personal care products (PCPs)
- ▹ Point source pollution
- ▹ Pharmaceuticals

STATE AND NATIONAL STANDARDS

COMMON CORE

Literacy: RST.9-10.8, RST.11-12.7, RST.11-12.8

Math: MP.2, HSN.Q.A.1, HSN.Q.A.2, HSN.Q.A.3

NAAEE GUIDELINES

3.1
3.1.B
3.1.C

NGSS

HS-LS2-7
HS-ETS1-4

The Take-Away

Students and their families have the power to reduce PPCP pollution by changing habits, which will ultimately help aquatic ecosystems.

*All instructions that begin with an * are found on the Illinois-Indiana Sea Grant Resource or YouTube Page* [*http://tinyurl.com/oyhlv9z*](http://tinyurl.com/oyhlv9z)

Conventional Classroom Procedure:

The **night before class**, hand out the Pharmaceutical and Personal Care Product Worksheet and have students fill out the first two columns.

1. In class, have students search online the words "chemicals in personal care products" and review the information they gather from reputable links. Students should write down which sites they visited and take notes on important facts they learned. If conflicting information is given, that could be a point of discussion.
2. *Watch video *How Drugs Pollute Our Drinking Water* (3:00).
3. Split up students into research groups (2-4 students).
4. Have students investigate the ingredients they found in the homework page (Helpful research links posted below).
5. Based on the information provided in the video and the material and evidence gathered from the internet on PCP ingredients, student groups should summarize the issue in 1-4 sentences.
6. Each student should come up with a personal action plan to reduce improper PPCP disposal in their household (sheet provided).

Flipped Classroom Procedure:

1. The **night before class**, students should:
   a. Fill in the Pharmaceutical and Personal Care Product Worksheet
   b. Google "chemicals in personal care products" and read and watch information gathered from reputable links.
   c. *Read *How Drugs Pollute Our Drinking Water*
   d. *Review *How to Dispose of Unwanted Medicine and Personal Care Products Research and Resources*
   e. *Read the Pennsylvania Sea Grant Article
   f. Fill in the Personal Care Plan of Action worksheet
2. In class:
   a. Discuss the "surprises" of what students learned while filling out the Pharmaceutical and Personal Care Product Worksheet.
   b. Discuss potential fears, realities, and challenges of what they learned.
   c. Break students into groups to reflect on the Personal care Plan of Action worksheets and what extensions (stewardship projects) could be created from what they have learned. Share those discussions.

Resources:

- *How to Dispose of Unwanted Medicine and Personal Care Products Research and Resources
- *Pennsylvania Sea Grant
- *Environmental Working Group: Skin Deep (NGO)

- *Household Products Database
- *Learn About Chemicals in Your House – EPA

Extensions or Possible Student Projects:

- Have students make their own alternative personal care products like shampoo, conditioner, or face cleanser, and use only those products for one week. There are a number of websites that can be researched by Googling “homemade personal care products.” They can journal about their experience on how easy (or not) and effective the natural products were compared to their store-bought counterparts. Have them consider cost, availability of ingredients, storage issues (lifespan), and time required to make and use.
- Calculate the number of PPCPs that your class(es) is/are diverting and keep an ongoing total that can turn into a “green promotion” for your school’s efforts to restore the environment.
- Communicate with local authorities for a Drug Take Back event. See (Illinois-Indiana Sea Grant *Resource* Page) for a tool kit on how to hold a successful event.

Name ________________________________ Block/Period________________

Pharmaceutical and Personal Care Product Worksheet

Look at personal care products in your house (shampoos, conditioners, lotions, etc.). Write down any ingredients that you can't pronounce or know the purpose of. In class, research the uses for the ingredients.

Ingredient (at home)	Found in	Purpose (in class)
e.g. triclosan	toothpaste, soap	antibacterial

Summary of issue:

Name ___________________________________ Block/Period__________

Personal Care Plan of Action

Target: Reduce PPCP release in my home.

I, ___________________________________ plan to reduce the improper disposal of PPCPs in my home by *educating my family* <u>and</u> *following these steps*.

1.

2.

3.

4.

5.

Add more on the back as needed

- As my family and I make these changes in our household, we will be diverting _______ PPCPs (specific chemicals) from being improperly discarded into the environment. (Show your math.)

- These changes by my family are important because… (Discuss the cost, safety, reliability, and aesthetics as well as social, cultural, and environmental impacts of this habit change.)

Lesson 2:

What Happens to PPCPs? - Wastewater Treatment

9-12 Grade

45 Minutes

Subjects:
Biochemstry, Engineering

Setting:
Home and Classroom

Pre-Homework:
List items (other than toilet paper and body waste) they have flushed down the toilet in the past or what items they have seen family members flush.

Read the State of Washington Department of Ecology FAQ sheet:

http://bit.ly/1MLqJek

INTRODUCTION

When pharmaceuticals and personal care products are flushed down the toilet they are basically “out-of-sight, out-of-mind,” but where do they go from there? Eventually, many of those chemicals end up in the waterways that we use for our drinking water and recreation. From municipal wastewater treatment systems to private septic fields, knowing what happens after you flush may create a new perspective on what you flush in the future.

STUDENT OBECTIVES

1. Determine if they have a private septic system or are part of a larger public wastewater treatment facility.
2. Describe the current issues in wastewater treatment and brainstorm some possible solutions to those issues.
3. Design possible improvement(s) to current toilet design or to wastewater treatment plants that may help reduce what is released into public waterways.

   Be sure to consider the trade-offs of those improvement(s).

DAILY ASSESSMENT

Students should be able to discuss the topic in depth, clearly state the problem, and create a plausible solution.

Materials:

- ☐ Internet Access (for research or instruction)
- ☐ Materials for drawing, construction, and brainstorming

DSRP Vocabulary:

- ▹ Domestic wastewater
- ▹ Industrial wastewater
- ▹ Pharmacokinetics
- ▹ Septic system

STATE AND NATIONAL STANDARDS

COMMON CORE	NAAEE GUIDELINES	NGSS
Math: MP.2 MP.4	3.1 3.1.A 3.1.B 3.1.C 3.1.D	HS-ETS1-2 HS-ETS1-4

The Take-Away

A better understanding of how wastewater is treated using public or private water systems.

*All instructions that begin with an * are found on the Illinois-Indiana Sea Grant Resource or YouTube Page http://tinyurl.com/oyhlv9z*

Conventional Classroom Procedure:

1. Ask students to talk about items they have flushed down the toilet.
2. *On the board, write down the items they list. Compare that list to *11 Things You Should Never Flush Down the Toilet* at or video *10 Things You Should Not Flush Down the Toilet* (Clean My Space) on) (5:01) (list also attached). How many of the items that the students listed were on these "no-no" lists?
3. **Watch Wastewater: Where does it go?* (8:43). This video refers to the Canadian city of Windsor and the Detroit River. The information may apply to your local wastewater treatment plant.
4. *If your students live in areas where septic systems are prevalent, (5:03) *How does a septic system work?* or *Septics 101* (19:02) will be helpful.
5. *Now focus on pharmaceuticals. Review the video on biochemistry of pharmacology.
6. In groups, have students create a design that will improve the function of the toilet, i.e., how to prevent objects that shouldn't be flushed from entering the waste stream or develop a modification to wastewater treatment facilities that would help screen and/or separate out excreted pharmaceutical metabolites. Have the students talk about their ideas and suggest any improvements to their designs.
7. Discuss the constraints involved in the new design (cost, safety, reliability, aesthetics) as well as any social, cultural, and environmental impacts of the new design. (Whatever isn't finished is homework.)

Flipped Classroom Procedure:

1. The **night before class**, students should:
    a. *Read the State of Washington Department of Ecology's FAQ sheet.
    b. Fill out student handout *Flushing Trouble.*
    c. *Compare that list to *11 Things You Should Never Flush Down the Toilet* at (Illinois-Indiana *Resource* Page) or 10 Things You Should Not Flush Down the Toilet (Clean My Space) (5:01) (list also attached).
    d. *Watch *Wastewater: Where does it go?* This video refers to the Canadian city of Windsor and the Detroit River. The information may apply to your local wastewater treatment plant. If your students live in areas where septic systems are prevalent, *How does a septic system work?* or *Septics 101* will be helpful.
    e. *Learn about biochemistry of pharmacology.
    f. Fill out DSRP vocabulary
2. In class:
3. In groups, have students create a design that will improve the function of the toilet, i.e., how to prevent objects that shouldn't be flushed from entering the waste stream. They can develop a modification to wastewater treatment facilities that would help screen and/or separate out excreted pharmaceutical metabolites, reducing the amount of pharmaceuticals that reach the

watershed. Have the students talk about their ideas and suggest any improvements to the designs.

   a. Discuss the constraints involved in the new design (cost, safety, reliability, and aesthetics) as well as any social, cultural, and environmental impacts of the new design.
   b. If time, discuss the wastewater load of pharmaceuticals when they are directly dumped into the toilet compared to when they are excreted. Refer to the Water Resources Center document in the Resources for Research.
   c. If there are any student groups that show feasible plans, talk to them about further developing them as the unit project.

Resources:

- Regents of the University of Minnesota. (2010). Medication and your Septic System, Onsite Sewage Treatment Program (Illinois-Indiana *Resource* Page)

Extensions or Possible Student Projects:

- Contact your local wastewater treatment facility to see if tours are available for classes. If so, plan a field experience. If not, consider inviting a spokesperson from a wastewater treatment facility as a guest speaker to class. If your area predominately has septic systems, consider a guest speaker.
- Have students create a “What Not to Flush” public service announcement that is 30 -60 seconds in length as part of their class project.
- Students can further develop ideas on improving wastewater disposal/treatment designs through engineering practices.

Student Handout

Name ____ Block/Period___________

Flushing Trouble

What items have you flushed down the toilet?

1.

2.

3.

4.

5.

Add more on the back as needed

How many of the items on your list were on the “do not flush” list (in class)?

If you flushed an item down the toilet that caused a clog that you were not able to clear out, how much would it cost (estimate) to have a plumber fix the problem?
Show your research numbers and math.

11 Things You Should Never Flush Down the Toilet - Care2.com

http://www.care2.com/greenliving/11-things-you-should-never-flush-down-the-toilet.html

There are many things that should never EVER be flushed down the toilet. Doing so, you risk significant plumbing problems as well as environmental pollution.

1. Bathroom Wipes – These “moist towelettes” or as I like to call them “adult baby wipes” are becoming an increasingly popular bathroom accessory. Despite the fact that they’re marketed to be flushed like toilet paper, these wipes are creating clogs and backups in sewer systems around the nation. “An industry trade group this month revised its guidelines on which wipes can be flushed, and has come out with a universal stick-figure, do-not-flush symbol to put on packaging.” (Same thing goes for actual baby wipes and cleaning wipes).

2. Condoms – They probably seem small and very similar to toilet tissue, but these latex prophylactics are like kryptonite for septic tanks and sewage treatment plants. "I’ve been down the sewers in central London and seen what appear to be fish on the surface. They’re actually condoms filled with air, bobbing around. It is pretty grim.”

3. Cotton Balls & Swabs – They’re just cotton, right? It might seem like these small bathroom toiletries would just get soggy and eventually break down in the watery pipeline, but they don’t. They eventually gather together in bends of the pipe, causing massive blockages.

4. Prescription Medication – Don’t need the rest of those pills? Many people feel like they’re doing the safe thing, keeping meds out of the wrong hands by flushing them, but it’s actually very dangerous. These drugs destroy bacteria, contaminate groundwater supplies, and can have terrible effects on wildlife downstream.

5. Paper Towels – These household favorites are extremely wasteful; reusable rags/napkins are much better. However, if you do use paper towels, know that they’re NOT designed to break down in water like toilet paper. Flushing them can cause BIG problems.

6. Cigarette Butts – Not only do they look nasty when floating in the toilet, they’re full of incredibly toxic chemicals that just end up in the water supply. Also, think of all the water you’re wasting to get rid of ONE tiny butt!

7. Band-aids – These are made from non-biodegradable plastic, which is terrible for the environment and can cause terrible clogs in the sewage system.

8. Dental Floss – Despite feeling like string, dental floss is not biodegradable. Once flushed, it loves to wrap itself around other objects in the pipeline, making tiny clogs grow bigger in an instant.

9. Fats, Oil, and Grease – This is a tough one, and everyone has done it at one point, but cooking fats should NEVER go in the drain or garbage disposal. It seems like a liquid when it’s hot, but as soon as this grease hits the drain, it cools and congeals, becoming pipe-clogging wax. Scrape it into the trash, or, if it’s clean bacon fat, save it in a jar for reuse.

10. Cat Litter – I can understand how this would seem ok — it’s just the cat’s poop and pee, right? But cat litter is made from clay and sand, two things that you should NEVER be put down a toilet. Not to mention that cat waste contains toxins and parasites that shouldn’t be in our water system.

11. Disposable Diapers – just because there’s poop in it, doesn’t mean it belongs in the toilet. Diapers are made from toxic plastic that’s designed to expand when it comes in contact with water. In the slim chance you actually get it down the drain, it will instantly be caught in the u-bend, and cause a terrible back up.

Lesson 3:

Measuring Toxicity - Lettuce Seed Assay

9-12 Grade

90 Minutes

Subjects:
Life, Physical, and Earth science

Setting:
Classroom, Lab with students working in small groups

Pre-Homework:
Read article "What does ppm or ppb mean?" from *On Tap*:

http://bit.ly/1MLqJek

Develop a procedure to prepare a 100 percent solution of an assigned chemical.

Create data table for recording results.

INTRODUCTION

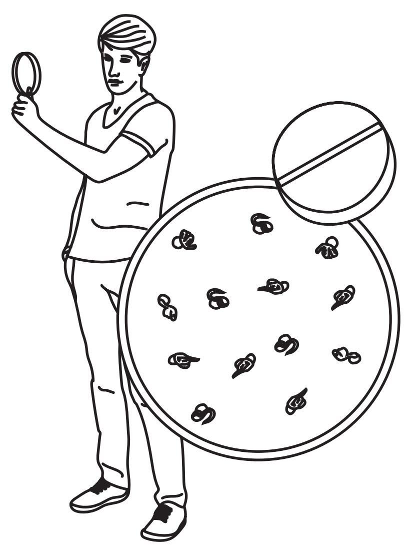
Pharmaceuticals and personal care products that we ingest or use on our bodies every day are excreted or washed off and ultimately enter the wastewater stream. In this lesson, students will conduct dose/response experiments to assess the effect of common household substances on the germination of lettuce seeds.

STUDENT OBECTIVES

1. Conduct a serial dilution to prepare solutions of a chemical over a range of concentrations.
2. Conduct a dose/response experiment with the solutions prepared in the serial dilution to determine the chemical's toxicity to lettuce or radish seeds.
3. Work collaboratively to conduct the experiment, analyze data, and interpret results. Document their work by writing a lab report.

DAILY ASSESSMENT

Students should be able to prepare a 100 percent solution and calculate the dilution's concentrations in terms of ppm. They should also create a data table with detailed observations and accurate results.



Materials:

- ☐ Lettuce/Radish Seeds
- ☐ Lab Equipment/Supplies (See next page for detailed list)

DSRP Vocabulary:

- ▹ ppm (parts per million)
- ▹ Serial dilution
- ▹ Toxicology
- ▹ TC_{50} (toxic concentration 50)

STATE AND NATIONAL STANDARDS

COMMON CORE

Writing: W.5.8, W.5.9, WHST.9-12.2, RI.5.1, RI.5.7, RI.5.9

Speech: SL.11-12.5

Math: MP.2, MP.4

Literacy: RST.9-10.7, RST.11-12.1 *(cont.)*

NAAEE GUIDELINES

1.C
1.D
1.E
1.G
2.1.A
2.4.A
2.4.B
2.4.C

NGSS

HS-LS1-A
HS-LS2.A
HS-LS2.C
HS-PS1.A
HS-PS1.B
HS-ESS3.C

The Take-Away

An understanding that "the dose" makes the poison, and that the sensitivity of an organism to a chemical depends on the identity of both the chemical and the organism.

Materials:

- Aspirin and/or acetaminophen tablets
- Balance
- Beakers
- Beral pipets
- Bleach
- $CaCl_2$ or ice melting salt
- Coffee filters
- $CuSO_4$ or Root Kill
- Distilled or deionized water (tap water is OK, but introduces more variability)
- Filter paper
- Funnels
- Graduated cylinders
- Lettuce or radish seeds
- Markers
- $MgSO_4$ or Epsom salts
- Mortar and pestle
- Parafilm or plastic baggies
- Plastic cups
- Polystyrene petri dishes
- Sodium lauryl sulfate
- Stirring rods
- Trays
- Tweezers
- Ringstands
- Ruler

Teacher Notes:

All instructions that begin with an * are found on the Illinois-Indiana Sea Grant Resource or YouTube page

Chemicals for Testing

It is recommended that each student group tests a single chemical on a single organism, and that all of that data is shared with the class. In this way, students have the opportunity to conduct the experiment and also think about the bigger picture, i.e. the effect of different chemicals on the same organisms or the effect of the same chemical on different organisms.

Depending on available resources, students can test readily available household chemicals or chemicals from a scientific supply company. A list of potential chemicals to test along with their solubility and recommended 100 percent concentration is given in Table 1.

Chemical name	**Rationale for inclusion**	**Solubility in water**	**Recommended 100% concentration**	**Other comments**
$NaCl$	Readily available household chemical	357 g/L at 25°C	12 g/L	Regular table salt
KCl	Alkali metal beneath Na in periodic table	360 g/L at 25°C	12 g/L	Sold as salt substitute
$CaCl_2$	Readily available household chemical	740 g/L at 20°C	12 g/L	Sold for deicing
$MgCl_2$	Alkaline earth metal above Ca in periodic table	400 g/L at 20°C	12 g/L	Sold for deicing
$KAl(SO_4)_2{\cdot}12(H_2O)$	Readily available; used in deodorants	140 g/L at 20°C		Sold as alum for baking
$CuSO_4{\bullet}6H_2O$	Readily available household chemical	320 g/L at 20°C	500 mg/L	Sold as Root Kill
$MgSO_4{\bullet}7H_2O$	Readily available household chemical; compare with $CuSO_4$	335 g/L at 20°C	500 mg/L or greater	Sold as Epsom salt
Sodium dodecyl sulfate	Used in many hygiene and cleaning products	~150 g/L at 20°C	800 mg/L	Also called sodium lauryl sulfate; purchase from lab supply
Aspirin	Readily available household chemical; OTC analgesic	3 g/L at 25°C	3 g/L	Try to obtain uncoated or minimally-coated tablets
Acetaminophen	Readily available household chemical; OTC analgesic	12.78 g/L at 20°C	13 g/L	Try to obtain uncoated or minimally-coated tablets

To prepare the 100 percent solutions from tablets of aspirin or acetaminophen, grind uncoated or minimally-coated tablets using a mortar and pestle, and weigh out the appropriate amount of powder. These organic molecules have much lower solubility than the inorganic salts, so it may be necessary to heat solutions to get the maximum amount dissolved. Since tablets for human consumption contain a small amount of fillers and other agents, it will be necessary to run the solutions through a coffee filter or filter paper. Even then, the solutions may appear cloudy.

Teachers can ask students to research their assigned chemicals to learn about their structures, properties, uses, handling, and toxicity. Safety data sheets (SDS, formerly known as MSDS) are a good source of information and are readily downloadable for no cost. Teachers can also ask students to make predictions about the effects of the chemicals on seed germination. Explanations for proposed effects could consider factors such as polarity, solubility, counter ion, cation location in the periodic table, molecular size, etc.

*All instructions that begin with an * are found on the Illinois-Indiana Sea Grant Resource or YouTube Page http://tinyurl.com/oyhlv9z*

Part 1: Serial Dilution

Optional: * Watch serial dilution demo video.

*Optional: **To visualize the serial dilutions, students can use food coloring or powdered dye as outlined in the video on the Illinois-Indiana Sea Grant YouTube page.

Note: To save time, the teacher can prepare all the solutions before class.

Pre-work: Assign a certain chemical to each student group, give them the 100 percent concentration (e.g. 4 mg/L) and ask them to create a procedure for preparing the 100 percent solution. Tell them that they will dilute the 100 percent solution 10-fold, 5 times and ask them to calculate the concentrations of the resulting solutions (6 total including the 100 percent solution) in units of ppm. Determining concentrations in ppm could also be assigned as part of the lab report.

1. Set up 6 plastic cups or beakers and label them with the following percent concentrations and the chemical name: 100% (#1), 10% (#2), 1% (#3), 0.1% (#4), 0.01% (#5), 0.001% (#6) and control.

2. Add 90 mL of distilled water to test tubes #2 – 6 and the control.

3. Measure 100 mL of the 100% solution and pour into #1.

4. Transfer 10 mL of solution from #1 to #2.

5. Gently swirl or stir #2 to mix the solution.

6. Repeat steps 4 and 5 for #3 – 6 measuring 10 mL each time. DO NOT add any solution to the control.

NOTE: The total remaining solution in each test tube is 90 mL; #6 will have a volume of 100 mL. If the solutions will not be used until the next class period, cover them with parafilm or plastic wrap.

Part 2: Set Up Dose/Response Assay

1. Treat the lettuce or radish seeds in a 10 percent bleach solution for 20 minutes, then rinse 5 times with deionized or distilled water to kill fungi or bacteria that can interfere with seed germination.

2. In each of the seven petri dishes, place a piece of filter paper cut to fit the dish. Label the dishes according to the identity of the chemical being tested and its concentration. *Note: Absorbent paper towels or coffee filters can be substituted for the filter paper – avoid bleached products as they may contain chlorine or dyes that can interfere with the experiment.*

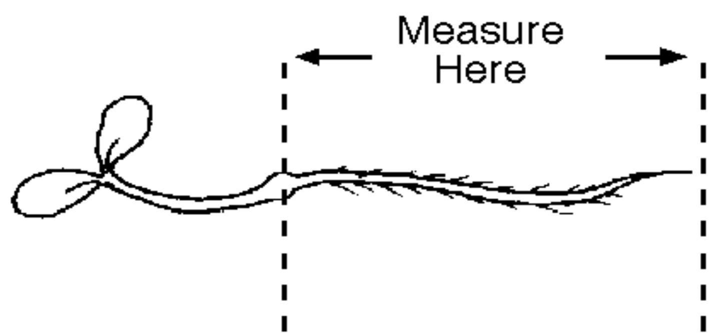
3. To each petri dish, add 2 mL of the appropriate test solution. In the control dish, use 2 mL deionized or distilled water (whichever was used to prepare the solutions).

4. To each dish, use tweezers or a spatula tip to add five lettuce seeds. Space them out evenly on the filter paper so that they do not touch each other or the sides of the dish.

5. Place the lids on the dishes, and seal the edges with parafilm to retain moisture. If parafilm is not available, dishes can be placed in a sealed baggie. Incubate the seeds in the dark at constant temperature (preferably 24.5°C) for five days (120 hours).

Part 3: Measurements and Data Processing

After seeds have incubated in the dark for five days, count how many seeds in each dish have germinated, and measure the root length of each to the nearest millimeter using a ruler. Create a data table to record the results and any other important observations. Use a paper towel to *gently* blot the seedlings dry prior to measurement. Look carefully at the plants to make sure you are measuring just the root, not the shoot as well (see Figure 1). Roots may curl so every effort should be made to straighten out the root for measurement without breaking it.



http://ei.cornell.edu/toxicology/bioassays/lettuce/data.asp

Factors to consider for the interpretation of results:

- Comparison of germination and root length data between the tested chemical and the control
- Comparison of control data across groups
- Identification of trends in germination and root length data
- Variability in the data
- Estimation of the TC_{50} for germination rate and root length

Data should be displayed in the lab report in both tabular and graphical formats.

Potential Questions for Students to Address:

These questions can be addressed during classroom discussion, student presentations or in lab reports.

- Which value TC_{50} value (germination rate or root length) showed a greater response to the chemical being tested? Which would you use in a bioassay to test environmental water samples for the chemical?

- For a given chemical, how did the TC_{50} values compare to the LD_{50} values from the SDS?
- Was the model used for the dose/response assay a good representation of an ecosystem? How could it be improved?

Resources:

Bleam, W., Cooper, S., Goode, R., McKinney, D., Pages, P., Sitzman, B., & Tempest, R. (2015, April). *April/May 2015 teacher's guide for Parabens: source of concern?* Retrieved from http://www.acs.org/content/acs/en/education/resources/highschool/chemmatters/teachers-guide.html

Bleam, W., Cooper, S., Goode, R., McKinney, D., Pages, P., Sitzman, B., & Tempest, R. (2014, December). *December 2014 teacher's guide for How toxic is toxic?* Retrieved from: http://www.acs.org/content/acs/en/education/resources/highschool/chemmatters/teachers-guide.html

Franzen, P. (1996, October 18). Investigating parts per million [newsletter]. Retrieved from http://ed.fnal.gov/trc_new/sciencelines_online/fall96/activities.html.

Gmurczyk, M. (2015). Parabens: source of concern? *ChemMatters, April/May 2015,* pages 8-9.

Rohrig, B. (2015). How toxic is toxic? *ChemMatters, December 2015/January 2015,* pages 5-7.

Satterfield, Z. (2004, Fall). What does ppm or ppb mean? On Tap, 38-40. Retrieved from http://www.nesc.wvu.edu/ontap.cfm.

SLS toxicology test. (2010). Retrieved from http://www.beyondbenign.org/K12education/middleschool.html

Trautmann, N.M., Carlsen, W.S., Krasny, M.E., & Cunningham, C.M. (2001). *Assessing toxic risk: Teacher edition.* Arlington, VA: NSTA Press.

Trautmann, N.M., Carlsen, W.S., Krasny, M.E., & Cunningham, C.M. (2001). *Assessing toxic risk: Student edition.* Arlington, VA: NSTA Press.

Extensions or Possible Student Projects:

- Allow students to conduct another bioassay using a chemical/substance of their choice or a different type of organism (such as *Daphnia,* see *Assessing toxic risk).* Students should submit proposals so that the teacher can approve their choices before they begin.
- Allow students to conduct another bioassay using the same organism and chemical, but using a narrower concentration range in order to better define the TC_{50} value.
- Obtain copies of the article *How Toxic is Toxic?* from *ChemMatters* for students to read and discuss. A free teacher's guide with activities is available.
- Obtain copies of the article *Parabens: Source of Concern?* from *ChemMatters* for students to read and discuss. A free teacher's guide with activities is available.

Lesson 4:

PPCPs in the Environment

INTRODUCTION

Pharmaceuticals affect the human body, but when these chemicals accumulate in lakes and rivers, aquatic wildlife are impacted as well. As chemicals amass in the environment, wildlife inadvertently consumes them and the effects of pharmaceuticals increase as they move up the food chain. People can make better choices that are not only healthy for them, but will also help prevent pharmaceuticals from ending up in the environment.

STUDENT OBECTIVES

1. Identify and describe the effects of pharmaceuticals that have shown to have adverse effects on aquatic wildlife.

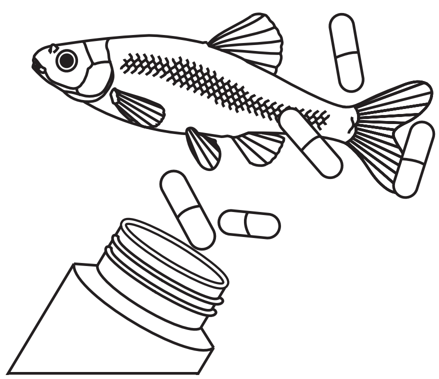
2. Use mathematical representations (graph) to support and revise explanations based on evidence about factors (estrogen) affecting biodiversity (lake populations) and populations (fathead minnows) in ecosystems of different scales (lab, natural water bodies).

3. Evaluate the claims, evidence, and reasoning in the statement that complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

4. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

DAILY ASSESSMENT

Students should be able to accurately graph the given information from A Real Life Small Fish Story Worksheet and be able to describe how the oestrone changed the physiology and survival of male fathead minnows. They should be able to distinguish controlled lab settings with uncontrolled natural environments and discuss possible complications of conducting experiments like this.



9-12 Grade | **45 Minutes**

Subjects:
Biochemistry,
Environmental science

Setting:
Home and Classroom

Pre-Homework:
Transfer information from the PPCP Worksheet **[Lesson 1]** to the PPCPs in the Environment worksheet.

Complete the unintended use column using the resources given as well as student research.

DSRP vocabulary

Materials:

- ☐ Graphing tools (electronic or hand)
- ☐ See materials section of Gummy Fish demonstration/lab (for flipped classroom.)

DSRP Vocabulary:

- ▹ Bioaccumulation
- ▹ Biomagnification
- ▹ Endocrine disruptors

STATE AND NATIONAL STANDARDS

COMMON CORE	NAAEE GUIDELINES	NGSS
Math: MP.2 MP.4	3.1 3.1.A 3.1.B 3.1.C 3.1.D	HS-ETS1-2 HS-ETS1-4

The Take-Away

Chemical changes to aquatic ecosystems can drastically affect the population of some species and may affect those who depend on those species.

*All instructions that begin with an * are found on the Illinois-Indiana Sea Grant Resource or YouTube page.* http://tinyurl.com/oyhlv9z

Conventional Classroom Procedure:

1. *Watch video on bioaccumulation vs. biomagnification (bioamplification) (1:22)
2. *Watch Endocrine Disruptors by Dr. Karen Kidd of the University of New Brunswick (28 minutes)
3. Break into lab groups and conduct either the Real Life Small Fish Story and/or the Gummy Fish demonstration/experiment.
4. Discuss the results, conclusions, and solutions in class or assign as a narrative for homework.

Flipped Classroom Procedure:

1. The **night before class**, have students watch/review.fill-in:
   a. *Watch video on bioaccumulation vs. biomagnification (bioamplification) (1:22)
   b. *Watch Endocrine Disruptors by Dr. Karen Kidd of the University of New Brunswick (28 minutes)
   c. *Read *As Pharmaceutical Use Soars, Drugs Taint Water and Wildlife* and *Two-headed salamander isn't radioactive, but is weird.*
2. In class:
   a. Discuss materials from the night before assignment.
   b. Graphing exercise: *A Real Life Small Fish Story*
   c. PPCPs and Gummy Fish lab
   d. Discuss results and create conclusions as well as solutions to the issue.

Resources:

<u>*Related Curriculum on Pollution:*</u>

*University of Illinois. (2011). Pollution solution. *Fresh and Salt*. pp. 136 – 162. (Curriculum)

University of Illinois. (2011). Where Do All the Toxins Go? (Internal View). COSEE's Greatest of the Great Lakes – A Medley of Model Lessons*. (IISG-07-02). pp. G111-130.

<u>*Research articles:*</u>

Daughton, C.G. (2 Dec 2006). *Environmental Life Cycle of Pharmaceuticals*, illustration, USEPA, NERL, Las Vegas, NV.

Daughton, C. G. (2012, 12). Comment on "Life Cycle Comparison of Environmental Emissions from Three Disposal Options for Unused Pharmaceuticals." *Environmental Science & Technology, 46*(15), 8519-8520. doi: 10.1021/es301975v.

Drury, B., Scott, J., Rosi-Marshall, E. J., & Kelly, J. J. (2013, 12). Triclosan Exposure Increases Triclosan Resistance and Influences Taxonomic Composition of Benthic Bacterial Communities. *Environmental Science & Technology*, 130725155410004. doi: 10.1021/es401919k.

Errata: Pharmaceuticals and Personal Care Products in the Environment: Agents of Subtle Change? (2000, 12). *Environmental Health Perspectives, 108*, 598. doi: 10.2307/3454551.

He, Y., Chen, W., Zheng, X., Wang, X., & Huang, X. (2013, 12). Fate and removal of typical pharmaceuticals and personal care products by three different treatment processes. *Science of The Total Environment, 447*, 248-254. doi: 10.1016/j.scitotenv.2013.01.009.

Huerta-Fontela, M., Galceran, M. T., & Ventura, F. (2011, 12). Occurrence and removal of pharmaceuticals and hormones through drinking water treatment. *Water Research, 45*(3), 1432-1442. doi: 10.1016/j.watres.2010.10.036.

Li, X., Zheng, W., & Kelly, W. R. (2013, 12). Occurrence and removal of pharmaceutical and hormone contaminants in rural wastewater treatment lagoons. *Science of The Total Environment, 445-446*, 22-28. doi: 10.1016/j.scitotenv.2012.12.035.

Lubliner, B, Redding, M., & Ragsdale, D. (January 2010). *Pharmaceuticals and Personal Care Products in Municipal Wastewater and Their Removal by Nutrient Treatment Technologies*. (State of Washington Publication No. 10-03-004).

Swan, G. E., Cuthbert, R., Quevedo, M., Green, R. E., Pain, D. J., Bartels, P., Wolter, K. (2006, 12). Toxicity of diclofenac to Gyps vultures. *Biology Letters, 2*(2), 279-282. doi: 10.1098/rsbl.2005.0425.

Thorpe, K., Benstead, R., Hutchinson, T., Cummings, R., & Tyler, C. (2003, 12). Reproductive effects of exposure to oestrone in the fathead minnow. *Fish Physiology and Biochemistry, 28*(1-4), 451-452. doi: 10.1023/B:FISH.0000030627.76841.ed

Zuccato, E. (2007, 12). Pharmaceuticals as Environmental Pollutants. *Drug Safety, 30*(10), 919-990. doi: 10.2165/00002018-200730100-00037

Lectures on pharmaceuticals impact on aquatic environments:

*Barber, L. (July 29, 2014) What are the Effects of Pharmaceuticals in Aquatic Ecosystems (51:38)

*Bennett, B. (July 29, 2014) Overview: How do Pharmaceuticals Enter the Environment? (13:10)

Extensions:

- As a demonstration for a public awareness event, students can replicate the gummy fish activity as a way to show others how chemicals can affect aquatic wildlife and the implications of our actions.
- Have students brainstorm on ways for wastewater treatment facilities to improve their filtration to address chemicals associated with PPCPs.
- Using information on states and facilities that have started treating wastewater for PPCPs, have students create projects on proactive systems, keeping associated costs and feasibility in consideration. Use the He, Huerta, Lubliner, and Li reports as a source. (Resources)

Name ________________________________ Block/Period________________

Pharmaceuticals and Personal Care Products in the Environment Worksheet

Name of PPCP	**Targeted Use**	**Unintended Use**
e.g. triclosan	Antibacterial agent found in soaps and other PCPs	Stops luminescence in some bacteria; toxic to algae

Summary of issue:

Examples of PPCPs Intended and Unintended Effects. (Teacher copy)

Nontarget species	**Compound**	**Intended use**	**Nontarget species effects**	**Source**
Fathead minnow	Oestrone (steroidal estrogen)	Replacement therapy in women and in vet med, increase animal growth rate	Male minnow mortality at 307ng/L and 781ng/L. Reduced egg spawn. Female sex characteristics in male spawn.	Thorpe, et.al.
Algae and bacteria	Tricolsan	Antibacterial found in soap, toothpaste, and other PCPs.	Stops luminescence in some bacteria; toxic to algae	Drury, et. al.
Daphnia	Acetaminophen	Analgesic/ anti-inflammatory	Immobilization	Daughton
	Verapamil	Cardiac drug		
	Propranolol	Beta-blocker		
	Diazepam	Psychiatric drug/ muscle relaxant		
Fish	17α-Ethinyl estradiol	Oral contraception	Female sex characterization in male fish	
Mussels	Fluoxetine (e.g. Prozac)	Antidepressant	Elicits significant spawning in males at 10^{-7} M and females at 10^{-6}M	
	Fluvoxamine (e.g. Luvox)		Elicits significant spawning in males at 10^{-9} M and females at 10^{-7}M	
Asian vultures	Diclofenac	Domestic livestock anti-inflammatory drug	Kidney failure (death)	Swan, et.al.

Real Life Small Fish Story (Teacher Information and Instructions)

As a relatively easy way to demonstrate the effects pharmaceuticals have on aquatic ecosystems, a small study was chosen so that students could plot and analyze the data. Overall, the effects of different pharmaceuticals are as varied as the pharmaceuticals themselves. References to other research are listed in the resources. If you have a preserved minnow specimen, it would be helpful as a visual aid to students.

Introduction: The fathead minnows are a popular baitfish and forage fish. According to the U.S. Geological Survey, its use has led to widespread introduction in waterways throughout the United States. A study by Thorpe, et.al tested the effects of a natural steroidal estrogen performed on fat-head minnows in a laboratory setting. Many other studies have witnessed that when estrogens are present in aquatic ecosystems they can affect male fish by changing their sex characteristics so that they develop into hermaphrodites and are able to produce eggs (Daughton, 1999).

Description: The U.S. Geological Survey describes fathead minnows as relatively small (75 to 102 mm) and having a body that is slightly laterally compressed and a head that is slightly flattened dorsally. The fish can reach maturity by age 2. Normal spawning begins when the water temperature is between 15-30^{o}C (59-86^{o}F) and generally peaks in natural waterways in July in the northern United States.

Pharmaceutical – Estrogen: According to Thorpe, et. al, the natural steroid, oestrone, is naturally present in wastewater treatment effluent in concentration between 10 and 20 ng/L in surface water. Estrogens can be found in many forms. Women produce it naturally. Cattle farmers use estrogen in combination with testosterone and progesterone to promote growth in cattle.

Thorpe, Benstead, et. al tested different strengths of the steroid to see how these levels impact physiology and population levels. An adaptation of that study (data approximated) has been created below. The results (in general) are approximately the same as the Thorpe study.

Six sets of six pairs of sexually mature fathead minnows were held in tanks and received clean, 25^{o}C water for 21 days (-21 to 0 days) with 16 hours of light and 8 hours of darkness. Scientists did this to test for compatibility between the pairs. One pair was kept as the control and the other five were given treatments of oestrone (scant, 34, 98, 307, and 781 ng/L) by adding it to flowing water. The following results were recorded (Table 1). Table 2 reveals the mortality results of the experiment. Observations can be made about that information as well.

Students should be able to graph the data given and make observations about the effects of oestrone on the fish. Their graphs should look like Graph 1.

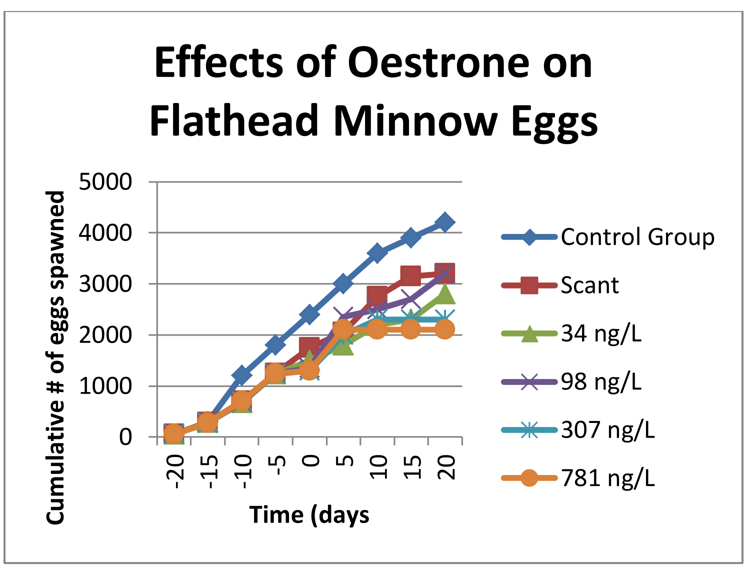
Table 1

Cumulative # of eggs spawned	Treatment amounts →	Control group	Scant oestrone	34 ng/L	98 ng/L	307 ng/L	781 ng/L
Time (days) ᐯ							
-20		50	50	50	50	50	50
-15		300	280	280	275	275	275
-10		1200	700	673	680	700	700
-5		1800	1250	1235	1245	1233	1250
0		2400	1750	1500	1350	1300	1300
5		3000	2050	1800	2350	2000	2100
10		3600	2750	2200	2500	2300	2100
15		3900	3150	2300	2700	2300	2100
20		4200	3200	2800	3200	2300	2100

Table 2

Concentration of oestrone	Male mortality after 20 days
Control	n=0
Scant	n=0
34 ng/L	n=0
98 ng/L	n=0
307 ng/L	n=2
781 ng/L	n=3

Graph 1



A Real Life Small Fish Story (Student Worksheet)

There are many studies on the effects of hormones on aquatic life. You have already viewed some research on this and have a general background.

For this activity, you are going to plot information on exposure of a natural steroidal estrogen, oestrone on fathead minnows.

Table 1 is from an experiment on fathead minnows conducted in a lab. Six sets of six pairs (36 minnows, 18 male, 18 female) of fathead minnows were held in controlled tanks. For the first 21 days, all of the fish were treated the same (25^{o}C of clean water, 16 hours of daylight and 8 hours of darkness). At day 0, oestrone was added to the experimental groups at the levels indicated. The temperature and photoperiod were maintained.

Instructions: Graph the information using tools available to you (e.g. Excel). Properly label the x and y axis. The graph should have the independent value on the x-axis. Properly name this graph at the top of this page. Table 2 will be addressed in the question section.

Table 1

Cumulative # of eggs spawned	Treatment amounts →	Control group	Scant oestrone	34 ng/L	98 ng/L	307 ng/L	781 ng/L
Time (days) ˅							
-20		50	50	50	50	50	50
-15		300	280	280	275	275	275
-10		1200	700	673	680	700	700
-5		1800	1250	1235	1245	1233	1250
0		2400	1750	1500	1350	1300	1300
5		3000	2050	1800	2350	2000	2100
10		3600	2750	2200	2500	2300	2100
15		3900	3150	2300	2700	2300	2100
20		4200	3200	2800	3200	2300	2100

Table 2

Concentration of oestrone	Male mortality after 20 days
Control	n=0
Scant	n=0
34 ng/L	n=0
98 ng/L	n=0
307 ng/L	n=2
781 ng/L	n=3

1. Describe the physiology of fathead minnows. List your source.
2. Describe in a narrative what happened in this experiment.
3. Why do you think the scientists used 36 fish?
4. What are general observations you can make about the graph?
5. What can you say about the control group?
6. At what level (ng/L) do you start to see the oestrone affect the spawn rate?
7. At what level (ng/L) do you see significant decline in spawn rate?
8. How do the increase levels of oestrone affect the spawning rate of the fathead minnows?
9. What are some possible explanations for this?
10. What do the results of *Table 2* say about the levels of oestrone for fathead minnows?
11. Do the effects on the minnows affect higher level aquatic wildlife? Defend your answer.
12. This lab was done in a controlled setting. Describe other factors that may affect the outcome of an experiment like this in different settings and scales of water.
13. What are some possible solutions to this issue (environmentally, engineering, personal change)?

PPCPs and Gummy Fish

A demonstration (or lab for flipped classrooms) can be conducted to show the effects of PPCPs on aquatic wildlife. Some of the results will seem obvious to your students, but by creating an "unknown mixture" of chemicals, you can demonstrate how detecting PPCPs isn't always easy because effluents of wastewater treatment plants do not release just one chemical, it's a mixture of many that may interact with each other.

Materials needed (for class lab, multiply by number of groups):
Note: The gummy fish must be as permeable as gummy bears. If you cannot find fish, you can substitute gummy bears, worms, or gumdrops or create fish out of molds and gelatin.

- 1 green (or red) gummy fish (female)
- 5 clear gummy fish (male)
- Food coloring (green, red, blue, yellow)
- Clean water
- Solutions of 1X green, 2X green, and 3X green (or red if using red fish)
- Solution of "Wastewater Effluent" (water with red, blue, green, and yellow food coloring to make brown)
- 5 clear cups
- Paper towel
- Plastic spoons

Instructions:

1. Before the demonstration, make:
    a. 1 – 1 drop green food coloring/25ml water solution
    b. 1 – 2 drop green food coloring/25ml water solution
    c. 1- 3 drop green food coloring/25ml water solution
    d. 1 – 2 drop each (red, green, and blue)/25ml water solution (wastewater effluent)

2. Put the wastewater effluent solution out of sight until the first part of the demonstration is complete.

3. Explain to the students that the green solution is estrogen. Pour 25 ml of each green solution into 3 clear cups and clean water into the fourth cup. Leave the fifth cup empty for now.
4. Set the green (female) gummy fish aside and place 1 white (male) gummy fish in each solution (clean, 1x green, 2x green, and 3x green).
5. Wait five minutes. During that time have students predict what will happen to the male fish in each solution.
6. After five minutes “fish” ☺ the males from the solutions and lay them next to each other in order of concentration. Have students make observations about the results.
    a. What can you say about color of each male fish?
    b. How does this compare to the female fish?
    c. Since this was estrogen, what can you say about the males’ sex characteristics (based on previous information).
7. Now bring out the “wastewater effluent” and add it to the fifth cup. Explain that wastewater effluent isn’t a simple one chemical output, but a mixture of many chemicals that the wastewater treatment plants are not designed to filter out. One of those chemicals is atrazine as discussed in the article Pesticide Atrazine Can Turn Male Frogs into Females.
8. Pour the solution into the fifth cup and place the last gummy fish in and let it sit for five minutes. While waiting, discuss the possible results of this mixture on aquatic wildlife.
9. Retrieve the male fish. Have students make observations.
10. Ask students what proactive environmentally thoughtful actions can people, industry, and doctors do to help minimize the problems associated with pharmaceuticals and personal care products? Use http://web.extension.illinois.edu/unusedmeds/reducewaste/index.cfm as a resource.

Lesson 5:

The Best of Intentions with Product Development

9-12 Grade

45 Minutes

Subjects:
Consumer economics, Environmental science

Setting:
Classroom

Pre-Homework:
DSRP vocabulary, review the PPCPs in the Environment Worksheet **[Lesson 4]**

INTRODUCTION

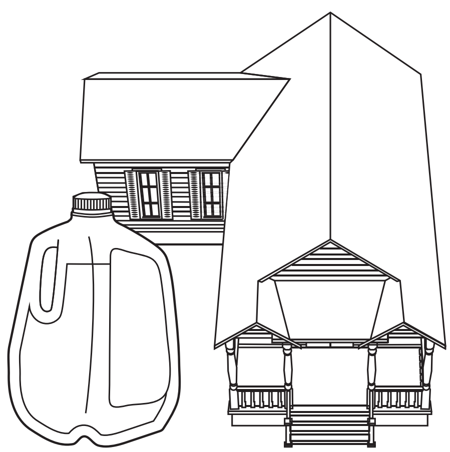
A well-designed product requires planning from "cradle to grave." Many products have unintended consequences, some good, some bad. The challenge for any developer is how to create a product that benefits the target audience without adversely affecting unintended populations. Developers must consider the trade-offs, and the answers are not always easy to determine.

STUDENT OBECTIVES

1. Consider the precautionary principle, life cycle assessment (LCA), and the unintended consequences of pharmaceuticals and prescription care products.
2. Analyze the issue's trade-offs from at least three perspectives.
3. Design a best-case solution that minimizes unintended impacts to the environment and is feasible for businesses and consumers.

DAILY ASSESSMENT

Students should participate in group conversations and debates to show that the ideas and concepts were internalized.



Materials:

- ☐ Internet Access (for research or instruction)
- ☑ Worksheet (PPCPs in the Environment) **[Lesson 4]**

DSRP Vocabulary:

- ▹ Life cycle assessment (LCA)
- ▹ Precautionary principle
- ▹ Unintended consequences

STATE AND NATIONAL STANDARDS

COMMON CORE

Literacy: RST.9-10.8, RST.11-12.7, RST.11-12.8

Math: MP.2, HSN.Q.A.1, HSN.Q.A.2, HSN.Q.A.3

NAAEE GUIDELINES

3.1
3.1.B
3.1.C

NGSS

HS-LS2-7
HS-ETS1-4

The Take-Away

Product developers have to be aware of LCA and possible unintended consequences when creating new products. The precautionary principle is a wise habit to implement.

*All instructions that begin with an * are found on the Illinois-Indiana Sea Grant Resource or YouTube Page* [*http://tinyurl.com/oyhlv9z*](http://tinyurl.com/oyhlv9z)

Conventional Classroom Procedure:

1. *Explain the precautionary principle, life cycle analysis, and unintended consequences. Use an example that is familiar to students. Students should familiarize themselves with the concepts presented on the video *resources 'This is Your Life Cycle' fun life cycle assessment & design* animation, Life *Cycle Assessment as part of Strategic Sustainability for Product Design*, *Tragedy of the Commons, Unintended consequences* (a Ted-Talks video), *What is the Precautionary Principle, and is it Good or Bad?, and The shocking cost of wasted prescription pills.*
2. Split students into three or six groups. Assign each group a concept (precautionary principle, life cycle analysis, unintended consequences). Have them discuss how their concept can be applied to the issue of pharmaceuticals and personal care products. They should take cost, safety, reliability, and aesthetics as well as social, cultural, and environmental impacts into account. They can use the Pharmaceuticals and Personal Care Products in the Environment Worksheet as examples of products to focus on for their concept. They should write down their ideas using the worksheet provided.
3. Once the groups have presented their view, other groups should constructively critique each view for possible holes in the arguments, consideration of the perspectives of other stakeholders, and contradictory data based on experience and research. The goal of the debate is to strengthen the original view and prepare students to defend their views.
4. If there is time, have students apply these critiques to strengthen their argument.

Flipped Classroom Procedure:

1. The **night before class**, students should:
   a. Review their Pharmaceuticals and Personal Care Products in the Environment Worksheet from Lesson 4.
   b. *Familiarize themselves with the concepts presented on the video *resources 'This is Your Life Cycle' fun life cycle assessment & design* animation, Life *Cycle Assessment as part of Strategic Sustainability for Product Design*, *Tragedy of the Commons, Unintended consequences* (a Ted-Talks video), *What is the Precautionary Principle, and is it Good or Bad?, and The shocking cost of wasted prescription pills*
   c. Complete DSRP vocabulary.
2. In class:
   a. Review the precautionary principle, life cycle analysis, and unintended consequences.
   b. Discuss real life application of each concept.
   c. Split students into three or six groups. Assign each group a concept (precautionary principle, life cycle analysis, unintended consequences). Have them discuss how their concept can be applied to the issue of pharmaceuticals and personal care products. They can use the Pharmaceuticals and Personal Care Products in the Environment Worksheet as examples of products to focus on for their concept. They should use the worksheet provided to write down their ideas.

    d. Once the students have presented their view, other groups should constructively critique each view for possible holes in arguments, perspectives of other stakeholders, and data that contradict their view based on experience and research. The goal of the debate is to strengthen the original view and prepare students to defend their views.
3. If there is time, have students apply these critiques to strengthen their argument.

Literature References:

Daughton, Christian G., and Ilene Sue Ruhoy. "Lower-dose Prescribing: Minimizing 'Side Effects' of Pharmaceuticals on Society and the Environment." *Science of The Total Environment* 443 (2013): 324-37.

Wu, Mae, and Sarah Janssen. "Dosed Without Prescription: A Framework for Preventing Pharmaceutical Contamination of Our Nation's Drinking Water." *Environmental Science & Technology* 45.2 (2011): 366-67.

Extensions:

- Have students create a survey to assess environmental habits before and after the students educate on the topic. Take that information to create a PSA on how the school is positively impacting people's attitudes on the topic.
- Debate who is responsible for the cost of extensive testing of products to ensure safety. Google and review *The Precautionary Principle and New Technologies and Products* (Good video, but requires a subscription after about three minutes of viewing.)
- Create a talk show program on PPCPs and put it on a public YouTube channel and share it with Illinois-Indiana Sea Grant to then use on our Sea Grant Education YouTube page.
- Students can explore the types of careers that are involved in PPCP development and research.

Careers related to Pharmaceuticals and Personal Care Products

This is just a short listing.

1. Product Researcher
2. Manufacturer
3. Sale person
4. Pharmacist
5. Chemist
6. Biotech engineer
7. Product tester and developer
8. Environmental science researcher

Student Handout

Name _______________________________Block/Period____________

Precautionary Principle, Life Cycle Analysis and Unintended Consequences

Our group was assigned____

How can ____________________________________ be applied to pharmaceuticals and personal care products?

What helpful points did other groups make about your topic that will help you strengthen your argument?

What helpful points did you make to other groups to help strengthen their argument?

Lesson 6:

A Look Back - Historical Pharmaceuticals

9-12 Grade

45 Minutes

Subjects:
History, Biochemistry

Setting:
Classroom

Pre-Homework:
Review lesson 2: What happens to PPCPs?

INTRODUCTION

What did people do for medicinal needs and personal care products at the turn of the twentieth century? Thanks to archaeologists at the Illinois State Archaeology Survey and other sources, many of those questions have been answered. There are some interesting and sometimes scary treatments for common ailments that are easily treated today.

STUDENT OBECTIVES

1. Conduct a serial dilution to prepare solutions of a chemical over a range of concentrations.

2. Conduct a dose/response experiment with the solutions prepared in the serial dilution to determine the chemical's toxicity to lettuce or radish seeds.

3. Work collaboratively to conduct the experiment, analyze data, and interpret results. Document their work by writing a lab report.

DAILY ASSESSMENT

Students should be able to compare and contrast the structure of excrement disposal systems in the 1800s and today and how those systems are used. They should be able to describe possible life scenarios for the items found in the privies. They should be able to describe the differences in chemicals used to treat diseases in the 1800s and the problems that exist with using those chemicals.

Materials:

- ❐ Internet Access
- ❐ Copies of pharmaceutical advertisements cut, and possibly laminated
- ❐ Medicine bottles or boxes for current pharmaceuticals used to treat the same illnesses that are advertised on the worksheet. (Compare and contrast)
- ❐ Copies of the worksheets.

DSRP Vocabulary:

- ▹ Alchemy
- ▹ Apothecary
- ▹ Cure-all
- ▹ Privy (noun)

STATE AND NATIONAL STANDARDS

COMMON CORE

Literacy: RST.11-12.7
RST.11-12.8
RST.11-12.9

Math: MP.2
MP.4

NAAEE GUIDELINES

3.1.A
3.1.B
3.1.C
3.1.D
3.2.D
4.A

NGSS

HS-ETS1-1
HS-ETS1-3

The Take-Away

Outdoor privies provide a look into the history of people of the 1800s. Pharmaceuticals of the past had very little regulation

*All instructions that begin with an * are found on the Illinois-Indiana Sea Grant Resource or YouTube Page http://tinyurl.com/oyhlv9z*

Conventional Classroom Procedure:

1. *The **night before**, have students review the lesson on wastewater treatment (as a frame of reference). Then have students read the Student Background Reading and answer the questions associated with the reading. They can also check out the interview with Dr. Dappert on the Illinois Indiana Sea Grant Education YouTube Channel.
2. In class, give students one of the advertisements provided on the teacher sheet for Cure-alls and Quackery and have them answer questions associated with those advertisements. Discuss how cure-alls and pharmaceuticals were advertised and used in the 1800s and compare those uses to what we now know about those ingredients. Also discuss how much information was and was not provided to the purchasers of pharmaceuticals. Then discuss the history of product regulation and how products are regulated today. Weigh the benefits and challenges with today's regulations. (See reference in the resource section)
3. Place students in groups, and have them complete the *What's in that Privy?* worksheet. Discuss based on the questions posed on the page.

Flipped Classroom Procedure:

1. The **night before**, have students review the wastewater treatment lesson (as a frame of reference). Then have students read the Student Background Reading and answer questions associated with the reading. Also, give students one of the advertisements provided on the teacher sheet for Cure-alls and Quackery and have them answer questions associated with those advertisements. They can also check out our interview with Dr. Clare Dappert on the Illinois-Indiana Sea Grant YouTube Education Channel.
2. In class**,** discuss how cure-alls and pharmaceuticals were advertised and used in the 1800s and compare those uses to what we know about those ingredients. Also discuss how much information was or was not given to the purchasers of pharmaceuticals. Then discuss the history of regulation of these products and how products are regulated today. Weigh the benefits and challenges with today's regulations. (See reference in the resource section.)
3. Place students in groups, and have them complete the *What's in that Privy?* worksheet. Discuss based on the questions posed on the page.
4. If time allows, have students choose one ailment and create a comparison sheet (or poster) for treatments in the 1800s and today.

Resources:

9 Terrifying Medical Treatments from 1900 and Their Safer Modern Versions
http://mentalfloss.com/article/57983/9-terrifying-medical-treatments-1900-and-their-safer-modern-versions

How FDA Evaluates Regulated Products: Drugs
http://www.fda.gov/AboutFDA/Transparency/Basics/ucm269834.htm

Medicine in the 20th century
http://www.britannica.com/EBchecked/topic/372460/history-of-medicine/35667/Medicine-in-the-20th-century

Museum of the Royal Pharmaceutical Society: *How did people treat illness in the early 20th century?*
https://www.rpharms.com/museum-pdfs/pharmacy-information-and-enquiry-sheets.pdf

Privy digging http://en.wikipedia.org/wiki/Privy_digging

Welcome to the David Davis Mansion http://daviddavismansion.org/

Extensions:

- Create a presentation comparing and contrasting historical medicinal methods with modern day medicine with regards to recommendations for improved health.
- Create a mock privy dig site with artifacts that can be found in them as a way to show how outhouses were used as trash receptacles.
- Create a presentation on the history of pharmaceutical regulations.

Student Background Reading

The following information and pictures were provided by Dr. Clare Dappert, historical archaeologist from the Illinois State Archaeological Survey (http://www.isas.illinois.edu/staff/cdappert.shtml). Dr. Dappert, and her colleagues have been investigating a site in East St. Louis that was discovered when the Illinois Department of Transportation wanted to build a bridge relocating Interstate 70 http://www.academia.edu/1804719/The_New_Mississippi_River_Bridge_East_St_Louis_AD_1000-1200.

Around the turn of the 20th century, a massive range of proprietary and patent medicines were marketed to 'cure' a wide range of ailments from dropsy to consumption, headaches, and indigestion. Due to a lack of drug regulation, anything could be bottled, advertised, and sold as a medicine. Proprietary medicines were available without a prescription. While some remedies may have worked, many proprietary medicines provided no relief, except perhaps psychological. Others contained addictive and dangerous ingredients such as cocaine and opium, both of which were addictive, which, of course, could lead to increased sales. Almost all contained alcohol as a preservative. Though the individual medicines make claims to cure some primary ailment, in some cases a slew more, there is a possibility that the people of the time could have been using multiple medicines to treat a single illness.

The dubious claims of proprietary medicines began to be revealed in 1905, when Samuel Hopkins Adams published a series of 10 articles entitled 'The Great American Fraud." Adams condemned patent medicine manufactures for their deceitful practices in labeling and the use of addictive drugs. Federal investigations subsequently intensified, resulting in the passing of the Pure Food and Drug Act of 1906. This law was one of several succeeding ones that provided improved protection against bad food and drugs. As a result of these reforms, drug companies were required to list the amount of alcohol and dangerous drugs in the products.

Despite the Act of 1906, products were still advertised as 'cures'. In 1911 the American Medical Association published its findings about various proprietary medicines in a book entitled Nostrums and Quackery. The revelations in this book led to the passing of the Sherley Amendment in 1912, which prohibited any false and fraudulent curative or therapeutic claim on labels. In other words, companies were not allowed to use the word 'cure' unless they could prove that their product provided a cure. Subsequent laws in 1951, 1962, and 2004 added further protection for consumers, though even today there are still useless products on the market.

Questions on Background Reading

1. What surprised you most about the information Dr. Dappert shared?

2. Are there products that you have seen in the store that you suspect are not true to their claims?

3. Do you think there should be tighter restrictions on products and their claims? Why or why not?

4. Why do you think there are still companies that make false claims about what their product(s) do?

Name ______________________________Block/Period___________

What's in that Privy?

A privy, when used as a noun, is synonymous with the word "outhouse." Privies were commonly used before indoor plumbing was available. According to the Illinois State Archaeological Survey, privies were not only a way to dispose of human waste, but also used as a trash receptacle. For instance, if a woman wanted a new set of dishes, she might dispose of her current dishware by dropping them into the privy. Archaeologists and antique enthusiasts have excavated old privy sites to find evidence of socio-economic status, health, and habits of the time period.

So, it's your turn to be a budding archaeologist.

Below is a list of items found in five privies. What can you say about the people who used that privy based on what is listed? Create a story about the owners based on the items found.

Privy A	Privy B	Privy C	Privy D	Privy E
Ceramic bird feeder	Rubber doll	Porcelain dolls with moving eyes	Embalming fluid	China dishes
Glass Tear Catcher	Breast pump	Glass crucifix	Chemistry set	Hypodermic needles
Glass cosmetic jars	Dog skeletons	Gargoyle figurine	Leather dog collar	Medicine bottles (n=94)
Cigar jar	Rubber syringes	Shot glass	Toy tea pot/cup	Perfume bottles
Brass flower brooch	Chamber pot	Decorated glass goblets	Glass soda bottles	Whiskey bottles
Decorated serve ware	Plain serve ware	Glass wine bottle	Bulk perfume bottles	Jars of ointment/cream

- Compare and contrast indoor toilet systems and wastewater treatment systems of today to those of outdoor, primitive privies of the 1800s.

- Discuss where leftover medications (if discarded before being fully consumed) would possibly leach to if not properly disposed of or if the glass container broke.

- Discuss the story your group created for the owners of each privy compared to the story archaeologists have about them. Any surprises? How accurate were you? Does privy excavating sound like an activity you would enjoy? Why or why not?

Teacher Page:

After students have made conclusions, have them read their conclusions aloud. Once everyone has given their assessments, hand them the information about the privies to see how close their predictions were to the real story.

Background to What's in That Privy? (Information provided by Dr. Clare Dappert and Mrs. Eve Hargrave, Illinois State Archaeology Survey)

Privy A: Lizzie Benner owned 819 Bowman Ave. for almost 30 years. Lizzie's husband John died during the 1890s, leaving her to care for their young daughter Victoria. Lizzie occasionally took in boarders and rented out part of her property.

A birdfeeder was recovered from a privy at 819 Bowman Ave. This birdfeeder was a Redware ceramic with a lead-glazed interior. It had a small handle on the rim, which was there to attach the feeder to a birdcage. The birdfeeder was small, and likely appropriate for a bird such as a canary or sparrow. The bird may have provided an aesthetically pleasing addition to the home, while also potentially providing companionship. The bird probably belonged to Lizzie Benner and her daughter, although it is possible that one of the boarders bought it with them. The birdfeeder might have been discarded after the bird died.

One memento recovered at 819 Bowman Ave. is what researches believe to be a tear catcher. These small bottles would be used in Victorian mourning rituals to quantify the importance of the deceased. Once filled, the containers were sealed with a special stopper that allowed the tears to evaporate. The completion of the evaporation process signified an end of the mourning period. This tear catcher was recovered in a privy, dating to around 1905. Lizzie likely filled the heavily decorated vial after John died, and then carried it around with her. Even though it appears to be broken at one end, the tear catcher was likely accidently discarded. It's likely that the tear catcher fell into the privy without Lizzie noticing. Lizzie never remarried after her husband died.

A brass brooch depicting a small flower probably belonged to either Lizzie or Victoria. The brooch might have been partially functional in addition to being decorative; it could have been used to keep cloaks or scarves secured. Jewelry wasn't something that everyone could afford, but Lizzie's inheritance and money from renters would have made this purchase easier.

Lizzie set her table with decorated glass and ceramic dishes. She had several different types of serving ware, allowing her to set her table formally during holidays or when guests were visiting.

Privy B: 823/825 St. Clair Ave. was a boarding house from 1890 to at least 1920. It operated under a variety of names throughout the years, but was consistently providing housing to low- income single male laborers.

A rubber doll was found at 823/825 St. Clair Ave., though there is no record of children ever living in the home. It was likely around seven inches long. Such rubber dolls marketed around the turn of the century were described in the Sears Roebuck catalog as “Musical Gray Rubber Dolls,” perhaps playing a short tune or a “Ma-ma” sound when squeezed. They were advertised as, “Something the children can’t break.” The boarding house also had nine porcelain or bisque dolls, represented by legs, broken heads, and arms. These parts would have been attached to a soft, fabric body. These dolls were soft, durable, and rather easily fixed if a part was broken. These dolls show that children were regular visitors at the boarding house.

A breast pump was found in a privy dating to 1905 in the rear of 823 St Clair Ave. While there were four women living there during 1893, typically the occupants were all men until 1905 when three of the male boarders were listed as living with their wives. Potentially, one of these women was using the breast pump, although, again, there are no children listed as living there. It’s possible that one of these women was working outside the home to supplement her husband’s income, and pumped her breast milk to allow one of the other two women to take care of her child. Or it’s possible that the child could not nurse, and the mother did not want to supplement their diet with animal milk or formula.

The breast pump recovered looks rather similar to the English Breast Pump advertised in the 1897 Sears Roebuck catalog. They were relatively cheap, at 18 cents apiece or a dozen for $1.75. In comparison, even the cheapest and smallest bottle of infant formula from the same year was 20 cents apiece. Formula would have been a recurring cost; a breast pump could have been more affordable.

Two dogs were found in the privies at 823/825 St. Clair Ave. One was a large adult dog, and the other was a young, small dog. None of the remains display butchery marks or evidence of pathology or trauma. The dogs likely represent household animals or pets, discarded in the privy after they died. They might have belonged to specific boarders, or they could have been owned and cared for by the residents as a group.

Eight hard rubber syringes were recovered from the boarding house at 823 N. Second St., in a privy dating to around 1893. Attempting to maintain cleanliness and good health at the end of the 19th century was often a very difficult and dangerous task, especially when dealing with genital uncleanliness and disease. To maintain cleanliness, both men and women used rubber syringes to treat infections and occasionally to clean discharges from orifices. At this time, the boarding house was still primarily male, although there were four female residents. Both penile and vaginal syringes were recovered, indicating that at least two residents required their use. It’s possible that two residents used the syringes regularly, although it’s more likely that multiple residents used them. Hard rubber syringes were available in multiple sizes and styles, for both men and women, and adults and infants.

The boarding house used very plain, thick ceramic serve ware. The cost of boarding would have included food, which was served at one time to all the residents. By using this sturdy serve ware, the boarding house probably spent less on replacing them.

The boarding house manager was responsible for providing toilet accommodations. While residents had a privy at the back of the lot, chamber pots were used when it was too cold or dark to go outside, or if the resident was too ill or tired to go outside. The boarding house manager would have been responsible for cleaning out the chamber pots into the privy every day.

Privy C: Six bisque ceramic doll heads were recovered from a privy at 131 St. Clair Ave. The dolls are in various states of repair, ranging from almost entirely intact, to being essentially smashed. Uniquely, a pair of glass doll eyes were recovered with them. While the doll eyes were made of thin, fragile glass, this pair was recovered unharmed. Glass eyes such as these were moveable and appeared slightly more lifelike. Dolls with moveable eyes were more expensive and less durable than dolls with fixed parts. The first young children recorded as living at or near 131 St. Clair show up in the 1900 census, although it's possible that they were there earlier. The Walker children were the most probable owners of these dolls. In 1900 the Walker family had four children: Frank, George, Alice Maude, and Mary. Alice was three in 1900, and Mary was five months old. If the Walker children owned these dolls, they most likely belonged to Alice. While it's possible that Alice was merely careless with her toys, it's also possible that she broke them in a temper tantrum, possibly even in reaction to her little sister being born.

Other possible owners of the dolls at 131 St. Clair include the Brearton sisters. While all three of them were over 20 in 1900, it's possible that these were childhood dolls that they hung on to as they reached adulthood. If this was the case, the dolls might have been discarded after accidental breakage, or when the sisters felt they had outgrown them.

One of these families owned a few decorative items. These included a glass crucifix that could hold a candle, indicating that either family might be Christian. The crucifix was probably expensive, and held important religious status to that household. The crucifix would have only been discarded after breaking. The other figurine, a ceramic gargoyle, might have simply been a decorative wall hanging or it might have fit into their religious or spiritual beliefs. Gargoyles were originally used as symbols, to encourage believers to be vigilant against the devil's workings.

Both the Walkers and the Breartons likely consumed wine and liquor. Decorative wine and shot glasses show a more than casual interest in serving alcohol. These dishes were acceptable to serve liquor to guests or mix drinks. The presence of wine and liquor bottles was also confirmed.

Privy D: Several bottles and artifacts associated with embalming were recovered from 1106 N. 7th St., including an intact embalming fluid bottle from the Dr. G. H. Michel and Co. This particular fluid was developed to embalm bodies in extreme heat. It's still in production today due to its ability to preserve delicate skin textures, especially in infants and children (http://www.ghmichel.com/product.php). It's possible then, that the family member that was prepared for burial at 1106 N. 7th St. was a child. During

1900, the Dauchette family was living at 1106 N. 7th St. The mother, Verinico, had given birth to 12 children by 1900, but only eight were still living. Other embalming-related items include something that appeared to be a chemistry set. The glass vials, tubes, and measuring devices may have also been useful while preparing a body for burial. While funeral parlors and church funerals were gaining more popularity at the beginning of the 20th century, some more traditional families believed that life began and ended in the home. Both the embalming and wake for family members occurred at the home. It's possible that the family was preparing one of their own or that they were providing the service to other families in an unofficial capacity.

Several bulk size perfume bottles were recovered from 1106 N. 7th St. These perfume bottles could have been used by female residents to mask body odor. They could have also been used by the embalmer to cover the smell of decomposition, or to protect their senses while they were preparing the bodies. While embalming probably prevented further decomposition, at least until the bodies were buried, smell still would have been a concern in the home.

Naturally, the home wasn't just for preparing bodies. Life continued on rather normally otherwise. The children of the Dauchette family had a toy tea set to play with, represented by a matching teapot and cup. A leather dog collar indicates that the family likely kept a dog as a pet, although it appears that the dog died after the family moved away. The Dauchette family clearly enjoyed soda. Almost 20 bottles were recovered from this lot. Even though the Dauchette family probably suffered personal loss, and prepared bodies for burial, they were still a typical family.

Privy E:

This privy was located at the David Davis Mansion (constructed 1870-1872) in Bloomington, Illinois (http://daviddavismansion.org/). Mr. Davis was a judge who was a friend of Abraham Lincoln. He was influential to the legal and political career of the future president. He owned the most land (2700 acres) in Illinois and his estate was valued at $4-5 million at the time of his death in 1886. It is thought that he may have had diabetes later in life. The artifacts were uncovered when the two (male and female) privy vaults associated with the mansion were cleaned out by construction workers. Further research on the items found was conducted in 1989-90. Further information about the family is provided by Floyd Mansberger and Daniel Warren in a research report to the Illinois Historic Preservation Agency in 1900.

The PDF of that report can be found at the end of this lesson.

Student Handout

Name ________________________________Block/Period____________

Cure-alls and Quackery

As you have read, claims of tonics curing whatever ails you were everywhere and there were no regulations on products. Compare examples of "pharmaceuticals" found in the East St. Louis area to those of modern day pharmaceuticals.

Instructions:

1. Your teacher will hand you one of several advertisements from the turn of the 20^{th} century.
2. Discuss with your group the claim being made.

    a. What does the product claim to do, if anything?

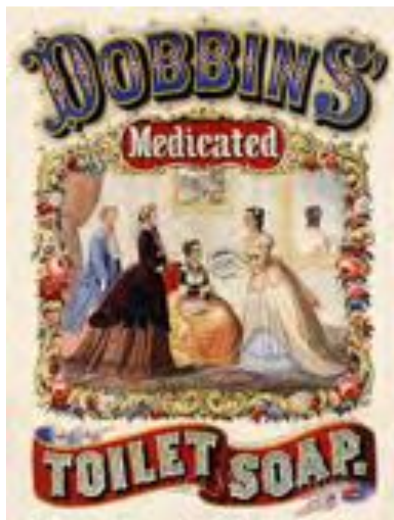
    b. What are your thoughts on the artwork/pictures?

    c. What do you know about the ingredients of the product?

    d. What information is missing from the advertisement?

3. How are products for these ailments different now? Look (at home or on the internet) for pharmaceuticals for the same ailments. Compare and contrast the advertising, and known ingredients.

Instruction to teachers: Print and cut out these advertisements to use with the Cure-alls and Quackery worksheet and the student reading.



Lesson 7:

More in Common - Veterinary Medications

9-12 Grade | *45 Minutes*

Subjects:
Consumer science,
Environmental science

Setting:
Home and Classroom

Pre-Homework:
Look for common medications in your household

INTRODUCTION

Did you know that many medications that people use are also used on animals? In this lesson you will investigate commonly used medications and determine whether or not they are given to both humans and animals. The proper disposal of all of these medications is important to decrease contamination of water supplies.

STUDENT OBECTIVES

1. Explain, based on research, the fact that many of our pets take the same pharmaceutical medications we do.
2. Learn how to use a Venn diagram.
3. Understand why it is important to properly dispose of animal feces.

DAILY ASSESSMENT

Students should have a clear understanding that pets may be able to take some of the same pharmaceuticals as humans, but that is important to know which ones are safe for pets and in what dosage.

Materials:

- ☐ Internet Access (for research)
- ☑ Worksheet (More in Common: Medication Worksheet) **[Included]**
- ☑ Worksheet (More in Common: Venn Diagram Worksheet) **[Included]**
- ☑ More in Common: Pharmaceutical List **[Included]**

DSRP Vocabulary:

- Antiparasitic
- Dosage
- Endocrine
- Venn diagram

STATE AND NATIONAL STANDARDS

COMMON CORE

Literacy: RST.9-10.8, RST.11-12.7, RST.11-12.8

Math: MP.2, HSN.Q.A.1, HSN.Q.A.2, HSN.Q.A.3

NAAEE GUIDELINES

3.1
3.1.B
3.1.C

NGSS

HS-LS2-7
HS-ETS1-4

The Take-Away

Proper disposal of medications given to pets is important. Also, picking up dog feces is significant to our ecosystem and wellbeing.

Conventional Classroom Procedure:

1. *The **night before class**, students should review the webpage How to Dispose of Unwanted Medicine and Personal Care Products Research and Resources.
2. Split up students into research groups (2-4 students).
3. Have students investigate either the information needed to complete the Venn diagram or medication worksheets
4. Based on information gathered from the internet on PPCP ingredients, student groups should summarize the issue in 1-4 sentences.

Flipped Classroom: Procedure:

1. The **night before class**, students should:
    a. Fill in the Venn diagram or medication worksheet
    b. Watch How to Dispose of Unwanted Medicine and Personal Care Products Research and Resources
2. In class:
    a. Discuss any surprises that students experienced while filling out the More in Common worksheets.
    b. Discuss potential changes they would make as a result of what they found.
    c. Break students into groups to reflect on what extensions (stewardship projects) could be created from what they have learned. Share those discussions.

Resources for Research:

- How to Dispose of Unwanted Medicine and Personal Care Products Research and Resources webpage.

Extension:

Have students discover what pharmaceuticals they have in their household and discuss proper disposal with their guardians.

Name ____________________________________ Block/Period__________________

More in Common: Pharmaceutical list

Choose a medication from the list to research and determine if it is for human or animal use or both and place it in the correct place on the Venn diagram provided.

TYLENOL

PYRANTEL PAMOATE

TAPAZOLE

PENICILLIN

BAYER

ASPRIN

INSULIN

ALEVE

ADDERALL

TRAMADOL

TAMIFLU

FENBENDAZOLE

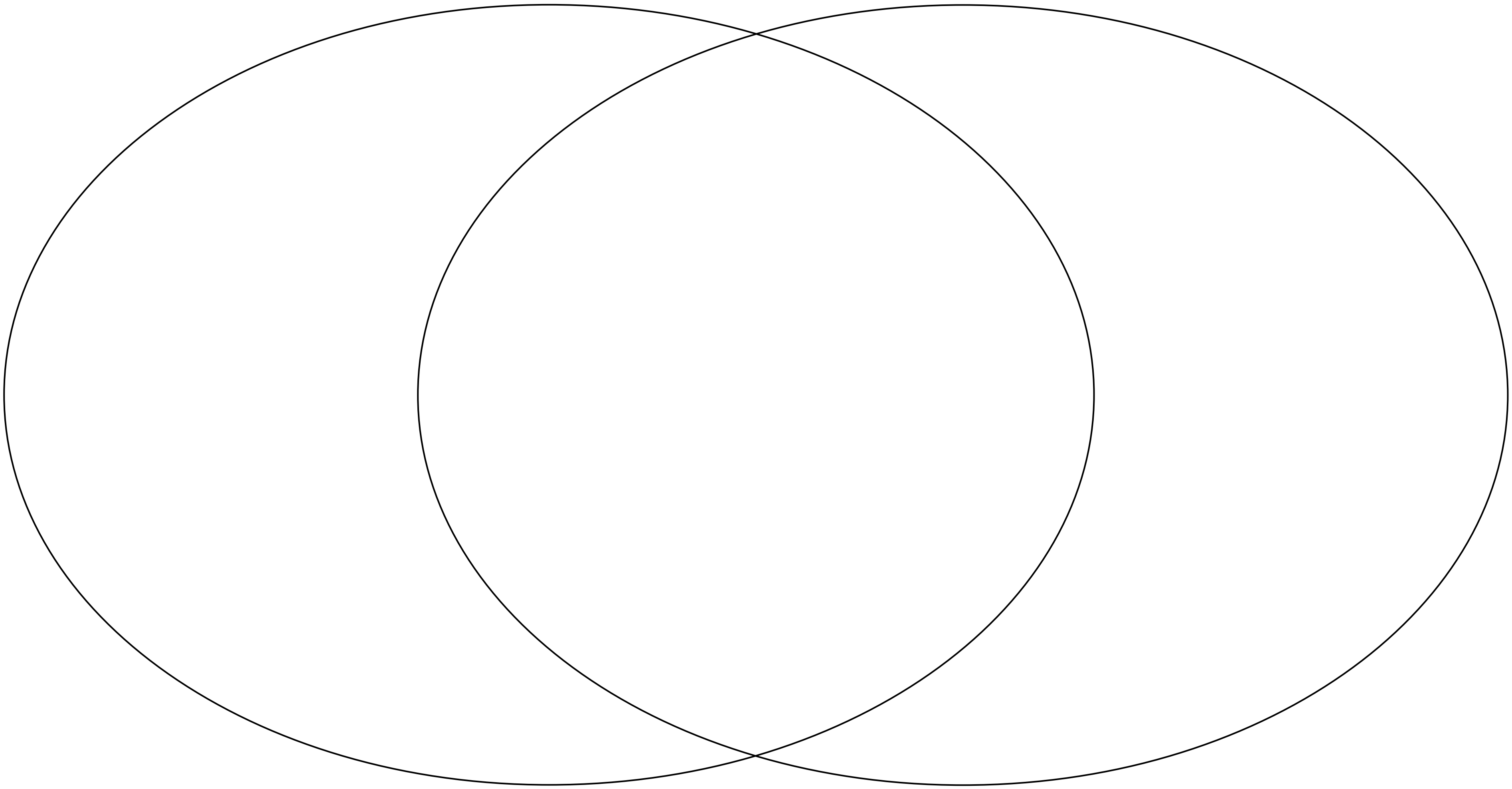
LEVOTHYROXINE

AMOXICILLIN

Name ________________________ **Block/Period**______________

More in Common: Venn Diagram Worksheet

Look at the list of medications and research at least six to determine if they are only for human or animal consumption or can be taken by both.



CATS AND DOGS **HUMAN**

Name ________________________________ **Block/Period**________________

More in Common: Medication Worksheet

Choose two types of medication and think of or research a common name for each, then determine if they are for human or animal use, or both. What is the best way to properly dispose of each?

FUNCTION	ANTIBIOTIC	ENDOCRINE REGU-LATOR	STEROID	ANTIPARASITIC	PAIN MEDICATION
COMMON PHARMA-CEUTICAL NAME					
HUMAN USE					
ANIMAL USE					
PROPER DISPOSAL					

Essay Test

Name___________________________________

Period/Block ______________________________

The Big Picture on Pharmaceuticals and Personal Care Products

For each of the questions, give thoughtful and complete responses using the information you obtained from this unit. Points will be assigned based on the thoroughness of your response.

1. Objectively describe PPCPs and issues related to their use.
2. How are PPCPs how have PPCPs changed over time? Give examples.
3. Give an example of how PPCPs are viewed from three different perspectives.
4. What are some possible solutions to the issue? Give two examples.
5. Who is an “Agent of Change” for this issue? Why?

The Big Picture on Pharmaceuticals and Personal Care Products

Assign points as you see best for this assessment

For each of the questions, give thoughtful and complete responses using the information you obtained from this unit.

1. Objectively describe PPCPs and issues related to their use.
   Students should describe:
   - The acronym PPCP
   - What they include
   - Issues:
     - Over prescribing by doctors
     - People flushing unwanted medications
     - Wastewater treatment inadequacies
     - Some possible effects of PPCPs on aquatic wildlife
2. How have PPCPs changed over time? Has anything remained the same? Give examples.
   - Medications were derived mainly from local botanicals
   - Many recommendations for improved health (exercise, eating right) haven't changed
3. Give an example of how PPCPs are possibly viewed from three different perspectives.
   - Doctors
   - Patients
   - Wildlife and aquatic biologists
   - Pharmaceutical companies
   - Wastewater treatment managers
4. What are some possible solutions to the issue? Give two examples.
   - Minimizing the number of prescriptions (if possible) through improved health
   - Properly disposing of unwanted medications
   - Equipping wastewater treatment plants with improved filtering methods
   - Pharmaceutical companies coming up with medications that are better absorbed in the body and reduce excretion

5. Who is an "Agent of Change" for this issue? Why?
   - Doctors: prescribing only as needed, minimizing wasteful prescribing
   - Patients: Refusing samples and any medication that is unnecessary.
   - Pharmaceutical companies: Creating more efficient medicines
   - #1 Agent of Change = YOU! (Education and advocacy for better choices)

Agents of Change on Pharmaceuticals in Waterways Presentation

Name: ____

Group Project Rubric

Category	(4) Excellent	(3) Good	(2) Almost	(1) Not Yet
Layout/Design	The presentation is exceptionally attractive and well organized.	The presentation is attractive and well organized.	The presentation is well organized.	The presentation's is confusing in its organization and care was not taken in preparing it.
Writing /Speaking Mechanics	The presentation is written (and spoken) in complete, well composed sentences. Attention to grammar, capitalization, and punctuation are apparent. The presenter(s) spoke with ease and was knowledgeable on their topic.	Most of the writing is done in complete sentences. Most of the grammar, punctuation, and capitalization are correct throughout. The presenter(s) spoke with few mistakes and were mostly at ease.	Some of the writing is done in complete sentences with punctuation, capitalization, and grammar somewhat complete. The presenter(s) would have benefited from more time spent on practicing and becoming experts on their topic.	Most of the writing lacks proper grammar, punctuation, capitalization, and sentences are not complete. Speaker(s) were not well prepared for their presentation.
Graphics	The graphics are appropriate for the presentation and they balance well with the text. For video presentations, the graphics were clear, appropriate, and timed correctly with the audio.	The graphics were appropriate for the topic, but were a bit distracting for the presentation. Video presentation was over-the-top and distracting to the subject matter.	The graphics were appropriate, but there were too few of them. Video presentation was more spoken word and did not fit with the graphics.	The graphics were not true to the topic or were inappropriate for the topic. Video presentation graphics lacked connection to the topic and appeared to be randomly chosen.
Sources (References)	There are an appropriate amount of citations (as assigned by your instructor) from a variety of sources accurately listed in the reference section.	There are some citations (less than assigned) from a variety of sources accurately listed in the reference section.	There are few (less than half) citations from a variety of sources accurately listed in the reference section.	Incomplete citation listed in reference section.

Agents of Change on Pharmaceuticals in Waterways Presentation

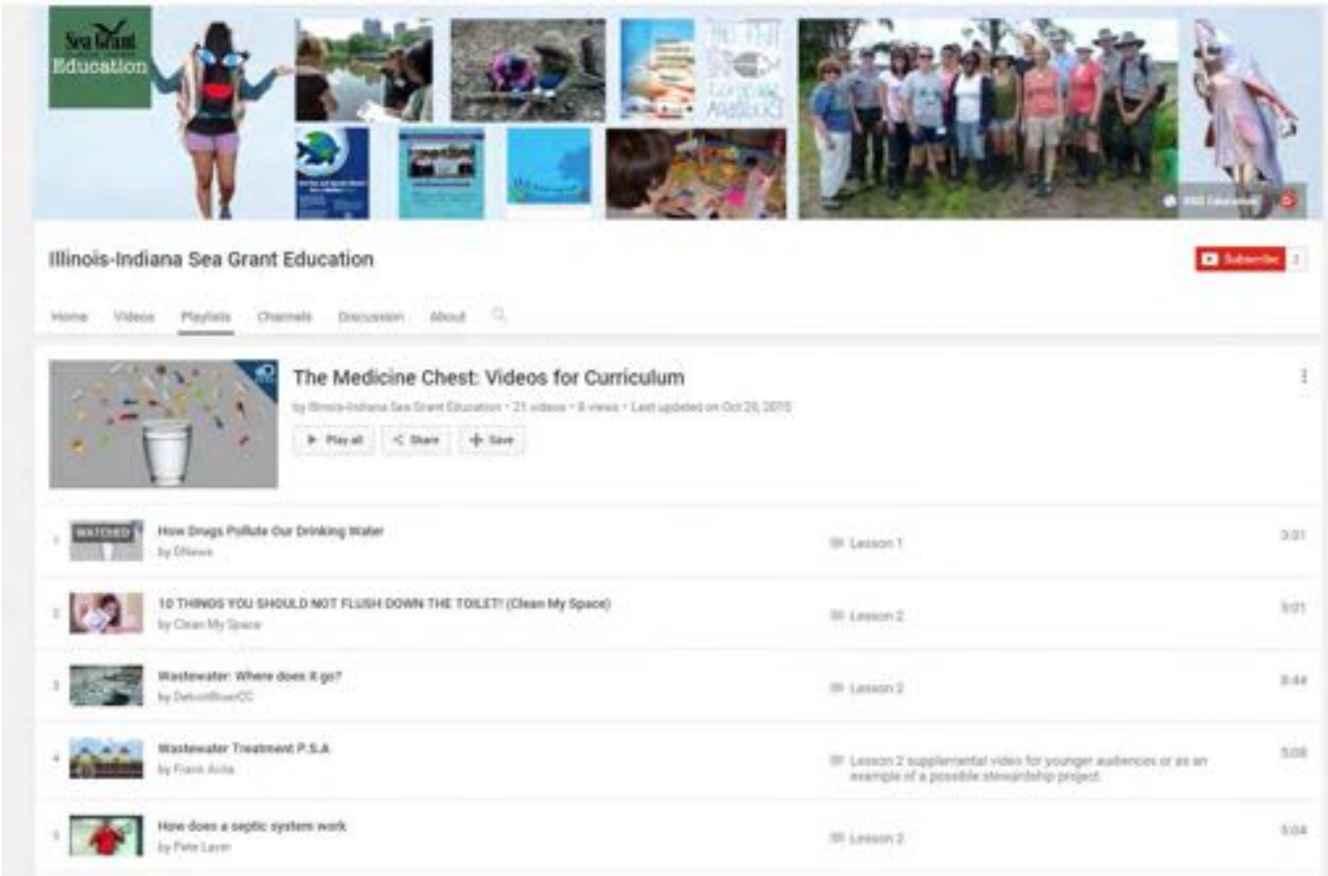
Name: ____

Pick at least five of the eight standards to cover in your research presentation on Interdependent Relationships in Ecosystems (Life science) and Engineering Design.

NGSS Standard	(4) Excellent	(3) Good	(2) Almost	(1) Not Yet
HS-LS2-1	Used effective mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.	Used some mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems but not at different scales.	Used poor mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems but not at different scales.	Used no mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
HS-LS2-2	Used effective mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems at different scales.	Used some mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems but not at different scales.	Used poor mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems but not at different scales.	Used no mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems but not at different scales.
HS-LS2-6	Effectively evaluated claims, evidence, and reasoning that the complex interactions in an ecosystem maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.	Evaluated some claims, evidence, and reasoning that the complex interactions in an ecosystem maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.	Evaluated few claims, evidence, and reasoning that the complex interactions in an ecosystem maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.	Did not evaluate claims, evidence, and reasoning that the complex interactions in an ecosystem maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
HS-LS2-7	Effectively designed, evaluated, and refined a solution for reducing the impacts of human activities on the environment and biodiversity.	Designed, evaluated, and refined a moderately plausible solution for reducing the impacts of human activities on the environment and biodiversity.	Designed, evaluated, and refined an unrealistic solution for reducing the impacts of human activities on the environment and biodiversity.	Did not address a design, evaluation, or refine a solution for reducing the impacts of human activities on the environment and biodiversity.
HS-LS2-8	Effectively evaluated the evidence for the role of group behavior on individual and species' chances to survive and reproduce.	Somewhat evaluated the evidence for the role of group behavior on individual and species' chances to survive and reproduce.	Insufficiently valuated the evidence for the role of group behavior on individual and species' chances to survive and reproduce.	Did not evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.
HS-LS4-6	Effectively created or revised a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.	Created or revised a moderately plausible simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.	Created or revised an unrealistic simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.	Did not create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.
HS-ETS1-2	Effectively designed a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.	Designed a moderately plausible solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.	Designed an unrealistic solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.	Did not design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
HS- ETS1-3	Effectively evaluated a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.	Evaluated a moderately plausible solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.	Evaluated an unrealistic solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.	Did not evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

Visit the Illinois-Indiana Sea Grant Education YouTube page for videos related to the lessons.

http://tinyurl.com/p73dp2e



Lesson 1: What are PPCPs and How Do They Affect Me?

- How to Dispose of Unwanted Medicine and Personal Care Products Research and Resources (http://web.extension.illinois.edu/unusedmeds/research/)
- Pennsylvania Sea Grant Article (http://seagrant.noaa.gov/News/FeatureStories/TabId/268/ArtMID/715/ArticleID/308/Students-come-together-to-reduce-toxins-in-the-environment.aspx)
- Environmental Working Group: Skin Deep (NGO) http://www.ewg.org/skindeep/
- Household Products Database http://householdproducts.nlm.nih.gov
- Learn About Chemicals in Your House – EPA http://www.epa.gov/kidshometour/tour.htm
- Drug Take Back Events http://www.iisgcp.org/unwantedmeds/index.html

Lesson 2: Wastewater Treatment 101: What Happens to PPCPs?

- "11 Things You Should Never Flush Down the Toilet" http://www.care2.com/greenliving/11-things-you-should-never-flush-down-the-toilet.html
- State of Washington Department of Ecology's FAQ sheet at http://www.ecy.wa.gov/programs/hwtr/pharmaceuticals/pages/pie.html
- Medication and your Septic System, Onsite Sewage Treatment Program. http://www.septic.umn.edu/prod/groups/cfans/@pub/@cfans/@ostp/documents/asset/cfans_asset_258054.pdf

Lesson 3: Measuring Toxicity

- Visualizing serial dilutions http://ed.fnal.gov/trc_new/sciencelines_online/fall96/activities.html

Lesson 4: PPCPs in the Environment

- *As Pharmaceutical Use Soars, Drugs Taint Water and Wildlife*. http://e360.yale.edu/feature/as_pharmaceutical_use_soars_drugs_taint_water_and_wildlife/2263/

- *Two-headed salamander isn't radioactive, but is weird.* http://www.mnn.com/earth-matters/animals/stories/two-headed-salamander-isnt-radioactive-but-is-weird
- *Environmental Life Cycle of Pharmaceuticals* http://www.epa.gov/esd/bios/daughton/drug-lifecycle.pdf
- Triclosan Exposure Increases Resistance and Influences Taxonomic Composition of Benthic Bacterial Communities. *Environmental Science & Technology* http://pubs.acs.org/doi/abs/10.1021/es401919k
- Fate and removal of typical pharmaceuticals and personal care products by three different treatment processes. *Science of The Total Environment* http://www.sciencedirect.com/science/article/pii/S0048969713000144
- Occurrence and removal of pharmaceuticals and hormones through drinking water treatment. *Water Research* http://www.sciencedirect.com/science/article/pii/S0043135410007451
- Occurrence and removal of pharmaceutical and hormone contaminants in rural wastewater treatment lagoons. *Science of The Total Environment* http://www.sciencedirect.com/science/article/pii/S0048969712015859
- *Pharmaceuticals and Personal Care Products in Municipal Wastewater and Their Removal by Nutrient Treatment Technologies* https://fortress.wa.gov/ecy/publications/publications/1003004.pdf
- Pesticide atrazine can turn male frogs into females http://newscenter.berkeley.edu/2010/03/01/frogs/

Lesson 5: Precautionary Principle

- The shocking cost of wasted prescription pills http://www.marketplace.org/topics/health-care/shocking-cost-wasted-prescription-pills
- Dosed Without Prescription: A Framework for Preventing Pharmaceutical Contamination of Our Nation's Drinking Water. http://www.nrdc.org/health/files/dosed4pgr.pdf

Lesson 6: A Look Back: Historical Pharmaceuticals

- 9 Terrifying Medical Treatments from 1900 and Their Safer Modern Versions http://mentalfloss.com/article/57983/9-terrifying-medical-treatments-1900-and-their-safer-modern-versions
- How FDA Evaluates Regulated Products: Drugs http://www.fda.gov/AboutFDA/Transparency/Basics/ucm269834.htm

- Medicine in the 20th century http://www.britannica.com/EBchecked/topic/372460/history-of-medicine/35667/Medicine-in-the-20th-century
- *How did people treat illness in the early 20th century?* **https://www.rpharms.com/museum-pdfs/pharmacy-information-and-enquiry-sheets.pdf**
- Welcome to the David Davis Mansion http://daviddavismansion.org/

Lesson 7: More in Common: A Look at Veterinary Medications

- How to Dispose of Unwanted Medicine and Personal Care Products Research and Resources (http://web.extension.illinois.edu/unusedmeds/research/

03 P^2D^2 LESSON PLANS

The Prescription Pill and Drug Disposal Program (P^2D^2) has created multidisciplinary lessons with a service-learning component so students can connect with their communities and develop medicine take-back programs.

The Nuts and Bolts of the P^2D^2 Program

What is the P^2D^2 Program?

The Prescription Pill and Drug Disposal Program (P^2D^2) began as a collaborative effort between local pharmacies, officials, and Pontiac Township High School students in Paul Ritter's Ecology class and Eric Bohm's Illinois Studies class. The purpose is to educate the public about the harm done to the environment due to the current prescription and non-prescription drug disposal practices and to provide the community with an alternative disposal approach that ensures the quality of our water for future generations.

History of the Program

The idea for the program started when Mr. Ritter's wife, Jodee, asked what she should do with some unused prescription pills in their medicine cabinet. Not sure about the correct method of disposal, Mr. Ritter posed the question to his Ecology students and they went right to work. The young ecologists accessed information from the Internet, books, journal articles, and through interviews with scientists. They also enlisted the help of local officials from Illinois American Water Plant Manager Tim Tuley, Pontiac's Street Superintendent Chris Brock, and Mayor Scott McCoy of Pontiac, IL. Students' hard work and research-based efforts uncovered startling information pertaining to the effect of pharmaceuticals on the quality of drinking water around the world. They found that scientists with the U. S. Geological Society have detected drugs such as antibiotics, anti-depressants, birth control pills, seizure medication, cancer treatments, painkillers, tranquilizers and cholesterol-lowering compounds in varied groundwater sources. (*"National Stream Reconnaissance,"* http://toxics.usgs.gov/regional/emc/streams.html, USGS Website, May 2008)

Informing the Community through Service-Learning Activities

Students also learned that, currently, wastewater treatment methods in the United States are not designed to remove these chemicals from our water supply. Scientists are worried about the impact to humans; i.e., the chemicals in our water could increase rates of breast, testicular, and prostate cancer, as well as lower sperm counts and disrupt hormones. Furthermore, the scientists also fear that increased levels of antibiotics in our environment could lead to eventual increases in bacterial resistance. Through their investigations, students also discovered that people played a role in the introduction of these chemicals based on a lack of knowledge regarding how to properly dispose of their unwanted medicines. From their own research, the Ecology students put together presentations for their local pharmacies, including Sartoris Super Drugs, K-Mart, Wal-Mart and Walgreen's Drugstore. These retailers were asked to allow patrons to bring in unused prescription drugs for proper and safe disposal.

Civics and Engagement

The initial project inspired a host of students from other classes to get involved. For example, Mr. Bohm's Illinois Studies class led a letter-writing campaign to ask federal, state, and local officials to help educate the citizenry about the benefits of proper disposal of their prescription and non-prescription drugs. Numerous legislators, environmental groups, and educators have returned letters and stated they are encouraged by the work of the Illinois Studies and Ecology students and hope students in their area will also initiate the program.

<u>Media and Promotion</u>

The student media group has played an important role on the P^2D^2 team, informing various television and radio stations, which led to a great public response. After contacting a popular radio show in Bloomington, Illinois, word of the Program spread like wildfire. This project has gained statewide attention from officials in Springfield, Illinois, the State capital. The Illinois Studies class has greatly enhanced the P^2D^2 program, furthering its goal of inspiring people of the world to be good stewards and take it upon themselves to help preserve our living (biotic) and non-living (abiotic) natural resources.

<u>Positive Partnership with Law Enforcement</u>

The Pontiac Police Department began the drug collection program after learning from Mr. Ritter about its benefits to the community and positive impacts on the local aquatic environment. Mr. Ritter had done extensive research on the issues of water contamination due to pharmaceutical medication being flushed down the drain in people's homes. In addition, the Salt Lake County Sheriff's Department assisted in creating the Pontiac Township High School program by providing a sample policy and ideas for the locked collection box.

In addition to the benefits associated with the environment, the Pontiac Police Department felt this program could be used to educate the community about the dangers these medications pose to our youth. This program creates a positive interaction between the community and the police force. It brings people into the police department where they are exposed to additional informational resources available to them.

The pharmaceuticals are retrieved from the locked box by the evidence officer. The Evidence Officer is the only one with keys to retrieve the discarded medications. The pharmaceuticals are retrieved, weighed, and photographed in bulk prior to placing in evidence. The items are transported for incineration with other illegal drugs when quantities dictate.

<u>P^2D^2 Program Identity</u>

The P^2D^2 Program has created a logo that should be incorporated into other schools' instructional and promotional materials that have incorporated this program into their local setting. Please visit the Program's homepage to access the logo. https://p2d2program.wordpress.com/

Pill Bottle Phil has been a popular costumed character used at many community events, education conferences, and other public gatherings to get the word out about the P^2D^2 Program.

If you would like to borrow the costume or create one of your own, please contact Paul Ritter at 815/844-6113 or PRitter@pontiac.k12.il.us

P^2D^2 : An Award-Winning Education Program

Proclamation by Illinois Governor Pat Quinn--P^2D^2 Day in Illinois
On May 1, 2009, Governor Quinn officially honored the P^2D^2 Program and its significant achievements through a State Proclamation.

2008 Governor's Green Youth Award for Excellence
The hard work and commitment of students to exhibit environmental leadership and stewardship was recognized. These awards, administered by the Illinois Environmental Protection Agency, acknowledged outstanding environmental protection and conservation projects by Illinois' young people. "These projects demonstrate the innovative ways young people throughout the state are working to protect Illinois' environment," said Illinois EPA Director Doug Scott. "Through these awards, we hope to teach other young people about the importance of environmental protection."

2008 Lt. Governor's Environmental Hero Award

On April 21, 2008, Lt. Governor Pat Quinn saluted the students and teachers of Pontiac Township High School who are taking immediate and preemptive action to reduce the amount of prescription and non-prescription drugs in the water supply.

"The students and teachers of Pontiac Township High School are not waiting around for tests to prove that their drinking water may contain trace amounts of drugs," said Lt. Governor Quinn. "They dove directly into the problem and surfaced with a solution. We want to salute these students and teachers for launching the P^2D^2 Program."

On October 23, 2008, PTHS received the **2008 Governor's Pollution Prevention Award**, presented by Illinois Governor Rod Blagojevich.

For full text of the press releases recognizing the positive contributions of the P^2D^2 Program, please visit this Webpage, http://www.p2d2program.org/Contacts.html.

Creating a Prescription Drug Disposal Program in Your Own Community

The following information is also described on the P^2D^2 website. An overview of the Program website follows this section.

How to Begin

- Decide which students and which classes you want to be involved in the project.
- Create a list of the pharmacies in your area.
- Have the students research problems associated with pharmaceuticals in the water.
- Instruct students to research currently accepted disposal methods of pharmaceuticals.
- Contact all area pharmacists and local officials and ask them if they would be willing to help discover possible solutions/prevention methods of improper disposal of pharmaceuticals in the environment.
- Have students provide formal presentations of their research to area pharmacists and local officials that will inform them of the possible pharmaceutical disposal methods that are available in your area.
- Develop an informational brochure/poster for display at various businesses with all contact names and numbers. In addition, create a flyer with the same information that can be easily stapled to small paper bags.
- Contact all local media outlets (both print and broadcast) to inform them of the program and its many benefits.
- Branch out to other schools, corporations, etc. and share your program. Serve as a mentor to these newly partnering schools.

Who Should You Partner With?

- Pharmacists
- Public Works Director
- Water Department and Sewage Treatment Plant Manager/Operator
- Solid Waste Management Districts
- Mayor
- County Board Member
- Local Farm Bureau Staff Member
- State Legislator
- U.S. Congressional Leaders
- University Scientists
- Government Agency Researchers
- Media Outlets (radio/tv stations, newspapers, etc.)

How to Work with Your Community to Start a Drug Collection Event

- Generate a list of the special/important people in their community who should become involved in this project.
- Have your students reach out with letters or phone calls.
- Invite these community members to the school to listen to presentations given by the P^2D^2 students.
- Combine pertinent information from everyone's PowerPoint presentations to create a comprehensive presentation to give to these important community members.
- Have students choose representatives from the various student workgroups in the class to deliver the presentations to each target group; e.g., a pharmacist, wastewater treatment plant official, police officer, representative from the Mayor's office, City Council member, County Board member, Rotary Club member, etc.
- The representatives (business members, decisionmakers, interested citizens, etc.) should be invited to the school to learn about the P^2D^2 Program because it will bring them to an "environment" that the kids are familiar with and are comfortable in. This approach also demonstrates to the community members the learning environment where the P^2D^2 Program is being taught and implemented.

In preparing their presentations and deciding who to invite, students are always encouraged to think outside the box. One interesting example of an unlikely community business partner was an ATV dealership that wanted to deliver the P^2D^2 message. They connected with Paul Ritter and got ahold of the P^2D^2 logo, which they affixed to the side of their ATV quad vehicle, which brought visibility to the Program with a new audience.

How to Branch Out to Other Schools to Get them Involved in the P^2D^2 Network

The P^2D^2 Program has expanded beyond Illinois to schools and communities throughout the United States and the world. Teachers at Pontiac Township High School continue to work diligently to involve schools in many more locations.

"We encourage our kids to divide and conquer," says P^2D^2 Program Coordinator Paul Ritter. "We are always looking for new school partners to give away our P^2D^2 Program." Ritter and his students will communicate with a town that has expressed an interest or a school that seems to be a good, logical choice. For example, a pharmacist from LaSalle-Peru, IL, asked Ritter about the Program, so he visited him after school hours to talk about it. Ritter has contacted fellow science teachers at other schools; emailed superintendents of other school districts; and called police departments and pharmacies to describe the Program and invite their participation.

An example of P^2D^2 Program expansion is the very successful partnership between Pontiac Township High School and Westfield High School in Houston, Texas. Students in the Spanish National Honor Society learned about the P^2D^2 Program and decided to help spread the messages to the Spanish-speaking community by translating the P^2D^2

Website into Spanish. Mr. Xavier Salat-Foix was the lead teacher in that project. The description of that Spanish Web development project is found later in this section. The website is located at http://www.p2d2program.org/espanol.html.

Sometimes, a young person will become inspired after learning about P^2D^2 and work on an individual basis to implement the project. For example, a 14 year old student from Reedsburg, Wisconsin, Jordyn Schara, worked in her own community to inform the public and organize a collection event.

Student Participation at Community Events—Getting the Word Out

It is important to get the students involved in after-school activities and public events to share their projects and spread the P^2D^2 message. For example, the Pontiac students exhibited the project at the September, 2009 Farm Progress Show in Decatur, IL. P^2D^2 students participated at *It's Our River Day Festival* held at Navy Pier, Chicago, on September 19, 2009. Students displayed the P^2D^2 rainbarrel to show that water is our most precious resource. This event gave our kids the opportunity to reach out to other young people. Art is a big part of P^2D^2. Not only does the artwork created by students get the message across, but it also provides youth with a skill they can use throughout their life.

P^2D^2 Green Day was an expansion of the Prescription Pill and Drug Disposal Program. About 500 pounds of unused prescription and over the counter medicines were collected for proper disposal in McLean County. P^2D^2 students were involved in delivering the important program messages as they helped pharmacists hand out magnets and flyers to inform visitors of proper disposal methods. They also helped evaluate the effectiveness of this collection event by counting the number of cars that came through to drop off unwanted medicines.

There are many examples of approaches to publicize these collection events found on Illinois-Indiana Sea Grant's Unwanted Medicine Toolkit Page—*Disposal of Unwanted Medicines: A Resource for Action in Your Community*. Check out these helpful approaches, including sample flyers, postcards, and other public outreach materials at http://web.extension.illinois.edu/unusedmeds/.

Environmental Science

P^2D^2

Pontiac Prescription Drug Disposal:
A Cooperative Program between High School Students, Local Officials, and Pharmacies
www.p2d2program.org

Lesson Plan

Creating an Effective Presentation to Inform the Public

Objectives

Students will:

1. Understand the effects of unused pharmaceuticals on the environment, citizens, and issues surrounding people ingesting medicine that was not meant for them.

2. Learn the proper methods of pharmaceutical disposal.

3. Serve as an important agent for change to help protect and improve the quality of our waters.

4. Learn how to defend their research findings to an audience.

5. Learn how to make PowerPoint presentations, posters, and billboards or other large displays that will deliver messages to help people understand how medicines can be harmful to people, pets, and the environment.

Based on successful attainment of these objectives, the P^2D^2 Program will:
Bring awareness to every community of the potential dangers of improper disposal of pharmaceuticals.
Educate citizens in reducing and eliminating pharmaceuticals from entering our environment.
Initiate positive working relationships between schools, pharmacies, communities, local government, and city officials.
Enable communities to improve their physical environments and quality of life through environmental education.
Reduce consumer waste in the environment.
Assess quantity of household pharmaceutical waste disposed of in an area.
Engage all involved in the production, distribution, sales and consumption of medicines in Environmentally-preferable practices.
Foster community health by providing an opportunity to work together towards a common goal.

Illinois Learning Standards

The standards associated with this lesson are extensive and may be found in this publication in the "Alignment to State and National Science Standards" section.

Procedure

Day 1 – Establish four student teams. Direct the students to research problems associated with pharmaceuticals in the water. Have the students use computers, books, magazines, and leading researchers to gather any and all information about the issues related to pharmaceuticals in the water.

Day 2 – Have the students continue investigating the problem and have them keep their records in a binder. The students will also create a list of pharmacies in the area.

Day 3 - Instruct students to research current accepted disposal methods of pharmaceuticals, as they continue investigating the problem, and document findings in a binder.

Day 4 – Students will continue to research the current accepted disposal methods of pharmaceuticals. Direct the students to contact all area pharmacists and local officials and ask them if they would be willing to collaborate in determining possible solutions/prevention methods of improper disposal of pharmaceuticals in the environment. Send out formal invitations to participate in this community stewardship project.

Days 5-7 – Instruct the students on best practices for creating effective PowerPoint presentations. (This instruction can take more than one day if needed.) Have the students develop their information into a PowerPoint presentation. (Depending on the student's abilities, this can take several school days to complete.)

Day 8 - Students will give formal presentations of their research to area pharmacists and local officials that inform them of the best practices for disposal methods available in your area. (Refer to P²D² Guidelines for Standard Operating Procedures regarding Collection of Unused/Expired Meds—Role of the Pharmacy.)

Day 9-10 – Students will develop an informational brochure/poster to display at local businesses. This product should include contact information for the public to learn about how and where they can bring their unwanted medicine. Participating sponsors should be acknowledged. In addition, students will create a flyer with this information that can be easily stapled to small paper bags for public distribution.

Day 11 – Students will contact local media outlets (print and broadcast) to inform them of this program and its benefits. In addition, students can create informational videos that will be linked on the P²D² website and on YouTube™ for broader dissemination. (Sample descriptions of selected videos posted on YouTube can be found in the section, "Sample Student Stewardship Projects to Initiate Action.")

Day 12 – Students will develop a billboard to put up near or on the interstate, or other high-traffic area. (Ask a billboard company if they will donate a billboard; P²D² teachers have found they will say yes or produce one at minimal cost.)

Day 13 – Share this project with other schools, corporations, etc. and share your program/curriculum unit(s). Identify community medicine collection events or other local festivals and events where students can distribute information to educate the public about safe disposal practices, for example Pontiac Township High School students participated in the P²D² Green Day in partnership with St. Joseph Medical Center (see promotional flyer following this lesson plan).

Developed By: Paul Ritter, Science Department, Pontiac Township High School

Information for Student Presentations to Pharmacists: P²D² Guidelines for Standard Operating Procedure for Pharmacists Regarding Collection of Unused/Expired Meds

Role of the Pharmacy

- Individuals take their unused and unwanted prescription and non-prescription drugs to participating pharmacies.
- Pharmacists take the pharmaceuticals and place them into secure bins. Please note that only licensed pharmacists and assistants handle the returned pharmaceuticals.
- When the bins fill up, pharmacists send them off to be incinerated.
- The company that incinerates the pharmaceuticals creates energy that is used to power homes and businesses.

1. Have a three-vial box system in place
   A. The first box is for pills.
      - Take the tablets or capsules out of the vials or container.
      - Pour into a lined vial box.

   B. The second box is for creams and ointments.
      - Most liquids are stable with others.
      - Pour out similar products into one bottle, making it full.
      - Cough meds can be added together; over-the-counter products like Pepto Bismol can be combined.
      - Inhalers like Nasonex and Flonase: Take off the caps or mouthpiece to free up space.
      - This should be in a lined vial box also.

   C. The third box is for blister packs.
      - Take the product out of the box.
      - Do not put in PPI or other papers.
      - This should be in a vial box.

   D. You can also have a fourth and fifth smaller box; one for mercury thermometers and one for aerosol products.
      - Keep these separate from the rest.
      - With any inhaler, remove the mouthpiece to free up space.
2. You can drop the boxes off to the designated area at the collection site for proper placement in the EPA-provided drums.

Returned medication is separated at the pharmacy counter into four basic classifications for disposal. Boxes and containers are removed and can be added to normal recycling.

1. Pills and Tablets

2. Liquids, Creams, and Ointments

3. Blister packs

4. Pressurized Inhalers

Rubric: Creating an Effective P^{2}D^2 Power Point Presentation (Days 5-7)

Maximum Points: 50

Student Name: ____________________________

CATEGORY	5	3	1	0
6-7 slides	6-7 slides	4-5 slides	2-3 slides	under 2 slides
Color and Font	Font is readable and color on all pages.	Font is readable and color on all pages on at least 5 pages.	Font is readable and color on all pages on at least 3 pages.	Font is readable and color on all pages under 3 pages.
Creativity and Animation	Slides are unique in creativity and show animation.	Slides are unique in creativity and show animation on at least 5 pages.	Slides are unique in creativity and show animation on at least 3 pages.	Slides are unique in creativity and show animation under 3 pages.
Reasons for P^{2}D^2	More than five reasons.	Five reasons.	Three reasons.	Under three reasons.
Pictures of Pharmaceuticals	More than five pictures.	Five pictures.	Three pictures.	Under three pictures.
Participation	Participated all days.	Participated four out of five days.	Participated three out of five days.	Participated under three days.
Time	Finished on time.	Took one extra day.	Took two extra days.	Took more than two extra days.
Research	More than five sources.	At least five sources.	At least three sources.	Under three sources.
Organization	More than five slides are organized and have no grammar errors.	At least five slides are organized and have under three errors.	At least three slides are organized and have under five errors.	under three slides are organized and have more than five errors.
Effort	Effort out of everyone all five days.	Effort out of everyone for three days.	Effort out of everyone for one day.	No effort was shown.

Rubric: Creating an Effective P^2D^2 Poster Project (Days 9-10)

Maximum Points: 50

Student Name: ___________________________

CATEGORY	5	3	1	0
Quote	There is a quote about pharmaceuticals with author.	There is a quote about pharmaceuticals with no author.	There is no quote about pharmaceuticals.	No quote
Color	Color is on entire poster.	Color is on 3/4 of poster.	Color is on 1/2 of poster.	No color
Picture	There is a picture of a pharmaceutical.	N/A	N/A	No picture
Creativity	Poster is unique and creative in design.	Poster shows creativity but not unique.	Poster shows little creativity and not unique.	No creativity
Sponsors	All sponsors are listed.	More than 1 sponsor is missing.	More than 2 sponsors are missing.	No sponsors are listed.
Acknowledgment of the high school ecology class	Pontiac Township High School Ecology class is on poster.	N/A	N/A	Pontiac Township High School Ecology class is not on poster.
Student group identified	Student names are acknowledged.	N/A	N/A	No Name
P^2D^2 Program Acknowledgment	Prescription Pill and Drug Disposal Program is on the poster.	N/A	N/A	Prescription Pill and Drug Disposal Program is not on the poster.
Use of attention-getter to effectively deliver the message	Catch phrase is on the poster.	N/A	N/A	No Catch phrase is on the poster.
Grammar	All Grammar is correct.	One Grammatical Error	Two Grammatical Errors	More than two Grammatical Errors

Illinois Studies*

P^{2}D^2

Pontiac Prescription Drug Disposal:

A Cooperative Program between High School
Students, Local Officials, and Pharmacies

www.p2p2program.org

Lesson Plans

* **This can be easily adapted for civics/social studies classes.**

Lesson 1

The Powers and Duties of Illinois Government

Objectives

Students will:

1. Explain how the various levels of government work together to solve problems.
2. Discuss the role of citizens and the press in the operation of government, especially as types of government work together.
3. Explain the concept of "separation of powers."
4. Describe the basic function of each branch of government.
5. Explain some of the basic services that Illinois provides.

Illinois Learning Standards

14.A.4 Analyze how local, state, and national governments serve the purposes for which they were created.

14.A.5 Analyze the consequences of participation and non-participation in the electoral process.

14.D.5+ Interpret a variety of public policies and issues from the perspectives of different individuals and groups.

Materials

Whiteboard

"Why Do We Need Government" from the *Governing Illinois* Textbook, 2003

Procedure

1. Ask students to come up with a list of reasons why we need government. ("Why Do We Need Government?" pp. 19-20)
   - Have students write their reasons on the whiteboard.
   - Discuss as a class.
2. Ask students to list the three branches of government on the whiteboard
   - Ask students: Why are the powers of government separated?
   - Review the powers of each branch
3. Ask students what kind of complaints they have heard about the government.
   - Think, pair, share.
4. Discuss the services provided by the government.

Assessments

1. Ask students if the above services could be provided privately (by corporations, for instance).
   - What would be the advantages? The disadvantages?
2. Have students read pp 17-29 in *Governing Illinois* and complete the accompanying study guides.
   - Discuss answers as a class.

Developed By: Eric Bohm, Social Studies Department, Pontiac Township High School

Lesson 2

Local Governments of Illinois

Objectives

Students will:

1. Understand the importance of local government on their lives.
2. Explain the different types of local governments in Illinois, and how they can and do work together (and sometimes against each other).
3. Discuss how local government is influenced, and how individuals, like the students themselves, can be effective in doing so.

Illinois Learning Standards

14.A.4 Analyze how local, state, and national governments serve the purposes for which they were created.

17.D.4 Explain how processes of spatial change have affected human history.

14.B.5 Use methods of social science inquiry to study the development and functions of social systems and report conclusions to a larger audience.

Materials

A Plat book

Governing Illinois Textbook

Procedure

1. List the units of local government in Illinois.
   Discuss each governmental unit.
2. Discuss the advantages and disadvantages of having so many units of local government.
   Ask students: Do the advantages outweigh the disadvantages, or vice-versa?
3. Inform students that in other states, local government units take on larger ranges of function.
   Ask students: Can they, then, do these multiple jobs as well?
4. Ask students: How can the units of local government affect us (the class) as we sit here (in the classroom) right now? What rule has each governing unit made that affects us (the class) right now?
   Have students come up with a list.
   Think, pair, share.
5. Ask students: What services are provided by our local government? Are there any services you wish were improved upon? How would you improve them if you were in a leadership position?
6. Ask the mayor to come in and discuss his/her role in the local government. Make sure students have prepared questions prior to the event.

Assessments

1. Have students look in a Plat book and find out what township they live in, describe the geographical features, and explain the jobs of all the township trustees.
2. Have students read pp 93-110 in *Governing Illinois* and complete the accompanying study guides.

Developed By: Eric Bohm, Social Studies Department, Pontiac Township High School

Lesson 3

Getting Involved: Beginning the Process of the Prescription Pill and Drug Disposal Program

Objectives

Students will:

1. Understand the importance of individual participation to the function of our democracy.
2. Describe the ways in which students can participate in government.
3. Understand government in terms of it being our possession vs. a mysterious entity unattached to us.

Illinois Learning Standards

14.A.4 Analyze how local, state, and national governments serve the purposes for which they were created.

14.A.5 Analyze the consequences of participation and non-participation in the electoral process.

15.B.4b Analyze the impact of current events on consumer prices.

15.C.4b Explain the importance of research, development, invention, technology and entrepreneurship to the United States economy.

15.E.4a Explain why government may intervene in a market economy.

16.A.4a Analyze and report historical events to determine cause and effect relationships.

17.B.4a Explain the dynamic interactions within and among the Earth's physical systems including variation, productivity and constructive and deconstructive processes.

17.B.5 Analyze international issues and problems using ecosystems and physical geography concepts.

17.D.5 Analyze the historical development of a current issue involving the interaction of people and geographic factors.

18.B.5 Use methods of social science inquiry to study the development and functions of social systems and report conclusions to a larger audience.

Materials

Whiteboard

U.S. Geological Survey article

Procedure

1. Have students read U.S. Geological Survey article.
   Have students write down main points of the article.
   Have students write down main points on the whiteboard.
   Discuss as a class.
2. Ask students what they can do to help keep water safe for future generations.
   Brainstorm ideas.

Assessments

1. Ask students pointed questions about the article.
2. Have students create a list of ways they can reduce, reuse, or recycle products.
   Discuss as a class.

Developed By: Eric Bohm, Social Studies Department, Pontiac Township High School

Lesson 4

Getting Involved: Beginning the Prescription Pill and Drug Disposal Program

Objectives

Students will:

1. Understand the importance of individual participation to the function of our democracy.
2. Describe the ways in which students can participate in government.
3. Understand government in terms of it being our possession vs. a mysterious entity unattached to us.

Illinois Learning Standards

14.A.4 Analyze how local, state, and national governments serve the purposes for which they were created.
14.C.5 Analyze the consequences of participation and non-participation in the electoral process.
15.B.4b Analyze the impact of current events on consumer prices.
15.C.4b Explain the importance of research, development, invention, technology and entrepreneurship to the United States economy.
15.E.4a Explain why government may intervene in a market economy.
16.A.4a Analyze and report historical events to determine cause and effect relationships.
17.B.4a Explain the dynamic interactions within and among the Earth's physical systems including variation, productivity and constructive and destructive processes.
17.B.5 Analyze international issues and problems using ecosystems and physical geography concepts.
17.D.5 Analyze the historical development of a current issue involving the interaction of people and geographic factors.
18.B.5 Use methods of social science inquiry to study the development and functions of social systems and report conclusions to a larger audience.

Materials

Whiteboard
"Creating an Action Plan" Guideline worksheet
Governing Illinois

Procedure

1. Inform students of the Prescription Drug and Disposal program and its benefits.
2. Ask students who should be informed about the program.
   Make a list on the whiteboard.
3. Break class up into the following groups:
   - Research and Development
   - Media
   - Documentation
   - IL Representatives
     - Republicans
     - Democrats

IL Senators
    Republicans
    Democrats
U.S. Representatives
    Committee Members
    Subcommittee Members
U.S. Senators
    Committee Members
    Subcommittee Members

4. Discuss the roles of committees and subcommittees. Show students how to access information pertaining to committee and subcommittee assignments.
5. Discuss what an Action Plan is and how it is important when working on a project.

Assessment

1. Have students get into their groups and develop an Action Plan.
   Discuss with each group.

Developed By: Eric Bohm, Social Studies Department, Pontiac Township High School

Creating an Action Plan

Team Names

Action Plan Title

Final Goal

List a goal for each week spent on this project. (How will you *plan your work and work your plan*?)

List 5 or more actions steps that you plan to take to help accomplish your goals.

What are some possible problems that you think could make it difficult for you to accomplish your project goals?

What actions will help you overcome these obstacles?

List the community partner/s that will work with your team.

What role will each team member be responsible for? List the person's name and job title.

Answer the following questions with your team. Be prepared to share your responses with the larger group.

What went well and what needs improvement?

How did the experience affect you?

What impact will it have on your future actions?

This Action Plan Template was developed by Terri Hallesy, Illinois-Indiana Sea Grant Program.

Lesson 5

Getting Involved: Preparing an Informational Letter and Fax to Get the Word Out about the Prescription Pill and Drug Disposal Program

Objectives

Students will:

1. Understand the importance of individual participation to the function of our democracy.
2. Describe the ways in which students can participate in government.
3. Understand government in terms of it being our possession vs. a mysterious entity unattached to us.

Illinois Learning Standards

14.A.4 Analyze how local, state, and national governments serve the purposes for which they were created.
14.C.5 Analyze the consequences of participation and non-participation in the electoral process.
15.B.4b Analyze the impact of current events on consumer prices.
15.C.4b Explain the importance of research, development, invention, technology and entrepreneurship to the United States economy.
15.E.4a Explain why government may intervene in a market economy.
16.A.4a Analyze and report historical events to determine cause and effect relationships.
17.B.4a Explain the dynamic interactions within and among the Earth's physical systems including variation, productivity and constructive and destructive processes.
17.B.5 Analyze international issues and problems using ecosystems and physical geography concepts.
17.D.5 Analyze the historical development of a current issue involving the interaction of people and geographic factors.
18.B.5 Use methods of social science inquiry to study the development and functions of social systems and report conclusions to a larger audience.

Materials

Computer
Paper
"Letter Writing Evaluation Sheet" rubric

Procedure

1. In the computer lab, have students find the names, addresses, e-mail addresses, phone numbers, and other contact information for each of their assigned groups determined in the previous lesson.
2. Have each group create a spreadsheet with all the contact information. (This will be vital to stay organized.)
3. Have the Documentation Group work on a letter that can be sent out to all members of the Illinois General Assembly.
4. Students who are in groups that will be contacting U.S senators and representatives will need to track down fax numbers.

Assessments

1. Have students explain, in a paragraph, what they have specifically done in their group.
2. Refer to “Letter Writing Evaluation Sheet” for sample rubric.

Developed By: Eric Bohm, Social Studies Department, Pontiac Township High School

Lesson 6

Getting Involved: Class Critique of an Informational Letter and Fax about the Prescription Pill and Drug Disposal Program

Objectives

Students will:

1. Understand the importance of individual participation to the function of our democracy.

2. Describe the ways in which students can participate in government.

3. Understand government in terms of it being our possession vs. a mysterious entity unattached to us.

Illinois Learning Standards

14.A.4 Analyze how local, state, and national governments serve the purposes for which they were created.
14.C.5 Analyze the consequences of participation and non-participation in the electoral process.
15.B.4b Analyze the impact of current events on consumer prices.
15.C.4b Explain the importance of research, development, invention, technology and entrepreneurship to the United States economy.
15.E.4a Explain why government may intervene in a market economy.
16.A.4a Analyze and report historical events to determine cause and effect relationships.
17.B.4a Explain the dynamic interactions within and among the Earth's physical systems including variation, productivity and constructive and destructive processes.
17.B.5 Analyze international issues and problems using ecosystems and physical geography concepts.
17.D.5 Analyze the historical development of a current issue involving the interaction of people and geographic factors.
18.B.5 Use methods of social science inquiry to study the development and functions of social systems and report conclusions to a larger audience.

Materials

Computer
Paper
Address labels
Envelopes
Fax forms
"Letter Writing Evaluation Sheet" rubric

Procedure (on reverse side)

Procedure

1. Hand out a copy of the letter created by the Documentation Group.
   Review as a class.
   Make changes as needed.
   Save on shared drive
2. In the computer lab, have groups access letter on the shared drive and set it up as a form letter using their spreadsheet.
3. Have students print out their letters and sign.
4. Have students create address labels.
5. Have students prepare the letters to be sent out.
6. U.S. Senators and Representatives Groups will need to fill out a fax form as they will not be sending via USPS.

Assessments

1. Have students write an essay rating each of their group members and explain how they have contributed to the goals of the group.
2. Have students write an essay explaining the importance of a program such as P^2D^2.
3. Refer to the "Letter Writing Evaluation Sheet" for sample rubric.

Developed By: Eric Bohm, Social Studies Department, Pontiac Township High School

Rubric for Lessons 5 and 6

Letter Writing Evaluation Sheet

Name: ________________________
Subject: _____________________
Date: ________________________

Focus: Score _____

- Introductory section (main idea) is in proper format and appropriate length.
- Topic (subject matter) is clearly stated.
- Purpose is clearly implied.
- Unity or oneness is maintained throughout.
- Conclusion brings sense of finality.

Comments:

Support/Elaboration: Score _____

- Each idea is fully addressed.
- Support is valid and effective.
- Details or elaboration and/or examples are given.
- Relevant vocabulary is used effectively.

Comments:

Organization: Score _____

- Composition is logically organized.
- Clarifying devices or transitions are used effectively.

Comments:

Conventions: Score _____

- No major grammatical errors are made.
- Minor mechanical errors are avoided.
- No slang or nonstandard English is included in dialogue.

Comments:

Integration: (Point value is often doubled.) Score _____

- All elements combine for a strong overall effect.
- Generally strong writing occurs throughout.
- Goal of assignment is achieved.
- Students' evaluation of the effectiveness of their project as a whole.

Comments:

Total Score _____

Lesson 7

Getting Involved: Sending an Informational Letter and Fax about the Prescription Pill and Drug Disposal Program

Objectives

Students will:

1. Understand the importance of individual participation to the function of our democracy.

2. Describe the ways in which students can participate in government.

3. Understand government in terms of it being our possession vs. a mysterious entity unattached to us.

Illinois Learning Standards

14.A.4 Analyze how local, state, and national governments serve the purposes for which they were created.
14.C.5 Analyze the consequences of participation and non-participation in the electoral process.
15.B.4b Analyze the impact of current events on consumer prices.
15.C.4b Explain the importance of research, development, invention, technology and entrepreneurship to the United States economy.
15.E.4a Explain why government may intervene in a market economy.
16.A.4a Analyze and report historical events to determine cause and effect relationships.
17.B.4a Explain the dynamic interactions within and among the Earth's physical systems including variation, productivity and constructive and destructive processes.
17.B.5 Analyze international issues and problems using ecosystems and physical geography concepts.
17.D.5 Analyze the historical development of a current issue involving the interaction of people and geographic factors.
18.B.5 Use methods of social science inquiry to study the development and functions of social systems and report conclusions to a larger audience.

Materials

Computer
Stamps
Fax machine
"Assessment Guide for Oral Presentation" rubric

Procedure

1. Send out letters to all members of the Illinois General Assembly.
2. Have students go to the office and send out the faxes to all members of the committees and subcommittees they selected.

Assessments

1. Have groups create a PowerPoint presentation that explains, in detail, the processes they went through to complete their group's objectives.
2. Refer to "Assessment Guide for Oral Presentations" for sample rubric for this lesson.

Developed By: Eric Bohm, Social Studies Department, Pontiac Township High School

Rubric for Lesson 7

Assessment Guide for Oral Presentations

Group Assignment: ______________________________

Group Members: ______________________________

____

Group Assessment	*Excellent*	*Good*	*Average*	*Needs Improvement*	*Unsatisfactory*
1. The group made good use of its preparation time.	5	4	3	2	1
2. The presentation reflected analysis of the issues under consideration.	5	4	3	2	1
3. The presentation was coherent and persuasive.	5	4	3	2	1
4. The group incorporated relevant sections of the background reading into its presentation.	5	4	3	2	1
5. The group's presenters spoke clearly, maintained eye contact, and made an effort to hold the attention of their audience.	5	4	3	2	1
6. The presentation incorporated contributions from all the members of the group.	5	4	3	2	1
Individual Assessment					
1. The student cooperated with other group members.	5	4	3	2	1
2. The student was well-prepared to meet his or her responsibilities.	5	4	3	2	1
3. The student made a significant contribution to the group's presentation.	5	4	3	2	1

Health Education

P^2D^2

Pontiac Prescription Drug Disposal:
A Cooperative Program between High School Students, Local Officials, and Pharmacies
www.p2d2program.org

Lesson Plan

Health Education Prescription Drug Lesson—P²D²

Objectives

Students will:

1. Describe the factors that influence people to use prescription drugs.

2. Understand the effects of the use of different prescription drugs on the body and on developing fetuses.

3. Learn about the programs that will help a person overcome their addictions.

[Note: Detailed objectives are listed under the individual lessons for Days 1-5.]

Illinois State Goals

1. State Goal 22: Understand principles of health promotion and the prevention and treatment of illness and injury.
    a. 22.A.4b: Analyze possible outcomes of effective health promotion and illness prevention.
    b. 22.A.5a: Explain strategies for managing contagious, chronic and degenerative illness.
    c. 22.B.4: Explain social and economic effects of health problems on individuals and society.
2. State Goal 23: Understand human body systems and factors that influence growth and development.
    a. 23.A.4: Explain how body systems functions can be maintained and improved.
    b. 23.B.4: Explain immediate and long-term effects of health habits on the body systems.
    c. 23.B.5: Understand the effects of healthy living on individuals and their future generations.
3. State Goal 24: Promote and enhance health and well-being through the use of effective communication and decision-making skills.
    a. 24.B.4: Explain how decision making affects the achievement of individual health goals.
    b. 24.B.5: Explain immediate and long-term impacts of health decisions to the individual, family, and community.
    c. 24.C.4: Formulate a plan to achieve individual health goals.
    d. 24.C.5: Evaluate progress toward the attainment of a health goal.

MPOs:

1,2,7,8,9,10,12,21,23

Procedure

Day 1

Objective 1: Identify reasons why people use prescription drugs.

- Prevent disease
- Relieve pain
- Fight pathogens
- Promote health

Duration: 10 minutes
Format: Lecture
Assessment: Teacher observation

Objective 2: Identify factors that influence teens to abuse prescription drugs.

- Peer pressure
- Family members
- Role models
- Media messages
- Perceptions of drug behavior
- Misleading information

Duration: 10 minutes
Format: Lecture
Assessment: Teacher Observation

Objective 3: Define substance abuse.

- Any unnecessary or improper use of chemical substances for non-medical purposes

Duration: 5 minutes
Format: Lecture
Assessment: Teacher Observation

Objective 4: Describe the dangers of substance abuse.

- Physical health
    - Tolerance
    - Physiological dependence
    - Addiction
    - Increased high risk behaviors
- Mental health
    - Psychological dependence
    - Depression
    - Suicide
- Social health
    - Loss of interest and goals
    - Increased violence and crime

Duration: 20 minutes
Format: Lecture
Assessment: Teacher observation

Day 2

Objective 1: Define prescription drugs.

- A drug prescribed to a patient by a doctor or licensed health professional that requires government control
- Non-food substances that alter the functions of the body and/or mind

Duration: 5 minutes
Format: Lecture
Assessment: Teacher observation

Objective 2: Differentiate between responsible and irresponsible prescription drug use.

- Responsible prescription drug use
  - Taking a prescription drug as it is intended
    - To promote good health
- Irresponsible prescription drug use
  - Selling prescription drugs
    - Jail time
    - Fines
    - Loss of social network
  - Sharing prescription drugs
    - Cause of overdose
    - Death
    - Disease
      - HIV
      - Hepatitis B
  - Using prescription drugs not prescribed
    - Overdose
    - Death
    - Disease
      - HIV
      - Hepatitis B

Duration: 20 minutes
Format: Lecture
Assessment: Teacher observation

Objective 3: Explain ways prescription drugs can enter the body.

- Implantation
  - Drugs placed under the skin
    - Absorbed in the bloodstream
- Mouth
  - Swallowing
    - Absorbed in the bloodstream after reaching the stomach and small intestines
- Injection
  - Syringe and needle use
    - Absorbed in the bloodstream immediately after being injected into muscle or blood vessel
    - High risk of HIV and hepatitis B if syringes are shared

Day 2 (cont'd)

- Absorption
  - Buccal
    - Oral absorption between the cheek and gum
      - Enters the bloodstream through the skin or mucous membranes
  - Sublingual
    - Oral absorption under the tongue
      - Enters the bloodstream through the skin or mucous membranes
  - Skin patch
    - Enters the bloodstream through the skin or mucous membranes
  - Suppository
    - Anal absorption
      - Enters the bloodstream through the skin or mucous membranes
    - Vaginal absorption
      - Enters the bloodstream through the skin or mucous membranes
  - Topical
    - Enters the bloodstream through the skin or mucous membranes
      - Cream
      - Lotions
      - Ointment
      - Sprays
- Inhalation
  - Nasal passage
    - Enters the bloodstream in the lungs
  - Oral passage
    - Enters the bloodstream in the lungs

Duration: 20 minutes
Format: Lecture
Assessment: Teacher observation

Day 3

Objective: Discuss factors that determine prescription drug effects.

- Age
    - Drug effects will vary for:
        - Infants
        - Teens
        - Adults
        - Elderly
- Albumin concentration
    - Protein found in the bloodstream and urine
- Alcohol intake
    - Alcohol mixed with drugs can produce a multiplier effect
        - Antagonism
            - Occurs when each drug's effect is canceled out or reduced by another
        - Synergism
            - Occurs when drugs interact to produce effects greater than those that each drug would produce alone
- Amount or dosage of drug(s) used
    - Prescription drugs are prescribed according to the patients size and weight
- Barometric pressure
    - Changes drug action
    - Changes metabolism
- Behavior
    - Violent
    - Depression
    - Anger
    - Hyperactivity
- Body fat of user
    - Prescription drugs are prescribed according to the patients size and weight
- Body weight of user
    - Prescription drugs are prescribed according to the patients size and weight
- Cardiovascular function
    - Heart health
- Dietary factors
    - Amount of food eaten
    - Types of foods eaten
- Disease
    - Alters how the body would normally use the drug
- Fever
    - Alters how the body would normally use the drug
- Gastrointestinal function

Day 3 (cont'd)

    - Absorption capabilities
    - Presence of acids
- Gender
    - Lean versus fat body tissue
        - Males
        - Females
- Immunologic function
    - Presence of white and red blood cells
- Infection
    - Alters how the body would normally use the drug
- Lactation
    - Nursing mothers
    - Alters how the body would normally use the drug
- Liver function
    - The rate at which the liver can breakdown and absorb the drug
- Marijuana intake
    - Marijuana mixed with drugs can produce a multiplier effect
        - Antagonism
            - Occurs when each drug's effect is canceled out or reduced by another
        - Synergism
            - Occurs when drugs interact to produce effects greater than those that each drug would produce alone
- Mood
    - Stress
    - Anger
    - Fear
    - Anxiety
    - Joy
- Nicotine intake
    - Nicotine mixed with drugs can produce a multiplier effect
        - Antagonism
            - Occurs when each drug's effect is canceled out or reduced by another
        - Synergism
            - Occurs when drugs interact to produce effects greater than those that each drug would produce alone
- Pregnancy
    - Alters how the body would normally use the drug due to an increase in hormones

Day 3 (cont'd)

- Presence of other drugs in the body
    - Drugs mixed with other drugs can produce a multiplier effect
        - Antagonism
            - Occurs when each drug's effect is canceled out or reduced by another
        - Synergism
            - Occurs when drugs interact to produce effects greater than those that each drug would produce alone
- Renal function
- Speed at which the drugs were taken
- Sunlight
    - Increased metabolism
    - Increased coagulation
- Type of drug/s used
    - Antibiotic
    - Antidepressant
    - Antiepileptic
    - Antihypertensive
    - Antiulcer
    - Bronchodilator
    - Hypnotic
    - Lipid Lowering
    - Prescription Analgesic
    - Sedative

Duration: 20 minutes
Format: Lecture
Assessment: Teacher observation

Day 4

Objective 1: Discuss common types of prescription drugs.

- Antibiotic
  - Used to treat bacterial infections
    - Aminoglycosides, Carbapenems, Cephalosporins (1^{st} Generation, 2^{nd} Generation, 3^{rd} Generation, 4^{th} Generation, 5^{th} Generation), Fluoroquinolones, Glycycline, Macrolides, Monobactam, Penicillins, Polypeptides, Sulfonamides, Tetracyclines, Miscellaneous Antibiotics
- Antidepressant
  - Used to treat depressive disorders
    - Asendin, Cymbalta, Desyrel, Dexedrine, Effexor, Elavil, Lexapro, Ludiomil, Luvox, Norpramin, Nardil, Pamelor, Parnate, Paxil, Pertofrane, Prozac, Remeron, Ritalin, Serzone, Sinequan, Surmontil, Tofranil, Wellbutrin, Zoloft

- Antiepileptic
  - Used to control and prevent epileptic seizures
    - Celontil, Cerebex, Convulex, Depakene, Depakote, Diacomit, Diamox, Dilantil, Epanutin, Epilim, Felbamate, Felbatol, Fosphenytoin, Frisium, Gabapentin, Gabitril, Gemonil, Keppra, Klomopin, Lamictal, Lamotrigine, Lyrica, Mesatoin, Milontil, Mysoline, Neptazane, Neurontin, Peganone, Rivotril, Sabril, Tegretol, Topamax, Topiramate, Tridione, Trileptal, Valium, Zarotin, Zonegran
- Antihypertensive
  - Used to reduce elevated blood pressure
    - Accupril, Altac, Aceon, Adalat CC, Anhydron, Apa-Doxazosin, Aquatag, Aquatensen, Atacand, Atenolol, Avapro, Benicar, Blocadren, Calan, Capoten, Cardene, Cardizem, Cardura, Cartrol, Coreg, Corgard, Cozaar, Diovan, Diucardin, Diuril, Doxaloc, DynaCirc, Enduron, Esidrix, Exna, Gen-Doxazosin, HydroDiuril, Hytrin, Inderal, Isoptin, Kerlone, Levatol, Lopressor, Lotensin, Marazide, Mavik, Med-Doxazosin, Metahydrin, Micardis, Minipress, Monopril, Naqua, Naturetin, Nimotop, Normodyne, Norvasc, Plendil, Prinivil, Procardia XL, Renese, Renormax, Saluron, Sectral, Sular, Tenormin, Teveten, Tiazac, Trandate, Univasc, Vascor, Vasotec, Verelan, Visken, Zebeta, Zestril, Ziac
- Antiulcer
  - Used to treat ulcer discomfort
    - Axid, Carafae, Cytotec, Pepcid, Prilosec, Tagamet, Zantac
- Bronchodilator
  - Opens airways for those with asthma
    - Albuterol, Bitolterol, Epinephrine, Fenoterol, Formoterol, Isoetharine, Isoproterenol, Metaproterenol, Pirbuterol, Procaterol, Racepinephrine, Salmeterol, Terbutaline
- Hypnotic
  - Sleep Aids
    - Abilify, Adapin, Adderall, Akineton, Ambien, Ambien-CR, Amytal, Anafranil, Antabuse, Aquachloral, Aropax, Artane, Asendin, Atarax, Ativan, Aurorix Provigil, Aventyl, Benadryl, Buspar, Butisol, Campral, Catapres, Celexa, Centrax, Cibalith-S, Cipram, Cipramil, Citopam, Clozaril, Cogentin, Compazine, Concerta, Cylert, Cymbalts, Cytomel, Dalmane, Decadron, Depakene, Depakote, Deprax, Deroxat, Desoxyn, Desyrel, Dexedrine, Dobupal, Dolophane, Doral, Dutonin, Edronax, Effexor, Elavil, Eldepryl, Emsam, Equanil,

Day 4 (cont'd)

Equetro, Eskalith, Eufor, Faverin, FazaClo ODT, Felbatol, Fluanxol, Fluctine, Fluocim, Gabitril, Geodon, Gladem, Halcion, Haldol, Imovane, Inderal, Invega, Kemadrin, Keppra, Klonopin, Lamictal, Lexapro, Lexomyl, Lexotan, Lexotanil, Librium, Litarex, Lithane, Litonate, Litotabs, Loxitane, Ludiomil, Lunesta, Lustral, Luvox, Manerix, Marplan, Mellaril, Metadate-CR, Metadate-ER, Methylin, Miltown, Mirapex, Moban, Modiodal, Nalorex, Nardil, Navane, Nefadar, Nembutal, Neurontin, Niravam, Norebox, Norpramin, Nortilen, Nozinanan, Odranal, Orap, Pamelor, Parnate, Paxil, Periactin, Pertrofran, Pexeva, Phaltrexia, Placidyl, Prisdal, Prolixin, Prosom, Prozac, Psiquial, Reapam, Remeron, Restoril, ReVia, Risperdal, Ritalin, Ritalin-LA, Rivotril, Rozerem, Saroten, Seconal, Serax, Sercerin, Serentil, Seresta, Serlect, Seropram, Seroquel, Serotax, Serzone, Sinequan, Somnote, Sonata, Stesolid, Strattera, Subutex, Surmontil, Symmetrel, Synthroid, Tegretol, Temesta, Tenormin, Thorazine, Tofranil, Tolre, Topamaxn, Tranxene, Trexan, Trilafon, Trileptal, Trypitzol, Typtanol, Urecholine, Valium,Veritina, Versed, Vestra, Visken, Vistaril, Vivacil, Vivitrol, Wellbutrin, Wellbutrin-SR, Wellbutrin-XL, Xanax, Zoloft, Zonegran, Zyban, Zyprexa

- Lipid-lowering
  - Lowers blood cholesterol levels
    - Advicor, Altocor, Antara, Atromid-S, Colestid, Crestor, Lescol, Lipitor, Lipofen, Lopid, Lovaza, Mevacor, Niacor, Omacor, Pravachol, Questran, Simcor, Tricor, Triglide, Vitorin, Welchol, Zetia, Zocor
- Prescription analgesic
  - Pain Reliever
    - Damason-P, Darvon Compund-65, Empirin with Codeine No. 3, Empirin with Codeine No. 4, Endodan, Lortab ASA, Panasal 5/500PC-Cap, Percodan, Percodan-Demi, Propoxyphene Compound-65, Roxiprin, Synalgos-DC Talwin Compound
- Sedative
  - Slows down the central nervous system
    - Calms behavior
      - Ambien, Carisoma, Equinail, Hypnoge, Ivadal, Lunata, Meprospan, Miltown, Myslee, Nimadorm, Nitrest, Sanoma, Sanval, Soma, Somit, Stella, Stilnoct, Stilnox, Zodorm, Zoldem, Zolfresh, Zolt

Duration: 20 minutes
Format: Lecture
Assessment: Teacher observation

Objective 2: Discuss prescription drug guidelines.

- Keep prescription drugs in their original containers.
- Never take prescription drugs that have been prescribed for another person.
- Keep prescription drugs out of the reach of children.
- Follow instructions for storing the prescription drug.
- Do not use a prescription drug if it is expired.
- Never take prescription drugs if that appear to have been tampered. with, are discolored, or have a suspicious odor.
- Carefully follow the instruction on the label.
- Do not stop taking the drug if you start feeling better.
- Report new or unexpected symptoms to a physician.
- Contact a physician if the drug does not seem to be producing the desired effects.

Duration: 25 minutes
Format: Lecture
Assessment: Teacher observation

Day 5

Objective 1: Discuss off-label drug use.

- Prescription drug not approved by the FDA
  - Drugs commonly prescribed off-label
    - Albuterol, Aripiprazole, Gabapentin, Lamictal, Lisoderm, Modafinil, Propranolol, Risperidone, Tiagabine, Topiramate, Trazodone, Viagra

Duration: 10 minutes
Format: Lecture
Assessment: Teacher observation

Objective 1: Describe what is involved in making a commitment to be drug-free.

- Working on refusal statements
- Finding healthy alternatives
- School efforts
- Community efforts

Duration: 10 minutes
Procedure: Lecture
Assessment: Teacher observation

Objective 2: Identify help that is available for individuals who presently use drugs.

- Sources in the community
  - Counselors
  - Support groups
  - Outpatient drug-free treatment
  - Short-term treatment
  - Maintenance therapy
  - Therapeutic communities
- Friends
- Family

Duration: 10 minutes
Format: Lecture
Assessment: Teacher observation

Objective 3: Discuss the costs of drug use to the user, the user's family and friends, and to society in general.

- Individual
  - Physical health
    - Tolerance
    - Physiological dependence
    - Addiction
    - Increased high risk behaviors
  - Mental health

            - Psychological dependence
            - Depression
            - Suicide
        - Social health
            - Loss of interest and goals
            - Increased violence and crime
- Family and friends
    - Stop spending time with family and friends
    - Emotional betrayal
    - Financial loss
- Society
    - Rise of drug related crime and violence
    - Cost to U.S economy due to:
        - Jail time
        - Accidents
        - Deaths
        - Health care costs
        - Legal fees
        - Law enforcement costs
        - Insurance costs
        - Drug-related damages

Duration: 25 minutes
Format: Lecture
Assessment: Teacher observation

Developed by: Heather Christenson, Betty Murphy, Health Education Department, Pontiac Township High School and Tara Hanson, Graymont Grade School

Language Arts

P^{2}D^2

Pontiac Prescription Drug Disposal:
A Cooperative Program between High School Students, Local Officials, and Pharmacies
www.p2d2program.org

Lesson Plan

Language Arts Lesson—P^2D^2

The Eco-ku

Objectives

Students will:

1. Work in a cooperative learning environment to employ figurative language, written in haiku format, to express a message of ecological importance to a greater audience.

2. Confer with classmates regarding format, message, and editing issues.

3. Present their "eco-ku" orally to the class along with appropriate illustrations, graphics, and explanations.

Illinois State Goals

The lesson plan addresses, but is certainly not limited to, the following Illinois Learning Standards:
2A4a, 2b4a, 3A4, 3B4b, 3B4c, 3C4b, 4B4a, 4B4b

Materials

Notebook paper
Pen
Magazines
Construction/printer paper
Markers or other drawing/writing utensils
Tape or glue
Scissors
Stapler

Procedure

Background and Overview of the Lesson:

Eco-kus are a hybrid of ancient Japanese poetry and a contemporary awareness of environmental needs in our community. Written in haiku form, eco-kus are created to carry ecology-oriented messages to the public. The eco-ku lesson plan was inspired by the P^2D^2 project and conceived as a device to interest students who were not ordinarily high achievers in language arts courses, but were heavily invested in local ecology projects. Through their efforts in writing eco-kus, students will be simultaneously exposed to a new form of critical and creative writing as well as given an opportunity to articulate the pro-environmental message of programs such as P^2D^2.

In its initial run, the eco-ku lesson was an astounding success, generating interest from both the governor of Illinois and school districts state-wide. Although this lesson plan was designed primarily for high school sophomores and keyed accordingly to the appropriate Illinois Learning Standards, modifications can easily be made for different age levels.

1. The lesson will begin with a teacher led-discussion of the haiku format:

    Haiku Rules

    - Has three lines
    - Has 17 syllables
    - Has five syllables in the first line, seven in the second, and five in the third

2. Next, analyze and discuss an original composition from the instructor:

Example Haiku written by Mr. Soares

Sitting in the sand.
Wave touches foot and pulls back.
Old sand trades for new.

4. Using the Smartboard, explore haikus further on http://www.haikusociety.com, discussing content and counting syllables.

5. Eco-ku Explanation: "Haiku-writing is an ancient Japanese practice that tries to capture a 'moment in time,' much like a snapshot. For this project, you will consider what you have learned about our environment today and programs such as P^2D^2. Ultimately, you will create 'eco-ku' based on those concepts. You will either cut out or create three pictures and write an eco-ku poem for each. These three poems need to be turned in as a book with your name on the cover."

6. In groups of two or three, students should begin discussing haiku and ecology, culminating in the creation of eco-ku. Magazines should be available for students to find pictures that will accompany their eco-ku; conversely, they may create their own pictures by drawing them (or creating them on a computer). For verification purposes, the students will confer with each other on format and syllable count. When a student has created three eco-kus, he or she should use available materials to construct a "book," gluing or creating a picture for each eco-ku. In addition, the student should add a cover incorporating his or her name into a title.

7. Before students submit their eco-ku books, they will have their work peer reviewed by those in their groups. Any corrections can be made at this time.

8. Finally, students will use their eco-ku books to facilitate an oral presentation replete with any explanations necessary. Students making the oral presentations should be prepared to answer any questions from fellow students concerning the message of their eco-ku. Please see student-created haikus in the section "Sample Student Stewardship Projects to Initiate Action."

Rubric

Timely Completion: Was it done on time? Yes No _______(5 pts)

Basic Criteria Met: Did it follow the prescribed pattern? Yes No _______(5 pts)

Creativity: Is it imaginative? Eye-catching? Colorful? Neat? _______(5 pts)

Correctness: Are there errors in spelling? Grammar? Syllables? _______(5 pts)
(Total) _______(20 pts)

Developed by Michael Soares, English Department, Pontiac Township High School

Pontiac Township High School Student Examples, 2009

Eco-ku: Ecology-inspired poems written in haiku form.

Old meds with no clue?
Just send to P^2D^2.
Make safe energy. By Myles Rich

Don't do wrong, instead
Be eco-smart, re-claim meds
P^2D^2 saves. By Marcus Fultz

Got old, unused drugs?
Turn them in while you still can.
Improve our future! By Chase Alford

Pharmaceuticals?
Be responsible with them.
P^2D^2 works! By Megan Schmoeger

To make energy
Send your expired pills to
Local pharmacies. By Jake Heller

Do you have old pills?
Take them to a pharmacy.
Save our planet now! By Alex DeMattia

Don't flush medicine.
Take them to a pharmacy.
Go P^2D^2! By Jacqui DeFrees

Got old medicine?
P^2D^2 will take them.
Let's save the planet. By Jacqui DeFrees

Get rid of old pills.
Let's start saving the planet.
Go P^2D^2! By Jacqui DeFrees

And the winner:

Take back your old pills
Before fish have many more gills.
Save the water now. By Liz Howard

Music

P^2D^2

Pontiac Prescription Drug Disposal:
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www.p2d2program.org

Lesson Plan

Project Plans: Creating a Radio Jingle

Objectives

Students will:

1. Collaborate within the class and offer input to create an effective jingle.
2. Incorporate the use of composition, ear training, music theory, and music technology knowledge and skills, as well as an understanding of how the final musical product will reflect and promote the message or product.
3. Use technology through computer notation and sequencing software.
4. Learn to consider performance by creating melody and harmony vocal lines, and creation of appropriate sound effects and instrumental parts.
5. Gain "real-world" music experience and record tracks in a studio environment.
6. Create a radio jingle to reinforce the goals of the P^2D^2 Program.

Illinois State Goals

25: Know the language of the arts:
Students should understand the sensory elements, organizational principles and expressive qualities of the arts. Students will analyze and evaluate student and professional works for how aesthetic qualities are used to convey intent, expressive ideas and/or meaning.

26: Through creating and performing, understand how works of art are produced:
Students will understand the processes, traditional tools and modern technologies used in the creation of their work. They will analyze and evaluate how the choice of media, tools, technologies and processes support and influence the communication of ideas. Students will apply the skills and knowledge necessary to create and perform their jingle. Students will create and perform a complex work of art using a variety of techniques, technologies and resources and independent decision making.

27: Understand the role of the arts in civilizations, past and present:
Students will analyze how music functions in history, society and everyday life. They will see how careers in the arts are expanding based on new technologies and societal changes. They will also see how music shapes and reflects ideas, issues or themes.

Procedure

1. Students will research the P^2D^2 project to understand its unique goals and purposes. Students will learn about the methods used to deliver relevant science and stewardship messages. By listening to and discussing real radio jingles, they will gain understanding about the impact the lyrics may have on the listener and the possible musical reasons for this impact.
2. From their own concept of the product and the project, students will create their own lyrics for a thirty-second radio jingle.
3. Students will individually create a melody and lead sheet for the lyrics. These student-created melodies may change or alter the original lyrics, but must maintain the integrity of the message.
4. Students will brainstorm possible tunes from any style of music (classical, jazz, rock, pop, etc) that have already been written that might fit the chosen lyrics.
5. From a recording of the tune selected, students will transcribe all parts to computer music notation in score format. Adaptations to the original in length, timbre, and style

may be made once the transcription has been created.

6. After assembling all of the potential jingles from all classmates, the class will make the final decision for the chosen jingle (lead sheet) they should continue to pursue. Students will then create in computer notation all appropriate parts necessary for the performance and recording of the jingle. [See the final P^2D^2 jingles, "Cleaner Water" and "We Love P^2D^2" in this publication in the "Sample Student Stewardship Projects to Initiate Action" section.]
7. Students will rehearse the performance of the vocal and instrumental parts to the music.
8. Students will use a music sequencing software program to create and record all parts, instrumental and vocal, for the finished product. If a local recording studio is available, students will record to CD the instrumental and vocal tracks.
9. The jingle will be then tested and feedback drawn from students and adults as to its possible impact and usefulness in a real world situation.

Developed By: Keith Schmink, Music Department, Pontiac Township High School

Art Design

P^2D^2

Pontiac Prescription Drug Disposal:
A Cooperative Program between High School Students, Local Officials, and Pharmacies
www.p2p2program.org

Lesson Plans

P^2D^2 T-shirt design

Objectives

Students will:

1. Use art skills and practices to create a design for a t-shirt that represents the message being conveyed through the P^2D^2 program.

2. Receive an overview of the program and discuss possible designs.

3. Learn balance and composition, which will be encouraged in the design.

Illinois State Goals

Visual Arts: Analyze and evaluate how tools/technologies and processes combine to convey meaning.

Materials

P^2D^2 poster
Photo of P^2D^2 mailbox design
Handout of P^2D^2 design
Performance Assessment(s) Rubric

Procedure

Students will examine a poster of a student-created P^2D^2 drug disposal project and brainstorm and sketch out ideas for a t-shirt to promote the program. Through a handout, students will also learn general design requirements (e.g., one color, good balance, P^2D^2 logo, year, and school). When the t-shirt designs are completed, the science department will choose one to represent the P^2D^2 program.

Details, Process, Practice, Method, Course of Action, Formula:

Anticipatory Set - Introduce the lesson by showing a poster of the P^2D^2 drug disposal program created by students. Discuss the background goals of the P^2D^2 program, and its benefits. This will provide a foundation for creating a design that will best illustrate and promote the P^2D^2 program messages.
Input - (Teacher-guided) Students brainstorm and sketch out ideas for the P^2D^2 t-shirt designs. Once the ideas have been discussed with the instructor, students can move on to the final design.
Closure - Review keys to the t-shirt design.

Assessments

Personal communication(s)
Observation
Whole group instruction
One-on-one instruction
Performance assessment(s) rubric

Potential Accommodations

Students with disabilities will receive extra time on their drawings.

Developed by: Nick Vogt, Art Department, Pontiac Township High School

P^2D^2 T-shirt Design

Students will create a design for the P^2D^2 prescription drug program. Included in the design will be the name of the school, and the year. Special attention should be paid to design and layout. Pill Bottle Phil should be incorporated in some way to advertise the logo. Design should be balanced. This project is worth 50 points.

P^2D^2 Design Rubric

Focus (15pts)

Design incorporates P2D2
Interesting creative design/ Interesting layout
Design has year/logo

Elements of Design (15pts)

Design has good balance
Good use of line/shapes/ Pill Bottle Phil drawn accurately
Good use of color

Creativity effort (20pts)

Spent time wisely
Did not rush/put effort in design
Unique unlike any others/ did not trace/transfer images
Worked to develop to full potential
Solved problems

Art Lesson Plan - P^2D^2

P^2D^2 Drop-off Box Lesson

P^2D^2 Drop-off box design

Objectives

Students will:

1. Use art and design skills to create a graphic design for the prescription drug drop-off box. The drop-off box is an old mailbox that has been painted white.
2. The students will hear an overview of the purpose of the program, and discuss the purpose of the drop-off box with Mr. Ritter.
3. After completing their design, the students will write about their design proposal, explaining how their design expresses the intent of the P^2D^2 program and the purpose of the drop-off box.
4. The students will present their final design to the class.

Illinois State Goals

25.A.4 – Analyze and evaluate the effective use of elements, principles and expressive qualities in a composition/performance in the visual arts.
26.B.4d – Demonstrate knowledge and skills that communicate clear and focused ideas based on planning, research, and problem solving.
27.A.4b – Analyze how the arts are used to inform and persuade through traditional and contemporary art forms.
26.A.5 – Analyze and evaluate how the choice of media, tools, technologies and processes support and influence the communication of ideas.

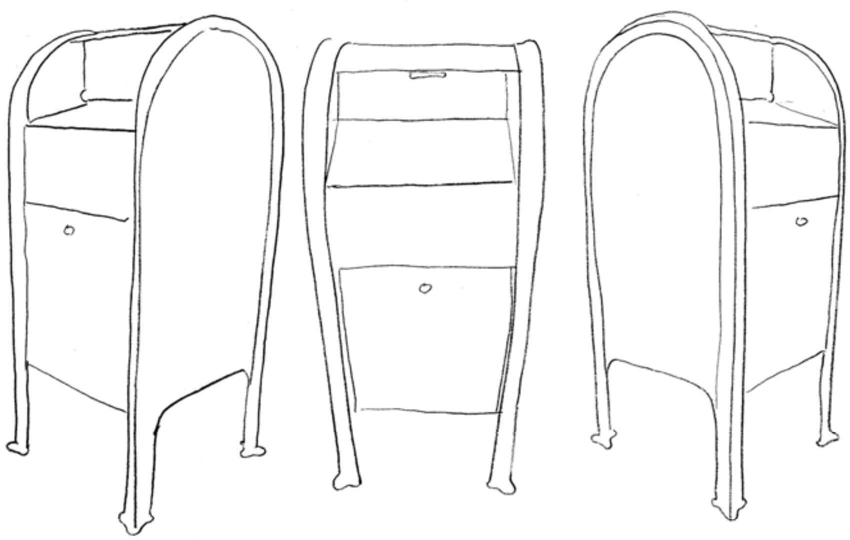
Materials

Mailbox
List of people or groups that need to be recognized on the mailbox:
  Illinois Environmental Protection Agency (logo)
  Illinois Indiana Sea Grant (logo)

PTHS Ecology class
PTHS Illinois Studies class
PTHS Music Theory class
LACC Commercial Art class
LACC Welding class
Local Auto Body Shop
Local Sign Company
Illinois State Police, State Police (patch)

Artwork of Pill Bottle Phil

Drawing paper, colored pencils, etc.
A drawing template of the mailbox with three views for sketches



Procedures

Day 1, 2, and 3: Introduction to the graphic design assignment, P^2D^2 drop-off box. P^2D^2 program and information are introduced, and the purpose of the drop-off box. Students can also find information at the web site, www.p2d2program.org. Students are given handouts that provide the information that must appear on the box. The front and sides of the mailbox will be used in the design. The students will create a list of their own ideas and use the template to sketch out a minimum of five different concepts for their design. These are done quickly. These are due at the beginning of the 4th day.

Day 4 and 5: The students will do their final design based on their sketches, changing and altering them as needed. The final design will show the three sides, be in color, and show the placement of the necessary elements for the design. The design can be done by hand or on the computer. They must also write a one-page paper with an explanation of their design concept.

Day 6: Students present their designs to the class. The class discusses the various designs with the intent to come to a consensus of the best design possibilities.

Closure

Our goal was to have a student-generated design for the mailbox/drop box that could be repeated on many other mailboxes. Rather than have the students paint the mailbox, a time consuming project, you can take the design to a local sign company. They assisted us with the final design so it looked professional. It could be then printed on a wrap, or template and used on as many mailboxes as needed. If desired, students can paint the design on the drop-off box themselves. Our final design was a combination of 3-4 ideas by the students. The sign company shared the design with us, and after the graphics were added to the mailbox, it was returned to the art room for final discussion by the class. It was then taken out to the State Police Headquarters where it is being used.

Assessments

Observation and communication with students while working on the assignment

Thumbnail sketch ideas (50 points)

- Minimum of five different ideas for design
- Interesting design concepts
- Required elements are present in the designs
- On task during class

Final Design (50 points)

- Has all required elements in the design
- On task during class
- Design shows development from one or more of the thumbnail sketches
- Design is appropriate for the use of the drop-off box
- Skill and knowledge of color, drawing skills, etc. are evident
- Final design demonstrates effort, care, and concern

Writing and presentation (20 points)

- Ideas presented clearly with elaboration
- Conventions, grammar used correctly
- Presentation was done

Students with disabilities will receive extra time if necessary.

Our Final Design

Commercial art students designed the mailbox for the drugs that were collected by the police department. This mailbox was one that was completed and is now located at a state police headquarters. (News release about use of these drop-off boxes follows.)

At the State Police Headquarters

Developed by: Robert Sear, art instructor, Livingston Area Career Center, Pontiac Township High School

Illinois State Police NEWS

Larry G. Trent • Director

FOR IMMEDIATE RELEASE

Contact:
Trooper Joseph Dittmer
815-844-1500
Illinois State Police
District Six Headquarters

January 13, 2009

The Illinois State Police District Six provide pharmaceutical disposal.

PONTIAC – The Illinois State Police District Six and the Students and staff of Pontiac Township High School in Pontiac have teamed together to provide a safe location for prescription drug disposal. The lobby of the Illinois State Police District Six headquarters has been equipped with a prescription drug disposal box. The disposal box will be maintained and operated by Illinois State Police personnel.

In the past year, the students and staff of the Pontiac Township High School took part in establishing the Prescription Pill and Drug Disposal Program (P^2D^2). The program focuses on a cleaner environment by providing the public with a safe and secure means of disposing of unused pharmaceuticals. The P^2D^2 program has been successful in collecting and properly disposing of thousands of pounds of medications. The program has also been adopted in the city of Fife, Washington.

The Illinois State Police supports the environmental efforts and is proud to provide a safe and secure disposal location at the Illinois State Police headquarters located at 800 South Old Airport Road in Pontiac.

Foreign Language

P^2D^2

Pontiac Prescription Drug Disposal:

A Cooperative Program between High School Students, Local Officials, and Pharmacies

www.p2d2program.org

Lesson Plan

P^2D^2 Program Website: Spanish National Honor Society Translation Project*

Objectives

Students will:

1. Undertake a collaboration project with the P^2D^2 program to provide a Spanish version of the website.

2. Be responsible for translating a section of the P^2D^2 program.com website, either as part of a group, or individually.

3. Implement a similar (P^2D^2) program in our community.

4. Be awarded community service hours.

Learning Standards - **Texas Essential Knowledge and Skills (TEKS) alignment**

This project aligns with the 5 Cs as follows:

1. Communication
   1.c Present information and convey short messages on everyday topics to listeners and readers.
2. Cultures
   2.b Use the language to demonstrate understanding of products and how they are related to the perspectives of cultures.
3. Connections
   3.b Use language to obtain, reinforce, or expand knowledge of other subject areas.
4. Comparisons
5. Communities
   5.a Use the language beyond the school setting through activities, such as participating in cultural events and using technology to communicate.

Procedure

The translation of the entire website shall be completed in no more than one month.
(The following schedule assumes that there are two meetings per month):

Meeting 1: The first meeting will consist of distribution of the tasks. Tasks will be distributed based on preferences of the student. After tasks are assigned, students will deliver a rough draft to be edited (if necessary) and approved by the rest of the Spanish National Honor Society members in attendance.

Meeting 2: Students will complete the translation process during a two-week period between meetings. A completed translation must be turned in at the second meeting.

Assessment

The completed website will be verified by the teacher for accuracy.

* Mr. Salat-Foix's class became involved in this project as a result of talking to the P^2D^2 Coordinator Paul Ritter.

Developed By: Xavi Salat-Foix, Spanish Teacher, Carl Wunsche Senior High School (Spring Texas)

Sociology

P^2D^2

Pontiac Prescription Drug Disposal:

A Cooperative Program between High School Students, Local Officials, and Pharmacies

www.p2d2program.org

Lesson Plan

Sociology Lesson Plan- P^2D^2

Creating a Promotional Video to Inform the Public about the Prescription Drug and Disposal Program

Objectives

Students will:

1. Learn about and discuss the challenges facing adolescents in today's society, with a focus on drug use.
2. Research the Prescription Pill and Drug Disposal Program.
3. Learn how to create a storyboard to communicate key components of the Prescription Pill and Drug Disposal Program.
4. Create a promotional video using Movie Maker.

Illinois Learning Standards

14.A.4 Analyze how local, state and national governments serve the purposes for which they were created.

14.C.4 Describe the meaning of participatory citizenship (e.g., volunteerism, voting) at all levels of government and society in the United States.

14.D.5 Interpret a variety of public policies and issues from the perspectives of different individuals and groups.

14.F.5 Interpret how changing geographical, economic, technological and social forces affect United States political ideas and traditions (e.g., freedom, equality and justice, individual rights).

16.A.4a Analyze and report historical events to determine cause and effect relationships.

17.B.4a Explain the dynamic interactions within and among the Earth's physical systems including variation, productivity and constructive and destructive processes.

17.B.5 Analyze international issues and problems using ecosystems and physical geography concepts.

18.A.5 Compare ways in which social systems are affected by political, environmental, economic and technological changes.

18.B.5 Use methods of social science inquiry (pose questions, collect and analyze data, make and support conclusions with evidence, report findings) to study the development and functions of social systems and report conclusions to a larger audience.

Materials

Computer with Internet access
Story Board Worksheet
Video Camera or Flip
Assessment Rubric

Procedures

1. Complete a graphic organizer on the "Challenges of Adolescence."

2. Brainstorming and discussion: *In your opinion, do students in our community abuse drugs, both illegal and prescription? How do we address drug use among adolescents?*

3. Direct Instruction: Introduce the P^2D^2 Program. Have students visit the website p2d2program.org to learn about and research the Prescription Pill and Drug Disposal Program. Students can supplement their research using additional references listed in that section of *The Medicine Chest* curriculum.

4. Divide students into three groups and give each group a topic of focus. Topics may include:

    What is P^2D^2?
    How to implement a P^2D^2 Program.
    Past and present success of the P^2D^2 Program—How and why did the Program make an impact in the various communities it has reached?

5. Using previous research, students should meet in groups to discuss their assigned topic and create an outline of their topic's most important points.

6. Direct Instruction: The Purpose of a Public Service Announcement.
What makes a successful PSA campaign? http://www.psaresearch.com/bib4111.html
How to make a good PSA. http://www.ehow.com/how_7469497_make-good-psa.html
Students can meet with the school's Media Learning Center director or specialist to learn how to create a Story Board and use Movie Maker to create a Public Service Announcement. The Wiki from the lesson developed at Pontiac Township High School can be accessed using the following web address: http://pthsstudentresources.pbworks.com/w/page/36267906/Creating-a-Video-with-Visual-Communicator-and-Movie-Maker

7. Students should meet in groups to brainstorm and create their Story Board (see Figure 1. below).

8. Students should meet outside of class to film and create their Public Service Announcements using Movie Maker.

8. Students will present their Public Service Announcements to the class.

Assessment

1.Graphic Organizers should be graded for content and completion.
2. Make an informal assessment of class discussion and group work.
3. Assess Public Service Announcements using the grading rubric provided in Figure 2.

Figure 1. Story Board Template

Title of Slide: Picture/Graphic Text: To Do:	Title of Slide: Picture/Graphic Text: To Do:

Figure 2. Assessment Guide for Public Service Announcements

Topic: ______________________________

Group Members: ______________________________

Group Assessment	Excellent	Good	Average	Needs Improvement	Unsatisfactory
The group made good use of its preparation time.	5	4	3	2	1
The PSA reflected analysis of the issues under consideration.	5	4	3	2	1
The PSA was coherent and informative.	5	4	3	2	1
The group incorporated relevant sections of the background reading into its PSA.	5	4	3	2	1
The group's presenters spoke clearly, maintained eye contact, and made an effort to hold the attention of the audience.	5	4	3	2	1
The presentation incorporated contributions from all the members of the group.	5	4	3	2	1

Individual Assessment	Excellent	Good	Average	Needs Improvement	Unsatisfactory
The student cooperated with other group members.	**5**	**4**	**3**	**2**	**1**
The student was well prepared to meet his or her responsibilities.	**5**	**4**	**3**	**2**	**1**
The student made a significant contribution to the group's PSA.	**5**	**4**	**3**	**2**	**1**

Grand Total: __________ (45)

Comments:

Developed by: Megan Bozarth, Social Studies Department, Pontiac Township High School

Ecology/Environmental Science
Illinois State Learning Standards

STATE GOAL 11: Understand the processes of scientific inquiry and technological design to investigate questions, conduct experiments and solve problems.

Illinois Learning Standards:

LEARNING STANDARD A. Know and apply the concepts, principles and processes of scientific inquiry.
LEARNING STANDARD B. Know and apply the concepts, principles and processes of technological design.

Illinois Assessment Framework Objectives:

BENCHMARK:

11.A.4a Formulate hypotheses referencing prior research and knowledge.
11.A.4b Conduct controlled experiments or simulations to test hypotheses.
11.A.4c Collect, organize and analyze data accurately and precisely.
11.A.4e Formulate alternative hypotheses to explain unexpected results.
11.A.4f Using available technology, report, display and defend to an audience conclusions drawn from investigations.
11.B.4a Identify a technological design problem inherent in a commonly used product.
11.B.4b Propose and compare different solution designs to the design problem based upon given constraints including available tools, materials and time.
11.B.4d Determine the criteria upon which the designs will be judged, identify, advantages and disadvantages of the designs and select the most promising design.
11.B.4e Develop and test a prototype or simulation of the solution design using available materials, instruments and technology.
11.B.4f Evaluate the test results based on established criteria, note sources of error and recommend improvements.
11.B.4g Using available technology, report to an audience the relative success of the design based on the test results and criteria.
11.A.5a Formulate hypotheses referencing prior research and knowledge.
11.A.5b Design procedures to test the selected hypotheses.
11.A.5c Conduct systematic controlled experiments to test the selected hypotheses.
11.A.5d Apply statistical methods to make predictions and to test the accuracy of results.
11.A.5e Report, display and defend the results of investigations to audiences that may include professionals and technical experts.
11.B.5a Identify a design problem that has practical applications and propose possible solutions, considering such constraints as available tools, materials, time and costs.
11.B.5b Select criteria for a successful design solution to the identified problem.
11.B.5c Build and test different models or simulations of the design solution using suitable materials, tools and technology.
11.B.5d Choose a model and refine its design based on the test results.
11.B.5e Apply established criteria to evaluate the suitability, acceptability, benefits, drawbacks and consequences for the tested design solution and recommend modifications and refinements.
11.B.5f Using available technology, prepare and present findings of the tested design solution to an audience that may include professional and technical experts.

BENCHMARK:

- 13.A.5a Design procedures and policies to eliminate or reduce risk in potentially hazardous science activities.
- 13.A.5b Explain criteria that scientists use to evaluate the validity of scientific claims and theories.
- 13.A.5c Explain the strengths, weaknesses and uses of research methodologies including observational studies, controlled laboratory experiments, computer modeling and statistical studies.
- 13.A.5d Explain, using a practical example (e.g., cold fusion), why experimental replication and peer review are essential to scientific claims.
- 13.B.5a Analyze challenges created by international competition for increases in scientific knowledge and technological capabilities (e.g., patent issues, industrial espionage, technology obsolescence).
- 13.B.5b Analyze and describe the processes and effects of scientific and technological breakthroughs.
- 13.B.5c Design and conduct an environmental impact study, analyze findings and justify recommendations.
- 13.B.5d Analyze the costs, benefits and effects of scientific and technological policies at the local, state, national and global levels (e.g., genetic research, Internet access).
- 13.B.5e Assess how scientific and technological progress has affected other fields of study, careers and job markets and aspects of everyday life.

STATE GOAL 12: Understand the fundamental concepts, principles, and interconnections of the life, physical, and earth/space sciences.

Illinois Learning Standards:

LEARNING STANDARD: A. Know and apply concepts that explain how living things function, adapt and change.

LEARNING STANDARD B. Know and apply concepts that describe how living things interact with each other and with their environment.

Illinois Assessment Framework Objectives:

BENCHMARK:

12.B.4a Compare physical, ecological and behavioral factors that influence interactions and interdependence of organisms.

12.B.4b Simulate and analyze factors that influence the size and stability of populations within ecosystems (e.g., birth rate, death rate, predation, migration patterns).

12.A.5a Explain changes within cells and organisms in response to stimuli and changing environmental conditions (e.g., homeostasis, dormancy).

STATE GOAL 13: Understand the relationships among science, technology and society in historical and contemporary contexts.

Illinois Learning Standards:

LEARNING STANDARD A. Know and apply the accepted practices of science.

LEARNING STANDARD B. Know and apply concepts that describe the interaction between science, technology and society.

Illinois Assessment Framework Objectives:

BENCHMARK:

13.A.4a Estimate and suggest ways to reduce the degree of risk involved in science activities.

13.A.4b Assess the validity of scientific data by analyzing the results, sample set, sample size, similar previous experimentation, possible misrepresentation of data presented and potential sources of error.

13.A.4c Describe how scientific knowledge, explanations and technological designs may change with new information over time (e.g., the understanding of DNA, the design of computers.

13.A.4d Explain how peer review helps to assure the accurate use of data and improves the scientific process.

13.B.4a Compare and contrast scientific inquiry and technological design as pure and applied sciences.

13.B.4b Analyze a particular occupation to identify decisions that may be influenced by a knowledge of science.

13.B.4c Analyze ways that resource management and technology can be used to accommodate population trends.

13.B.4d Analyze local examples of resource use, technology use or conservation programs; document findings; and make recommendations for improvements.

13.B.4e Evaluate claims derived from purported scientific studies used in advertising and marketing strategies.

Ecology/Environmental Science
Indiana State Science Standards

Principles of Environmental Science-- Standard 1

Environmental Systems

Env.1.4 Understand and explain that human beings are part of Earth's ecosystems and give examples of how human activities can, deliberately or inadvertently, alter ecosystems.

Env.1.8 Recognize/ describe the difference between systems in equilibrium and systems in disequilibrium.

Env.1.10 Identify and measure biological, chemical, and physical factors within an ecosystem.

Natural Resources

Env.1.28 Understand and describe the concept and the importance of natural and human recycling in conserving our natural resources

Environmental Hazards

Env.1.31 Understand and explain that waste management includes considerations of quantity, safety, degradability, and cost.

Env.1.34 Differentiate between natural pollution and pollution caused by humans; give examples of each.

Principles of Biology-- Standard 1

Ecology

B.1.41 Recognize that and describe how human beings are part of Earth's ecosystems. Note that human activities can, deliberately or inadvertently, alter the equilibrium in ecosystems.

B.1.43 Understand that and describe how organisms are influenced by a particular combination of living and nonliving components of the environment.

B.1.44 Describe the flow of matter, nutrients, and energy within ecosystems.

B.1.45 Recognize that and describe how the physical or chemical environment may influence the rate, extent, and nature of the way organisms develop within ecosystems.

Advanced Life Science: Animals Standards—Standard 4
Animal Genetics and the Environment

Ecology

AS.4.20 Explain the role of resources in every ecosystem. Define trophic level. Explain the concept of energy flow: primary producers, primary consumers, secondary and tertiary consumers, and decomposers.

AS.4.21 Describe the impact humans have on the capacity of any system to support life. List the factors that limit the capacity of an ecosystem. Discuss the interactions that occur between birth rate, population growth, and carrying capacity of the ecosystem.

AS.4.22 Explain difference between exponential and logistic growth curves. Define carrying capacity. Describe the impact of carrying capacity on an ecosystem (community ecology). Predict the impacts of overcrowding, disease, and waste on animal health

Ecology/Environmental Science
Alignment with National Science Education Standards

Science as Inquiry

Content Standard A--As a result of their activities in grades 9-12, all students should develop understanding of:

- Abilities necessary to do scientific inquiry
  - Identify questions and concepts that guide scientific investigations.
  - Design and conduct scientific investigations.
  - Formulate and revise scientific explanations and models using logic and evidence.
  - Communicate and defend a scientific argument.

- Understandings about scientific inquiry
  - Scientists usually inquire about how physical, living, or designed systems function. Conceptual principles and knowledge guide scientific inquiries. Historical and current scientific knowledge influence the design and interpretation of investigations and the evaluation of proposed explanations made by other scientists.
  - Scientists conduct investigations for a wide variety of reasons. For example, they may wish to discover new aspects of the natural world, explain recently observed phenomena, or test the conclusions of prior investigations or the predictions of current theories.
  - Scientists rely on technology to enhance the gathering and manipulation of data. New techniques and tools provide new evidence to guide inquiry and new methods to gather data, thereby contributing to the advance of science. The accuracy and precision of the data, and therefore the quality of the exploration, depends on the technology used.
  - Mathematics is essential in scientific inquiry. Mathematical tools and models guide and improve the posing of questions, gathering data, constructing explanations and communicating results.
  - Scientific explanations must adhere to criteria such as: a proposed explanation must be logically consistent; it must abide by the rules of evidence; it must be open to questions and possible modification; and it must be based on historical and current scientific knowledge.
  - Results of scientific inquiry—new knowledge and methods—emerge from different types of investigations and public communication among scientists. In communicating and defending the results of scientific inquiry, arguments must be logical and demonstrate connections between natural phenomena, investigations, and the historical body of scientific knowledge. In addition, the methods and procedures that scientists used to obtain evidence must be clearly reported to enhance opportunities for further investigation.

Life Science

Content Standard C--As a result of their activities in grades 9-12, all students should develop understanding of:

- Interdependence of organisms
  - Human beings live within the world's ecosystems. Increasingly, humans modify ecosystems as a result of population growth, technology, and consumption. Human destruction of habitats through direct harvesting, pollution, atmospheric changes, and other factors is threatening current global stability, and if not addressed, ecosystems will be irreversibly affected.

Science in Personal and Social Perspectives

Content Standard F--As a result of their activities in grades 9-12, all students should develop understanding of:

- Natural resources
    - The earth does not have infinite resources; increasing human consumption places severe stress on the natural processes that renew some resources, and it depletes those resources that cannot be renewed.
    - Humans use many natural systems as resources. Natural systems have the capacity to reuse waste, but that capacity is limited. Natural systems can change to an extent that exceeds the limits of organisms to adapt naturally or humans to adapt technologically.

- Environmental quality
    - Natural ecosystems provide an array of basic processes that affect humans. Those processes include maintenance of the quality of the atmosphere, generation of soils, control of the hydrologic cycle, disposal of wastes, and recycling of nutrients. Humans are changing many of these basic processes, and the changes may be detrimental to humans.
    - Materials from human societies affect both physical and chemical cycles of the earth.
    - Many factors influence environmental quality. Factors that students might investigate include population growth, resource use, population distribution, overconsumption, the capacity of technology to solve problems, poverty, the role of economic, political, and religious views, and different ways humans view the earth.

- Natural and human-induced hazards
    - Human activities can enhance potential for hazards. Acquisition of resources, urban growth, and waste disposal can accelerate rates of natural change.
    - Natural and human-induced hazards present the need for humans to assess potential danger and risk. Many changes in the environment designed by humans bring benefits to society, as well as cause risks. Students should understand the costs and trade-offs of various hazards—ranging from those with minor risk to a few people to major catastrophes with major risk to many people. The scale of events and the accuracy with which scientists and engineers can (and cannot) predict events are important considerations.

- Science and technology in local, national, and global challenges
    - Understanding basic concepts and principles of science and technology should precede active debate about the economics, policies, politics, and ethics of various science- and technology-related challenges. However, understanding science alone will not resolve local, national, or global challenges.
    - Individuals and society must decide on proposals involving new research and the introduction of new technologies into society. Decisions involve assessment of alternatives, risks, costs, and benefits and consideration of who benefits and who suffers, who pays and gains, and what the risks are and who bears them. Students should understand the appropriateness and value of basic questions—"What can happen?"—"What are the odds?"—and "How do scientists and engineers know what will happen?"
    - Humans have a major effect on other species. For example, the influence of humans on other organisms occurs through land use—which decreases space available to other species—and pollution—which changes the chemical composition of air, soil, and water.

History and Nature of Science

Content Standard G--As a result of their activities in grades 9-12, all students should develop understanding of:

- Science as a Human Endeavor
  - Individuals and teams have contributed and will continue to contribute to the scientific enterprise. Doing science or engineering can be as simple as an individual conducting field studies or as complex as hundreds of people working on a major scientific question or technological problem. Pursuing science as a career or as a hobby can be both fascinating and intellectually rewarding.
  - Scientific explanations must meet certain criteria. First and foremost, they must be consistent with experimental and observational evidence about nature, and must make accurate predictions, when appropriate, about systems being studied. They should also be logical, respect the rules of evidence, be open to criticism, report methods and procedures, and make knowledge public. Explanations on how the natural world changes based on myths, personal beliefs, religious values, mystical inspiration, superstition, or authority may be personally useful and socially relevant, but they are not scientific.
  - Because all scientific ideas depend on experimental and observational confirmation, all scientific knowledge is, in principle, subject to change as new evidence becomes available. The core ideas of science such as the conservation of energy or the laws of motion have been subjected to a wide variety of confirmations and are therefore unlikely to change in the areas in which they have been tested. In areas where data or understanding are incomplete, such as the details of human evolution or questions surrounding global warming, new data may well lead to changes in current ideas or resolve current conflicts. In situations where information is still fragmentary, it is normal for scientific ideas to be incomplete, but this is also where the opportunity for making advances may be greatest.

Government--Illinois State Learning Standards

GRADE LEVEL: High School

State Goal 14: Understand political systems, with an emphasis on the United States.

- 14.A.4 Analyze how local, state, and national governments serve the purposes for which they were created.
- 14.C.4 Describe the meaning of participatory citizenship (e.g., volunteerism, voting) at all levels of government and society in the United States.
- 14.C.5 Analyze the consequences of participation and non-participation in the electoral process (e.g., women's suffrage, voter registration, effects of media).
- 14.D.4 Analyze roles and influences of individuals, groups and media in shaping current debates on state and national policies.
- 14.D.5 Interpret a variety of public policies and issues from the perspectives of different individuals and groups.
- 14.F.5 Interpret how changing geographical, economic, technological and social forces affect United States political ideas and traditions (e.g., freedom, equality and justice, individual rights).

State Goal 15: Understand economic systems, with an emphasis on the United States.

- 15.C.4b Explain the importance of research, development, invention, technology and entrepreneurship to the United States economy.
- 15.E.4b Describe social and environmental benefits and consequences of production and consumption.

State Goal 17: Understand world geography and the effects of geography on society, with an emphasis on the United States.

- 17.A.4b Use maps and other geographic instruments and technologies to analyze spatial patterns and distributions on earth.
- 17.B.4a Explain the dynamic interactions within and among the Earth's physical systems including variation, productivity and constructive and destructive processes.
- 17.C.5b Describe the impact of human migrations and increased urbanization on ecosystems.
- 17.C.5c Describe geographic factors that affect cooperation and conflict among societies.

State Goal 18: Understand social systems, with an emphasis on the United States.

- 18.B.5 Use methods of social science inquiry (pose questions, collect and analyze data, make an support conclusions with evidence, report findings) to study the development and functions of social systems and report conclusions to a larger audience.

Health Education--Illinois State Learning Standards

SUBJECT AREA: Health

Illinois State Goals

State Goal 22: Understand principles of health promotion and the prevention and treatment of illness and injury.

BENCHMARK:

- 22.A.4b: Analyze possible outcomes of effective health promotion and illness prevention.
- 22.A.5a: Explain strategies for managing contagious, chronic and degenerative illness.
- 22.B.4: Explain social and economic effects of health problems on individuals and society.

State Goal 23: Understand human body systems and factors that influence growth and development.

BENCHMARK:

- 23.A.4: Explain how body systems functions can be maintained and improved.
- 23.B.4: Explain immediate and long-term effects of health habits on the body systems.
- 23.B.5: Understand the effects of healthy living on individuals and their future generations.

State Goal 24: Promote and enhance health and well-being through the use of effective communication and decision-making skills.

BENCHMARK:

- 24.B.4: Explain how decision making affects the achievement of individual health goals.
- 24.B.5: Explain immediate and long-term impacts of health decisions to the individual, family, and community.
- 24.C.4: Formulate a plan to achieve individual health goals.
- 24.C.5: Evaluate progress toward the attainment of a health goal.

Language Arts--Illinois State Learning Standards

SUBJECT AREA: Language Arts
GRADE LEVEL: Early High School

BENCHMARK:

3.A. 4 Use standard English to edit documents for clarity, subject/verb agreement, adverb and adjective agreement and verb tense; proofread for spelling, capitalization and punctuation; and ensure that documents are formatted in final form for submission and/or publication.

3.B.4a Produce documents that exhibit a range of writing techniques appropriate to purpose and audience, with clarity of focus, logic of organization, appropriate elaboration and support and overall coherence.

3.B.4b Produce, edit, revise and format work for submission and/or publication (e.g., manuscript form, appropriate citation of sources) using contemporary technology.

3.B.4c Evaluate written work for its effectiveness and make recommendations for its improvement.

3.C.4a Write for real or potentially real situations in academic, professional and civic contexts (e.g., college applications, job applications, business letters, petitions).

3.C.4b Using available technology, produce compositions and multimedia works for specified audiences.

BENCHMARK:

4.A.4a Apply listening skills as individuals and members of a group in a variety of settings (e.g., lectures, discussions, conversations, team projects, presentations, interviews).

4.A.4b Apply listening skills in practical settings (e.g., classroom note taking, interpersonal conflict situations, giving and receiving directions, evaluating persuasive messages).

4.A.4c Follow complex oral instructions.

4.A.4d Demonstrate understanding of the relationship of verbal and nonverbal messages within a context (e.g., contradictory, supportive, repetitive, substitutive).

4.B.4a Deliver planned informative and persuasive oral presentations using visual aids and contemporary technology as individuals and members of a group; demonstrate organization, clarity, vocabulary, credible and accurate supporting evidence.

4.B.4b Use group discussion skills to assume leadership and participant roles within an assigned project or to reach a group goal.

4.B.4c Use strategies to manage or overcome communication anxiety and apprehension (e.g., developed outlines, notecards, practice).

4.B.4d Use verbal and nonverbal strategies to maintain communication and to resolve individual and group conflict.

BENCHMARK:

5.A.4a Demonstrate a knowledge of strategies needed to prepare a credible research report (e.g., notes, planning sheets).

5.A.4b Design and present a project (e.g., research report, scientific study, career/higher education opportunities) using various formats from multiple sources.

5.B.4a Choose and evaluate primary and secondary sources (print and nonprint) for a variety of purposes.

5.B.4b Use multiple sources and multiple formats; cite according to standard style manuals.

5.C.4a Plan, compose, edit and revise information (e.g., brochures, formal reports, proposals, research summaries, analyses, editorials, articles, overheads, multimedia displays) for presentation to an audience.

5.C.4b Produce oral presentations and written documents using supportive research and incorporating contemporary technology.

5.C.4c Prepare for and participate in formal debates.

BENCHMARK:

1.B.5a Relate reading to prior knowledge and experience and make connections to related information.

1.C.5c Critically evaluate information from multiple sources.

1.C.5d Summarize and make generalizations from content and relate them to the purpose of the material.

1.C.5e Evaluate how authors and illustrators use text and art across materials to express their ideas (e.g., complex dialogue, persuasive techniques).

1.C.5f Use tables, graphs and maps to challenge arguments, defend conclusions and persuade others.

BENCHMARK:

3.B.5 Using contemporary technology, produce documents of publication quality for specific purposes and audiences; exhibit clarity of focus, logic of organization, appropriate elaboration and support and overall coherence.

3.C.5a Communicate information and ideas in narrative, informative and persuasive writing with clarity and effectiveness in a variety of written forms using appropriate traditional and/or electronic formats; adapt content, vocabulary, voice and tone to the audience, purpose and situation.

3.C.5b Write for real or potentially real situations in academic, professional and civic contexts (e.g., applications, job applications, business letters, resume, petitions).

BENCHMARK:

4.A.5a Use criteria to evaluate a variety of speakers' verbal and nonverbal messages.

4.A.5b Use techniques for analysis, synthesis, and evaluation of oral messages.

4.B.5a Deliver planned and impromptu oral presentations, as individuals and members of a group, conveying results of research, projects or literature studies to a variety of audiences (e.g., peers, community, business/industry, local organizations) using appropriate visual aids and available technology.

4.B.5b Use speaking skills to participate in and lead group discussions; analyze the effectiveness of the spoken interactions based upon the ability of the group to achieve its goals.

4.B.5c Implement learned strategies to self-monitor communication anxiety and apprehension (e.g., relaxation and transference techniques, scripting, extemporaneous outlining, repetitive practice).

4.B.5d Use verbal and nonverbal strategies to maintain communication and to resolve individual, group and workplace conflict (e.g., mediation skills, formal and informal bargaining skills).

BENCHMARK:

5.A.5a Develop a research plan using multiple forms of data.

5.A.5b Research, design and present a project to an academic, business or school community audience on a topic selected from among contemporary issues.

5.B.5a Evaluate the usefulness of information, synthesize information to support a thesis, and present information in a logical manner in oral and written forms.

5.B.5b Credit primary and secondary sources in a form appropriate for presentation or publication for a particular audience.

5.C.5a Using contemporary technology, create a research presentation or prepare a documentary related to academic, technical or occupational topics and present the findings in oral or multimedia formats.

5.C.5b Support and defend a thesis statement using various references including media and electronic resources.

Fine Arts—Illinois State Learning Standards

SUBJECT AREAS: Music and Visual Arts

Music

BENCHMARK:

- 26.A.4c **Music**: Analyze ways in which musical sounds are produced and how they are used in composing, conducting and performing.
- 26.A.4d **Music**: Demonstrate the ability to read written notation for a vocal or instrumental part.
- 26.B.4c **Music**: Create and perform music of challenging complexity and length with expression.

Visual Arts

BENCHMARK:

- 26.A.4e **Visual Arts**: Analyze and evaluate how tools/technologies and processes combine to convey meaning.
- 26.B.4d **Visual Arts**: Demonstrate knowledge and skills that communicate clear and focused ideas based on planning, research and problem solving.

Common to all the Arts

State Goal 25: ***Know the language of the arts.***

BENCHMARK:

- 25.A.4 Analyze and evaluate the effective use of elements, principles and expressive qualities in a composition/performance in dance, drama, music and visual arts.
- 25.A.5 Analyze and evaluate student and professional works for how aesthetic qualities are used to convey intent, expressive ideas and/or meaning.
- 25.B.4 Analyze and evaluate similar and distinctive characteristics of works in two or more of the arts that share the same historical period or societal context.
- 25.B.5 Understand how different art forms combine to create an interdisciplinary work (e.g., musical theatre, opera or cinematography).

State Goal 26: ***Through creating and performing, understand how works of art are produced.***

BENCHMARK:

- 26.A.5 Analyze and evaluate how the choice of media, tools, technologies and processes support and influence the communication of ideas.
- 26.B.5 Create and perform a complex work of art using a variety of techniques, technologies and resources and independent decision making.

State Goal 27: ***Understand the role of the arts in civilizations, past and present.***

BENCHMARK:

- 27.A.4a Evaluate how consumer trends in the arts affect the types and styles of art products.
- 27.A.4b Analyze how the arts are used to inform and persuade through traditional and contemporary art forms.
- 27.A.5 Analyze how careers in the arts are expanding based on new technologies and societal changes.
- 27.B.4a Analyze and classify the distinguishing characteristics of historical and contemporary art works by style, period and culture.
- 27.B.4b Understand how the arts change in response to changes in society.

04 ADDITIONAL LESSON PLANS

Looking for more? Extend student learning or change things up with lessons from a variety of sources.

Subject: Health, Environmental Health, Science, Chemistry, Biology
Grade Levels: Middle School & UP

Take this personally

(How to scrub toxic chemicals from personal care products!)

Objectives - To investigate, prepare, take action, reflect and demonstrate that personal choices can have huge positive consequences.

Students will be able to:

- Learn the FDA's and the EPA's role in ensuring PCP "safety"
- Investigate potentially harmful ingredients used in PCPs
- Determine if any personal care products they use on a daily basis contain harmful ingredients
- Learn about scientific research that shows PPCPs can cause damage to humans, wildlife and the environment
- Design a consumer health/environmental awareness brochure or poster about potential harmful effects of toxic ingredients in PCPs

Materials

PA Sea Grant/Erie Times-NIE publications

- 9/ 23/14 – Something's fishy – Marine life shows signs of troubled ecosystems
- 9/30/14 – Take this personally – You can act to scrub chemicals from personal care products

Other Resources

http://www.paseagrant.org/topics/toxins/

- Dose of Reality
- What you can't see – Hidden chemicals in your water
- Say Good riddance – Progress in eliminating PPCPs from the environment

Student worksheets

Story of Cosmetics – www.storyofcosmetics.org

Environmental Working Group Skin Deep Database – www.ewg.org/skindeep/

EWG Skin Deep Free Mobile App – www.ewg.org/skindeep/app/

Standards

Apply the elements of scientific inquiry to solve problems.
Apply knowledge and understanding about the nature of scientific and technological knowledge.
Apply process knowledge and organize scientific phenomena in varied ways.
Explain concepts about the structure and properties of matter.
Explain sources and uses of earth resources.

This lesson was created by Anna McCartney for Pennsylvania Sea Grant 10/1/14

Science Skills and Processes
Defend a position on a scientific issue and take into account the different types of risks and benefits in formulating a plan of action

- The student will investigate an environmental, health and social issue.
- The student will apply skills, processes, and concepts of biology, **chemistry**, physics, and earth/space science to societal issues.
- The student will apply chemistry to the concepts of biology, earth/space science, and environmental science.

Environmental Science: Students will use scientific skills and processes to explain the interactions of environmental factors and analyze their impact from a local to global perspective
Health: Students will evaluate the short and long term consequences of safe, risky, and harmful behaviors to determine and practice ways to avoid and reduce threatening situations and harmful relationships. Analyze individual responsibility as a factor in enhancing the health of self and others as well as wildlife to identify and practice behaviors for health promotion

Optional Chemistry Connection: *Demonstrate safety when conducting an investigation.* The student will recognize safe laboratory procedures and *demonstrate safe handling of the chemicals and materials of science.*

Evaluation

- Students will be given a check plus, check or check minus for completion of worksheets.
- Students will be graded on their PCP safety brochure or poster based on the rubrics
- Students will retake the "How much do you know about PCP safety after the completion of this lesson to see how much they learned

Who's Trashing the Ocean and Waterways?
Be a Data Detective and then solve the problem

Have any ideas!

This is a problem you can help solve. We already know the oceans and waterways need our help. Investigating the PPCP issue reveals the exact action needed by you and guides you in creating a brochure or poster to share what you learn to encourage others to take action.

Overview

Although the FDA has overall responsibility for ensuring that the cosmetics and personal care products (PCPs) we use on a regular basis are safe, they have very few restrictions or guidelines that insure their safety. In fact, they don't even approve products before they go to market. Wastewater treatment plants or septic systems do not remove many of these chemicals before they enter surface or groundwater. They are adding up in the environment and wildlife is showing signs that these chemicals are doing harm. The EPA does not regulate these toxins.

In this lesson, students will learn about PCP safety issues and concerns. Through readings, guided Internet research, homework, class discussion, the video "Story of Cosmetics" and other activities they will learn that the products they use regularly may actually contain ingredients that can cause human and environmental health problems. Students will have an opportunity to create a PCP safety brochure or poster designed for the average consumer, to create awareness about PCP safety concerns. The goal is to get students to replace harmful products with safe ones.

Procedures

Teacher Prerequisites: Spend some time familiarizing yourself with the Internet resources listed, especially the two searchable databases that the students will be using for their research and preview the Story of Cosmetics. About a month before, start saving empty samples of personal care products and ask your family, friends and colleagues to do the same. This will insure you have enough for all your students to use for their Internet searches.

Make enough photocopies of the student worksheets and quiz. **Assign the PCP Student Use Worksheet for homework prior to starting this lesson.**

On day one, students will take a brief quiz to determine their pre-existing knowledge about PCP safety issues.

Each student will focus on personal care products that they use regularly. During Days 2 and 3, students will conduct research and share information on their products to determine if there are any ingredients in these products that are considered to be of moderate or high concern. They will look for safe replacements and discuss what they can do to keep PCPs out of the environment. Finally, as a culminating activity, students will individually create a PCP safety health/environment brochure targeted for the average consumer to raise awareness of PCP safety issues.

Students should have some familiarity with how to conduct effective searches on the Internet.

Day 1: Daily Challenge Question: What are the personal care products you use on a daily basis and who ensures that they are safe to use or that they are safe for the environment?

45-minute class period

Have students take the pre-assessment quiz on PCPs to test their prior knowledge.

Class discussion to review the answers to the quiz will help students gain a solid understanding of the issues surrounding PCP safety and the FDA's role in product safety and the EPA's role in keeping PCPs out of the environment.

Ask students: *What are PCPs?*
Some might think the term is limited to makeup primarily used by females.

Define PCPs: *Products intended to be rubbed, poured, sprinkled, or sprayed on, introduced into, or otherwise applied to the human body or any part thereof for cleansing, beautifying, promoting attractiveness, or altering the appearance.*

Over the next several days, they will be investigating the safety of common personal care products they use every day and if any contain ingredients that may possibly be harmful to their health or the environment.

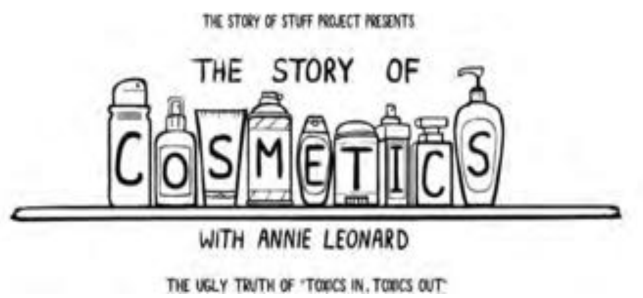
Read aloud or have students read the PA Sea Grant/Erie Times NIE pages on PPCPs to give students examples of commonly used products that may potentially be harmful to human health or wildlife.

Activity - Brainstorm

- Share samples of PCPs so that students can see all the different categories
- Discuss the PCP student Use worksheet students did for homework prior to this lesson
- Give students about 10 minutes to share the products that they use regularly (at least three times per week).

Day 2

Lead a discussion about the cosmetics that students use regularly, safety issues and concerns, and the role of FDA. Have a brief class discussion about some of the commonly used personal care products in order to show a variety of products and quantities used on a daily basis.



Watch The Story of Cosmetics www.storyofcosmetics.org with your students.

1. Segue into discussion about safety.
   - *Do students feel as if they products they use are safe?*
   - *What do they know about PCP safety?* Maybe some students have had allergic reactions, or have heard about articles that have linked PCP to cancer or other health problems. Discuss all these things as a class.
   - *What do students know about the FDA?*
2. Give students about 5 minutes to share their findings of the Toxic 15 the worksheet
3. Revisit Question #1 from the cosmetics quiz. "Does the FDA guarantee PCP safety?" Discuss the FDA's role and mention that the agency only oversees the prohibition of a few ingredients. Also note to students that these ingredients were once included in products, and it wasn't until recently (2002) that they were prohibited. Also mention that there are still many questionable ingredients being used in PCPs.
4. Explain that although the FDA has overall responsibility for the "safety and labeling" of cosmetics, there is truly very little regulation within the industry.
5. Discuss why cosmetic companies self-regulating their own product safety may be of consumer concern. Mention that PA Sea Grant, Fresh Face Forward and advocacy groups such as Safe Cosmetics (safecosmetics.org) and the Environmental Working Group (EWG) are working to help create consumer awareness of PPCP safety issues.

Post Viewing Activities

How will students utilize the information they gathered while viewing the video? Students will have gained an awareness and basic understanding of PCP safety. This knowledge will help them with their homework assignment and move into the next day's activity.

Wrap Up: Tell students that there are several ingredients currently being used in cosmetic products that are of high concern but still have not been prohibited from being used. Students will take the next few days to conduct research to find out if any products they use contain these "high priority" or "high concern" ingredients and the reasons for an ingredient being high concern (i.e., potential health hazard).

Assign the Fresh Face Forward Toxic 15 worksheet for homework. Tell students they will be conducting research to determine if any products that they use on a daily basis contain ingredients that are considered to be of moderate to high concern by looking for the toxic 15 in the products they use regularly.

Students will determine if any of the PCPs they use regularly contain chemicals of moderate to high concern.
Students will fill in their worksheets as they look for the Toxic 15 chemicals in products they use.
Students will have gained a greater awareness of both the products they use as well as any potential health/environmental effects associated with those products.

Days 3: How safe are my products?

Daily Challenge Question: Are there any ingredients in the products that I use regularly that are of moderate-to-high concern? What are the potential health and environmental effects of these "high concern" ingredients or products?

45-minute class

Establish student pairs ahead of time. Ideally, pair students of different genders so that their cosmetic products offer a good mix of different types of products. Arrange for access to a computer lab for student research.

Directions:

Have students share what they found on their labels and ingredients on each of their products with a partner.

Discuss answers to homework questions.

Hand out Safer Alternatives worksheet and have students work with their partner to complete this activity.

PCP Safe Alternatives Student Worksheet Day 3

Teacher Presentation & Motivation:

Optional: Depending upon your students' skill level with conducting Internet searches, you may want to give a quick overview of the two searchable databases as a class, to make sure students know how to use the sites efficiently.

http://householdproducts.nlm.nih.gov/index.htm and http://www.ewg.org/reports/skindeep2/index.php

Use the product you find as an example.

Search more than 69,000 products at Environmental Working Group Skin Deep here: http://www.ewg.org/skindeep/

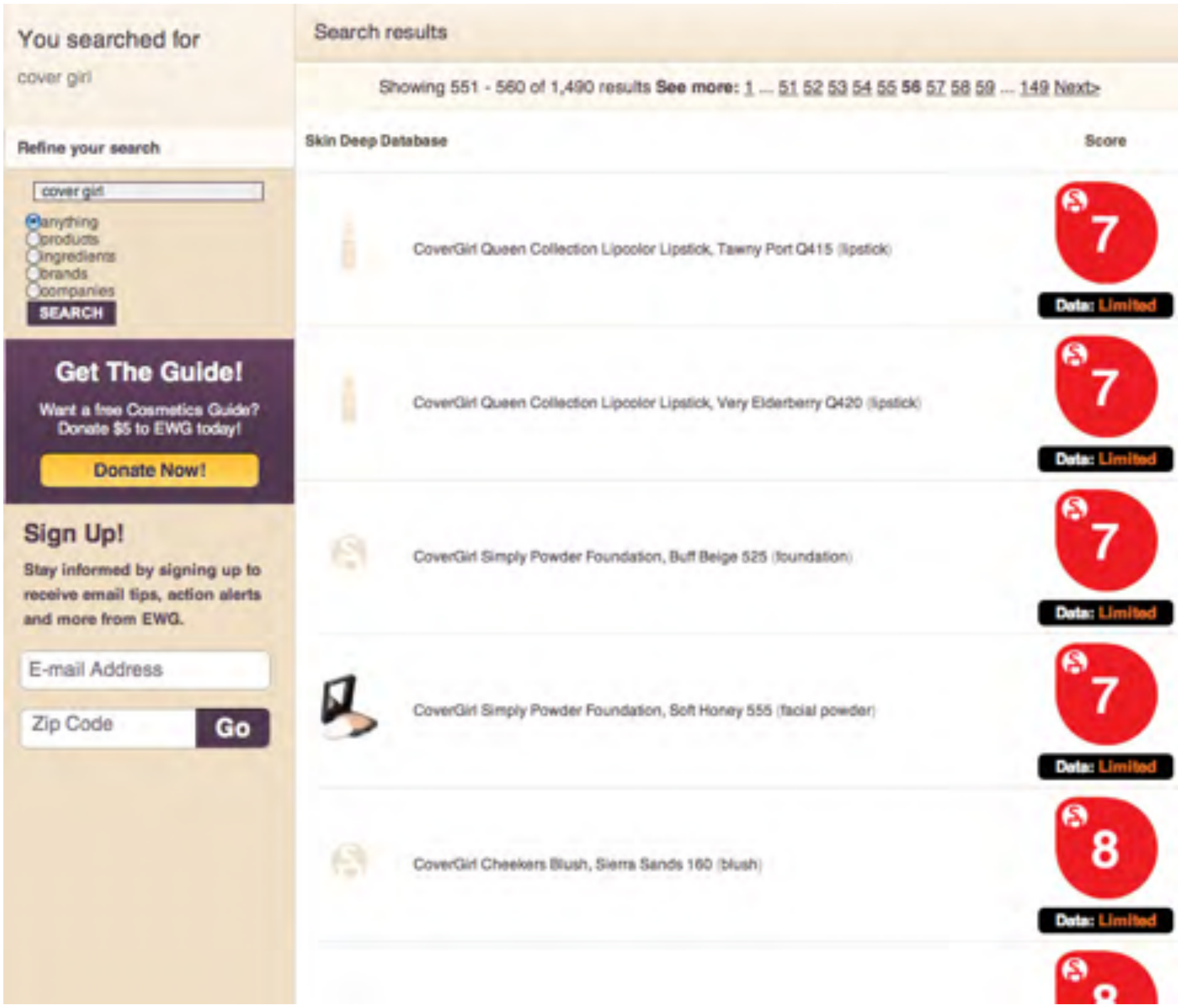
- Browse by product type, example toothpaste lowest to highest safety concern
- Look for alternatives to products you can use that don't have the toxic 15 or are scored 0-2.

When you find a product with low concern, click on the link. You will then find a more detailed view of the product. Have students make a list of products they can use to replace any of their products that contain toxic chemicals on the worksheet provided.

Students will follow the steps outlined on their student worksheet, using the websites provided, to conduct research on specific products they use, as well as ingredients in those products.

The number of products and ingredients that students investigate will depend upon how quickly they become acclimated to the research databases. For two days worth of research, students should be able to look up a minimum of 20 ingredients.

Sample of search for cover girl products:



On day 4 have students wrap up about 15 minutes before the class ends.

Discuss effects of PPCPs on wildlife and the environment. Why doesn't the Clean Water Act or Safe Drinking Water Act keep these chemicals out of streams, rivers, groundwater and lakes used for drinking water? Discuss the reasons and ask students for their solutions.

Ask student pairs to report on any products they use that may contain ingredients of moderate to high concern and the potential health and environmental effects of these ingredients. Tell students they may want to do further research on dosage and quantity amounts to be certain they're not exposed to too much of a potentially harmful substance.

For homework (give students about a week), have students create a health brochure or poster about PCP safety. Instructions and guidelines are included on Part III of their worksheet. Distribute the rubric as well.

See extension: Tell students if they are truly concerned about the health issues associated with PCP use, that can write to the FDA and EPA, urging them to better regulate the PCP industry and keeping them out of the environment.

Enrichment Options

Community Connection
Have students write a letter to the FDA or EPA encouraging them to more fully regulate PPCPs Hold a PPCP safety fair at a local community center, or for **the school to raise awareness.**

Parent-Home Connection
Have students share their brochures/posters with their parents and discuss with them use of personal care products.

Field Experiences
Visit a local wastewater treatment plant and find out why some toxic chemicals in PPCPs cannot be removed.

Cross-Curricular Extensions
Bring in more of a language arts component and engage students in an ethical debate about the use of animals for product safety and testing or about the harm the products we use are causing wildlife.

Chemistry: Have students make their own perfume or personal care products by using the recipes at freshfaceforward.org.

Teacher Reflection

What instructional strategies worked and what made them successful? What will you change the next time you use this lesson? Why?

More Resources are on the following pages

Sample Press Release

FOR IMMEDIATE RELEASE: Today's date

Catchy title:

What: Over 50 dedicated members of Youth In Action decided to do something about all the toxic chemicals in personal care products that are accumulating in their bodies and in the environment.

To keep these PCP chemicals from entering surface or groundwater they are replacing products they use that contain harmful chemicals with safer choices. They are also sharing what they learned at:

When: Date and time
Where: Location:
For more details, contact: (contact information)

Why (give reasons why you participated): "Whether we live near a coast or hundreds of miles away, we are all need clean water to survive. If we continue to add toxic chemicals from PCPs to the water we threaten our health and the wildlife that relies on clean water.

Toxic chemicals cannot be seen but they are one of the most pervasive issues currently facing our rivers, lakes, groundwater, and the ocean. These chemicals negatively affect the quality of our drinking water, the health of our communities, and are hazardous to wildlife and even hurt our economy. Most of the products we use have safe alternatives. "Although PCP pollution is one of the most challenging of problems, it is also one of the most preventable." (This compelling quote by teacher and contact information)

Tips on Writing Effective Letters to the Editor

The letters section is one of the most highly read sections in any newspaper or magazine. In addition, many web sites also now have special sections for readers to comment on issues of the day. Make sure you read the paper before you write to get an idea of their particular format and focus, and be sure to name specifically the editor you're addressing.

Letters to the editor are an easy way for you to voice your opinion to policy makers and to educate readers about issues that concern you. Letters to the editor can be used to correct facts in an inaccurate or biased article, to praise or criticize a recent article or editorial, or simply promote your opinion on an important issue.

Key points: Be timely – Capitalize on recent news and events, respond within 24 hours of a story if possible. Be sure to refer to the article or event you are responding to in the first sentence of the letter.

Keep it short and simple – Under 250 words ideally, even less if you can. Research the paper or magazine you are writing to see if they have a specific word limit. Keep your points clear and stick to one subject. Look at the editorial page of the publication you're writing to and copy the format they normally print.

Think locally – Demonstrate how this issue effects you locally, and - if possible - mention lawmakers or news makers by name to ensure you get their attention. Sign your letter. Include your name, address and telephone number. Papers may need to contact you if they are considering printing your letter. Don't worry—they won't print your phone or street address.

Follow-up. If the newspaper doesn't call you, call them! Speak to the person in charge of letters to the editor (You should know who this is before writing your letter). Ask if they plan on printing your letter, and if not, ask if they have any feedback for you. Thank them for their time and feedback.

Don't be discouraged if your letter is not printed. Every time you submit a letter, you are educating the editorial board of your paper and paving the way for future letters to be printed. Keep trying!

Seal the deal. If your letter is printed, be sure to send us a copy so we can track our effectiveness. If you mention an elected official, or other newsmaker you may want to send them a copy too.

PCP Use Student Worksheet
(Homework given before day 1)

NAME______________________________________

Personal Care Products you use

Based on the definition of PCPs, brainstorm as many products that you use on a regular basis (at least three times per week) and list them below.

Type of product / category	Brand name and product		Type of product / category	Brand name and product
Ex: Face Cream	Oil of Olay – Total Effects Night Firming Cream			
Ex: Toothpaste				

Day 1: PCP Safety – Test Your Knowledge Pre Test

NAME______________________________________

How much do you know about PCP safety?

1 The FDA must approve all PCPs before they are sold in stores. ____ T _____ F

2 Chemicals used in PCPs like soaps, lotions, and shampoos can cause problems in fish, frogs and other wildlife. ____ T _____ F

3 The EPA has limits for the amount of chemicals in PPCPs that can enter streams, rivers lakes and groundwater. ____ T _____ F

4 Wastewater treatment plants remove all chemicals from water ____ T _____ F

5 “Cruelty free” or “not tested in animals” means that no animal testing was done on the product and its ingredients ____ T _____ F

6 If a product is labeled “all natural” or “organic” it’s probably safer ____ T _____ F

7 Even if a product is labeled “hypoallergenic” it may contain substances that can cause allergic reactions ____ T _____ F

8 Choosing products with the claim “dermatologist tested” is a way to avoid an allergic reaction or other skin irritation ____ T _____ F

9 PCPs are required to have an expiration date. _____T ______F

10. Government and FDA regulations require companies to perform specific tests to demonstrate the safety of individual products or ingredients and requires them to share their safety information with the FDA. _____T ______F

As you review the answers as a class, use this space to take notes about PCP safety.

Homework Day 1 - How safe are my products?
The Fresh Face Forward Toxic 15

NAME____

Directions: Read the labels on the products that you listed on "My personal care products" worksheet and look for the Fresh Face Forward toxic 15 chemicals. Add the products that contain any of the toxic 15 and complete this table for each of those products. Use the back of this sheet if you need more space.

Type of product / category	Brand Name and product	Toxic 15 ingredients in my product	Health Effects (possible or known); Use the Environmental Working Group Skin Deep Database for more information www.ewg.org/skindeep.

Answer the following questions about your products:

What products do you use that contain, "*organic*", "*hypoallergenic*", "*natural*" or "*dermatologist tested*" on the label?

How many of your products contain Fresh Face Forward Toxic 15 chemicals?

Sea Grant Pennsylvania

FRESH FACE FORWARD TOXIC 15

Are they in your products? Read your labels!

Did you know only 11% of the ingredients in personal care products have been tested for safety? The toxic 15 on this list were chosen because of known and suspected health and environmental hazards, and the frequency of their use in PCPs. An Environmental Working Group hazard score is listed for each chemical. For more information on chemicals and ratings, visit the Environmental Working Group's Skin Deep Database at http://www.ewg.org/skindeep/. The ingredient hazard score, from 1-10 reflects known and suspected hazards.

0-2	3-6	7-10
Low hazard	**Moderate hazard**	**High hazard**

Toxic 15 in alphabetical order

EWG Ratings	*CHEMICAL NAME/RISK*	*COMMON USES*
Aluminum Powder: **4-9** Aluminum Chlorohydrate: 3 Aluminum Sulfate: 2	**Aluminum -** Research links to Alzheimer's and breast cancer.	Antiperspirants, spray types very dangerous as they are absorbed through the nasal passages.
BHA: 9-10 **BHT: 6**	**BHA and BHT -** Absorbed through the skin, is metabolized and stored in various body tissues.	Preservatives, in moisturizers, creams, and cosmetics
10	**Coal Tar and Coal Tar Dyes -** can cause cancer (stomach, esophagus, bladder, kidney and liver), skin irritation, are toxic to the liver, digestive system, immune system, brain development and build up in body organs and the brain	Byproducts of coal processing found in dandruff shampoos and medicated shampoos for lice and in hair dyes
DEA: 7-10 **MEA: 4-5** **TEA: 5**	**Ethanolamines – Monoethanolamine (MEA), diethanolamine (DEA) and triethanolamine (TEA** can cause cancer (stomach, esophagus, bladder, kidney and liver), skin irritation, and impaired vision, toxic to the liver, digestive system, immune system, brain development and they build up in body organs and the brain	Most common chemical in cosmetic and personal care products. Used to produce foam and blend oil and water ingredients - found in perfume, shaving products, facial cleansers, bubble bath, body wash, shampoo, soap, baby products, moisturizers, sunscreen and hair dyes.
Formaldehyde DMDM hydantoin **10** **Diazolidinyl urea - 4** **Imidazolinyl urea - 3**	**Formaldehyde (DMDM hydantoin, 2-Bromo-2-nitropropane-1,3-diol) also diazolidinyl urea or imidazolidinyl urea - known carcinogen, human respiratory toxin, can cause irritation to skin, eyes, and lungs, strong evidence that it causes allergies and is an immunotoxin**	Preservative in some cosmetics including mascara, anti-aging creams to prevent bacteria growth. Also used in nail polish and some hair treatment chemicals for perms or hair straightening. Also used in soap, shampoo, bubble bath, toothpaste and mouth wash.
8	**Fragrance** is a complex mix of mystery ingredients considered proprietary for each company - an average of 14 chemicals per product not listed on the label, that can trigger allergic reactions or interfere with hormone function	Nearly every personal care product, even those marked "fragrance-free" or "unscented," may contain fragrance ingredients or those that mask the odor of the product.
8	**Oxybenzone** absorbs through the skin in significant amounts and is known to accumulate in people. Has been linked to allergies, hormone disruption and cell damage.	Sunscreen ingredient

EWG Ratings	*CHEMICAL NAME/RISK*	*COMMON USES*
Methyl- and ethyl- 4 **Propyl-, butyl-, isopropyl- parabens: 7**	**Parabens – Methyl-, propyl-, butyl-, isopropyl-, and ethyl- parabens -** endocrine disruption, immunotoxicity, biochemical and cellular level changes by interfering with gene expression, developmental/reproductive toxin, and a wildlife and environmental toxin	Preservatives usually found in products that contain water to prevent the growth of fungus and bacteria
4	**Petrolatum** is derived from petroleum - can cause contact dermatitis and is commonly contaminated with cancer causing chemicals	Used as a conditioner and moisturizer in bath products, cleansing products, skin care products, cosmetics, hair products, shaving products, and tanning products
3-7	**Polyethylene Glycol (PEG-20, Ceteareth) -**May contain potentially toxic impurities like 1,4-dioxane and ethylene oxide that can cause organ and immune system damage, and that cause cancer (uterine, breast, leukemia, brain), reduced immunity, nervous system disorders, miscarriages, and birth deformities	Thickens, dissolves oil and grease, and used in oven cleaners. Found in shampoo, conditioner, bath products, shaving products, deodorant, sunscreen, and cosmetics
DBP: 10 **DEP: 3** **DEHP: 10.**	**Phthalates (- dibutyl- (DBP), diethyl- (DEP), and diethylhexyl- (DEHP)**) linked to male reproductive system disorders. Dibutyl Phthalate is an endocrine disruptor, developmental or reproductive system toxin, immunotoxin, human respiratory toxin, and bioaccumulates and persists in wildlife	Used in cosmetics as solubulizers and in perfumes to make the scent last longer. Pregnant women should avoid nail polish containing dibutyl phthalate. Everyone should avoid products with "fragrance" since the unlisted chemical mixture may contain phthalates.
Cyclotetrasiloxane: 5 **PEG-8 Dimethicone: 3**	**Siloxanes -** can cause uterine tumors, endocrine disruption, impair fertility and neurotransmitter function, and are toxic to the immune system. They have been shown to create stress on liver, kidneys and lungs in animal studies. They can build up in living tissues	Used to soften, smooth and moisten. Found in hair products (shampoo, conditioners, hair spray, hair styling), deodorants, body wash, lotions, sunscreen, shaving products and facial products
3	**Sodium Lauryl (Laureth) Sulfate -** Despite its low rating, it is expected to be toxic or harmful to non-reproductive organ systems, is an eye and skin irritant when airborne, and is a suspected environmental toxin	Used in cleansing products like creams and lotions, and bubble baths. It helps with cleansing and removing oils and dirt from the body
10	**Toluene/Benzene** - strong evidence that these are developmental and reproductive toxins, toxic to other organ systems, bioaccumulates and persist in humans, are skin irritants and wildlife and environmental toxins. A pregnant woman's exposure to toluene vapors during pregnancy may impair fetal development. In human epidemiological and animal studies, toluene has been associated with toxicity to the immune system. Some evidence suggests a link to malignant lymphoma.	Volatile petrochemical solvents and paint thinner used in nail products to help with hardening.
7	**Triclosan/Triclocarban -** studies have shown it to be: an endocrine disruptor even at low doses, toxic to organ systems, a skin, eye and lung irritant, and considered a wildlife and environmental toxin. Triclosan can cause possible immune or allergenic effects, bioaccumulate in wildlife, disrupt thyroid function and reproductive hormones. Overuse may promote the development of bacterial resistance.	A pesticide used in anti-bacterial and anti-microbial soaps, acne lotions, some toothpastes and deodorants. The American Medical Association and the American Academy of Microbiology say that soap and water is best to prevent spread of infections and reduce bacteria on the skin.

Many of these ingredients have been linked to cancer in animals and/or humans, or are often contaminated with carcinogens, or readily form carcinogenic nitrosamines when mixed with other ingredients. These pose greater risks than food contaminants because they are absorbed by the skin and bypass the liver's protective detoxification process reaching the general blood circulation quickly. Many of them are known to also cause environmental harm.

PCP Safe Alternatives Student Worksheet Day 3

NAME______________________________________

Search more than 69,000 products at Environmental Working Group Skin Deep here: http://www.ewg.org/skindeep/

- You can browse by product type, example toothpaste lowest to highest safety concern
- Look for alternatives to products you can use that don't have the toxic 15 or are scored 0-2.

When you find a product with low concern, click on the link. You will then find a more detailed view of the product. Make a list of products you can use to replace any of your products that contain toxic chemicals on the worksheet provided.

Include your original list of products and make a list of safer alternatives on the right.

Type of product / category	Brand name and product you currently use		Possible safer alternative product to replace it
Ex: Face Cream	Oil of Olay – Total Effects Night Firming Cream		
Ex: Toothpaste			

In Class/Homework – Day 4
Using a desktop publishing program such as Microsoft Publisher or Word or Apple Pages, create a three-panel consumer health awareness brochure or a poster that educates consumers about potential adverse health effects of some ingredients found in commonly used personal care products. Your target audience is the consumer…anyone who uses personal care products. Your brochure or poster should include the following information:

- Potentially harmful ingredients and their adverse health and environmental effects
- How personal care products are regulated
- PA Sea Grant, Fresh Face Forward and Consumer advocacy groups and the FDA contact information ("for more information…")

Be sure to consult the brochure rubric (cosmetic-brochure_rubric.doc) so you know how you will be graded. Use the resources below as well as additional sites you can find on your own to help you with the content of your brochure.

- Pennsylvania Sea Grant: www.paseagrant.org/toxins
- Fresh Face Forward: www.freshfaceforward.org
- Environmental Working Group Skin Deep: www.ewg.org/skindeep/app
- Safe Cosmetics http://www.safecosmetics.org/
- Story of Cosmetics: www.storyofcosmetics.org
- USGS Emerging Contaminants http://toxics.usgs.gov/regional/emc/
- Link to a variety of articles on cosmetic safety http://www.nlm.nih.gov/medlineplus/cosmetics.html

Enrichment Options

Community Connection

Write a letter to the FDA or EPA encouraging them to more fully regulate PPCPs.

Hold a PPCP safety fair at a local community center, or for the school to raise awareness.

Parent-Home Connection

Share your brochure with your family and discuss the use of personal care products.

<u>**Uncover the Truth about PCP Safety Brochure or Poster Rubric**</u>

A total of 20 points is possible for each category. **Name: ___________________________**

Group project rubric

CATEGORY	(4) Excellent	(3) Good	(2) Almost	(1) Not Yet
Layout / Design	The brochure is exceptionally attractive and well organized.	The brochure is attractive and well organized.	The brochure is well organized.	The brochure's formatting and organization of material are confusing.
Writing - Mechanics	All of the writing is done in complete sentences. Capitalization punctuation and grammar are correct throughout	Most of the writing is done in complete sentences. Most of the capitalization, punctuation and grammar are correct throughout	Some of the writing is done in complete sentences. Some of the capitalization, punctuation and grammar are correct throughout	Most of the writing is not done in complete sentences. Most of the capitalization, punctuation and grammar are not correct throughout
Graphics	The graphics go well with the text and there is a good mix of text and graphics.	The graphics go well with the text, but there are so many that they distract from the text.	The graphics go well with the text, but there are too few.	The graphics do not go with the accompanying text or appear to be randomly chosen.
Content - Accuracy (Ideas)	The brochure/poster contains a significant amount of accurate and detailed information about PCP safety.	The brochure/poster contains a good amount of accurate information about PCP safety	The brochure/poster contains some content (more could be included) and/or some information not accurate.	The brochure/poster contains little to no useful or accurate information.
Sources	There are many citations from a variety of sources accurately listed in the appendix.	There are some citations from a variety of sources accurately listed in the appendix	There are few citations accurately listed in the appendix	Incomplete citations are listed in the appendix

Individual Project Rubric **Name: ______________________**

CATEGORY	(4) Excellent	(3) Good	(2) Almost	(1) Not Yet
Time-management	Routinely used time well throughout the project, got things got done by the due date. The group did not need extra time because of this person.	Usually used time well throughout the project to get things done by the due date. The group did not need extra time because of this person.	Did not routinely use time well throughout the project to get things done by due date. The group needed a little extra time because of this person.	Rarely used time well throughout the project to get things done by the due date. The group needed extra time because of this person.
Contributions	Routinely provided useful ideas during group participation the and in classroom discussion. He/she was a definite leader who contributed a lot of effort.	Usually provided useful ideas when participating in the group and in classroom discussion. He/she was strong group member who tried hard!	Sometimes provided useful ideas when participating in the group and in classroom discussion. He/she was a satisfactory group member.	Rarely provided useful ideas when participating in the group and in classroom discussion. He/she may have refused to participate at times.
Attitude	Was never publicly critical of the project or the work of others. He/she always had a positive attitude about the task(s).	Was rarely publicly critical of the project or the work of others. He/she usually had a positive attitude about the task(s).	Occasionally publicly criticized the project or work of other members and occasionally had a positive attitude about the task(s).	The student was often publicly critical of the project or the work of other members and rarely had a positive attitude
Organization of Materials	Notes/ information were kept in a folder and were neat and organized.	Notes/information were kept in a folder and were somewhat neat and organized.	Notes/information were kept in a folder but were not neat and organized.	Notes/information were disorganized or lost.
Knowledge Gained	Can accurately answer all questions related to facts in the brochure/poster and technical processes used to create it.	can accurately answer most questions related to facts in the brochure/poster and to technical processes used to create it.	can accurately answer some questions related to facts and to technical processes used to create it.	Appears to have little knowledge about facts or technical processes used.
Compare/ Contrast	Able to list several similarities/differences that reference the brochure/poster presentations.	Able to list some similarities/differences that reference the brochure/poster presentations.	Able to list a few similarities/differences that reference the brochure/poster presentations.	Unable to list similarities/differences that reference the brochure/poster presentations.

PCP Safety – Test Your Knowledge Post Test

NAME____

How much do you know about PCP safety?

1 The FDA must approve all PCPs before they are sold in stores. ____ T _____ F

2 Chemicals used in PCPs like soaps, lotions, and shampoos can cause problems in fish, frogs and other wildlife. ____ T _____ F

3 The EPA has limits for the amount of chemicals in PPCPs that can enter streams, rivers lakes and groundwater. ____ T _____ F

4 Wastewater treatment plants remove all chemicals from water ____ T _____ F

5 "Cruelty free" or "not tested in animals" means that no animal testing was done on the product and its ingredients ____ T _____ F

6 If a product is labeled "all natural" or "organic" it's probably safer ____ T _____ F

7 Even if a product is labeled "hypoallergenic" it may contain substances that can cause allergic reactions ____ T _____ F

8 Choosing products with the claim "dermatologist tested" is a way to avoid an allergic reaction or other skin irritation ____ T _____ F

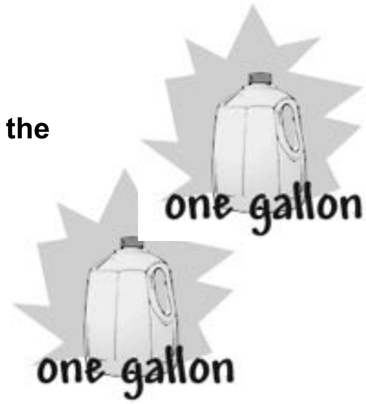
9 PCPs are required to have an expiration date. _____T ______F

10. Government and FDA regulations require companies to perform specific tests to demonstrate the safety of individual products or ingredients and requires them to share their safety information with the FDA. _____T ______F

Use this space and the back of this page to share your thoughts on solving the health and environmental problems caused by PPCP chemicals. Include ideas on who, when, why, what, where and how.

WALK FOR WATER – Do you take drinking water for granted?

Timing: 20-40 minutes
Activity Type: Physical Fitness/Math/Reading/Discussion/Journaling



Description: Students will go on a group walk and carry water to appreciate the scarcity of water and the role women and children play as water collectors in developing countries.

Preparation:
Collect enough plastic gallon milk or water containers so each student has two.

Expectations:
Health and Physical Education – Active Participation
Social Studies/Geography – Find countries where drinking/clean water is scarce or polluted and where it is plentiful and discuss the thinking that access to clean water should be a right for every living thing.
Math – use conversion factors to determine distance and weight to appreciate the value of having clean drinking water piped to our homes, schools etc.
Writing – collect thoughts on paper to compare our water resources with those or lack of them in other countries and in our own country

Conversion factors:
1.00 miles = 1.61 kilometers
2.2 pounds = 1 kilogram
1 gallon of water weighs 8.35 pounds

Teaching Strategies:

1. Lead your class on a mile-long walk having each student carry 2 gallons of water. If there are not enough to go around, divide students into groups and ask them to take turns carrying the water, without letting it touch the ground.
2. Have students read "The Facts About The Global Drinking Water Crisis. Explain to the students that many people in developing countries, usually women and girls, have to walk several kilometers for water. Once filled, their water jugs can weigh as much as 20 kilograms. (Math 1 kg = 2.2 pounds) Have them think about how tiring it was to walk a fraction of that distance, with a fraction of that weight.
3. Have students compare and contrast their walk with people from other countries. Using the facts and conversion factors have students determine: the average distance in miles these people walk to get water, the average weight of the water they carry and the time they spend collecting it. Ask them to address the disparity of water use in this country compared to other countries.
4. Ask students how they feel after learning this information. Have their opinions changed about the importance of access to water for everyone. How does it make them feel about the access to water that we have in this country?
5. Ask the students to write a journal entry about their thoughts on the role of women in developing countries. Ask students to think about some of the other things women and children could be doing with their time instead of walking to collect water. D
6. **Use the website below to find maps to locate areas where access to clean water and sanitation are problems.**

The Facts About The Global Drinking Water Crisis http://blueplanetnetwork.org/water/facts

Developed by: Anna McCartney – Communication and Education Specialist for Pennsylvania Sea Grant to accompany the special Erie Times-NIE/Great Lakes Sea Grant Network supplement about problems associated with pharmaceuticals and personal care products, PPCPs.

One-in-six people in the world lack safe drinking water. Water-related illnesses are the leading cause of human sickness and death.

In many countries, the water problem is the primary reason people are unable to rise out of poverty. **Women and children bear the burdens disproportionately, often spending six hours or more, each day fetching water for their families and communities.** But there is hope. Proven solutions to the water problem currently exist, such as digging wells and rainwater harvesting. Proper funding and a collective will can make universal safe drinking water a reality.

Scope

• **1.1 billion people** in the world don't have access to safe drinking water, roughly **1/6 of the world's population**.
• **2.2 million people** in developing countries, most of them children, **die every year** from diseases associated with lack of access to safe drinking water, inadequate sanitation and poor hygiene. In the past 10 years, diarrhea has killed more children than all the people lost to armed conflict since World War II.
• **Half of the world's hospital beds** are filled with people suffering from water related illnesses.
• Despite the size of the problem, we have made little progress against it. There are even places in the U.S. that still empty raw sewage into the water.
• 50 percent of people on earth lack adequate sanitation: Nearly half of the world's population fails to receive the level of water services available 2,000 years ago to the citizens of ancient Rome.

Women and Children

• Some **6,000 children die every day** from disease associated with lack of access to safe drinking water, inadequate sanitation and poor hygiene - equivalent to 20 jumbo jets crashing every day.
• **The average distance that women in Africa and Asia walk to collect water is six kilometers.**
• Tens of millions of children cannot go to school because they must fetch water every day. Drop out rates for adolescent girls, who even make it that far, skyrocket once they hit puberty, as there are no private sanitation facilities at their schools.

Water Diseases

• 80% of diseases in the developing world are caused by contaminated water
• Waterborne diseases (the consequence of a combination of lack of clean water supply and inadequate sanitation) cost the Indian economy 73 million working days per year.
• If we did nothing other than provide access to clean water, without any other medical intervention, we could save 2 million lives a year.
• The water and sanitation crisis claims more lives through disease than any war claims through guns.
www.water.org

Geography

• The **average person in the developing world uses 2.64 gallons** of water a day. The average person in the **United Kingdom uses 35.66 gallons** of water per day. The average person in the **United States uses between 100 and 175 gallons** every day at home.
• More than 40 million hours are wasted each year in Africa alone from women and children gathering water.
• It is estimated that 5.3 billion people, two-thirds of the world's population, will suffer from water shortages by 2025.

Economics

• Every $1 spent on water and sanitation generates a return of $9 in saved time, increased productivity and reduced health costs in Africa. **-- United Nations Development Program**
• Water is a $400 billion dollar global industry; the third largest behind electricity and oil.
• The UN estimates it would cost an additional $30 billion to provide access to safe water to the entire planet. That's a third of what the world spends in a year on bottled water.
• An estimated 25% of people from cities in developing countries purchase their water from vendors at a significantly higher price than piped water. In some cases, it costs more than a quarter of their household income. **-- CBS News, FLOW**

Consumption

• The average American uses 100 to 175 gallons of water per day.
• The average African uses 5 gallons per day.
• It takes 5 liters of water to make 1 liter of bottled water.
• Almost 70 percent of the available fresh water gets used for irrigation in agriculture.
• More than half of the water used for irrigation leaks, evaporates or runs off.
• It takes 2,900 gallons of water to produce one quarter pound hamburger (just the meat)

Our Planet

• 20 percent of freshwater fish species have been pushed to the edge of extinction from contaminated water.
• Half of the world's 500 major rivers are seriously depleted or polluted.
• "The U.S. has more than 300,000 contaminated groundwater sites.
• **New contaminants including pharmaceuticals and toxins in personal care products are showing up in drinking water around the world.**
• **The water we drink today is the same water the dinosaurs drank—there is no new water.**

These statistics are generally accepted by United Nation, World Health Organization and Millennium Development Goals.
Unicef/WHO Joint Monitoring Program for Water Supply and Sanitation
http://www.wateraid.org/documents/plugin_documents/global_cause_and_effe...
Costing MDG Target 10 on Water Supply and Sanitation, World Water Council, March 2006.
http://www.financingwaterforall.org/fileadmin/Financing_water_for_all/Re...

Chemicals, the Environment, and You: Explorations in Science and Human Health

under a contract from the
National Institutes of Health

National Institute of Environmental Health Sciences

BSCS
5415 Mark Dabling Boulevard
Colorado Springs, Colorado 80918

Videodiscovery, Inc.
1700 Westlake Avenue, North, Suite 600
Seattle, Washington 98109

Lesson 1 Engage

Chemicals, Chemicals, Everywhere

At a Glance

Overview
Students divide substances into categories: made of chemicals/not made of chemicals, synthetic/naturally occurring, and toxic/nontoxic. When the teacher reveals that all the substances are made of chemicals, students discuss how their concept of what a chemical is might differ from the scientific definition. Students observe a mystery chemical and determine what precautions they might need to take when handling an unknown substance. Then, students read case studies of real exposures to chemicals.

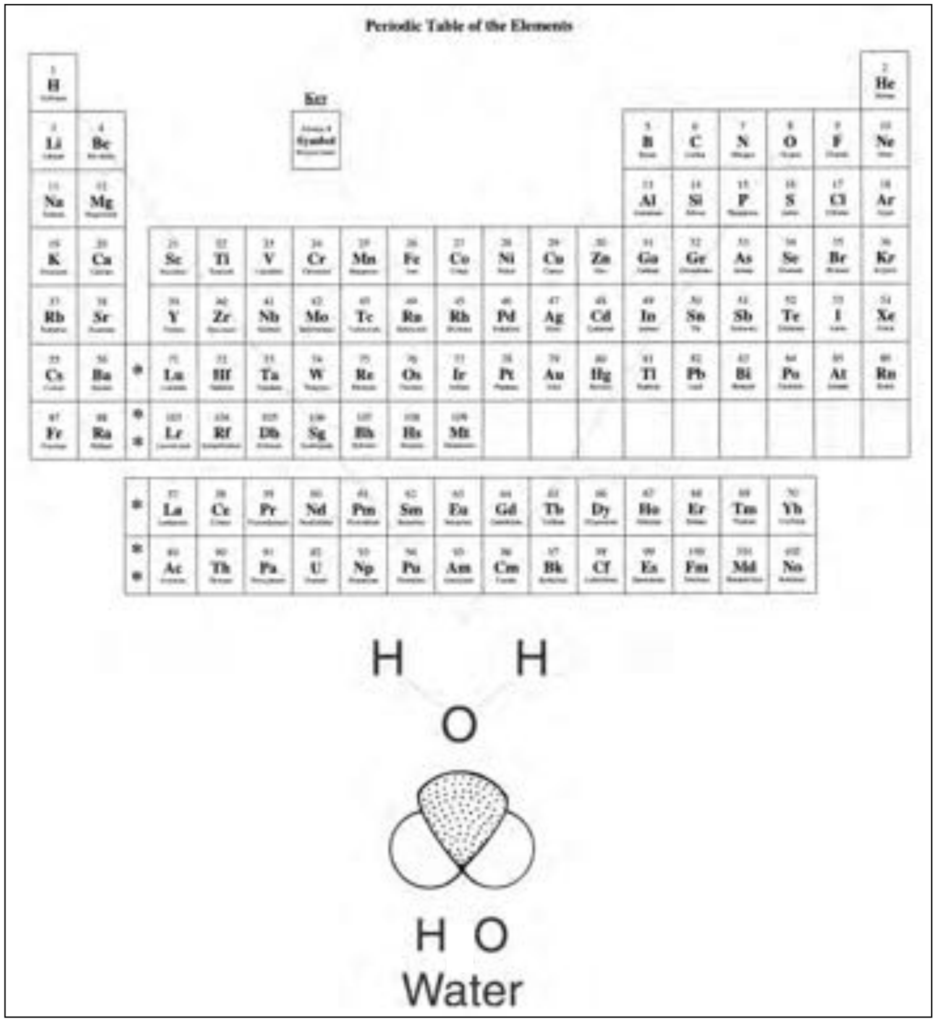
Major Concepts
Everything in the environment is made of chemicals. Both naturally occurring and synthetic substances are chemical in nature. People are exposed to chemicals by eating or swallowing them, breathing them, or absorbing them through the skin or mucosa, and they can protect themselves from harmful chemicals by blocking these routes of exposure.

Objectives
After completing this lesson, students will

- understand that everything in their environment is made of chemicals;
- indicate that both naturally occurring and synthetic substances are chemical in nature;
- recognize that their view of a chemical as "bad" or "good" relates to their perception of a chemical's potential toxicity to humans or other living organisms;
- realize that toxicologists study chemicals to find out if they are harmful to living organisms;
- understand that people are exposed to chemicals by eating or swallowing them, breathing them, or absorbing them through the skin or mucosa; and
- demonstrate that people can protect themselves from harmful chemicals by blocking these routes of exposure.

Background Information

What Is a Chemical?
Simply stated, **a chemical is any substance that has a defined molecular composition**. Molecules, which are the smallest units into which a compound can be divided and still be that compound, can be made up of one or more elements. Sometimes, the elements are the same, such as in oxygen: Two oxygen atoms are chemically bonded together to form the gas, oxygen, or O_2. Sometimes, the elements that form molecules are of different types, such as those in water: Two hydrogen atoms combine with one oxygen atom to form a molecule of water, or H_2O. All forms of matter are made of one or more of the more than 100 elements combined in many different molecular combinations. This means that all forms of matter are made of chemicals.



The Science of Toxicology

Long ago, humans observed that some chemicals derived from nature were poisonous. Poisonous chemicals produced naturally by living organisms (such as plants, animals, and fungi) are called **toxins**. Historically, knowledge of toxins was a powerful tool to use against enemies: many murderers in ancient Greece and later throughout Europe used toxins.[1] A significant contribution to the field of toxicology was made by the scientist Paracelsus (1493–1541). He recognized that the same chemical could have both therapeutic (medicinal) and toxic (poisonous) properties depending on how much of it was used. His work paved the way for the concept of the dose-response relationship (see Lesson 3 for more information about dose and response).[1]


Paracelsus

With the onset of the industrial revolution and the emergence of the science of synthetic chemistry, a variety of new chemicals was made by humans. It is estimated that more than 65,000 chemicals have been manufactured for commercial use in industrialized countries.[1] Whether on purpose or not, humans come into contact with these chemicals during manufacture, handling, or consumption. Exposure to a vast array of synthetic chemicals can occur when a person ingests food or drink, works in an agricultural setting with pesticides, or lives in a home among solvents, paints, plastics, and fuels. Although many of the chemicals greatly benefit us, some can have a toxic effect on human systems. These substances are called **toxicants**, a broad category that includes naturally occurring toxins.

How do people know if a chemical is toxic? The science of **toxicology** informs them of the nature of poisons. A **toxicologist** is a scientist who is trained to study the harmful effects of chemicals on living organisms. These harmful effects can include death, but not all toxicants are lethal. Some other harmful effects that toxicologists study are disease, tissue damage, genetic alterations, and cancer. Because there are so many ways that toxicants can affect living things and there are so many different kinds of chemicals in the environment, toxicology is a very broad science and there are many different kinds of toxicologists.[2]

What Do Toxicologists Do?

Descriptive toxicologists evaluate the toxicity of drugs, food additives, and other products. They ask the question, What happens if…? about the amount of a toxicant and the response that a living system has to the toxicant. The descriptive toxicologist might work in a pharmaceutical laboratory or in an academic setting doing data analysis, animal testing, and/or human clinical trials.[3]

Photo: Corel

Mechanistic toxicologists study how a chemical causes toxic effects on living organisms. They study biomedical research, biochemistry, and physiology to understand how a chemical is absorbed, distributed, and excreted. A mechanistic toxicologist uses information about how a chemical harms an organism in order to develop antidotes. This kind of toxicological work often is done in an academic setting or in private industry.[3]

Clinical toxicologists usually are physicians interested in the prevention, diagnosis, and treatment of poisoning cases. Clinical toxicologists specialize in toxicology issues concerning drugs used for treatment, such as side effects and overdoses; drugs of abuse, such as alcohol and cocaine; and accidental poisonings. These toxicologists have specialized training in emergency medicine and poison management. Veterinarians also can be clinical toxicologists who study poisons in animals.[3]

Photo: Cameron Davidson

Forensic toxicologists study the application of toxicology to the law. They work with pathologists and law enforcement officers at a crime scene. The forensic toxicologist uses chemical analysis to help establish the cause of death and determine the circumstances of death in a postmortem investigation.[2]

Environmental toxicologists study the effects of pollutants on organisms, populations, ecosystems, and the biosphere. Toxicologists concerned with the effects of environmental pollutants on human health fit into this group. Most commonly, however, environmental toxicologists study the impacts of chemicals on nonhuman organisms such as fish, birds, terrestrial animals, and plants.[2]

Regulatory toxicologists use scientific data to decide how to protect humans and animals from excessive risk. Regulatory toxicologists aim to protect the public from chemical exposure by establishing regulatory standards for food, drugs, water, air, and insecticides, to name only a few. Government bureaus such as the U.S. Food and Drug Administration (FDA) and the U.S. Environmental Protection Agency (EPA) employ regulatory toxicologists.[2,3]

Routes of Exposure

Toxicants can harm an organism only if they are absorbed by the organism and reach the organs that are the target of their toxicity. This can happen through three routes:

- ingestion
- inhalation
- absorption through the skin

In humans and other animals, toxicants usually affect one or more target organs such as the lungs, skin, or gastrointestinal tract. For example, if a person inhales asbestos fibers, the fibers get stuck in the airways of the lungs and irritate the lung lining, causing lung impairment over time. Dermatitis can result if the asbestos fibers irritate skin cells.

Sometimes the toxicant crosses from the external environment of the lung, skin, or gastrointestinal tract into the bloodstream.[1] Many parts of the human body are designed to absorb chemicals quickly and effectively. The stomach, intestines, and colon absorb nutrients from our diet. These organs easily absorb nutrients and other chemicals because of their large surface area, thin diffusion distance, and high blood flow. The lungs also are designed for rapid absorption. Chemicals that are inhaled are quickly absorbed into the bloodstream through the thin walls of the air sacs in the lungs. The skin protects the body from harmful agents in the environment. However, the skin is in direct contact with the environment. While the dense outer layer of skin cells is a good barrier to chemical absorption, it is not perfect, even when intact. When the skin is cut or abraded, it absorbs chemicals very rapidly.[4]

Students' Misconceptions About Chemicals

Students often harbor misconceptions about chemicals. When asked what a chemical is, rather than define the word, students tend to give examples of synthetic, toxic chemicals like pesticides. When asked to name some things made of chemicals, students list items such as shampoo, window cleaner, processed foods, and "fake sugar" (aspartame). Students believe that chemicals pollute rivers and air. Students often do not realize that natural substances in the world around them also are made of chemicals. When asked if it would be better if there were fewer chemicals in the world, one student replied that fewer human-made chemicals would mean less pollution. When pressed, students will agree that some synthetic chemicals, like a pain reliever, can be good; however, students also recognize that even "good" chemicals like pain relievers can be toxic if a person takes too much.[5]

Notes About Lesson 1

The purpose of this lesson is to help move students from the view that chemicals are toxic, synthetic substances that are bad for human health and the environment to the more inclusive view that all things in the environment, including their bodies, are made of chemicals. Some of both naturally occurring and synthetic chemicals can have a detrimental effect on human health and the environment, but many do not. Those that have a harmful effect on human health do so because they get into the body through inhalation, ingestion, and absorption.

In Advance

CD-ROM Activities	
Activity Number	**CD-ROM**
Activity 1	yes
Activity 2	yes
Activity 3	yes
Extension Activity	no

Photocopies		
Activity Number	**Master Number**	**Number of Copies**
Activity 1	Master 1.1, *Item Cards* Master 1.2, *Periodic Table of Elements* Master 1.3, *Elemental Composition of the Human Body*	1 set for the class 1 transparency (optional) 1 transparency
Activity 2	none	none
Activity 3	Master 1.4, *Questions for Case Studies* Master 1.5, *Case Studies of Routes of Exposure*	1 transparency 1 copy of Case Study #1 for each student; number of copies of Case Studies #2–5 varies; see *Preparation* for Activity 3
Extension Activity	none	none

Materials		
Activity 1	**Activity 2**	**Activity 3**
For the class: • CD-ROM • computers • overhead projector • transparency of Master 1.2, *Periodic Table of Elements* (optional) • transparency of Master 1.3, *Elemental Composition of the Human Body* • 12 samples of things made of chemicals[a] • 1 set of Item Cards, from Master 1.1, *Item Cards*[b] • 8 4-by-6-inch index cards **For each student:** • science notebook	**For the class:** • CD-ROM • computers • blue food coloring • 50-mL graduated cylinder • 50 mL of purified water • 50-mL or larger glass jar with a lid • 1 large shoe box with a lid[c] • variety of clothing in a large basket or box[d]	**For the class:** • CD-ROM • computers • overhead projector • transparency of Master 1.4, *Questions for Case Studies* **For each student:** • 1 copy of Case Study #1 for each student from Master 1.5, *Case Studies of Routes of Exposure*; copies of Case Studies #2–5; see *Preparation* for Activity 3 • science notebook

[a] Because everything in the environment is made of chemicals, any item will work, such as salt, sugar, lemon, soft drink, liquid soap, window cleaner, shampoo, apple, rock, leaf, chair, and water. Use the chemicals students test in Lesson 2 (see *Preparation* for Activity 3 on page 28), plus others that do and do not fit students' concept of chemical.

[b] Item cards depict objects that are too big for the materials table or are potentially dangerous substances that students should consider when they choose items made of chemicals.

[c] Make sure that the glass jar fits inside the shoe box.

[d] Collect clothing such as elbow pads, knee pads, shorts, T-shirt, long-sleeved shirt, pants, different kinds of hats, hip waders, boots, sandals, sneakers, socks, sunglasses, protective goggles, ear and nose plugs, paper mask, mittens, gloves, and latex gloves.

PREPARATION

Activity 1

Arrange for students to have access to computers.

Collect samples of things made of chemicals. Place them on a materials table.

Tip from the field test: To make gathering the materials easier, ask students to bring in one item they think is made of chemicals and one they think is not made of chemicals.

Duplicate and cut out the Item Cards from Master 1.1, *Item Cards*. Fold them in half to make tent cards. Place the Item Cards on the materials table with the things made of chemicals.

Fold the index cards in half to make tent cards and label them with one of the following titles:

- made of chemicals
- not made of chemicals
- synthetic
- naturally occurring
- toxic
- nontoxic
- good
- bad

Make a transparency of Master 1.2, *Periodic Table of Elements* (optional).

Make a transparency of Master 1.3, *Elemental Composition of the Human Body.*

Activity 2

Arrange for students to have access to computers.

Make 50 mL of a mystery chemical:
- Measure 5 mL of blue food coloring into a 50-mL graduated cylinder.
- Add purified water to the graduated cylinder until you have 50 mL of blue solution.

Pour the mystery chemical into a 50-mL or larger glass jar and screw on the lid tightly. Place it inside the shoe box. Place the shoe box behind your desk.

Ask students to bring in articles of clothing. Place them and any you have gathered in a basket or box behind your desk.

Activity 3

Arrange for students to have access to computers.

Make a transparency of Master 1.4, *Questions for Case Studies*.

Duplicate Case Study #1 from the Master 1.5, *Case Studies of Routes of Exposure*, 1 for each student. Decide whether each student or teams will complete Case Studies #2–5 and duplicate the appropriate number.

Procedure

ACTIVITY 1: WHAT IS A CHEMICAL?

1. **Place the samples of things made of chemicals and the Item Cards on the materials table.**

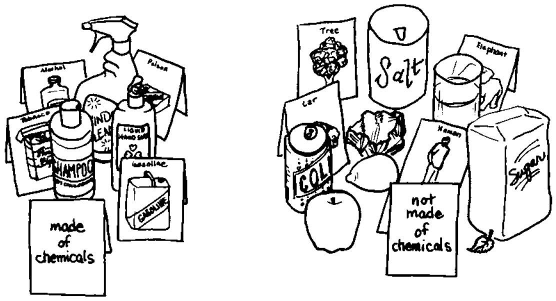
2. **Ask the students to look at the materials table and select one thing that they think is made of chemicals and one thing they think is not made of chemicals. Direct students not to remove the items, but to record the name of the items in their science notebooks.**

   Tip from the field test: In large classes where it might be difficult for students to see the materials, prepare a list of the names of all the materials and make a copy for each student. Instruct students to circle those materials on the list that are made of chemicals.

   You might find that students want more information. They might want to know what you mean by "made of chemicals." They might want you to be more specific about whether they should consider only synthetic items or those that may be toxic. Acknowledge that you have given them limited information, but ask them to do their best to make their choices. Do not provide any assistance at this time.

3. **Once all the students have recorded the items in their notebooks (or circled the items on their list), ask each student to name one item that is made of chemicals and one that is not. As students tell you their choices, stand by the materials table and separate the items according to student choices into two categories: made of chemicals and not made of chemicals. Continue until all students have shared their ideas. Use two of the tent cards to label the two categories: "made of chemicals" and "not made of chemicals."**

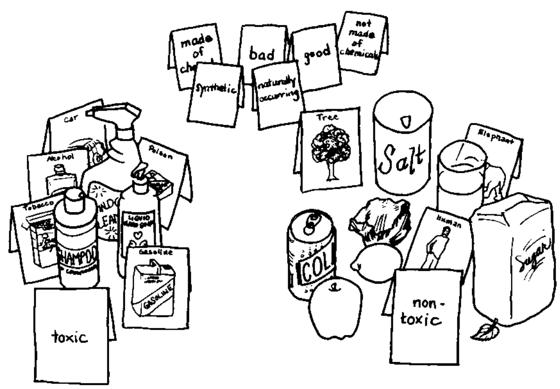
This activity provides you with a good assessment of students' prior knowledge of the concept of chemicals.



4. **Direct students to look at the groups of substances they think are and aren't made of chemicals. Conduct a discussion by asking questions similar to these:**

   - **Why do you think these are (or are not) chemicals?**
   - **Can you redivide these items into several different categories, such as synthetic (made by people) or naturally occurring? Good for humans or the environment or bad for humans or the environment? Toxic (harmful) or nontoxic (not harmful)?**
   - **Can a natural substance be made of chemicals?**
   - **Can a synthetic substance not be made of chemicals?**
   - **Is a natural substance always nontoxic, or a synthetic substance always toxic?**

   As you conduct this discussion, rearrange the items on the table several times and use new tent cards to label the new categories: "synthetic" or "naturally occurring"; "toxic" or "nontoxic"; and "bad" or "good."



Content Standard B:
…There are more than 100 known elements that combine in a multitude of ways to produce compounds, which account for the living and nonliving substances we encounter.

5. **As you progress through the discussion in Step 4, students may realize that they do not know a useful definition for "chemical." Have this definition ready for them:**

   chemical: any substance that is made of specific elements combined into molecules

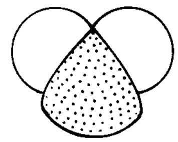
6. **As a class, view the segment from the CD-ROM titled *Everything Is Made of Chemicals.***

   To view the segment, load the CD (see Installation Instructions on page 13) and go to the main menu. Click on *Chemicals, Chemicals, Everywhere* and select the segment titled *Everything Is Made of Chemicals***.**

Note: If you do not have access to a projection screen for the CD-ROM, set up a computer center where students can view the CD-ROM on their own or in small groups at a later time. At this time, display the transparency of Master 1.2, *Periodic Table of Elements,* and discuss the following:

- **Ask students to consider one substance, water, in light of the definition. Is water made of elements combined into molecules?**

Students are familiar with the molecular composition of water: H_2O. Point out the elements hydrogen and oxygen on the periodic table.


Water

- **Help students recognize that sugar and salt also are made of a combination of elements that form molecules.**

Table sugar is a crystalline carbohydrate, $C_{12}H_{22}O_{11}$. Salt is sodium chloride, NaCl.

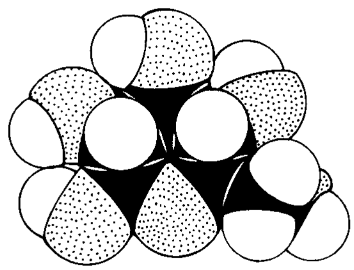


Table sugar

7. **After viewing the CD-ROM or discussing the periodic table, continue by helping students recognize that all of the substances on the materials table are made up of specific molecules, even if the students don't know exactly what they are. Once they recognize this, students will begin to realize that all things are made of chemicals. Ask students to tell you, based on their new understanding, some other things around them that are made of chemicals. Let students continue until you see that they understand that everything around them, or everything in their environment, is made of chemicals.**

8. **To make sure that the students understand that they, too, are made of chemicals, display a transparency of Master 1.3, *Elemental Composition of the Human Body*. Let your students know that these elements are combined in many different ways to form thousands of different chemicals that make up the human body.**

9. **Discuss with students how their original idea about what a chemical is, which led them to their choices in Step 2, is different from the scientific definition of a chemical. Why do they think this is so?**

Students will recognize that they hear most about the chemicals that are toxic to humans or the environment. Because of this, students often think of chemicals as only those synthetic substances that are introduced to the environment and cause harm. Help students recognize that they also know a lot about synthetic chemicals that are beneficial to humans, such as pain relievers and other medicines. They also know about naturally occurring chemicals that are toxic to humans, such as hydrogen sulfide (sewer gas) and carbon monoxide, to name two. By the end of the discussion, help students recognize that chemicals can be synthetic or naturally occurring and make up every substance on Earth, even our bodies.

Bridge to Activity 2 by helping students understand that many chemicals, both synthetic and naturally occurring, can be beneficial to humans and the environment. Those chemicals that are not beneficial are the ones we want to know more about so that we can protect ourselves and the environment from harm.

ACTIVITY 2: PROTECT THE TOXICOLOGIST

1. **Bring out the shoe box from behind your desk. Tell the students that inside the shoe box is a mystery chemical. Discuss with the students some things they might want to know about the contents of the shoe box before they open it. Ask why it would be important to know these things.**

   Be sure that students recognize that they would want to know what the chemical is (for example, name; naturally occurring or synthetic; solid, liquid, or gas; how much of the chemical is in the container). Most importantly, they would want to know if it is toxic to the humans in the classroom because they would not want to accidentally expose themselves to a harmful substance.

Content Standard G: Students should develop an understanding of science as a human endeavor.

2. **Tell the students that they are asking a lot of the same questions that a toxicologist might ask. Write the word *toxicologist* on the board. Ask students to identify the root of the word, *toxic*. Underline it on the board. Tell students that toxicologists are scientists who are specially trained to examine the nature of the harmful effects of chemicals on living organisms. They try to understand which chemicals are toxic to living organisms and in what amounts those chemicals are toxic. While they want to know which chemicals might cause death, they also are interested in other toxic effects, such as disease, tissue damage, genetic alterations, and cancer.**

3. **Select a student (or ask for a volunteer) and tell the student that he or she is a toxicologist. Tell students that you want the student toxicologist to open the shoe box and look at the mystery chemical, but you do not know anything about the chemical. The student toxicologist needs to protect himself or herself in case the chemical is harmful to humans.**

   Present to the class the large basket or box of clothing. Ask the class to work together to think of items that the toxicologist should wear for protection from exposure to the chemical. Find items in the basket as students suggest them and give the items to the student toxicologist to put on until he or she is dressed in a protective manner that satisfies the class.

Tip from the field test: You may not have access to a wide variety of true protective gear. Use regular clothing, but ask students what problems there might be with certain items. For example, if students suggest that the toxicologist's hands need to be covered, you could pull out a pair of mittens. Direct the toxicologist to put on the mittens, but ask the class if the mittens are the best choice and why or why not.

As students select an item, question why a toxicologist needs to wear it. Probe for understanding that a toxicologist is concerned about exposure to a chemical by eating or drinking it, by breathing it, and by absorbing it through the skin. Look to see whether the student toxicologist's skin, eyes, mouth, and nose are covered.

This activity is engaging and fun for the students, but it also helps you assess students' knowledge of an important concept of toxicology: routes of exposure.

4. **Once the student toxicologist is dressed protectively, explain that real toxicologists know that chemicals can enter the body in three ways, called routes of exposure: through the mouth by ingestion, through the nose and mouth by inhalation, and through the skin by absorption. Write the list of the three routes of exposure on the board:**

Routes of Exposure

✓ ingestion

✓ inhalation

✓ absorption through the skin

Use the list as a checklist and ask students if they think the student toxicologist is adequately protected from all routes of exposure. If not, have them adjust the protective clothing or suggest useful clothing that is not in the basket.

Point out that the mystery chemical could be a solid, a liquid, or a gas. Discuss each form of a chemical and how the form can help determine which routes of exposure are most likely. For example, a gas might be easily inhaled as soon as the container is opened, while a solid might only be harmful if a person touches it or ingests it. In addition, chemicals can change form. For example, dry ice is solid carbon dioxide that quickly becomes a gas. Liquid mercury can evaporate into a gas, causing exposure by inhalation.

Thank the student toxicologist and ask him or her to return the protective clothing to the basket.

5. **Tell students that people who work around toxic chemicals protect themselves in ways similar to those the students suggested for the student toxicologist. Provide time for students to view the segment *Ride Along with HAZMAT* on the CD-ROM.**

To find the segment, load the CD and go to the main menu. Click on *Chemicals, Chemicals, Everywhere* and select *Ride Along with HAZMAT*.

Photo: Corel

6. **Tell the students that you will dress protectively and remove the mystery chemical from the container when they are not in the room (because they are not protected). Let them know that they will be able to examine the chemical during the next class if you decide it is safe to do so.**

ACTIVITY 3: CASE STUDIES OF ROUTES OF EXPOSURE

1. **Set up the class so that each team of students has access to a computer, such as in a computer lab. Instruct teams to do the activity titled *What's Wrong Here*? on the CD-ROM. Circulate around the room and listen as groups work through each situation.**

To view the activity, load the CD and go to the main menu. Click on *Chemicals, Chemicals, Everywhere* and select *What's Wrong Here?*

Content Standard E: Students should develop understandings about science and technology.
Content Standard F: Students should develop understanding of natural hazards, and risks and benefits.
Content Standard G: Students should develop understanding of science as a human endeavor.

2. **Tell students that now they will consider some true chemical exposures. Display a transparency of Master 1.4, *Questions for Case Studies*. Then, distribute a copy of Case Study #1 from Master 1.5, *Case Studies of Routes of Exposure*, to each student.**

3. **Ask students to work in teams and to read Case Study #1. Instruct them to answer the questions on the transparency in their science notebooks.**

4. **Once teams have read and answered the questions about Case Study #1, conduct a class discussion about the case study by answering the questions on the transparency.**

Sample Answers to Questions for Case Study #1 on Master 1.4

Question 1. What happened? Where did it happen? When did it happen?

A Dartmouth College scientist died of mercury poisoning in 1997 in New Hampshire after being exposed to the chemical in 1996.

Question 2. What chemical was involved?

The chemical was dimethylmercury (die-METH-ul-MER-kyoo-ree).

Question 3. What was the route of exposure?

The route of exposure was absorption through the skin.

Question 4. What were the symptoms of toxicity?

The symptoms of toxicity were permanent nervous system damage, numbness of fingers, unsteady walking, difficulty speaking, blurred vision, hearing problems, coma, and death.

Question 5. How could a person have prevented his or her exposure to the chemical?

Answers will vary. The researcher used precautions thought to be adequate at the time.

Question 6. Have any changes occurred since the incident? Describe them.

Researchers now know that dimethylmercury can seep through latex gloves. They now use neoprene gloves with long cuffs or wear two pairs of gloves, one of them laminated and one of them heavy duty.

5. **There are four more case studies, two describing chemical exposure through inhalation and two describing chemical exposure through ingestion. Continue to have students read, discuss, and answer the questions about each case study.**

This is a good time to assess your students' understanding of the three ways chemicals can enter the human body and cause harm: ingestion, inhalation, and absorption.

Tip from the field test: Give a different study to each team and ask the teams to read their study. Then, instruct teams to present their case study to the class. Teams can explain their case study and answer the questions from the transparency so that everyone in the class learns about the case and discusses the route of chemical exposure. The case studies vary in length, allowing you to individualize the reading assignment for students of varying reading abilities.

Sample Answers to Questions for Case Studies #2–5 on Master 1.4

Case Study #2

Question 1. What happened? Where did it happen? When did it happen?

Gas leaked from a chemical plant in 1984 in India.

Question 2. What chemical was involved?

The chemical involved was methylisocyanate (METH-ul-EI-soh-SIE-uh-nate).

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Question 3. What was the route of exposure?

The routes of exposure were inhalation and absorption through the eyes and the nose.

Question 4. What were the symptoms of toxicity?

The symptoms of toxicity were eyes and lungs burning, vomiting, lung impairment, loss of motor control, neurological disorders, and damaged immune system.

Question 5. How could a person have prevented his or her exposure to the chemical?

Answers will vary. Students should recognize that people who lived in Bhopal had little choice over their exposure. People could have made the choice not to live near a chemical plant.

Question 6. Have any changes occurred since the incident? Describe them.

The chemical plant was sold to a company in Calcutta. Proceeds from the sale supported hospitals and clinics in Bhopal.

Case Study #3

Question 1. What happened? Where did it happen? When did it happen?

Jane had lead poisoning; it happened in her home during her first two years of life.

Question 2. What chemical was involved?

The chemical involved was lead.

Question 3. What was the route of exposure?

The route of exposure was ingestion.

Question 4. What were the symptoms of toxicity?

The symptoms of toxicity were abdominal pain, constipation, vomiting, and lethargy; in severe cases, learning disabilities, decreased growth, hyperactivity, impaired hearing, and even brain damage can occur.

Question 5. How could a person have prevented his or her exposure to the chemical?

Prevention for children includes annual blood tests to check lead levels; clean play areas, floors, windowsills, and hands; professional paint removal; and drinking of milk.

Question 6. Have any changes occurred since the incident? Describe them.

Students can assume that Jane's mother acted on the doctor's suggestions for minimizing the family's exposure to lead.

Case Study #4

Question 1. What happened? Where did it happen? When did it happen?

Jimmy Green died from sniffing gasoline in the spring of 1999.

Question 2. What chemical was involved?

The chemical was gasoline.

Question 3. What was the route of exposure?

The route of exposure was inhalation.

Question 4. What were the symptoms of toxicity?

The symptoms of toxicity were short-term memory loss, hearing loss, arm and leg spasms, permanent brain damage, liver and kidney damage, and death.

Question 5. How could this person have prevented his or her exposure to the chemical?

Jimmy Green voluntarily exposed himself to gasoline fumes. He could have prevented his exposure by choosing not to sniff gasoline.

Question 6. Have any changes occurred since the incident? Describe them.

Parents and students are now informed of the dangers of inhalants.

Case Study #5

Question 1. What happened? Where did it happen? When did it happen?

In 1971, more than 6,500 people were poisoned in Iraq.

Question 2. What chemical was involved?

The chemical was methylmercury (METH-ul-MER-kyoo-ree).

Question 3. What was the route of exposure?

The route of exposure was ingestion.

Question 4. What were the symptoms of toxicity?

The symptoms of toxicity were nervous system disorders.

Question 5. How could a person have prevented his or her exposure to the chemical?

If people had been better informed, they would have planted the seed instead of eating it.

Question 6. Have any changes occurred since the incident? Describe them.

No changes were mentioned in the case study, but students might discuss the need for better warning labels and instructions for grain shipped between countries.

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Extension Activity

Ask students to find current event stories in newspapers, magazines, or television programs that talk about chemical exposure. Challenge students to find one event that involves a chemical exposure that harms humans or other living things and one that involves a chemical exposure that benefits humans or other living things.

You will be able to use a chemical exposure described in these articles in the extension activity in Lesson 5.

Tip from the field test: If students in your school are required to bring in current event articles for several other classes, coordinate with teachers making similar assignments so that students are not duplicating efforts. Alternatively, collect articles yourself and display them in the classroom.

Teacher's Guide

Return to Lesson Plans

Lesson 5—What Is the Risk?
Elaborate

Files for Printing

At a Glance

Overview

Students apply their growing understanding of the concepts of toxicology (dose, response, individual susceptibility, potency, and threshold) to their discussion of the 1950s tragedy in Minamata, Japan. They learn how to assess the risk of people to specific chemical hazards and make decisions about how to manage that risk.

Major Concepts

People can make some choices about chemical exposure; however, some exposure is controlled at a level other than an individual one. Collective groups of people, such as communities and governments, seek to control chemical exposure on a community or global level.

Objectives

After completing this lesson, students will

- use their knowledge about dose, response, individual susceptibility, and route and frequency of exposure to understand a historical situation involving hazardous chemical exposure;
- assess the risk to people in Minamata of mercury poisoning using a risk assessment flow chart;
- compare their own risk of mercury poisoning with that of the people of Minamata; and
- understand the kinds of critical choices people make about chemical exposure and that some exposure is controlled at a level other than an individual one, such as the community or global level.

Background Information

The Minamata Case Study

When people living in Minamata, Japan, in the 1950s began slurring their speech occasionally or dropping their chopsticks at a meal, no one thought much of it. Some people cruelly laughed, claiming their clumsy friends were acting like the cats that were "dancing" strangely in the street and falling to their death in the sea. When it seemed like more and more people were suffering from the mysterious lack of coordination, the community began to realize that something was seriously wrong. But, people did not know that they were seeing the first signs of a debilitating nervous condition caused by ingesting mercury.[1]

We now know the tragic story of Minamata. The Minamata Bay was polluted with the industrial waste from the Chisso Corporation, which manufactured acetaldehyde used to make plastics. The mercury that the company used in the production process was discharged into the bay, incorporated into bacteria, and passed through the food chain to people living in the area. The people in the town were slowly being poisoned by their most important food source: fish.

The consequences of such blatant polluting seem obvious to people today. But at the time, science had not yet documented the hazards of mercury, and environmental awareness was not pervasive. In fact, the Minamata case has become a classic lesson in the tragedy of industrial pollution and the need to anticipate the unexpected consequences of introducing chemicals into the environment. Although the story is now half a century old (and "ancient history" for today's middle school students), it has a well-documented cause and effect, as well as a resolution. In this way, it provides a good model for teaching about risk assessment and management that students can apply to their analysis of current exposures to chemicals.

Photo: W. Eugene Smith and Aileen M. Smith

Risk Assessment

Today, when toxicologists study the extent and type of negative effects associated with a particular level of chemical exposure, they can use what they learn to assess the threat of that chemical to people's health. To do this, toxicologists measure a person's risk of exposure to the chemical. For example, even though dioxin is considered the most toxic synthetic chemical known, it does not pose the greatest risk to humans because the potential for significant dioxin exposure is quite small. In addition, while the lethal dose of a chemical is an important measurement to make, it is quite possible that a chemical will produce a very undesirable toxic effect at doses that cause no deaths at all. These lower doses may be the amount to which people are regularly exposed.

How a person is exposed to a chemical also determines the factor of risk. In the case of a single exposure, the amount of chemical and the way the body is known to respond to the chemical determine the severity of the toxic response. In the case of repeated exposures to a chemical, it is not only the amount of chemical that counts, but also the frequency of exposure. If the body is able to rid itself entirely of the chemical before the next exposure, it is possible that each exposure is akin to a single exposure to the chemical. If, however, the body still retains some of the chemical from the previous exposure, accumulation of the chemical can occur and eventually can reach toxic levels, even if each exposure is small.

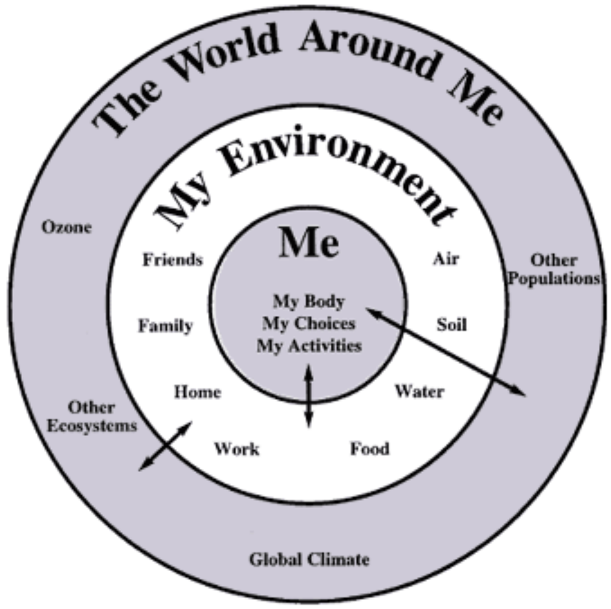
Many of the measurements that guide toxicologists in their assessment of human risk are based on studies of animals other than humans. This fact, coupled with the individual susceptibility of different members of the human population, makes it difficult to know with absolute certainty the level of risk to which each individual is exposed. With adequate information, however, toxicologists can predict the health risks associated with specific chemical exposures and help the human population make informed decisions about how to limit those exposures.

Managing Risk

The built-in uncertainty of risk assessment makes it essential for people to possess enough knowledge to make decisions about their own exposures to chemicals. With adequate knowledge, individuals can make decisions concerning their exposure to tobacco smoke, pollutants in water, and chemicals in food. By modifying their individual behavior, people can have some control over the chemicals they absorb into their body.

Not all decisions about chemical exposure and control can be made at an individual level, however. Local, national, and global communities of people are exposed to chemicals over which they have very little individual control. People are exposed to air pollution from factories and cars or chemicals used by farmers on crops without any individual consent. To manage a community's risk from chemicals in the environment, organizations and agencies set standards to protect human health.

There are choices about chemical exposure over which individuals have control (represented by the inner circle in the adjacent diagram). Individuals are also affected by their immediate environment (their friends and family, as well as the air, soil, and water around their homes and workplaces); the middle circle of the diagram describes influences on an individual over which he or she has less control. Finally, the outer circle describes the world that surrounds individuals over which they have little control but that can have an impact on individuals. The arrows between each concentric circle indicate that individuals, their environment, and the world at large all affect each other.



D

One step in community risk management is to determine how much risk is acceptable to people. If the chance that exposure to a particular chemical causes cancer is only 1 in 1 million, people often are less concerned than if the chance is 1 in 10. The picture becomes more complicated when societal issues weigh in. Is the exposure voluntary (as in smoking cigarettes) or involuntary (as in pollution from a factory)? Does it occur in the workplace or at home? Are there acceptable alternatives to the use of the toxic chemical? How would use of a safer chemical change the economic picture?[2]

To establish some individual control over community management of chemical exposure, people can choose to be involved with organizations and agencies that are concerned with the prevention of toxic chemical exposure on a community level.

Notes about Lesson 5

In this lesson, students have the opportunity to apply many of the concepts of toxicology to a scenario that involved toxic chemicals in Minamata, Japan. By looking at a situation from the 1950s, students can recognize how far scientists and the general public have come in their understanding of chemical hazards and their knowledge of how to minimize risk from these hazards. Students can begin to identify situations in their own lives in which they make conscious decisions to limit their chemical exposure and those over which they have little control.

In Advance

Web-Based Activities

Activity Number	Web Version
Activity 1	Yes
Activity 2	No
Extension Activity	No

Photocopies

Activity Number	Master Number	Number of Copies
Activity 1	Master 5.1, *Risk Assessment and Management* Master 5.2, *Minamata Disease*	1 transparency 1 for each student
Activity 2	Master 5.1, *Risk Assessment and Management* Master 5.2, *Minamata Disease*	1 transparency 1 for each student
Extension Activity	None	None

Materials

<table>
<tr><th>Activity 1</th><th>Activity 2</th><th>Activity 3</th></tr>
<tr>
<td>For the class:
Web site address
computer with Internet access
overhead projector
transparency of Master 5.1, Risk Assessment and Management
plain paper
For each student:
1 copy of Master 5.2, Minamata Disease</td>
<td>For the class:
overhead projector
transparency of Master 5.1, Risk Assessment and Management
plain paper
For each student:
1 copy of Master 5.2, Minamata Disease</td>
<td>For the class:
current event stories students began collecting in Lesson 1, Extension Activity</td>
</tr>
</table>

PREPARATION

Activity 1
Arrange for students to have access to computers.

Make a transparency of Master 5.1, *Risk Assessment and Management*.

Duplicate Master 5.2, *Minamata Disease*, one for each student. To allow students to read only small amounts of the information at a time, fold along the dashed lines.

Activity 2
Gather the same materials used in Activity 1.

Extension Activity
Remind students to bring in the current event stories they began collecting in Lesson 1.

Be sure to have a transparency of Master 5.1, *Risk Assessment and Management*.

Procedure

ACTIVITY 1: PEOPLE AT RISK

1. Remind students that there are chemicals in the environment that cause health problems for humans. Tell students that toxicologists study the extent and type of health problems associated with a particular level of chemical exposure and use what they learn to assess the threat of that chemical to the health of people in particular situations. This kind of analysis is called a *risk assessment*. Display the top half of a transparency of Master 5.2, *Risk Assessment and Management*.

2. Distribute the folded sheets made from Master 5.2, *Minamata Disease*. Tell students that they are going to practice the steps to making a risk assessment by using a well-known case from Japan in the 1950s. Instruct students to read Part I of Master 5.2. Then, discuss the answers to the questions in Step 1 on the *Risk Assessment and Management* transparency.

Content Standard F: Students should develop understanding of personal health, natural hazards, and risks and benefits.

- **Is a new health problem present?**

  Yes. Fish, cats, and birds were sick and dying. Also, people were acting strangely.

- **What are the symptoms?**

  People were stumbling, unable to write, fumbling with their buttons, having difficulty balancing, falling from boats, suffering from convulsions, and dying.

- **What do the affected individuals have in common?**

  Many work as fishermen or were in the families of fishermen.

Once students have answered the questions on the transparency, ask them to offer ideas about what they think was contaminating the fish.

3. Instruct students to unfold the first fold, revealing Part II. Ask them to read the paragraphs and then answer the questions in Step 2 of the Risk Assessment on the transparency.

- **What is causing the problem?**

  Pollution was contaminating the fish with mercury, and people were getting sick when they ate the fish.

- **What is the source of the problem?**

Photo: W. Eugene Smith and Aileen M. Smith

The Chisso Corporation was dumping the mercury, so the company was the source of the problem. It might be interesting to discuss the role the community had in allowing the pollution of the bay to continue by accepting compensation for poor fishing conditions. Could the townspeople have demanded cleaner water instead of being satisfied with a monetary solution to the problem of fewer fish for harvest?

Once students have answered the questions on the transparency, ask them to suggest answers to the question at the end of Part II: What made this contamination of the fish so dangerous to humans?

Content Standard E: Students should develop understandings about science and technology. Perfectly designed solutions do not exist. All technological solutions have tradeoffs, such as safety, cost, efficiency, and appearance. . . . Technological solutions have intended benefits and unintended consequences. Some consequences can be predicted, others cannot.

4. Instruct students to unfold the next fold, revealing Part III. Ask students to read the paragraph and then answer the questions in Step 3 of the risk assessment.

- **What are the sources of exposure to the chemical?**

  People were exposed to mercury by eating contaminated fish. The contamination of the fish was serious because it was a primary food source for the community.

- **How much exposure are people in the area receiving?**

  People in Minamata, especially fishermen and their families, ate fish often. They were getting a small amount of mercury often over a period of time. Any amount of contaminated fish over 30 pounds per year is likely to provide a harmful exposure to mercury.

- **Is the exposure acute or chronic? (Is it likely to happen only once, or often over the course of time?)**

  The exposure to mercury happened in Minamata over a long period of time: It was a chronic chemical exposure.

5. Ask students *not* to unfold the last fold until directed to do so during the next activity. Discuss the information from the reading and answer the concluding question on the risk assessment: How great is the risk to people?

Because of their dependence on fish as a primary source of food, the potential risk of mercury poisoning from contaminated fish for people living in Minamata was very high.


Photo: Corel

6. Play the video segment on the Web site that describes the Minamata story.

Open the Web site in your browser (see instructions for using the Web site). From the main page, click on *Web Portion of Student Activities*, then select *Lesson 5—What Is the Risk?* Play the video documentary for the students.

Because the time period and geographic location of the Minamata tragedy are so far removed from students' experiences, the visual representation of the story on the Web site helps it come alive for students.

ACTIVITY 2: WHAT IS *YOUR* RISK?

1. Remind students that mercury is used today in thermometers and batteries. (Although newer thermometers now use red alcohol, many old ones contain mercury.) Tell students that although they do not live in Minamata in the 1950s, inappropriate disposal of items containing mercury poses a threat to their environment, even today. Since garbage either is incinerated or covered up in landfills, mercury can make its way into the environment through emission of burning gases into the air or groundwater contamination. Fish contaminated with mercury can make their way into the food supply.


Photo: Corel

2. Ask students how they think they can avoid mercury poisoning from contaminated fish.

Most students will say that they could stop eating fish, thereby eliminating their risk just by avoiding exposure to the mercury-contaminated fish. Some students may indicate that the risk of mercury poisoning provides a great excuse to avoid a less-than-favorite food: fish.

Ask students if it is always possible to avoid a chemical in order to eliminate possible exposure. What about a chemical in the air? Could students choose not to breathe in order to avoid exposure to an air pollutant?

This question brings up the issue of control. If your food supply is varied enough, you can choose not to eat fish and still remain healthy. (This might not be an option for an island population that depends on fish for protein.) You cannot, however, choose not to breathe as a way to avoid exposure to an air pollutant. You would need to find other ways to limit your exposure to the air pollutant, like staying inside, not exercising outside, or wearing a mask that filters the air.

3. Tell students that one of the reasons for understanding the role of toxicology in human health is to empower the students to make choices that decrease their risk of becoming ill due to exposure to harmful chemicals. Once they know the risk from a chemical exposure, they can manage their risk by deciding how to deal with the risk. Walk the students through the steps of Risk Management on the bottom half of the transparency of Master 5.1, *Risk Assessment and Management.* Contrast the situation in Minamata, Japan, in the 1950s with the life of today's typical U.S. middle school student.

First, ask the students to think about risk assessment:

- **What is a person's risk of mercury poisoning?**

  Because of their dependence on fish as a primary source of food, the potential risk for a person living in Minamata in the 1950s was high. For today's middle school students, the risk is relatively low. The average middle school student does not consume enough fish to pose a problem, and most of the fish is commercially caught in regulated waters. Only a middle school student who lived near contaminated water and regularly ate the fish from the contaminated water would be at a higher risk.

  Then, continue answering the questions in the Risk Management section of the transparency:

- **How do the people involved perceive the risk? Are their perceptions accurate?**

  Possible answers: At first, Minamata residents did not know of the risk or worry about it. Once they began to see the effects of mercury poisoning, they perceived the risk as very serious. Their perceptions were accurate: Their primary food source was contaminated by industrial pollution, and that pollution was having a direct effect on the health of the community.

  Middle school students should perceive their risk as minimal. If a student perceives his or her risk as high, that perception would not be accurate according to the risk assessment above.

- **Who is responsible for the harmful substance and its presence in the environment? What role does the responsible party have in any cleanup?**

  Allow time for students to discuss who they think was responsible for the situation in Minamata and what they think the responsible party should have done. Then, instruct them to unfold the last fold on Master 5.2 and read Part IV.

  The Chisso Corporation was responsible for discharging polluted effluent into the bay. The corporation ultimately was held liable for its negligence in the 1970s. More complicated, however, are the social and economic pressures that influenced the placement of the plant in Minamata: People in the fishing village were interested in progress and enjoyed the prosperity that the industry brought to the town.

  Middle school students could be indirectly responsible for some of the mercury contamination in their local area because of the way they dispose of batteries. Students and family members can take responsibility for disposing of potentially harmful materials in a safe way and using safer alternatives, such as rechargeable batteries.

- **What are the benefits and tradeoffs that a person must weigh when making a decision about the risk?**

  Fish provide many health benefits to the cardiovascular system and to brain development. The dietary proteins that fish provided to the residents of Minamata were very important to good health. However, we now know that mercury poisoning from eating contaminated fish results in serious brain damage. The U.S. Environmental Protection Agency has advised that there are health benefits to eating fish and that consumption of fish should continue, but at a rate not to exceed 30 pounds per year. Because middle school students rarely reach an annual level of consumption of 30 pounds of fish, they can enjoy all the healthy benefits of eating fish without being concerned about any negative tradeoffs.

- **What action should people take to minimize their risk? Can the risk be managed by individuals, the community, and/or governments?**

In Minamata, industrial manufacture of acetaldehyde needed to stop. The corporation still operates in Minamata but produces liquid crystals, preservatives, fertilizers, and other chemicals. Over several years, 1.5 million cubic meters of contaminated sludge was dredged from the bay. Over the main dumping site, there now are museums, memorial sites, parks, and a study center. In 1997, the water in the bay was declared safe again for fishing and swimming. People have chosen to move away from Minamata to make their living elsewhere: The town has only 70 percent of the number of people it once had.

Middle school students can eat fish sensibly, dispose of mercury-containing products safely, and support organizations that provide hazardous waste cleanup in their communities. Regulatory agencies can measure mercury contamination in fish and regulate fishing or sales of fish from contaminated waters.

Before discussing the current event with the class, ask students to do a risk assessment individually. Collect students' written summaries and evaluate them for an understanding of the process of assessing risk. Then discuss the students' ideas for managing the risk.

Extension Activity

1. Review a local or current situation in which people are being exposed to a hazardous chemical. Use the *Risk Assessment and Management* transparency to discuss students' ideas about the level of risk for the community and ways to manage that risk.

Tip from the field test: This is a good time to go back to the current event articles the students have been collecting since Lesson 1. Choose one or two of the most interesting situations and assess risk for the population and decide how to manage the risk.

Because a current situation most likely will be unresolved, you will need to lead an open-ended discussion and help students recognize that there might not be answers for some of their questions at this time. This process of asking questions and not knowing the "right" answers is representative of the nature of science and scientific inquiry.

NSES

Content Standard G: Students should develop an understanding of the nature of science and the history of science.

◄ Return to Lesson Plans

Resource Management

9-12

Protecting your Drinking Water

INTRODUCTION:

In almost any town, a large variety of chemicals and wastes are used or disposed of in day-to-day life. We are now learning that if things like gasoline, road salt, pesticides or sewage are not used or discarded wisely, they can contaminate a town's water supply.

We are also learning that some sources of water are easier to contaminate than other sources. Whether or not your town's supply is **vulnerable** to contamination depends on many different factors. These factors may add together to protect the supply, or to leave it very vulnerable to contamination.

To estimate the vulnerability of the ground water flowing under an area of land, a hydrogeologist measures several factors which affect how quickly rain water moves through the ground in that area. Pollutants will usually move in the same way as rain water.

Once you know something about each of these factors, you will be able to decide what must be done to be sure your drinking water will always be safe.

OBJECTIVE:

In this activity, you will use a simple mathematical model of *ground water vulnerability* to estimate the vulnerability of a small town's water supply.

Table I
Estimated Value of Five Factors Affecting Groundwater Vulnerability

FACTOR	VALUE	
1. Yearly Rainfall	3	...if more than 40 in.
(Total amount of rain	2	...if from 15 to 40 in.
that falls in one year)	1	...if less than 15 in.
2. Depth to Water	3	...if less than 10 ft.
(Vertical depth from	2	...if from 10 to 75 ft.
surface to aquifer)	1	...if greater than 75 ft.
3. Aquifer Type	3	...if sand or gravel
(Type of soil/rock	2	...if limestone
aquifer passes	1	...if bedrock
through)		
4. Soil Type	4	...if sand or gravel
(Main type of soil and	3	...if limestone
rock above aquifer)	2	...if loam or silt
	1	...if clay or shale
5. Lay of the Land	3	...if flat
(The general slope of	2	...if gently rolling hills
surface of the land)	1	...if steep hills/mountains

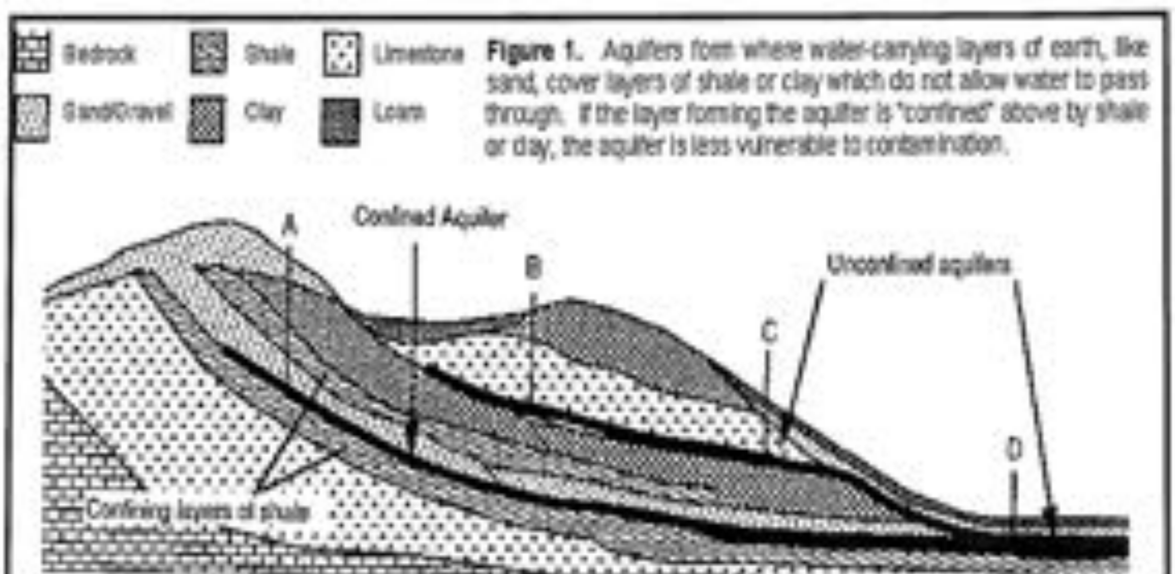


Figure 1. Aquifers form where water-carrying layers of earth, like sand, cover layers of shale or clay which do not allow water to pass through. If the layer forming the aquifer is "confined" above by shale or clay, the aquifer is less vulnerable to contamination.

MODEL OF GROUND WATER VULNERABILITY:

There are many factors affecting the vulnerability of a water supply, but we will only look at the five factors described in **Table 1**. A value of 1 means it is harder for rain water (and pollutants) to reach the supply, while a value of 3 means it is easier. It may be easy to see that the greater the depth to water, the longer it will take rain water to reach the supply. But how does a steep slope make the area less vulnerable? Figure 1 shows how some of these factors affect the vulnerability of various aquifers.

DIRECTIONS:

Use **Table 1** to find out how many points should be given for each of the five factors.

For example, **Table 1** tells you that if the depth to water is less than 15 ft, you should give 3 points for this factor in Quadrant 1. Values from **Table 1** may be averaged.

Fill in the rest of the blanks for each factor, then add them up to find the vulnerability of each quadrant.

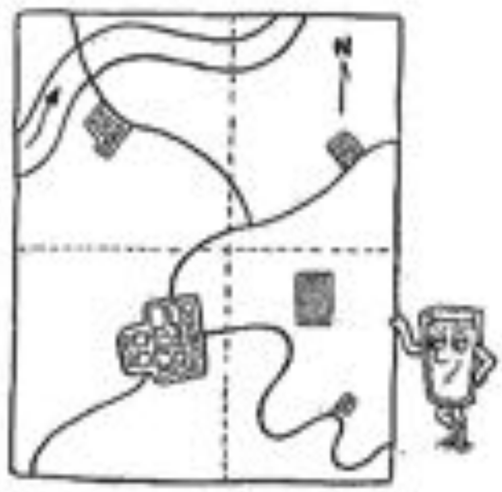
Table 2

Quadrant 1		
Depth to Water	12ft	3
Yearly Rainfall	45"	
Aquifer Type	Sand/Gravel	
Soil Type	Loam/Sand	
Lay of the Land	Flat	
VULNERABILITY SCORE		
Quadrant 2		
Depth to Water	40ft	
Yearly Rainfall	45"	
Aquifer Type	Limestone	
Soil Type	Limestone/Loam	
Lay of the Land	Gentle Slope	
VULNERABILITY SCORE		
Quadrant 3		
Depth to Water	60ft	
Yearly Rainfall	38"	
Aquifer Type	Limestone	
Soil Type	Limestone/Clay	
Lay of the Land	Rolling Hills	
VULNERABILITY SCORE		
Quadrant 4		
Depth to Water	100ft	
Yearly Rainfall	34"	
Aquifer Type	Sand/Gravel	
Soil Type	Shale/Clay	
Lay of the Land	Steep Hills	
VULNERABILITY SCORE		

HOW TO USE THE MODEL:

You can get a rough idea of the vulnerability of the underlying aquifer in each of Priceford's four quadrants. By using these five factors to give each quadrant a "score" on how easy it would be for a pollutant to pass through the ground to contaminate the aquifer.

Follow the instructions for filling out **Table 2**, then use your results along with the map of the Priceford area to answer the questions at the bottom of the page. **Give your reasons for each answer!**



QUESTIONS:

1. Discuss how factors 2-5 described in **Table 1** affect the vulnerability of water supplies at Points B, C and D in Figure 1. If three towns get their water supplies at Points B, C and D, which supply would be the most vulnerable? The least vulnerable?

2. Use **Table 3** below to interpret the vulnerability scores you calculated in **Table 2**. Which town's water supply would be most likely to be contaminated if a larger tanker truck full of a toxic chemical spilled its contents during a traffic accident on the nearest road?

3. Compare the vulnerability values you calculated in the four towns in the above map to Points A, B, C and D in Figure 1. Which of these towns is most likely to be located at which of these Points?

4. How would one town's pollutants affect the other town's supplies? If a wood preserving chemical is found in Smalltown's water, but not in Riverville's, where is the most likely area where the source of contamination might be found?

Table 3.
Vulnerability Score

5	7.5	10	12.5	15
very low		moderate		very high

Relative Vulnerability

Watershed Patch Project
2004

Projects and Activities

Home and Lawn Care Checklist: "Personal Pollution"

When rain falls or snow melts, the seemingly small amounts of chemicals and other pollutants in your driveway, on your lawn, and on your street are washed into storm drains. In many older cities, the storm water runoff is not treated and runoff flows directly into rivers, streams, bays, and lakes. Pollutants in this runoff can poison fish and other aquatic animals and make water unsafe for drinking and swimming.

What can you do to help protect surface waters and groundwaters? Start at home. Take a close look at practices around your house that might contribute to polluted runoff. The following is a checklist to help you and your family become part of the solution instead of part of the problem!

Do-It-Yourself Home Cleaning Products

General, multipurpose cleaner (for ceramic tiles, linoleum, porcelain, etc.): Measure 1/4 cup baking soda, 1/2 cup white vinegar, and 1 cup ammonia into a container. Add to a gallon of warm water and stir until baking soda dissolves.

Window Cleaner: 3 tablespoons of ammonia, 1 tablespoon of white vinegar and 3/4 cup of water. Put into a spray bottle.

Visit http://www.epa.gov/grtlakes/seahome/housewaste/src/recipes.htm for more ideas on nontoxic alternatives!

Household Products

1. **Do you properly dispose of household hazardous waste such as leftover oil-based paint, excess pesticides, nail polish remover, and varnish by taking them to your city's or county's hazardous waste disposal site or by putting them out on hazardous waste collection days?** Labels such as **WARNING, CAUTION, and DANGER** indicate the item contains ingredients that are hazardous if improperly used or disposed of.

   ☐ Yes ☐ No

2. **Do you use less toxic alternatives or nontoxic substitutes?** Baking soda, distilled white vinegar, and ammonia are safe alternatives to caustic chemicals. And they save you money.

   ☐ Yes ☐ No

3. **Do you limit the amount of chemicals, fertilizers, and pesticides you use and apply them only as directed on the label?**

   ☐ Yes ☐ No

4. **Do you recycle used oil, antifreeze, and car batteries by taking them to service stations and other recycling centers?**

   ☐ Yes ☐ No

Landscaping and Gardening

5. **Do you select plants with low requirements for water, fertilizers, and pesticides? (e.g., native plants)**

   ☐ Yes ☐ No

6. **Do you preserve existing trees and plant trees and shrubs to help prevent erosion and promote infiltration of water into the soil?**

☐ Yes ☐ No

7. **Do you leave lawn clippings on your lawn so that the nutrients in the clippings are recycled, less fertilizer is needed, and less yard waste goes to landfills?** If your community does not compost lawn trimmings, they usually go to landfills.

☐ Yes ☐ No

8. **Do you prevent trash, lawn clippings, leaves, and automobile fluids from entering storm drains?** Most storm drains are directly connected to our streams, lakes, and bays.

☐ Yes ☐ No

9. **If your family uses a professional lawn care service, do you select a company that employs trained technicians and minimizes the use of fertilizers and pesticides?**

☐ Yes ☐ No

10. **Do you have a compost bin or pile? Do you use compost and mulch (such as grass clippings or leaves) to reduce your need for fertilizers and pesticides?** Compost is a valuable soil conditioner that gradually releases nutrients to your lawn and garden. In addition, compost retains moisture in the soil and thus helps conserve water and prevent erosion and runoff. Information about composting is available from your county extension agent (see the blue pages in your phone book).

☐ Yes ☐ No

Did You Know?

One quart of oil can contaminate up to 2 million gallons of drinking water!

11. **Do you test your soil before fertilizing your lawn or garden?** Overfertilization is a common problem, and the excess can leach into groundwater and contaminate rivers or lakes.

☐ Yes ☐ No

12. **Do you avoid applying pesticides or fertilizers before or during rain?** If they run off into the water, they will kill fish and other aquatic organisms.

☐ Yes ☐ No

Water Conservation

Homeowners can significantly reduce the volume of wastewater discharged to home septic systems and sewage treatment plants by conserving water. If you have a septic system, you can help prevent your system from overloading and polluting ground and surface waters by ensuring that it is functioning properly and decreasing your water usage. For other ideas on what you can do to conserve water, check out a new Web site, http://www.h2ouse, developed in partnership with the California Urban Water Conservation Council.

13. **Do you use low-flow faucets and shower heads, and reduced-flow toilet flushing equipment?**

☐ Yes ☐ No

14. **When washing your family's car, do you use a bucket instead of a hose to save water?**

☐ Yes ☐ No

15. **Do you use dishwashers and clothes washers only when fully loaded?**

☐ Yes ☐ No

16. **Do you take short showers instead**

Give Water A Hand

What is your city, town, or school doing to prevent polluted runoff? GIVE WATER A HAND ACTION GUIDE contains checklists for schools, communities, and farms. This guide can help you and your school identify potential problems in your community and take action.

You can download a free copy of *Give Water A Hand Action Guide and Leader Guidebook* at http://www.uwex.edu/erc/gwah. Or to order printed copies call:

University of Wisconsin-Extension
608-262-3346
Items 4-H450 & 4-H855
Leader Guidebook ($4.92)
Action Guide ($6.96)
Price includes shipping.

of baths and avoid letting faucets run unnecessarily (e.g., when brushing teeth)?

☐ Yes ☐ No

17. **Do you promptly repair leaking faucets, toilets, and pumps to conserve water?**

☐ Yes ☐ No

18. **Do you conserve the amount of water you use on your lawn and water only in the morning and evening to reduce evaporation?** Overwatering may increase leaching of fertilizers to groundwater.

☐ Yes ☐ No

19. **Do you use slow watering techniques such as trickle irrigation or soaker hoses?** These devices reduce runoff and are 20 percent more efficient than sprinklers.

☐ Yes ☐ No

In Your Community

20. **Do you always pick up after your pet (e.g., Rover's poop)? Be sure to put it in the trash, flush it down the toilet, or bury it at least 5 inches deep.** Pet waste contains viruses and bacteria that can contaminate surface and groundwater.

☐ Yes ☐ No

21. **Have you helped stencil stormdrains to alert people that they drain directly to your local waterbody?** If not, get involved with a local conservation group or organize your own stenciling project.

☐ Yes ☐ No

22. **Do you ride or drive only when necessary?** Try to walk instead. Cars and trucks emit tremendous amounts of airborne pollutants, which increase acid rain. They also deposit toxic metals and petroleum by-products.

☐ Yes ☐ No

23. **Do you participate in local planning and zoning decisions in your community?** If not, get involved! These decisions shape the course of development and the future quality of your watershed.

Reflection Activities

Reflection activities play an important role in helping students to analyze, understand, and gain meaning from the service they are participating in. Most teachers/facilitators think reflection activities have to be writing intensive, but there are a variety of ways that students can reflect. The following list of reflection activities is divided into activities to be used pre-service, during service, post-service, and general activities that could be used throughout the process.

Pre-Service Activities

Pre-service activities should assist students in looking at their assumptions and biases, as well as expectations of what they hope to accomplish.

1. Have students write a letter to themselves describing their feelings, their expectations, and what they hope to gain from this process. The teacher/facilitator should keep the letters and return them at the end of the program during the final reflection stage.

2. Working individually or in groups, have students design and create a utopia envisioning what their community would be like if they could fix all the problems that they have discovered during the community inventory. They could present their utopia in a variety of ways - in a written format, as a poster, or as a play.

3. As a group, create a list of expectations and hoped for outcomes from the program. Write the list on chart paper and refer back to it at the end of the program during the final reflection phase.

During Service Activities

Reflection activities carried out during service should allow students to process their feelings and revisit their expectations in light of what they have done so far. Reflection is also useful at this point to help students look at the direction they are going, identify next steps, and make adjustments if needed.

1. Hold a mock debate where students defend various sides relating to the issue they are pursuing.

2. Have students write a letter to their family or friends explaining the project they are working on and what their goals are.

Suggestion: The teacher/facilitator may be more successful using writing based activities as this point, particularly if students are very involved with the issue they are working on.

Post Reflection Activities

Post-service reflection activities should assist students in evaluating and drawing conclusions from their experiences. They should also provide meaning and help students to understand what they found out about themselves during the service experience.

1. Have the students take photographs throughout the process. At the end, tell each student to select a group of photographs that most accurately portrays the experience they had. Have them create a poster using these photographs with captions explaining why they chose particular pictures.

2. Have the group save items throughout the process then use these to make a group scrapbook at the end. Items that could be included - letters, meeting agendas, surveys, phone transcripts, photographs, etc.

3. Ask students to choose one word that best describes their service experience. Have them make a poster based around this word. (This poster could be combined with the photo poster. Students could choose their word, then select photographs that represent it.)

4. Individually or in groups, have students create an artistic representation of their experience. It could be a collage, a drawing, a painting, or a mural.

5. To facilitate a final reflection discussion, create reflection stations by writing questions on chart paper, posting them around the room, and having students write answers to the questions on each chart. Questions could include 1. What was your most memorable experience? 2. What do you feel best about? 3. What disturbs or puzzles you about your experience? and 4. How has this experience changed the way you think? The teacher/facilitator could then use the responses to lead a class discussion.

6. Have students videotape the process throughout then create a documentary at the end. If discussion was the primary mode of reflection, students could record discussions on an audiotape then edit sections to create an audio documentary.

7. Have students create a resume listing the skills they developed or improved through their experience with the program.

Reflection Activities to be Used Throughout

1. As an alternative to a written journal, students could keep an **artistic journal** where they draw what they are feeling about their experiences. They could also cut out pictures or use computer graphics.

2. **Discussion**-based activities:
   - As a lead-in to reflective discussion, pose a question and have students do five minutes of silent reflection before the discussion begins.
   - Write a quote on the board and have students respond.
   - Use metaphors, (i.e. doing this project is like …)
   - Create a continuum representing various views of an issue. Have students stand at a point on the continuum and explain why they chose to stand there.
   - Pose a question then think, pair, share (have students pair off, discuss the question, then report back to the group).
   - Skittle game – pass out a skittle to each student. Have a list of reflection questions prepared and link each question to a color. Go around the room and have each student answer a question based on the color of the skittle they received.

3. **Writing** based activities:
   - Have students keep a journal throughout.
   - Have students write stories or poems to express their feelings or describe experiences.
   - Round Robin Poetry – Pose a reflection question or a theme and have each student write two lines of poetry relating to that question or theme. As the poem goes around the room, fold the paper so that each student can only see the lines written by the previous student. At the end, read the full poem to the group. Rewrite the poem onto a poster board.
   - Each day as students are preparing to leave, pose a question (i.e. what did you find out today that you did not know before?) and write the question on a piece of chart paper. Before each student leaves, have him/her write a one-sentence response to the question. The teacher/facilitator could also write the sentence for the student.
   - Instead of keeping individual journals, the group could create a group journal where students could jot down ideas and feelings throughout the program.

3\. Other kinds of activities that could be used for reflection:
   - Writing plays / Writing songs / Creating dances / Doing role plays

4\. **Critical Incident Activity.** Anytime students have a pivotal experience during the Earth Force program, the teacher/facilitator could use the critical incident activity to help students assess the impact of the experience. This activity could be done as a discussion or as a written activity. The activity has three steps: 1. Describe your role in the incident. 2. Analyze the incident- what is you understanding of it? How did you react? 3. What impact did the incident have on you?

Reflection Opportunities

Segment One

Your Earth Force group has just completed a walking tour in order to develop a community inventory. When you return to the classroom, the group develops a list of community strengths and weaknesses. The students are able to come up with a long list of weaknesses and a relatively short list of strengths. What reflection questions would be beneficial to pose at this point? What kinds of activities could you use to address these questions?

For facilitator - Possible reflection questions might include:

1. How do you view your community?
2. How does the list of weaknesses you developed make you feel about your community?
3. Were you surprised at the strengths you found in your community?
4. What did you learn about your community that you did not know?
5. What do you want your community to be like?
6. When looking at the list of weaknesses, which weakness concerns you the most?

Segment Two

Your group has finally selected the problem they wish to focus on. After cutting the list down to four problems, the group used their criteria to select their problem. The issue they plan to focus on is the pollution in their neighborhood lake. What reflection questions would be beneficial to pose at this point? What kinds of activities could you use to address these questions?

For facilitator - Possible reflection questions might include:

1. What do you hope to accomplish in relation to this problem?
2. When you determined your criteria, which of the criteria were most important to you and why?
3. What strengths in your community might help you solve this problem?
4. Did you feel your voice was heard in the process of selecting the problem?

Segment Three

Your group has chosen to focus on the issue of school waste and the lack of recycling. In order for your students to determine how the waste is being created and the opportunities provided for recycling, you set up a sleuthing activity. In this activity you divided the group into smaller groups and each one was given a sheet describing a possible waste contributor (i.e. a student, a janitor, the school secretary, a teacher, the principal). Each group of students sought out their potential contributor and asked a list of questions included with the description to help determine what waste the individual was creating and whether they were doing any recycling. After returning to the classroom, the groups debated who was the biggest contributor in creating waste and not recycling. What reflection questions would be beneficial to pose at this point? What kinds of activities could you use to address these questions?

For facilitator - Possible reflection questions might include:

1. What new knowledge have you gained about this issue?
2. How do you contribute to the problem?
3. Who contributes most to the problem?
4. Do you feel like your group will be able to have an influence on this problem?

Segment Four

Your group has chosen to pursue the issue of waste and recycling in their school. When choosing their action, group members have decided to try to get the school cafeteria to change from Styrofoam to paper or other kinds of trays, to provide a location for teachers, students, and the office to recycle paper, to provide recycling for aluminum cans, and to get all members of the school community to recycling printing cartridges. In order to prepare the students in your group for potential opposition, you set up an activity for them. In this activity you have two sets of students swinging two jump ropes a few feet from each other. On the other side of the jump rope you have three students staggered in a zigzag line. You tell the students in the group that in order to be successful they have to make it through the two ropes and past the three students. One rope represents the school principal, and the other is the cafeteria manager. The three students represent the students of the school, the teachers, and the school office workers. The students try making it through the obstacle course, but only few are successful. What reflection questions would be beneficial to pose at this point? What kinds of activities could you use to address these questions?

For facilitator - Possible reflection questions might include:

1. What are the obstacles that you will have to surmount in order to achieve your goal?
2. If your project is successful, what difference will it make for the people in your community?
3. How do you feel about the action you have chosen to take? Does your goal seem achievable?

Segment Five

Your group has just met with the cafeteria manager to request that the cafeteria start using something other than Styrofoam trays. The cafeteria manager tells your group that the other options are not cost effective and she cannot make the change at this time. What reflection questions would be beneficial to pose at this point? What kinds of activities could you use to address these questions?

For facilitator - Possible reflection questions might include:

1. Is your group heading in the right direction to achieve its goal?
2. Should the group revisit its expectations in light of what has happened so far?
3. What are the next steps that the group should take? What kind of adjustments should the group make?

Segment Six

Your group chose the issue of pollution in a neighborhood lake. The action they chose to take was to stencil warnings on surrounding storm drains asking community members not to use storm drains to dump waste since it will end up in the lake. The day after the group completed the stenciling, they sit down to reflect on the completion of the project. What reflection questions would be beneficial to pose at this point? What kinds of activities could you use to address these questions?

For facilitator - Possible reflection questions might include:

1. How well did your plan for action work?
2. What problems did you encounter in carrying out your plan?
3. How did you respond to these problems?
4. What were you not able to achieve?
5. What did you accomplish?
6. How do you feel about what you accomplished?
7. Do you feel like you made a difference in your community?
8. Was making a difference difficult or easy?
9. How has this experience changed you?

Creating an Action Plan

Team Names

Action Plan Title

Final Goal

List a goal for each week spent on this project. (How will you *plan your work and work your plan*?)

List 5 or more actions steps that you plan to take to help accomplish your goals.

What are some possible problems that you think could make it difficult for you to accomplish your project goals?

What actions will help you overcome these obstacles?

List the community partner/s that will work with your team.

What role will each team member be responsible for? List the person's name and job title.

Answer the following questions with your team. Be prepared to share your responses with the larger group.

What went well and what needs improvement?

How did the experience affect you?

What impact will it have on your future actions?

This Action Plan Template was developed by Terri Hallesy, Illinois-Indiana Sea Grant Program.

Community Partnerships – Meeting Community Needs

Service-Learning Guidelines

- The most important service you and your students can provide to the community is to **meet a community need**. *Make sure your community wants jellybeans before you show up with a hundred jellybean baskets!*

- The best way to discover a community need is to **ask questions** of community members.

- Some **ways to ask effective questions** to determine community need include:

    - Invite a representative from that community or organization to speak to your students about their needs. *Example:* Invite a social worker from a local homeless shelter to visit your class and identify volunteer projects to benefit the shelter.

    - Create a survey for community members that will help identify needs. *Example:* Students create a survey for their parents to discover literacy needs in the home. Students create "book bags" that parents can check out and read to their children.

    - Take a field trip into the community you wish to serve such as, your school, neighborhood, or entire town. What issues do you observe as a class that you could address through service? *Example:* While touring the school, students notice that a wall is crumbling and dirty. You decide as a group to paint a mural on that wall.

    - Read local newspapers and identify social issues in your community. *Example:* While following local news stories, your class records a high amount of fires in the area. They put together a fire safety program to present at other area schools.

    - Educate yourself about a community need by interacting with members of that community. *Example:* While visiting the local hospital, your students discover that many patients wish they had magazines to read. Your students run a magazine drive to donate to the hospital.

- Remember to **think locally and globally** – a community can be your classroom, your school, your neighborhood, your town or city, the United States, or the global community!

Building Effective Partnerships For Service Learning

Effective partnerships between agencies, schools, colleges or universities, businesses, government, and residents for the benefit of the community are a vital part of youth service in America. Service learning collaborations provide students with an increased confidence in their ability and show the community that young people can make valuable contributions. (PA Service-Learning Resource and Evaluation Network) By working together, we can reach a larger population, avoid duplication of efforts, make better use of resources and deal more effectively and thoroughly with the myriad of problems faced by our young people. Whether it is schools partnering with Volunteer Centers, community based organizations partnering with business, or youth corps partnering with nursing homes, the potential for and productivity of effective partnerships are limitless. However, there are a number of issues related to creating effective partnerships and this Resource Packet provides some resources that will get you thinking about how to develop and sustain them.

Like a piece of art, true collaboration is a long-term process, often going through many revisions as our environment and relationships change. However, there are a few techniques that will ensure the final masterpiece is ready for the gallery. Here are a few simple guidelines, or techniques, to guide you as you form collaborations for service learning:

- Make sure everyone shares a commitment to a common vision, since some problems will surely arise.
- Put agendas and needs (personal and organizational) out in the open, agendas or needs do not need to be identical, but should be compatible.
- Be sensitive to the needs, styles, and limitations of other collaborators.
- Involve more people at all levels; by involving more people at your organization and those with whom you collaborate you will improve the sustainability of the collaboration.
- Maintain frequent and open communication.
- Be sure everyone understands expectations especially concerning tasks and accountability.

"Full collaboration, includes not only the exchange of information, altering activities and sharing resources, but also enhancing the capacity of other partners for mutual benefit and to achieve a common purpose." (*Working Together for Youth*) It is important to realize that DiVinchi did not paint the Mona Lisa the first time he picked up a paintbrush. Since full collaboration is the most complex form of partnership, it may not be the best way to start partnerships among organizations that are unfamiliar with each other. For example, a school that has never worked with a community based organization may want to start a partnership by networking or coordination, which are simpler forms of partnership. Networking is simply sharing information for the benefit of both parties, while coordination includes a willingness to alter activities to achieve a common purpose. So our school may choose to work with a community organization by sharing relevant information about its curriculum; that is networking. If the school (or teachers at the school) decided to teach a unit at a different time during the school year because it fits in with a service opportunity, that would be coordination. A

Benefits of Service-Learning Partnership

- Accomplish work together that would be difficult or impossible to accomplish alone.
- Build a shared sense of commitment and responsibility throughout the community.
- Ensure that everyone who is touched by the service is represented in the leadership, planning and implementation.
- Avoid unnecessary duplication of efforts among agencies.
- Offer opportunities for people to learn from each other and share resources.
- Contribute to rebuilding healthy, caring communities.

slightly more ambitious form of partnership is cooperation. It builds on coordination by involving shared resources. In our example, the community organization might provide brochures and background information for students and teachers. Establishing these partnerships and personal relationships can prepare people and organizations to enter into strong true collaborations for service learning. Remember success is the best way to encourage continued partnership, so be sure to set goals that are concrete and obtainable, especially at the early stages of a partnership.

The remainder of this resource packet will include on-line resources, information on organizations and more tips. Supplementary materials have been created to help agencies work with colleges, universities and schools, as well as for colleges, universities and schools work with community organizations. If you did not receive the appropriate supplement to this packet please contact Youth Outreach at the Points of Light Foundation.

Sorting Out Agency/School Partnerships

Type	Description	Elements	Example
Networking	Sharing information	• Open • Low commitment, low risk • Separate	Volunteer Center puts a teacher on a mailing of youth volunteer opportunities
Coordination	Sharing information and altering activities for mutual benefit	• Open • Low commitment, low risk • May be joint may be separate	Two agencies planning schedule for service projects so they build off of one another and are not competing for volunteers. May schedule joint activities
Cooperation	Sharing resources, as well as information and altering activities for mutual benefit	• Open • Higher commitment • Work together	No one school can hire a Service Learning Coordinator, so two schools hire a service learning coordinator to find service opportunities for students at both schools
Collaboration	Sharing resources, information and altering activities to enhance the capacity of other partners for mutual benefit	• Open • Very high commitment • Work hand-in-hand • Seek joint funding	School and multiple agencies form a collaboration to engage young people as leaders. The new collaboration gets a grant to fund youth led projects with sponsoring agencies

Discussion Starter Questions

The following questions can help you start conversations about partnering with schools, agencies or campus. Remember it will also be important that you provide answers to these questions to potential partners.

- What experiences have you had in community service or volunteering? What impact has that had on you?
- What experiences has your agency had working with students?
- What experiences have you had working with students?
- Why are you interested in this partnership?
- What do you think is the most important reason for involving students in service-learning?
- What is one thing you hope students would learn about the community or society?
- What are the major challenges to providing services to community?
- One dream you have for those served through your agency.
- What do you hope service-learning will accomplish at your organization?

ESTABLISHING EFFECTIVE RELATIONSHIPS

1. Know your objectives. Before contact, build a solid base.
2. Be able to articulate your goals, your service objectives and your learning expectations.
3. Know your volunteers. What types, their range of interests, their limitations, their talents.
4. Know your resources. Can you provide PR, transportation, duplication? Remember, simple details loom large to agencies.
5. Know agencies and their programs. Understand their structure, their mission, and their activities at least well enough to ask informed questions.
6. Make a strong effort to involve others in approaching agencies and to use them in an on-going way for program implementation.

A Checklist for Successful Partnership is:

IDENTIFY POTENTIAL PARTNERS

- Schools
- Youth Service Organizations
- Nonprofit Organizations
- Businesses
- Recipients of Services
- Individuals

IDENTIFY NEEDS WHICH ARE OF MUTUAL CONCERN

- Do a needs assessment of the community with students and agency representatives.

DETERMINE INDIVIDUALS WHO WILL SERVE AS PRIMARY LIAISONS IN THE PLANNING AND IMPLEMENTATION PROCESS

- Assign student coordinators.
- Visit agencies ahead of time.

SET UP A LOCAL ADVISORY BOARD

NEGOTIATE AND AGREE UPON DESIRED OUTCOMES FOR:

- Recipient of Volunteer Services
- Student/Youth Volunteer
- Nonprofit Organization
- Educational Institution
- Others

NEGOTIATE AND AGREE UPON EXPECTATIONS FOR THE:

- Recipient of Volunteer Services
- Student/Youth Volunteer
- Nonprofit Organizations
- Educational Institution
- Others

DETERMINE BEST METHOD FOR ON-GOING COMMUNITY AND EVALUATION

PERIODICALLY, REDESIGN RELATIONSHIPS BASED ON CHANGING NEEDS AND CIRCUMSTANCES

05 RESOURCES

Videos, websites, and other online sources to connect students to service-learning project ideas, career development, and the latest in PPCP research.

UNDO THE ENVIRONMENTAL CHEMICAL BREW

Keep Unwanted Medications & Chemicals Out of the Great Lakes

You can help protect the environment & ecosystem of the Great Lakes region

We All Can Make A Difference

Sea Grant
Great Lakes Network

This fact sheet from the Great Lakes Sea Grant Network and Great Lakes Restoration Initiative will help get you started on learning about proper disposal of unwanted medicines & other potentially hazardous substances.

Great Lakes RESTORATION

A New & Troubling Form of Water Pollution Threatens the Great Lakes

Each day, antibiotics, vitamins, pain medications, hormonal supplements, over-the-counter and prescription medications and other PPCPs are finding their way into the environment, including the waters of the Great Lakes region. ***These substances represent a new form of water pollution.*** PPCPs can cause harm if disposed of improperly when no longer needed or expired.

What Are PPCPs? Pharmaceuticals and Personal Care Products

PPCPs finding their way into the Great Lakes include:

- Antidepressants
- Antibiotics
- Birth Control Pills
- Blood Pressure Meds
- Cholesterol-lowering Medications
- Cosmetics
- Detergents
- Diet Supplements
- Fragrances
- Herbal Supplements
- Hormonal Substances
- Over-the-Counter Medicines
- Pain Medicines
- Prescription Medications
- Sun Screen
- Tranquilizers
- Vitamins

How do PPCPs enter the environment?

Bioactive chemical substances in PPCPs affect the living tissues of the body and enter the environment in several ways: **1**) excreted as waste with compounds not completely metabolized by the body; **2**) flushed down the toilet by people thinking they are properly disposing of unused/unwanted medicines; **3**) discharged as wastewater treatment plant (WWTP) effluent — many bioactive chemicals are not removed by standard WWTP operations (WWTP effluent has been scientifically documented as a pathway for pharmaceuticals, hormones and other organic wastewater compounds to enter the environment); **4**) applied as wastewater treatment sludge (biosolids) used as fertilizer/soil supplement; **5**) discharged after veterinary application with family pets and farm animals through wastewater treatment systems, from pastures and manure- and fertilizer-treated fields, and as leachate from animal feedlots and aquaculture facilities near streams, creeks and other water bodies; and **6**) discharged from improperly built landfills.

Cause for Concern

The U.S. Environmental Protection Agency and U.S. Geological Survey consider the presence of PPCPs in the environment a significant emerging threat.

More research is needed to evaluate the effects of low-level and long-term PPCP exposure on aquatic organisms and to continue to identify the ecological impacts of these emerging contaminants on water quality, fish and wildlife health and reproduction.

- U.S. Geological Survey and U.S. Environmental Protection Agency water monitoring studies have found pharmaceuticals, including anti-depressants and hormones, in streams, rivers and the Great Lakes.
- Scientists have identified freshwater fish with both male and female sexual characteristics (this intersex condition is a form of endocrine disruption) in streams and rivers across the U.S. and in the Great Lakes. An unnatural imbalance in the ratio of female to male fish in some fish populations can have obvious consequences on the reproductive potential of the species impacted.
- Antidepressants have been found in surface waters of the Great Lakes. Researchers at the Aquatic Toxicology Laboratory at St. Cloud University in Minnesota found that minnows they exposed to mixtures of four antidepressant pharmaceuticals showed slowed predator avoidance behaviors.

What about the greater food web? Alterations caused by antibiotics and other pharmaceuticals on bacteria at the base of our aquatic food webs will be felt well up the food chain as fish and other organisms consume the various levels of food sources. Pharmaceutical-based changes in behavior and reproduction have already been documented in frogs, mussels and other freshwater organisms.

Proper PPCP Disposal

Proper disposal of unused and expired medicines and other bioactive chemicals is critically important to protect the water we drink and the Great Lakes ecosystem.

What You Can Do

- Become an informed and proactive consumer to reduce the amount of PPCPs you need to discard.
- Take unwanted/expired medicines to local "drop-off" events or other take-back programs for pharmaceuticals and unwanted personal care products.
- If no drop-off, take-back or return programs are available in your area, check county/state guidelines and with your trash removal provider for recommended best medicine/pharmaceutical disposal procedures for your area. Some areas may accept unwanted medicines in the trash if they have been mixed with kitty litter, fireplace ashes or coffee grounds in a sturdy container (e.g., original container, margarine tub, coffee can), and sealed with duct or packing tape. Place container in trash and out of reach of children and animals. If you dispose of medicines in original containers, cover patient name with permanent marker. Do NOT flush down the toilet
- Partner with your doctor to avoid accumulating unwanted or unused medicines that will require disposal. Avoid taking "samples" you may be unlikely to use. Finish an entire prescription as prescribed. Properly store medicines together to avoid overpurchasing or asking your doctor for additional, unnecessary medications.
- Ask your pharmacy/drug store to accept unwanted/unused/expired medicines.
- Keep all medicines out of reach of children and pets.

What You Should *NOT DO*:

- Do not flush unwanted/unused medicine down the toilet or pour them down the drain unless the label specifically advises you to do so.
- Never give or sell unused or unwanted medicines to others.
- Never put unwanted/unused medicines in the trash without some form of disposal containment as suggested above

Few standards have been established for identifying the impacts of wastewater effluent content on human health or aquatic animal health.

The proper disposal of PPCPs reduces:

- **environmental impact;**
- **risk of poisoning; especially by children or pets;**
- **illegal use of drugs; and**
- **identity theft from personal information found on prescription containers.**

A Finite & Delicate Supply

The Great Lakes are the source of drinking water for 42 million people in the U.S. & Canada. In the last 100 years we have added tons of toxins to the finite system of the world's freshwater supply that is continuously cycling through our air, soils & waters.

If we all learn to properly dispose of unwanted or unused medicines, we will be reducing an environmental threat and its potential impacts on our vital Great Lakes aquatic ecosystem.

Help Keep Unwanted Medications & Chemicals Out of the Great Lakes

BE AN INFORMED CONSUMER

Learn about the Great Lakes aquatic environment & how you can help protect this vital natural resource.

A healthy Great Lakes benefits people, places, wildlife & the economy.

For More Information: www.unwantedmeds.org

Great Lakes Sea Grant Network: ***Illinois-Indiana Sea Grant, Michigan Sea Grant, Minnesota Sea Grant, New York Sea Grant, Ohio Sea Grant, Pennsylvania Sea Grant, Wisconsin Sea Grant & Lake Champlain Sea Grant***

Resources & Publications:

- Disposal of Unwanted Medicines resource kit/Illinois-Indiana Sea Grant: www.iisgcp.org/unwantedmeds
- Erie Times-NIE/Great Lakes Sea Grant Network *Dose of Reality: Remedies to keep everyday chemicals out of waterways*: www.seagrant.psu.edu/publications/fs/Dose_of_Reality_Publication.pdf
- U.S. Environmental Protection Agency: The potential environmental impacts of pharmaceuticals: www.epa.gov/ppcp
- U.S. Geological Survey research on the presence of pharmaceuticals in the environment: http://toxics.usgs.gov/regional/emc

References:

- Lee, K.E., Barber, L.B., Furlong, E.T., Cahill, J.D., Kolpin, D.W., Meyer, M.T. and Zaugg, S.D., 2004, Presence and distribution of organic wastewater compounds in wastewater, surface, ground, and drinking waters, Minnesota, 2000-02: *U.S. Geological Survey Scientific Investigation Report 2004-5138, 47 p.*
- Painter M, Buerkley M, Julius M, Vajda A, Norris D, Barber L, Furlong E, Schultz M, Schoenfuss H. Antidepressants at environmentally relevant concentrations affect predator avoidance behavior of larval fathead minnows (*Pimephales promelas*); *Environmental Toxicology and Chemistry*, Vol. 28, No. 12, pg 2677–2684, December 2009
- Emerging Contaminants In the Environment: http://toxics.usgs.gov/regional/emc/index.html

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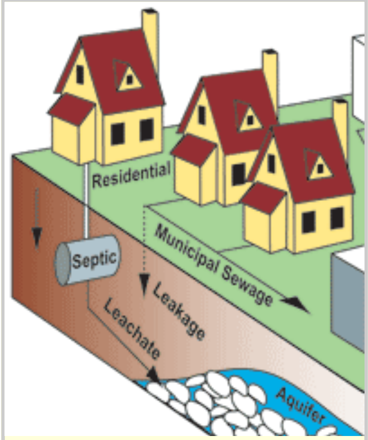
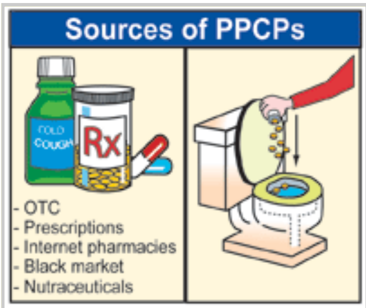
UNDO THE ENVIRONMENTAL CHEMICAL BREW: You Can Help Keep Unwanted Medications & Chemicals Out of the Great Lakes by Helen M. Domske, New York Sea Grant

You are here: EPA Home » Research and Development » PPCPs » Basic Information

Basic Information



This drawing shows the pathway between homes and septic or municipal sewage facilities.



Discarding unused drugs and personal care products down the toilet is a common but poor disposal method.

Pharmaceuticals and personal care products were first called "PPCPs" only a few years ago, but these bioactive chemicals (substances that have an effect on living tissue) have been around for decades. Their effect on the environment is now recognized as an important area of research.

PPCPs include:

- Prescription and over-the counter therapeutic drugs
- Veterinary drugs
- Fragrances
- Cosmetics
- Sun-screen products
- Diagnostic agents
- Nutraceuticals (e.g., vitamins)

Sources of PPCPs:

- Human activity
- Residues from pharmaceutical manufacturing (well defined and controlled)
- Residues from hospitals
- Illicit drugs
- Veterinary drug use, especially antibiotics and steroids
- Agribusiness

The importance of individuals directly contributing to the combined load of chemicals in the environment has been largely unrecognized. PPCPs in the environment illustrate the immediate connection of the actions/activities of individuals with their environment.

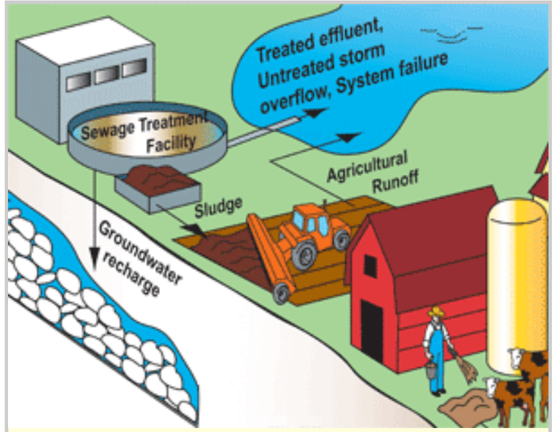
Individuals add PPCPs to the environment through excretion (the elimination of waste material from the body) and bathing, and disposal of unwanted medications to sewers and trash. In February 2007, the White House Office of National Drug Control Policy issued the first consumer guidance for the Proper Disposal of Prescription Drugs (pdf, 1pp, 95 KB) EXIT Disclaimer. Proper disposal of drugs is a straightforward way for individuals to prevent pollution.

Some PPCPs are easily broken down and processed by the human body or degrade quickly in the environment, but others are not easily broken down and processed, so they enter domestic sewers. Excretion of biologically unused and unprocessed drugs depends on:

- individual drug composition (certain excipients -- i.e., inert ingredients -- can minimize absorption and therefore maximize excretion)
- ability of individual bodies to break down drugs (this ability depends on age, sex, health, and individual idiosyncrasies)

Because they dissolve easily and don't evaporate at normal temperatures or pressure, PPCPs make their way into the soil and into aquatic environments via sewage, treated sewage sludge (biosolids), and irrigation with reclaimed water.

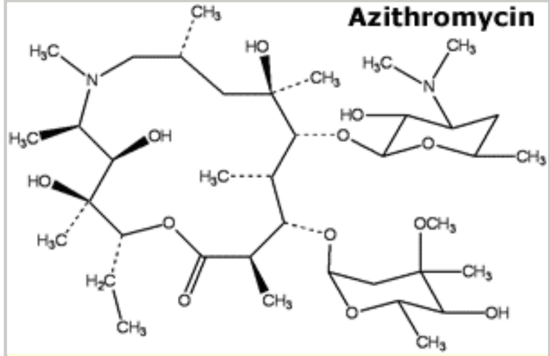
Please read the PPCP Frequent Questions for more details and background information. The poster Origins and Fate of PPCPs in the Environment (PDF) (poster, 284KB, About PDF) illustrates the origins/sources of PPCPs.



This drawing shows some of the contributions of sewage, biosolids and farms to PPCPs in the environment.

Frequent Questions

Azithromycin



Azithromycin is a synthetic version of a naturally produced macrolide antibiotic - - erythromycin. It is among the top 10 of the most widely prescribed pharmaceuticals and can be frequently found in environmental samples.

Consumer Focus

What are "PPCPs"?

Pharmaceuticals and Personal Care Products as Pollutants (PPCPs) refers, in general, to any product used by individuals for personal health or cosmetic reasons or used by agribusiness to enhance growth or health of livestock. PPCPs comprise a diverse collection of thousands of chemical substances, including prescription and over-the-counter therapeutic drugs, veterinary drugs, fragrances, lotions, and cosmetics.

What are the major sources of PPCPs in the environment?

Sources of PPCPs:

- Human activity (e.g., bathing, shaving, swimming)
- Illicit drugs
- Veterinary drug use, especially antibiotics and steroids
- Agribusiness
- Residues from pharmaceutical manufacturing (well defined and controlled)
- Residues from hospitals

The importance of individuals adding chemicals to the environment has been largely overlooked. The discovery of PPCPs in water and soil shows even simple activities like shaving, using lotion, or taking medication affect the environment in which you live.

People contribute PPCPs to the environment when:

- medication residues pass out of the body and into sewer lines,
- externally-applied drugs and personal care products they use wash down the shower drain, and
- unused or expired medications are placed in the trash.

Personal use and manufacturing of illicit drugs are a less visible source of PPCPs entering the environment.

Many of the issues pertaining to the introduction of drugs to the environment from human usage also pertain to veterinary use, especially for antibiotics and steroids.

The discharge of pharmaceuticals and synthesis materials and by-products from manufacturing are already well defined and controlled. For more information regarding manufacturing discharges, see: Development Document for Final Effluent Limitations Guidelines and Standards for the Pharmaceutical Manufacturing Point Source Category, Office of Water, EPA-921-R-98-005, September 1998.

This poster shows a generalized synopsis of the sources of PPCPs in the environment (PDF). (1pp, poster, 307KB)

What is the overall scientific concern?

Studies have shown that pharmaceuticals are present in our nation's waterbodies. Further research suggests that certain drugs may cause ecological harm. More research is needed to determine the extent of ecological harm and any role it may have in potential human health effects. To date, scientists have found no evidence of adverse human health effects from PPCPs in the environment.

Reasons for concern:

- Large quantities of PPCPs can enter the environment after use by individuals or domestic animals.
- Sewage systems are not equipped for PPCP removal. Currently, there are no municipal sewage treatment plants that are engineered specifically for PPCP removal or for other unregulated contaminants. Effective removal of PPCPs from treatment plants varies based on the type of chemical and on the individual sewage treatment facilities.
- The risks are uncertain. The risks posed to aquatic organisms, and to humans are unknown, largely because the concentrations are so low. While the major concerns have been the resistance to antibiotics and disruption of aquatic endocrine systems (the system of glands that produce hormones that help control the body's metabolic activity) by natural and synthetic sex steroids, many other PPCPs have unknown consequences. There are no known human health effects from such low-level exposures in drinking water, but special scenarios (one example being fetal exposure to low levels of medications that a mother would ordinarily be avoiding) require more investigation.
- The number of PPCPs are growing. In addition to antibiotics and steroids, over 100 individual PPCPs have been identified (as of 2007) in environmental samples and drinking water.

Should we be worried about ecological and/or human health?

Studies have shown that pharmaceuticals are present in some of our nation's waterbodies. Further research suggests that there may be some ecological harm when certain drugs are present. To date, no evidence has been found of human health effects from PPCPs in the environment.

Where are PPCPs found in the environment?

PPCPs are found where people or animals are treated with drugs and people use personal care products. PPCPs are found in any water body influenced by raw or treated sewage, including rivers, streams, ground water, coastal marine environments, and many drinking water sources. PPCPs have been identified in most places sampled.

The U.S. Geological Survey (USGS) implemented a national reconnaissance to provide baseline information on the environmental occurrence of PPCPs in water resources. You can find more information about this project from the USGS's What's in Our Wastewaters and Where Does it Go? site.

PPCPs in the environment are frequently found in aquatic environments because PPCPs dissolve easily and don't evaporate at normal temperature and pressures. Practices such as the use of sewage sludge ("biosolids") and reclaimed water for irrigation brings PPCPs into contact with the soil.

- For more information about biosolids see the National Research Council (NRC) report: Biosolids Applied to Land: Advancing Standards and Practices (2002) EXIT Disclaimer)
- USGS: Pharmaceuticals Found in Soil Irrigated with Reclaimed Water

How is the disposal of unused pharmaceuticals regulated by the US EPA?

The Resource Conservation and Recovery Act (RCRA) is a federal law controlling the management and disposal of solid and hazardous wastes produced by a wide variety of industries and sources. The RCRA program regulates the management and disposal of hazardous pharmaceutical wastes produced by pharmaceutical manufacturers and the health care industry. Under RCRA, a waste is a hazardous waste if it is specifically listed by the EPA or if it exhibits one or more of the following four characteristics: ignitability, corrosivity, reactivity and toxicity.

How do I properly dispose of unwanted pharmaceuticals?

In February 2007, the White House Office of National Drug Control Policy issued the first consumer guidance for the Proper Disposal of Prescription Drugs (pdf, 1pp, 95 KB) EXIT Disclaimer. Proper disposal of drugs is a straightforward way for individuals to prevent pollution.

RCRA does not regulate any household waste, which includes medications/pharmaceutical waste generated in a household. While discarded pharmaceuticals under the control of consumers are not regulated by RCRA, EPA encourages the public:

- to take advantage of pharmaceutical take-back programs or household hazardous waste collection programs that accept pharmaceuticals
- If there are no take-back programs near you,
  - contact your state and local waste management authorities (the disposal of household waste is primarily regulated on the state and local levels) with questions about discarding unused pharmaceuticals, whether or not these materials meet the definition of hazardous waste
  - follow any specific disposal instructions that may be printed on the label or accompanying patient information

Who can I contact for more information?

You can contact an EPA regional representative or a program office representative.

Scientific Focus

Where Did the Acronym PPCPs Originate?

The acronym "PPCPs" was coined in the 1999 critical review published in *Environmental Health Perspectives (PDF)* (41pp, 789 KB) to refer to Pharmaceuticals and Personal Care Products. PPCPs comprise a very broad, diverse collection of thousands of chemical substances, including prescription, veterninary, and over-the-counter (OTC) therapeutic drugs, fragrances, cosmetics, sun-screen agents, diagnostic agents, nutraceuticals, biopharmaceuticals, growth enhancing chemicals used in livestock operations, and many others. This broad collection of substances refers, in general, to any product used by individuals for personal health or cosmetic reasons. Since its introduction in 1999, the acronym PPCPs has become the most frequently adopted term in both the technical and popular literature and therefore is a useful keyword for performing literature searches.

What was EPA's historical role in this area?

EPA established a leadership role beginning in 1999 with publication of a critical review (PDF) (41pp, 789 KB) article that attempted to bring together the many different aspects of this complex issue.

From the beginning, a major objective has been to stimulate a proactive versus a reactive approach to this environmental issue. The work was driven by goals from the U.S. EPA's Strategic Plan. The relevant goals included:

- Clean and Safe Water
- Preventing Pollution and Reducing Risk in Communities, Homes, Workplaces, and Ecosystems
- Better Waste Management, Restoration of Contaminated Waste Sites, and Emergency Response
- and Sound Science - Improved Understanding of Environmental Risk and Greater Innovation to Address Environmental Problems

In addition, a primary goal of the U.S. EPA's Office of Research and Development is to identify and foster investigation of potential environmental issues/concerns before they become critical ecological or human health problems. Pollution prevention (e.g., source elimination or minimization) is preferable to remediation or restoration to minimize both public cost and human/ecological exposure.

Current Work:

- Comprehensive list of EPA research about PPCPs

In what quantities are PPCPs used or introduced to the environment?

As a whole, PPCPs are produced and used in large quantities. Personal care products tend to be made in extremely large quantities - thousands of tons per year. But quantities of production or consumption do not correspond with the quantities of PPCPs introduced to the environment. PPCPs manufactured in large quantities may not be found in the environment if they are easily broken down and processed by the human body or degrade quickly. PPCPs made in small quantities could be over represented in the environment, if they are not easily broken down and processed by the human body and make their way into domestic sewers.

What are some major issues with respect to effects?

- The effects of PPCPs are different from conventional pollutants. Drugs are purposefully designed to interact with cellular receptors at low concentrations and to elicit specific biological effects. Unintended adverse effects can also occur from interaction with non-target receptors.
- Environmental toxicology focuses on acute effects of exposure rather than chronic effects.
- Effects on aquatic life are a major concern. Exposure risks for aquatic organisms are much larger than those for humans. Aquatic organisms have:
  - continual exposures
  - multi-generational exposures
  - exposure to higher concentrations of PPCPs in untreated water
  - possible low dose effects
- Effects may be subtle because PPCPs in the environment occur at low concentrations. There's a need to develop tests that detect more subtle end-points. Neurobehavioral

effects and inhibition of efflux pumps are two examples. Subtle effects that accumulate may be significant.

- There are little aquatic/terrestrial toxicology data for PPCPs. There is substantially more data available for pesticides. For example, brief exposure of salmon to 1 ppb of the insecticide diazinon is known to affect signaling pathways (via olfactory disruption), leading to alteration in homing behavior (with obvious implications for predation, feeding, and mating). There's concern that low doses of PPCPs may also have effects.
- There are many drug classes of concern:
  - antibiotics which are actively being researched
  - antimicrobials
  - estrogenic steroids
  - antidepressants. Profound effects on spawning and other behaviors in shellfish can occur with antidepressant selective serotonin reuptake inhibitors (SSRIs).
  - calcium-channel blockers. Dramatic inhibition of sperm activity in certain aquatic organisms can be effected by calcium-channel blockers.
  - antiepileptic drugs (e.g., phenytoin, valproate, carbamazepine) have potential as human neuroteratogens, triggering extensive apoptosis in the developing brain, leading to neurodegeneration.
  - multi-drug transporters (efflux pumps). Possible significance of efflux pump inhibitors (EPIs) in compromising aquatic health.
  - musk fragrances are bioaccumulative and persistent
  - genotoxic drugs (primarily used at hospitals)

How can I contact scientists working on this topic?

Contact information for research scientists with active research about PPCPs in the environment and government scientists with interest in regulatory aspects, is available. Listing of research scientists and their contact information. (PDF) (2pp, 16KB)

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THE TELEOSIS INSTITUTE

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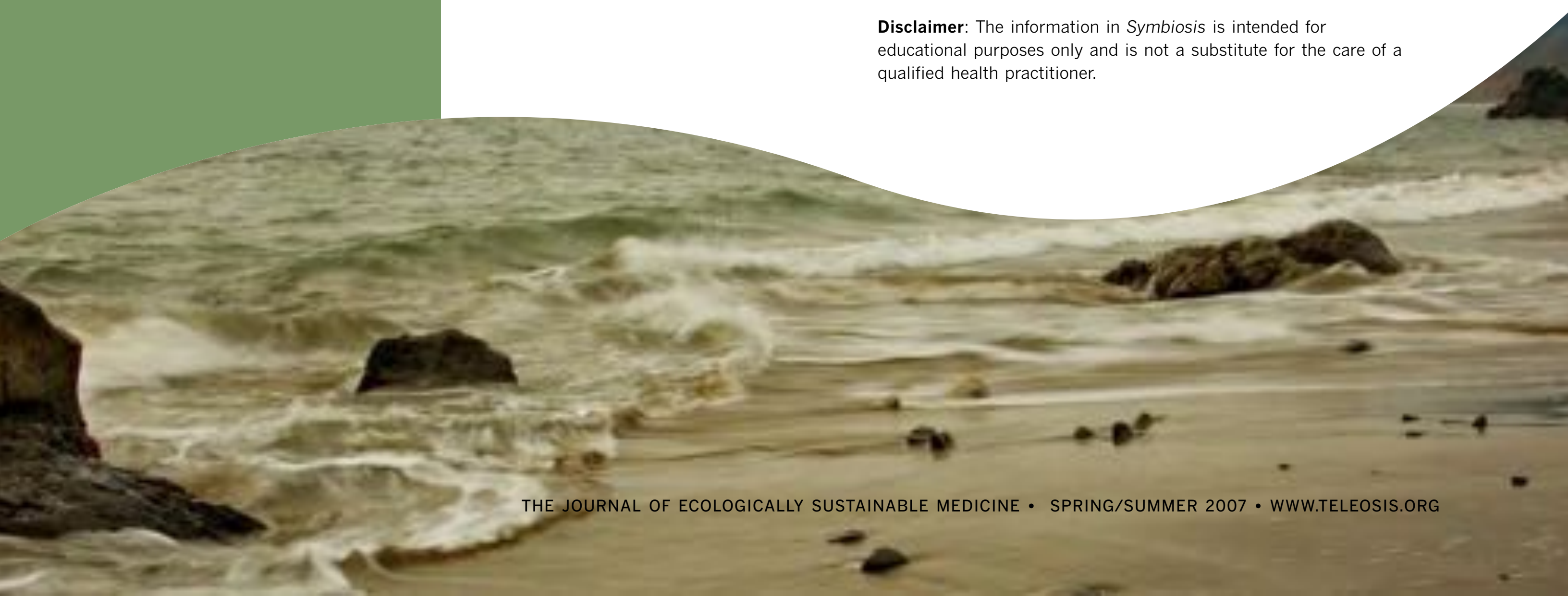


Letter from the Director

At last I can see clear water and blue sky! Perhaps just a vision, but it seems that our world is waking up to the inconvenient truth that our actions have ecological consequences and we must choose wisely to promote health. With so much talk about carbon footprints and greenhouse gas emissions, it may seem out of place to talk about green pharmacy practices, but it is equally important. Rather than waiting until researchers find more waterways contaminated with medicines, or sea life altered and deformed, we have an opportunity to exercise the precautionary principle—a choice to *prevent* health and environmental problems.

At Teleosis eight months ago, we initiated our investigation of pharmaceutical pollution prevention. To increase public awareness about this important topic, we compiled in this issue of *Symbiosis* a comprehensive, accessible series of articles dedicated to explaining this complex and often confusing subject.

We have condensed considerable research completed by Christian Daughton and many others, and we have connected with key players who are creating viable solutions today. Daughton, who has conducted much of the research in this field, encourages all of us to take responsibility: "A proactive, voluntary holistic stewardship program for pharmaceutical waste . . . offers thoughtful environmental responsibility rather than rote compliance to regulation."

This issue of *Symbiosis* also marks the beginning of our real work: Teleosis Institute is launching the Green Pharmacy Campaign, with a goal of zero pharmaceutical waste in the environment. This *can* be accomplished by eliminating improper disposal and reducing over-consumption of medicines. Daughton reminds us, "All aspects of society can play an integral role." I am enlisting all of us to help reach our goal. Each of us can begin by taking two initial steps toward pharmaceutical pollution prevention. First, go to your medicine cabinet and collect all expired and unneeded medicines and supplements and dispose of them in an environmentally safe manner; our website will show you how. Second, take care of your own health and promote personal, community, and environmental health, modeling to others that adopting diet and lifestyle commitments to wellness are essential for a sustainable future. The most effective way to prevent medical waste is by investing in better human and environmental health.

Paul Hawken recently inspired me with his words, "The promise of this unnamed movement is to offer solutions to what appear to be insoluble dilemmas . . . Inspiration is not garnered from litanies of what is flawed, it resides in humanity's willingness to restore, redress, reform, recover, reimagine, and reconsider. Healing the wounds of the Earth and its people does not require saintliness or a political party. It is not a liberal or a conservative activity. It is a sacred act" (Orion Magazine, May/June 2007).

Our sacred act begins with claiming our own health. Be the change.

JOEL KREISBERG, DC, MA
EXECUTIVE DIRECTOR

SYMBIOSIS
Greek syn, 'together', + bios, 'life' literally 'living together'

Symbiosis explores ecological principles of healing and medicine that support a healthy relationship with the living Earth. This educational forum offers relevant and timely information that promotes an ethic of sustainability for the Earth and its inhabitants.

Health News

Pharmaceutical Pollution

Wastewater Treatment Leaves Drugs in Water

In 1999-2000 the USGS analyzed pharmaceutical content in 139 streams throughout the U.S. to determine water contamination levels. Chemicals from various medications were found in 80% of samples: 24% of samples contained acetaminophen; 16% contained steroids and hormones (including 17-ethynyl estradiol, a birth-control hormone); 13% had Diltiazem (a blood pressure medication); 11% included codeine; 10% contained antibiotics and antimicrobials; and 10% contained Ibuprofen.

Sources of such pharmaceutical contamination are human excretion and waste disposal by healthcare providers and patients. Current wastewater treatment removes solids and other organic material, but organic micro-contaminants and low concentrations of synthetic pollutants such as pharmaceuticals remain. Two serious consequences of this pharmaceutical contamination are increased antibiotic resistance and disruption of human and animal endocrine systems.

Source: Kolpin D. et al. Pharmaceuticals, hormones and other organic wastewater contaminants in US streams, 1999-2000: A national reconnaissance. *Environmental Science and Technology* [online]. 2002;26:1201-1211. Available at: http://pubs.acs.org/journals/esthag/36/i06/pdf/es011055j.pdf. Accessed December 13, 2006.

Cow Manure: The Latest Weapon against Drug Contamination?

In 2004, 21 million pounds of antibiotics were administered to farm animals and pets in the U.S.

In 2004, 21 million pounds of antibiotics were administered to farm animals and pets in the U.S. Because antibiotics typically do not degrade on their own, they pose a significant environmental contamination problem. Cow manure may just be the solution. Agricultural Research Scientists (ARS), the U.S. Department of Agriculture's chief scientific research agency, ran a study on the effects that microbes, naturally found in cow manure, have on the traces of antibiotics that remain therein. In a scientific simulation of field conditions, manure laced with the common veterinary antibiotic *Sulfadiamethoxine* was mixed with soil, and then measured. The results showed that microbes from the manure actually play a role in speeding the degradation of the remaining antibiotics, with some even digesting and inactivating them.

Based on this evidence, scientists suggest that farmers should create an environment that is hospitable to these microbes. Storing the manure in a warm, moist place for as long as possible before spreading it on the fields allows the microbes to thrive and do their work on the contaminants.

Source: Agricultural Research Services. Microbes in manure can minimize potential pharmaceutical pollution. January 26, 2006. Available at: http://www.ars.usda.gov/is/pr/2006/060127.htm. Accessed December 3, 2006.

Green chemistry transforms benzene—a component of oil and oil products—into compounds that are useful in manufacturing drugs by introducing the bacteria Pseudomonas putida to benzene waste.

Study Finds Drugs in Coastal Waters

The National Center for Coastal Ocean Science (NCCOS) is conducting studies to determine the effects of pharmaceutical drugs in coastal environments. Drugs are brought to the coast primarily through municipal and industrial sewage effluents, as well as large-scale farms and golf courses that have been irrigated with treated sewage water. The pharmaceuticals commonly found include: antibiotics, hormones, blood lipid regulators, and chemotherapy drugs. In the past, monitoring the quantity and risk-level of contaminants has proven challenging due to the unpredictable levels of various components and highly complex interactions in a natural setting.

The project's goals are to evaluate the effects on and risks for humans of the pharmaceuticals found in estuaries, and to devise new methods for detecting these contaminants. The NCCOS studies of South Carolina waterways (including rivers) and the Atlantic coastline will continued through 2007.

Source: Key P. *National Centers for Coastal Ocean Science.* Determination of the effects of pharmaceutical drugs in the coastal environment. Available at: *http://www8.nos.noaa.gov/nccos/npe/projectdetail.aspx?id=58&fy=2007*. Accessed November 30, 2006.

Green Chemistry to the Rescue

The Pollution Prevention Act of 1990 put our nation on notice that reducing and preventing pollution is a high priority. In tandem with this goal, those involved in "green chemistry" design chemical products and processes that reduce or eliminate the generation and use of hazardous substances. Among the 12 principles of green chemistry are efficient and economical use of resources in production and safe and complete degradation of harmful elements.

In medicine for example, green chemistry transforms benzene—a component of oil and oil products—into compounds that are useful in manufacturing drugs by introducing the bacteria *Pseudomonas putida* to benzene waste. This not only reduces the amount of hazardous material entering the waste stream and eliminates the costly process of removing it from the environment, but also creates a new and useful element that generates profit. If these benefits weren't incentive enough, the synthetic compounds this process produces are often preferable to natural versions, as many drugs extracted from plants are available only in small quantities. Further, because these synthetic versions produce more reliable results in patients, quality control is easier.

Source: Vecellio K. *University of Florida News.* 'Green chemistry' cleans up environment and renders synthetic drugs. Thursday, July 16, 1998. Available at: http://news.ufl.edu/1998/07/16/grnchem/. Accessed November 21, 2006.

Green Pharmacy: Preventing Pharmaceutical Pollution

This issue of Symbiosis *features a series of articles on preventing pollution of the environment with pharmaceuticals and personal care products (PPCPs). A discussion of PPCP pollution is complex, involving many different aspects of chemistry, toxicology, ecology, science, medical science, public policy, and consumer behavior. Although public perception is based on a long-standing belief that our waterways are primarily polluted by agriculture and industry, the reality is that because of strong regulations put in place over the past 30 years, the primary contamination of fresh and ocean water today is from consumer wastes and personal human activities.*

The ubiquity of PPCPs, and the fact that they are constantly reintroduced into the environment as contaminants, are serious and significant aspects of our pollution problems. Our first article in this issue gives an overview of PPCP ecology and ecotoxicology; this is followed by a spotlight on the work of Christian Daughton, PhD, a senior scientist at the EPA in Las Vegas, Nevada. The next piece, entitled "The 4 Ts" (toxicant, totality, tolerance, trajectory) discusses a model for evaluating long-term stresses on personal health presented by exposure to multiple chemicals over time. A companion piece is an excerpt from Daughton's work that describes "cradle-to-cradle stewardship" of drugs as a way of minimizing any risks that might be posed to human health and the environment. In the final article, "Green Pharmacy: Preventing Pollution—A Cross Sector Approach", outlines practical steps we can take to address complex ecological issues previously outlined.

This series of articles provides an overview of the complicated issues and potential solutions (some of which are already being utilized) for PPCP pollution. You can find more information on the topic at the EPA's Web site on PPCPs (http://www.teleosis.org/epa/ppcp). Our review of this Web site is on page 47.

The primary contamination of fresh and ocean water today is from consumerism and personal human activities.

Pharmaceutical Pollution: Ecology and Toxicology

BY JOEL KREISBERG, DC, MA

Joel Kreisberg, DC, MA

Dr. Kreisberg holds a Doctor of Chiropractic degree from New York Chiropractic College and a Masters of Arts in Integral Ecology from Prescott College. He is adjunct faculty in JFK University's School of Holistic Studies. The author of several books on homeopathy, Dr. Kreisberg has been teaching for over 25 years and maintains a private practice in Berkeley, CA.

What happens to medicines after they are consumed? Are they utilized in their entirety by our bodies? Or are they partially excreted when we use the toilet? Where do unused and expired medicines end up? Do medicines have an effect on other organisms living in the environment? These are some of the questions the Office of Research and Development of the United States Environmental Protection Agency (EPA) is currently trying to answer. This first article in this series focuses on how pharmaceuticals and personal care products (PPCPs) enter our environment and what effects they trigger on organisms regularly exposed to them (ecotoxicology).

There are three main human activities that cause changes in ecosystems: habitat fragmentation, alteration of community structure, and chemical pollution.[1] During the past 3 decades, attention to the effects of chemical pollution has focused primarily on conventional "priority" pollutants, and rightfully so. These chemicals—referred to as persistent bioaccumulative toxicants (PBTs) or persistent organic pollutants (POPs)—include, for example, lead, mercury, and dioxin, and they continue to have highly detrimental effects over long periods of time (persistence). They are often bioaccumulative. *Bioaccumulation* refers to the tendency to increase concentration when a toxin is consumed in a successional food chain. Mercury, for example, is found in larger concentrations in fish than in shellfish, and is more concentrated in bigger fish, which feed on smaller fish. The good news is that through identification and regulation, the EPA and state and local municipal governments have curbed the most egregious of these chemicals to varying degrees. We continue to pay close attention to their ecological consequences.

Comparatively little attention, however, has been directed to a large class of chemicals comprising pharmaceuticals and personal care products (PPCPs). For the purposes of this discussion, pharmaceutical drugs include all the medicines used for the diagnosis, treatment, and prevention of disease; illicit or recreational drugs; veterinarian medicines (including those for agricultural livestock); over-the-counter medications; and nutritional supplements or nutraceuticals. Personal care products include fragrances, lotions and creams, cosmetics, sunscreen, and other consumer chemicals (including "inert" ingredients). The use of PPCPs continues to grow worldwide on par with many agrochemicals. Unlike agrochemicals, which are disposed of or discharged into the environment on a continual basis via domestic/industrial sewage and wet-weather runoff, PPCPs are in part subjected to the metabolism of the user; then, excreted metabolites plus some unaltered parent compounds are released

into sewage water. Although U.S. manufacturers try to minimize the discharge of APIs, they are released by by drug manufacturers and through disposal of unwanted and expired drugs directly into the domestic sewage system or via leachate from landfills. Through these processes, PPCPs enter the environment, where they are considered *pseudo-persistent* because the transformation/removal rate of PPCPs from the environment is compensated by the rate of replacement, a direct result of long-term use by consumers in higher quantities and subsequent improper disposal. A recent take-back event (where consumers return unused and expired medications) in the San Francisco Bay Area in California found that 45% of unused/expired medicines were flushed down the toilet, and 28% were disposed directly into the trash.[2] Persistence also results from medicines' natural resistance to degradation. One study in Germany showed that barbiturate concentrations were still found even though their use had been virtually eliminated 30 years ago.[3]

Since drugs in the environment have not captured as much attention as pesticides up until now, documentation of quantities and environmental impacts has been limited. Studies that quantify PPCPs in the environment are primarily European in origin. In sharp contrast, pesticide use is clearly documented and controlled. Unfortunately, pharmaceuticals are potentially released anywhere humans exist world-wide—for example, through human excretion in wilderness areas that have limited capacity for sewage treatment.[4,5] New drugs in development and clinical trials also are released directly into the environment, though in arguably low concentrations (see *"The True Cost of Drugs"* on page 31).

PPCPs in the Waste Stream

Ideally, sewage treatment facilities would capture PPCPs entering the environment. These waste systems are only designed to handle human waste that is primarily biological in origin. The two primary mechanisms for removal of substances from the incoming waste stream are microbial degradation and sorption to filterable solids for later removal as sludge.[1] Most anthropogenic (human-made) substances suffer an unknown fate in this system. Further complicating matters, new drugs introduced into the marketplace are usually overlooked in monitoring studies. In the case of PPCPs, many compounds resist degradation, and others resist removal through sorption.[1] In a primary waste treatment plant in Frankfurt/Main, Germany, the daily load of active pharmaceutical ingredients ranged from the tens to hundreds of grams. Removal efficiencies vary widely, from 10% to 100%, averaging about 60% of total drugs in the waterway.[6] This particular sewage plant had a flow rate of 60,000 m^3/day and serviced just over 330,000 people.

Removal efficiencies vary widely, from 10% to 100%, averaging about 60% of total drugs in the waterway.

Other factors affecting removal of substances from the waste stream include weather-related incidents such as wet-weather overflow or the opposite, low inflow during drought conditions, which leads to higher concentrations due to a low volume of water. During seasonal flooding, this same treatment plant in Frankfurt suffered a removal efficiency decrease to less than 5%; it returned to normal levels only after a week. There is also evidence that PPCPs from household waste leach from landfills. Landfills accept sewage sludge and may produce leachates carrying concentrations of drugs higher than in wastes. Holm et al.[7] found high concentrations of antibiotics and barbiturates in a Danish landfill over a 45-year period.

A recent study found over 100 kinds of PPCPs in significant concentrations in sampled waterways, the most common being aspirin, statins, hypertension mediciations, and hormones taken by women.

Pharmaceuticals have been identified in domestic drinking water. A recent study found over 100 kinds of PPCPs in significant concentrations in sampled waterways, the most common being aspirin, statins, hypertension medications, and hormones produced or taken by women.[8] Drinking water regulations historically have been designed to protect consumers from threats of pathogens and industrial chemicals, but not from PPCPs. Little baseline information for concentrations of PPCPs in drinking water exists. Precaution is necessary to stave off future problems.

Toxicity of PPCPs to Organisms and Environment

A significant problem in assessing ecotoxicolgical impacts of PPCPs at the ecosystem level occurs because of the orientation of traditional toxicological testing: individual chemicals are tested on a single species. This raises the question of whether these simplified tests of component parts of complex water systems can predict the impact of mixtures of pollutants on more highly organized communities.[1] Given the multitude of organisms potentially affected, it is doubtful that the spectrum of physiological effects of PPCPs can be effectively analyzed in this manner. The current system of quantifying toxicological effects of chemicals does not adequately assess PPCPs. (See *"The 4 Ts—Assessing Exposure to Multiple Chemicals"* on page 22.)

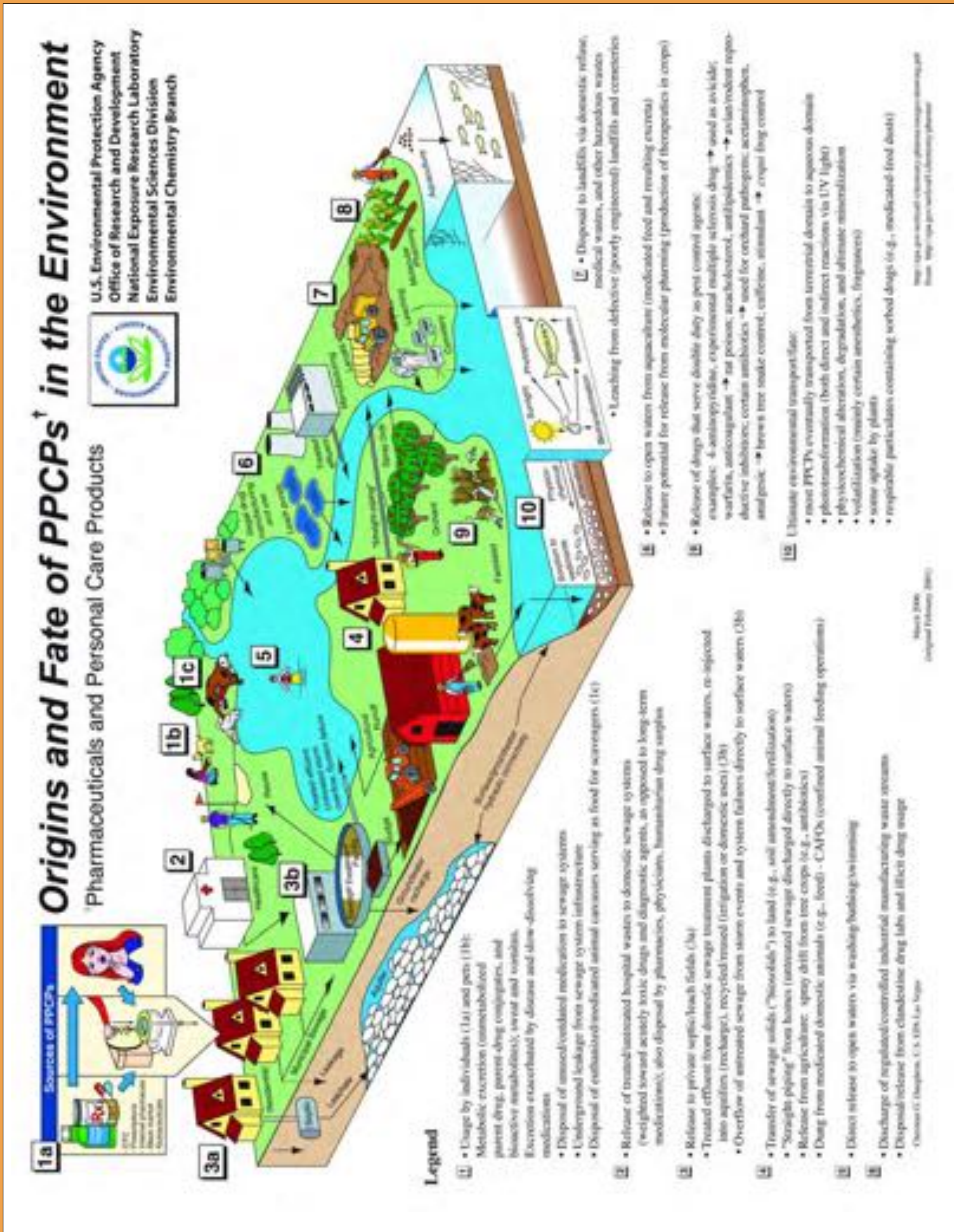
Due to biological diversity in aquatic environments, it is difficult to offer general conclusions about the mixtures of PPCPs found in surface waters today. Although limited data does exist for the potential of acute toxicity, this data may cloud our vision as to the subtle effects. There is plenty of evidence to suggest that this is a question of potential concern. Aquatic environments are a concern because aquatic organisms in this environment are subject to continual exposure.[1]

Interestingly, our regulatory system has not been designed to assess the potential risk. The Federal Drug Administration (FDA) requires Environmental Assessments (EA) under the National Environmental Policy Act of 1969 (NEPA), and the specifics for drug applications are set forth in "Guidance for Industry Environmental Assessment of Human Drug and Biologics Application."[9] The EA is only required if the expected concentration exceeds 1 part per billion (ppb). This does not take into account the cumulative effect of multiple drugs of similar type, each of which may be at a concentration less than 1 ppb, in the environment. In Europe, the European Commission-Pharmaceuticals and Cosmetics (EEC) responsible for regulating this process is somewhat more comprehensive. The concern is primarily acute and chronic effects as measured by traditional toxicity tests. Though provision is made for environmental effects other then toxicity, such as behavior or environmental impact, the effect must have significant intensity to be considered important. Again, this system is inadequate in assessing the effects of a variety of different PPCP compounds, many of which may act in the same or a different manner.

The next section of this article reviews evidence for the ecological effects of general categories of pharmacological agents. The list of medications that have not been evaluated is long. For more information, please refer to the EPA website dedicated to Pharmaceuticals in the Environment *(http://www.teleosis.org/epa/ppcp).*

continued on page 9 . . .

View the original image (PDF) here: Origins and Fate of PPCPs – http://www.teleosis.org/pdf/originfateppcp



Up to 95% of antibiotic compounds are released unaltered into the sewage system.

. . . continued from page 7

Ecotoxicological Effects of PPCPs

Hormones: Hormones—specifically estrogen compounds—are some of the earliest medicines reported in sewage, and they have been found in significant concentrations.[10,11,12,13] Synthetic oral contraceptive medication, combined with steroidal estrogens, cause feminization in male fish.[14] Screening for endocrine disruption is complex. Significant numbers of xenoestrogens—estrogen mimics—exist; certain PPCPs are often a subset of these mimics. Estrogen and their primary metabolites exacerbate the issue directly. (See *Symbiosis* Vol. 4, No. 1, July 2006 for more on the health effects of endocrine disruptors in the environment.)

Antibiotics: Due to the extensive use of antibiotics in aquaculture, veterinarian medicine, livestock, and human medicine, extensive literature exists on their environmental effects. Antibiotics enjoy widespread use, but studies show that up to 95% of antibiotic compounds can be released unaltered into the sewage system. This phenomenon may be a cause of the accelerated resistance of bacterial pathogens to antibiotics. High concentrations of antibiotics can lead to alterations in microbial community structure and affect food chains. Stream surveys document widespread prevalence of bacteria that are resistant to a wide array of antibiotics, including vancomycin.[15] Certain bacteria isolated from wild geese near Chicago, Illinois were reported be resistant to ampicillin, tetracycline, penicillin, and erythromycin.[16]

Blood Lipid Regulators: Perhaps the most frequently reported PPCP in Europe is clofibric acid, the active metabolite in an array of widely used blood lipid regulators called fibrates. A report by Buser et al. found concentrations in remote lakes without any atmospheric contribution.[17] The research concluded that the route of introduction must be medicinal use and excretion. Of note, concentrations were similar to those of the conventional persistent organic pollutants (POPs), such as lindane.[1] Buser found concentrations of clofibric acid in the North Sea (Northern Europe) to be up to 7.8 ng/L, higher concentrations than mecoprop, a pesticide structurally related to clofibric acid. Buser's conclusion is that 50-100 tons of clofibric acid enters the North Sea annually. Clofibric acid is, in fact, the most widely reported drug found in open waters.

Analgesics and Nonsteroidal Anti-inflammatory Drugs: Diclofenac, ibuprofen, acetylsalicyclic acid, ketoprofen, naproxen, indometacine, and phenazone have all been found in surface water. Heberer et al.[18] found that diclofenac, ibuprofen, and propyphenazone are the most commonly found drugs in the water systems after clofibric acid. Diclofenac has been proven to be acutely toxic to vultures, decimating populations in the Indian subcontinent due to its ubiquitous use in cattle.[19]

Beta-blockers/Sympathomimetics: Metoprolol, propranolol, and nadolol[20, 21] have been found in surface waters.

Antidepressants/Obsessive-Compulsive Regulators: SSRIs or selective serotonin reuptake inhibitors, comprise a major class of antidepressants including Prozac, Zoloft, Luvox, and Paxil. A biogenic amine, serotonin is common in both vertebrate and invertebrate nervous systems. Fong found that Prozac and Luvox induced spawning in bivalves at low concentrations.[22] This is significant, as first noted by Daughton and Ternes, because it demonstrates the potential for dramatic physiological effects on nontarget species at low concentrations. Kulkami et al. found that fluoxetine enhances the release of ovary-stimulating hormones in crayfish.[23] Evidence suggests that SSRIs elicit a subtle effect on aggressive behavior in lobsters, causing subordinates to engage in fighting against the dominant member, and reducing the propensity to retreat.[24]

Antiepileptics: Studies by Ternes and others have found that carbamazepine has very low removal efficiency from sewage treatment and therefore is ubiquitous.[20] It is the drug with the highest frequency and concentration found in his survey of German sewage treatment facilities.

Antineoplastics: Primarily used in hospitals, only small amounts are introduced into the environment due to their toxicity. Antineoplastics generally have longlived physiological effects and act as such in most organisms. Kümmerer et al. found ifosfamide in concentrations of up to 1.91 ug/L in the influent and effluent of treatment plants serving chemotherapy hospitals.[2] Kümmerer et al found this drug to be totally resistant to alteration during a 2-month bench scale simulation of sewage treatment, emerging essentially unchanged.[26] Kümmerer et al. also found that up to 30% of platinates including carboplatin and cisplatin reside in the body for years and are slowly excreted into residential sewage systems.[26] White provides an overview of the genotoxicity of wastewaters.[27] He found that municipal treatment plants have these compounds not just in the parts per trillion, but in parts per billion as well. Due to this data implicating antineoplastics for their ability to effect subtle genetic changes, antineoplastics are problematic.

Impotence Drugs: No data is available as to the toxicological effects on nontarget organisms; however, human usage has increased significantly. The physiological action of Viagra, for example, is to inhibit a phosphodiesterase. A logical concern is that this class of drugs will have the potential to disrupt phosphodiesterase metabolism in nontarget organisms.[1]

A take-back event in the San Francisco Bay Area in California found that 45% of unused/expired medicines were flushed down the toilet and 28% were disposed directly into the trash.

Synthetic musk from perfumes, found in aquatic life including bivalves and fish, has also been identified in human breast milk!

Retinoids: Retinoids have proven to have profound effects on the embryonic systems of amphibians. Though hydrophilic and photolabile, they are likely not to be persistent in the environment. However, high usage rates give cause for concern.[28]

Diagnositic Contrast Media: By design, contrast media have low physiologic activity and high persistence. The worldwide usage rate of diatrizoate and iopromide[29] exceeds 3000 tons, and the rate of contrast media in general is very high. The annual usage rate in Germany is 100 tons, with 95% of it unmetabolized. This leaves very high accumulations in the environment. As a class of pharmacological agents, they show no bioaccumulation potential and low toxicity.[30]

Personal Care Products: Personal care products—cosmetics, toiletries, fragrances, and the like—are marketed for use by the consumer, primarily on the human body. Many of these substances are used in extremely large quantities. Differing from drugs, personal care products are released directly into the environment, mostly through bathing, although excretion and disposal are routes of release as well.

Fragrances: Synthetic musks are somewhat persistent pollutants that can bioconcentrate to a limited extent; certain ones can be toxic. Musk xylol has been shown to be carcinogenic in rodents.[31] Significant research since 1981 shows that a variety of synthetic musks continue to be found in aquatic life including bivalves and fish. Some musks have been discovered in human breast milk, most likely due to applications in high concentrations directly to the skin. The worldwide production of synthetic musk in 1988 was 7000 tons![32] Because synthetic musks are used in such large quantities and are released primarily through sewage effluent, they are prime candidates for monitoring the presence and impact of other PPCPs.[1]

Preservatives: Parabens are the most widely used preservatives in cosmetics, toiletries, pharmaceuticals, and foodstuffs. Although parabens have low toxicity levels, there is evidence for estrogenic activity.

Disinfectants/Antiseptics: Triclosan has been widely used for over 30 years. Commonly found in toothpaste, footwear, hand soap, and acne creams, it is registered with the EPA as an insecticide. Direct discharge into water systems is common.[33] McMurray et al. found it acting as a bactericide, potentially initiating resistance.[34]

Sunscreens: Concentrations of six sunscreen agents (SSA) have been found in fish on par with DDT and PCBs.[35] The detection of SSAs in human breast milk also suggests that they have bioconcentration tendencies.

Nutraceuticals and Herbal Remedies: The growth of nutritional supplements as well as herbal remedies in the past decade has been significant. Regardless of whether biological activity can be proven or not, these products still have not been classified as drugs. Herbal preparations are difficult to standardize because they rely on an array of compounds at different concentrations. Systematically, the potential effects of these products are unknown. The argument that they are natural and therefore safe is misleading, due to the fact that as supplements they are highly concentrated and thus might be found in effluent water at much higher concentrations. At the same time, these products, which are produced naturally only in certain parts of the world, end up in water systems in different parts of the world, causing exposure to organisms that have not adapted to these products naturally.

Dispose of medicines and supplements safely

www.teleosis.org/greenpharmacy

Summary

Research to date points to the ubiquity of PPCPs in aquatic environments. Existing sewage treatment systems are not designed to remove them from the waste stream. Our current system of quantifying their toxicological effects is inadequate. Now is the time to prevent further harm to living organisms and the environment.

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We live in a chemical sea. How we focus on a few of those with respect to hazard and risk is important.

— Christian Daughton

Christian Daughton and the Ecology of PPCPs: An Integral Vision

BY JOEL KREISBERG, DC, MA

"When I started giving presentations almost 10 years ago, just about everything I said was news to everyone. These days many people in the audience know a lot about pharmaceutical waste. There has been a tremendous transfer of knowledge. I hope by the end of the presentation you feel confused. This is far more complicated. It is not just this topic by itself, but pharmaceuticals as pollutants are forcing us to look at pollutants in general in a more comprehensive way" (Daughton, PhD, oral communication, April 2007).

If you want to understand the complexity behind pharmaceuticals and personal care products (PPCPs) in the environment, begin with the work of Christian Daughton (http://epa.gov/nerlesd1/bios/daughton.htm). Most authors who write about PPCPs are sure to have some of Daughton's most prominent articles in their bibliography, including *Pharmaceuticals and Personal Care Products in the Environment: Agents of Subtle Change?* (co-authored with Thomas Ternes), and *Cradle-to-Cradle Stewardship of Drugs for Minimizing their Environmental Disposition while Promoting Human Health: Part I and Part II.* Another option is *Environmental Chemistry of Pharmaceuticals and Personal Care Products (PPCPs)*, a virtual online symposium sponsored by the American Chemical Society, hosted by Christian Daughton. Daughton's PowerPoint presentation in part of this symposium offers a clear and succinct summary of the various issues related to PPCPs.[1]

Much of the material in this issue of *Symbiosis* derives from the work of this accomplished scientist. Attempting to address the breadth of his work in so few pages is challenging. Among Daughton's numerous accomplishments is the EPA's *Scientific and Technological Achievement Award* for his seminal work on PPCPs in 1999.[2] His writing style is comprehensive and detailed, often integrating complex ideas from many different disciplines. He provides easily accessible and creative solutions through his elegant and often holistic perspective. On page 24 of this issue is a republished sample of Daughton's literature. Sophisticated and well-crafted visual summaries or posters of complex concepts—such as the poster of the "4Ts: Toxicant, Totality, Tolerance and Trajectory" (see page 22)—supplement his writings. His works incorporate important philosophical principles that reveal his mastery of chemistry, biology, ecology, education, holistic thinking, environmental action, and systems analysis.

"This is a society based on chemicals. PPCPs are an example of pollutants that we haven't look at before; they are only a fraction of the chemicals used in commerce.

We live in a chemical sea. How we focus on a few of those with respect to hazard and risk is important. It's a hard thing to reconcile with our sense of risk" explains Daughton (Daughton, PhD, oral communication, April 2007). In "Green Pharmacy," a monograph in *Environmental Health Perspectives,*[3,4] Daughton discusses "the concepts of environmental surprise" and the "precautionary principle." He says, "Miniscule differences in initial conditions can lead to differences far out of proportion in the system's subsequent behavior…minor perturbations can essentially be slowly amplified to yield major effects."[3(p762)] Daughton makes the scientific case for how changes in individual behavior and changes in larger systems such as the environment are connected. He points out that in toxicology, the process of cause and effect is quite different for single organisms than it is at higher levels of organization (e.g., communities and ecosystems), "because of the myriad interactions and spatial relationships within the system—some imparting vulnerability to synergistic effects."[3(p762)] Irreversible change occurs when perturbations exceed a system's resilience. To summarize, accumulating evidence suggests that "although it may never be possible to gauge precisely humanity's contribution to adverse environmental or human health events or outcomes, it might behoove us to eliminate as many extraneous variables (impacts) in ecosystems as possible—regardless of their perceived immediate importance."[3(pp762-763)]

Daughton's argument that small decisions have the potential to create significant changes is logical, clear, historically relevant, and persuasive. Insisting that we must be cautious about what we dump into the environment, he advocates for the precautionary principle: "The principle of precautionary action redistributes the burden of proof because the science required for truly and fully assessing risks lags far behind what is needed."[3(p763)] The shift here is from science to action: "Science in the face of uncertainty, must be melded with policy and political judgment to arrive at a course for further study or action."[3(p763)] He notes that precautionary principles are emerging as environmental considerations are melding market imperatives. In simple terms, environmental stewardship yields economic benefits.

One action for a healthier future for people and the environment is simple, if not easy, stop throwing PPCPs into the waste stream.

Daughton offers a visionary solution to the problems we are creating with PPCPs: "A proactive, voluntary holistic stewardship program for PPCPs would be preferable to a reactive, prescriptive regulatory program. By focusing on a mind set toward holistic, thoughtful environmental responsibility rather than rote compliance to regulations, all aspects of society can play integral roles."[3(p763)] Daughton's perspective is integral. "An integral worldview occurs when pluralism and relativism are transcended to include a more systemic whole. The beginning of an integral worldview allows for healthy value distinctions, acknowledging previous stages and integrating them without trying to change them."[5]

Daughton not only offers a pluralistic understanding of the many facets of the ecology of PPCPs, but also analyzes and evaluates potential opportunities. Expertly integrating many perspectives, he points out what each has to offer and enables readers to grasp the difficult and complex concepts surrounding the human use of PPCPs. His superb articulation of the issues offers the most helpful guide available to thinking through this thorny problem. Together, we can implement the clear and actionable solutions he outlines. "The ultimate question for physicians is, if we can get to the point where we have no leftover drugs, will that lead to improved therapeutic out-

The ultimate question for physicians is, if we can get to the point where we have no leftover drugs, will that lead to improved therapeutic outcomes?

comes? The right drug, at the right time, in the right amounts? Is the measure of unused drugs a way to determine the efficacy of the treatment?" (Daughton, PhD, oral communication, April 2007). Daughton reminds us that we do have a choice. A healthier future for people and the environment is simple, if not easy: stop the need for throwing PPCPs into the waste stream.

A significant part of the solution, Daughton explains, is *cradle-to-cradle stewardship*: "The fusion of ecology and marketplace imperatives has perhaps emerged most noticeably in the relatively recent product management philosophy termed 'cradle-to-cradle'...the incorporation of 'eco-effectiveness,' and 'ecologic intelligence' into life-cycle considerations for product development and use."[3(p764)] Cradle-to-cradle product stewardship is not only required for PPCPs, it is essential to all consumer goods and aspects of the built environment.

Daughton observes that while "The Institute of Medicine (IOM) Committee on Quality of Health Care in America...goals are far-reaching and urgently needed... [they] do not include the concept of ecology of health. Safety of the patient is pursued out of context of the safety of the ecology."[3(p764)] Daughton's critique is imperative for the future of the health of people and the environment. "With a little expansion of the IOM vision, an integration of human and ecological health could be formalized at a national level through their efforts. High-quality health care and environmental protection need not be competing goals—they are intimately linked."[3(p764)]

Christian Daughton is passionate in pursuing his goal of shedding light on the nature of a complex phenomenon—the effects of PPCPs in the environment. His integral and holistic vision identifies current efforts to solve these problems that are already under way and provides a unique forum for dialogue. In his words: "I hope these disparate professional communities will find compelling reasons to cross-communicate and, in doing so, expand their knowledge and effectiveness in their own fields."[3(p765)]

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Water Quality: Key to Many Doors in the 21st Century

The following is an excerpt from: Daughton C. Cradle-to-cradle stewardship of drugs for minimizing their environmental disposition while promoting human health. I. Rationale for and avenues toward a green pharmacy. Environmental Health Perspectives. 2003 May; 111(5): 763–765.

A healthier future for people and the environment is simple, if not easy: stop throwing PPCPs into the waste stream.

The growing, cardinal importance of water for sustaining societies is becoming more widely recognized as recently evidenced by its central role in the Broadway musical *Urinetown* (2002). The story is set at a time when "water is worth its very weight in gold": A depletion of the earth's water supply has led to a government enforced ban on private toilets. The privilege to pee is regulated by a single, malevolent corporation, which profits by charging admission for one of mankind's most basic needs.

A backdrop to the precautionary principle is the growing imperative for water reuse, which will prove to be the key, critical driving force for management of water quality in the 21st century. The NRC, as requested by the National Science Foundation (NRC 2001), synthesized the broad expertise from across the many disciplines embodied in environmental science to offer its judgment as to the most significant environmental research challenges of the next generation—based on their "potential to provide a scientific breakthrough of practical importance to humankind if given major new funding." Of the eight "grand challenges" identified in the NRC's report, two involve water quality issues, both relevant to PPCPs: *a*) hydrologic forecasting (for predicting changes in freshwater resources as a result in part of chemical contamination) and *b*) reinventing the use of materials. The impetus driving the second is that new compounds and other substances are constantly being incorporated into modern technology and hence into the environment, with insufficient thought being given to the implications of these actions. All of these issues assume added importance in urban areas, which concentrate flows of resources, generation of residues, and environmental impacts within spatially constrained areas. From a policy standpoint, reliable predictive models of material cycles could be invaluable in guiding decisions about . . . topics relating to human-environment interactions. . . . This grand challenge centrally encompasses questions about societal-level consumption patterns, since consumption is the primary force driving human perturbations of material cycles. (NRC 2001, p. 55)

Likewise, the World Health Organization's (WHO) World Water Day Report draws international attention to the intimate connection between water and health:

Due to a mix of geographical, environmental and financial factors, as well as to increased pollution from municipal and industrial waste, the leaching of fertilizers and pesticides used in agriculture, only about one-third of the world's potential fresh water can be used for human needs. As pollution increases, the amount of usable water decreases. (WHO 2001, p. 7)

Links to numerous resources regarding freshwater can be found at the World's Water website (2002). The concept of the "ecological footprint" (Wackernagel and Rees 1995) also highlights the central importance of water. Residents of industrialized countries may need an average of 10-22 acres per capita to support an urban lifestyle. One of the major issues facing water resource managers in the 21st century will be to understand the overall impact of the urban ecologic footprint on water resources. Although there are numerous consequences of the footprint, a major concern may be the continued use of urban waterways as "waste receptacles"—merely for diluting and transporting downstream the by-products of urban consumption.

Although this background material emphasizes the aquatic environment, it is important not to lose sight of the other environmental compartments with which PPCPs can interact. The most significant of these secondary concerns is sewage sludge, to which certain PPCPs can sorb or partition. Subsequent application of sewage sludge ("biosolids") to land (e.g., as a soil amendment) holds the potential for exposure of terrestrial ecosystems. The NRC revisited the issue of biosolids (NRC 2002b; see especially chapters 5 and 6) with respect to reevaluating the approach used by the U.S. EPA in setting its chemical standards for the biosolids rule (U.S. EPA Office of Wastewater Management 2002b). The NRC recommended that "a research program be developed for pharmaceuticals and other chemicals likely to be present in biosolids that are not currently included in routine monitoring programs." The NRC also recommended that alternative (i.e., nontraditional) toxic end points be considered.

Ecologic stress is reflected by stress in humans—the two are intimately tied.

Health of Ecology versus Ecology of Health

The intimate, inseparable connections between humans and the environment (actually, humans can be viewed as an integral part of the environment) have been discussed widely in many contexts. By applying principles of medicine and public health to the environment, David Rapport formalized the concepts of "ecologic health" and "ecosystem medicine" (Rapport 2002). The "health of ecology" refers to ecosystem health; the "ecology of health" refers to human health as determined partly by the condition of ecology (creation and transmission of antibiotic resistance is one example). Ecologic stress is reflected by stress in humans—the two are intimately tied. Adverse effects in one are eventually reflected in the other. The Institute of Medicine (IOM), a private, nonprofit institution that provides health policy advice under a congressional charter granted to the National Academy of Sciences, has called for a revolution and is reengineering all aspects of the health care system in the United States. A major objective of the IOM Committee on Quality of Health Care in America (formed in June 1998) was to develop a national strategy to radically improve the quality of U.S. health care within 10 years. To date, their recommendations (e.g., IOM, 2001; Kohn et al. 2000) address the many aspects of patient safety and how the concepts of quality systems can be applied.

Due to a mix of factors, including pollution, only about one-third of the world's potential fresh water can be used for human needs.

Although the IOM's goals are far-reaching and urgently needed, they do not include the concept of ecology of health. Safety of the patient is pursued out of context of the safety of the ecology. With a little expansion of the IOM vision, an integration of human and ecologic health could be formalized at a national level through their efforts. High-quality health care and environmental protection need not be competing goals—they are intimately linked.

Connecting Health of Ecology and Human Health: Health Promotion and Social Entrepreneurs

The specific environmental issues and the example solutions posed in this mini-monograph are not as pertinent to those parts of the world where PPCPs are little used, such as economically disadvantaged regions [except in areas where large-scale drug disposal occurs, e.g., from humanitarian operations (WHO 1999)] or where illicit drug manufacturing or use is prevalent (Daughton 2001c). Nonetheless, the basic, universal concept of a "health state" (rather than an "absence of illness")—one of a balanced and interconnected physical, mental, social, and spiritual well-being—is equally applicable to Western cultures and could have a profound impact on overall drug use (both licit and illicit). Treatment of physiologic and psychologic symptoms and even the curing of diseases are just one dimension of holistic health—and in many respects, preventive and curative approaches are but stop-gap measures in the absence of a sustainable environment. For example, one can argue that the single most important limitation in the continual quest to eliminate infectious diseases is not the lack of medication but rather the failure to address poverty and its attendant liabilities of hygiene and malnutrition.

Many people actively engaged in advancing the principles of "sustainability" (sometimes defined as meeting society's needs in ways not diminishing the capacity of future generations to meet theirs) have strongly felt that without empowering people to take charge of the basic aspects of their own lives, sustainable improvements in health are not possible. A model effort (Comprehensive Rural Health Project) begun in 1970 by the Indian medical doctors Raj Arole and Mabelle Arole has demonstrated how a holistic approach builds a foundation for sustainable living and only then is advancement in improving health possible. Health cannot be dissociated from all the other aspects of sustainable living (Arole 2001); the burgeoning field of sustainability is captured by the Initiative on Science and Technology for Sustainability (ISTS 2002), among others. Social entrepreneur projects in health promotion (vs. illness/disease prevention), such as those begun by the Aroles, abandon narrow technical objectives aimed at preventative and curative measures in pursuit of wider-ranging holistic goals that emphasize the interconnectedness of social systems.

Cradle-to-Cradle Stewardship

Guided by the interrelationships among the precautionary principle, the ever-increasing and key worldwide importance of water, and the idea of "ecology of health," the incorporation of "eco-effectiveness," "ecologic intelligence," or cradle-to-cradle design

concepts into life-cycle considerations for product development and use has gained momentum in the last decade. The idea of cradle-to-cradle stewardship has most recently been embraced by many international corporations. Some of the more visible and successful proponents of cradle-to-cradle concepts have been William McDonough and Michael Braungart (MBDC 2002; McDonough and Braungart 2002). They have been leaders in implementing the idea of full life-cycle product design, referring to this approach as the "next industrial revolution." One of the tenets of this philosophy for a truly sustainable industry is that it benefits not just the environment but also consumer and corporation; this is one reason for the expression sometimes used for these programs: "waste to wealth." Numerous similar efforts have been successfully under way; examples include those with such monikers as "Zero-Waste" and "Zero Emissions," being implemented in Canada by the Recycling Council of British Columbia (RCBC 2002). Another effort toward directing organizations toward sustainability is being led by the international organization The Natural Step (TNS 2002). Of the "four system conditions" that The Natural Step framework is based on, the second states that "in a sustainable society, nature is not subject to systematically increasing concentrations of substances produced by society." It is worth noting from an historical perspective, however, that the idea of sustainability was put forth decades ago, as early as 1966 (Blutstein 2003).

The United Nations Environment Programme (UNEP 2002) notes that although significant efforts in reducing environmental footprints have been made by a few companies across many industrial sectors, a gap continues to widen between these few and the vast majority that continue "doing business as usual." Among the five major areas for advancement toward true sustainability identified in UNEP (2002), the fourth is the "integration of social, environmental and economic issues." These efforts hint that a sustained future viability of this product life-cycle philosophy can be expected. A wide range of strategies that could foster a cradle-to-cradle approach for stewardship of PPCPs by the pharmaceutical/medical care industries could be adopted. Some could be implemented quickly (requiring only a collective will to implement them); others would require sustained research and development efforts (which in some cases are already under way, albeit for reasons unrelated to environmental benefits), and some would require major attention by the numerous agencies involved with a patchwork of laws and regulation of drug recycling and disposal. Several examples are outlined in various sections of this mini-monograph.

One of the tenets of this philosophy for a truly sustainable industry is that it benefits not just the environment but also consumer and corporation.

Viable Options for Minimizing the Introduction of PPCPs to the Environment

Numerous actions could be implemented in the near term for reducing what risks might exist from introducing PPCPs to the environment. In the longer term, a number of research avenues could be pursued regarding drug design, packaging, and delivery—all of which could provide environmental (as well as consumer) paybacks. Indeed, some of these are already being pursued. Many would yield direct benefits to human health for reasons unrelated to any environmental imperative, including reducing inappropriate drug use and lowering therapeutic dosages [thereby lessening adverse drug reactions (ADRs) and reducing consumer costs].

Health cannot be dissociated from all the other aspects of sustainable living.

Many pharmaceutical producers and organizations have "product stewardship" as an integral part of their business. These programs, however, although sometimes acknowledging the issues associated with consumer use of PPCPs, tend to focus on aspects of the manufacturing process (vs. distribution and use) as well as on hospital waste (Daughton/U.S. EPA 2002e). A potential mechanism for effecting change in the health care industry (starting with hospitals) is via an existing program established under a program agreed to in 1998 by the American Hospital Association and the U.S. EPA and administered by the Hospitals for a Healthy Environment (H2E 2002). This program's overall goal is to reduce the impact of health care facilities on the environment. Although the program initially focused on eliminating mercury and reducing total waste volume, a future area to consider is development of model chemical waste minimization plans such as that developed for mercury by H2E (2002).

Some of the ideas presented below may prove controversial. I highlight them solely to generate an active dialog or debate across the many disciplines that must become involved to successfully address this topic. Many of these disciplines have never before had reason to interact or collaborate with each other. With the increasing visibility of PPCPs as pollutants, I hope these disparate professional communities will find compelling reasons to cross-communicate and, in doing so, expand their knowledge and effectiveness in their own fields.

Avenues for Progress toward a "Green Pharmacy"

The last decade has seen tremendous progress in advancing the practice of "green chemistry" (e.g., minimizing the use of ecologically hazardous reagents and designing alternate synthesis pathways, some of which are based on aqueous chemistry) (U.S. EPA Office of Pollution Prevention and Toxics 2002). In fact, the pharmaceutical industry has a strong history of applying environmentally responsible chemistry (which also turns out to be economically advantageous) to drug synthesis and manufacturing. The same principles could be logically extended and applied to drug design, delivery, package design, dispensing, and disposal so that their benefits could accrue to the end user and not just the manufacturer. Some of these ideas for minimizing the release of PPCPs to the environment have already been put forth (Daughton and Ternes 1999) but are reiterated and expanded on here because all these ideas have never been brought together in one document. Unfortunately, despite the many avenues of advancement that could be—and sometimes are already being—made toward a green health care system, the transfer of new knowledge and technology to clinical practice is notoriously slow; as one example, new knowledge gained from clinical trials takes an average of 17 years to become incorporated into routine practice (IOM 2001).

To view the full article, or references for this excerpt, visit http:www/teleosis.org/public_html/pdf/CradletoCradlePt1.pdf

SYMBIOSIS

The 4 Ts: Assessing Exposure to Multiple Chemicals

BY JOEL KREISBERG, DC, MA

please see the chart on page 23

Assessing exposure to multiple chemicals requires an all-inclusive systems perspective.

Humans, like most life forms on Earth, are bombarded daily with multiple chemicals. Rarely are we exposed to a single, isolated chemical stressor. In analyzing the effects chemicals have on organisms, toxicologists traditionally have focused on a select number of pollutants regarded as "high volume" chemicals; but these represent only a small sample of the substances most organisms are exposed to on a regular basis. Although this type of research is valid and relevant, investigating the effects of one chemical on organisms or ecological systems may not be the best way to understand the toxic effects of multiple chemicals. Due to the large number of chemicals introduced into the environment in the 20th century, this approach does not account for many biologically transformed metabolites and other naturally occurring toxicants.

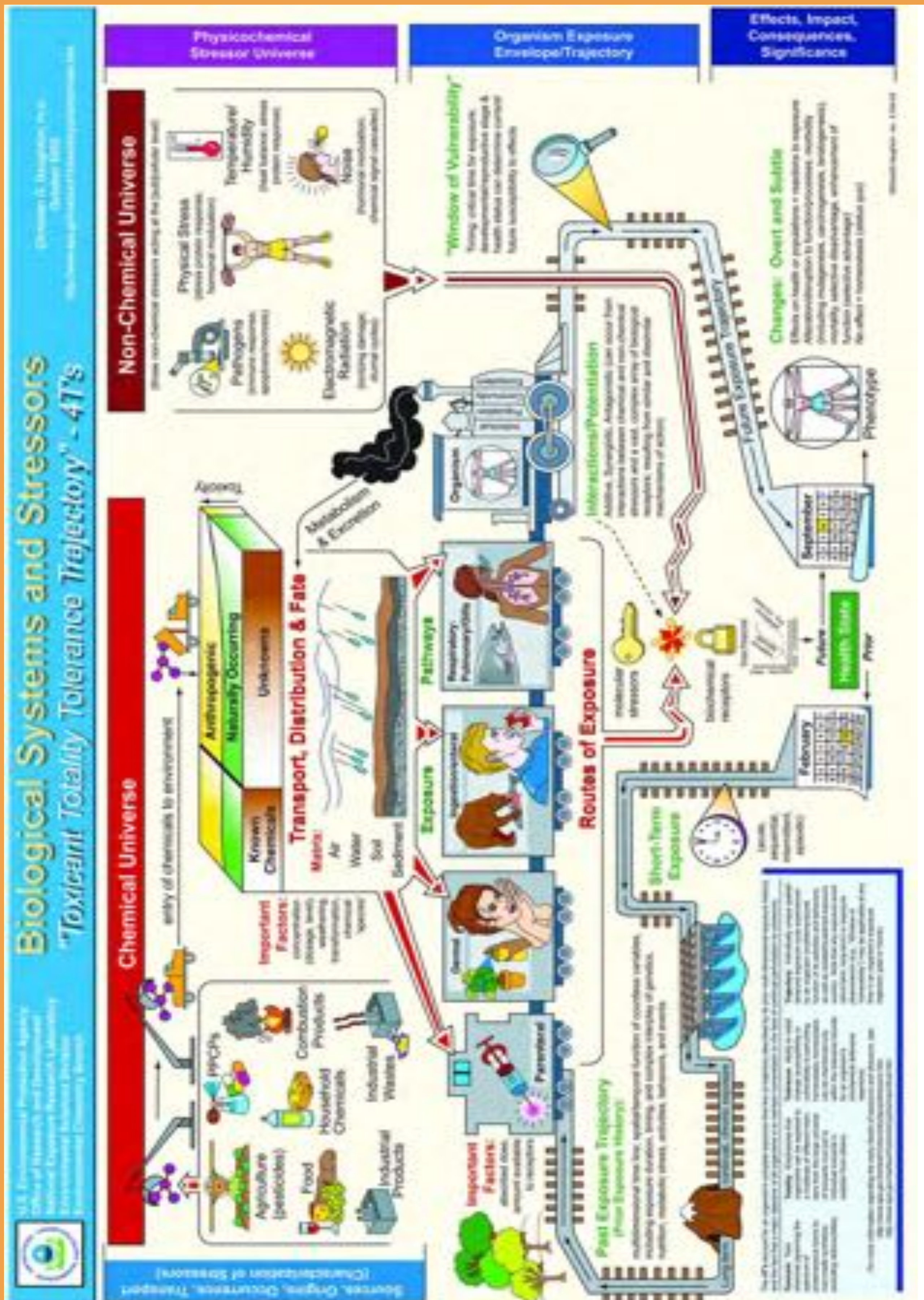
Assessing exposure to risk for multiple chemicals requires an all-inclusive systems perspective, and EPA senior scientist Christian Daughton has developed such a model: it outlines a way to conduct a holistic assessment of chemical exposure as it actually occurs in the real world. Dubbed "The 4Ts," the model's four primary categories are Toxicant, Totality, Tolerance, and Trajectory.[1] Daughton says, "The paradigm of the 4T's sets the stage for the overall true risk as reflected by the sum total of exposure of all toxicants (anthropogenic [or created by humans] and naturally occurring) throughout the historical multidimensional space and trajectory of all other exposure variables."[2](p15) The categories encompass not only individual offending substances (toxicants), but the entire world of stressors (totality), the vulnerability of an organism (tolerance), and combined history of an organism's exposure (trajectory) in assessing risk.

Holistic Exposure Assessment: Toxicant, Totality, Tolerance, Trajectory

In addition to exposure to chemicals, multiple nonchemical stressors—physical, biological, and psychological—effect organisms and react in complex, often synergistic, ways. An individual organism's vulnerability varies depending upon a variety of condi-

continued on page 24 . . .

View the original image (PDF) here: Biological Systems and Stressors – http://www.teleosis.org/pdf/4Ts_4.2



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tions; for humans, our developmental stages are one particularly important variable. For example, gestation and early childhood are more vulnerable stages of the human life cycle. Different toxicant dose concentrations and exposure duration—for example, lower doses for longer periods of exposure—may increase risk during these periods.

The macro-environment continues to accumulate "toxicants"—both naturally occurring and anthropogenic toxic chemicals. Chemicals may enter biological organisms in 4 ways: respiration, ingestion, dermal exposure, or parenteral (direct entry into the organism, e.g. through intravenous injection, such as a vaccine).

Rather than considering a one-time exposure to a single toxicant, it is important to take account for total number of past and present exposures, which occur in temporal patterns along a trajectory—long term, intermittent, episodic, and acute. This gives a more accurate picture of the organism's exposure by looking at the duration and concentration of individual toxicants as well as all previous toxic exposures. This "totality" may be synergistically enhanced or resisted by nonchemical stressors—such as pathogens, electromagnetic radiation, physical stressors, temperature/humidity, emotional stress and noise—that affect the organism.

An organism's "tolerance," which accounts for its ability to resist change at the organismic level, is determined by its general fitness and genetic disposition. Various chemical and nonchemical stressors challenge the individual's capacity for maintaining homeostasis, i.e., the tendency to return to a healthy physiological equilibrium.

The "trajectory" encompasses not only past cumulative exposures but also future exposure; this is a more accurate picture of overall exposure and resulting risk over time. Key to the 4Ts model is the critical state, which is defined as the "state at which an additional single exposure event can result in irreversible adverse effect, one that pushes the organism beyond its ability to maintain homeostasis."[2(p15)] In humans, we call this state disease.

The 4Ts model offers a more sophisticated and systemic approach than previously available for addressing the complex distribution and effects of multiple chemical exposure on living organisms. The significance of this model will emerge as toxicologists and physicians begin to utilize this valuable resource.

Holistic Exposure Assessment

Toxicants

Naturally occurring and human-made toxicants that enter organisms through respiration, ingestion, dermal exposure, or parenteral (intravenously)

Totality

All stressors including exposure to chemicals

Tolerance

Ability to resist change at organismic level—determined by fitness and genetics

Trajectory

Long term, intermittent, episodic, and acute—past and potential future cumulative exposures to toxins

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2 Daughton, CG. Emerging chemicals as pollutants in the environment: A 21st century perspective. *Renewable Resources Journal*. 2005; 23(4):6-23. [full text PDF also available at: epa.gov/esd/chemistry/ppcp/images/iom-2003.pdf]U.S.Environmental Protection Agency: National Exposure Research Laboratory

3 Environmental Sciences. Biological Systems and Stressors. Available at: http://www.epa.gov/nerlesd1/chemistry/ppcp/stressors.htm. Accessed April 16, 2007. [Pictorial representation of model available at: http://www.epa.gov/esd/chemistry/ppcp/images/stressor.pdf]

Green Pharmacy: Preventing Pollution

A Cross Sector Approach

BY JOEL KREISBERG, DC, MA

The recent increase in awareness of environmental issues is creating an opportunity for all constituencies involved with PPCPs to take action and reduce potential harm. A "cross-sector" approach offers a systems perspective that includes all individuals and organizations involved with the production, distribution, consumption, and disposal of pharmaceutical medicine. For pharmaceutical pollution, the solution calls upon all sectors involved in health care—pharmaceutical developers and manufacturers, hospitals, individual physicians and all those involved in the health care system, law enforcement agencies, pharmacies, waste management agencies, consumers, environmental protection organizations, and governmental agencies—to participate in preventing pharmaceutical pollution. This powerful approach provides a comprehensive solution to an issue that has the potential to affect much of life on Earth.

Dispose Medicines Wisely

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The Manufacturing Sector

The manufacturing of medicine is ripe for leadership. In the past decade "green chemistry," which minimizes the use of toxic chemicals in design and production, has emerged (see side bar on pg 37) as a technological advancement in the research and development of new pharmaceutical treatments. As manufacturers become more responsive to concerns about environmental hazards and sustainability, production techniques that lower the overall impact on the environment are becoming increasingly important. From a product standpoint, this sector is developing a new model of "product stewardship"—a "cradle-to-cradle" strategy for developing a new product. While all those involved in the production, distribution, sale, and use of any drug should be involved with product stewardship, the manufacturing sector is in the best position to reduce the environmental impact of medicines, because a product begins with development and manufacturing. If the process begins with cradle-to-cradle stewardship, it is more cost-effective and environmentally sensitive.

One way manufacturers can exercise healthy product stewardship is to design drugs that are more ecologically sensitive and medicines that biodegrade more quickly and yield end products that are less harmful. Innovative drug design can improve delivery systems to require lower doses for efficacy; shifting from the current system of averaging, the practice of refining a medication's expiration date can bring shelf life into closer alignment with real time; recyclable materials can be used for packaging, or package size can be reduced to minimize the unused portion of prescriptions; and more complete and direct information about proper disposal techniques can be added to packaging.

The pharmaceutical industry is in an excellent position to provide more information directly to physicians. The European pharmaceutical industry is currently implementing a system in which medicines are graded for persistence, bioaccumulation, and toxicity (PBT). This information will be available to prescribing physicians, who will be in a position to make healthier environmental choices (see our Spotlight article on the Stockholm County Council on page 45). As is already happening in Canada, Australia, and New Zealand, our pharmaceutical industry could provide funding for the proper disposal of unused or expired medicines. Such initiatives might promote advanced recycling strategies, which would require changes in the current laws for drug handling in America. The pharmaceutical industry could also devote a portion of its huge advertising campaign to educate both physicians and consumers about the environmental and health issues associated with PPCPs.

Pharmaceutical developers and manufacturers, hospitals, individual physicians, law enforcement agencies, pharmacies, waste management agencies, consumers, environmental protection organizations, and governmental agencies—all can help prevent pharmaceutical pollution.

Health Care Systems

Hospitals

Model solutions already exist for the medical industry. Those involved in hospital medicine are already developing methods for proper disposal. Hospitals for a Healthy Environment (H2E) *(http://www.h2e-online.org/)* is collaborating with many major hospitals in the United States, initiating proper disposal of hospital wastes. In May 2007, H2E's Environmental Excellence Summit focused on pharmaceutical waste management. Since much of medicinal waste is generated by hospital medicine itself, there is no reason why hospitals cannot be regional centers for "take-back" programs, where patients and consumers can easily return unwanted and expired medicines. With a high concentration of physicians and nurses, hospitals also offer an opportunity to expand the educational content required of the medical profession.

Physicians, Veterinarians, and Dentists

Individual physicians must also participate in the solution. Any medical office can offer a take-back program. Physicians, as the first line in any health care strategy, can inform patients about healthy product stewardship. The time when a doctor is prescribing a medication is an ideal moment to educate patients about proper disposal habits. Imagine receiving a phone call from your medical office reminding you not only about your next appointment but also to bring your expired and unused medicines with you. Veterinarians and dentists can take these steps as well. Domestic animals are the object of increasing amounts of PPCPs in medicine. These offices, too, can participate in proper disposal programs.

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At least $1 billion worth of unused drugs are flushed down the toilet each year.

Pharmacies and Law Enforcement Agencies

To date, many of the proposed solutions for proper disposal of PPCPs are focused on two sectors, pharmacies and law enforcement. Pharmacies seem a natural fit for proper disposal of medication, and in fact some pharmacies serve as take-back sites for proper pharmaceutical disposal. In British Columbia, 95% of all pharmacies have recycle bins, which allow consumers to bring their unused/expired medicines back whenever they shop. Because certain medications find their way into an illicit drug market, law enforcement agencies sometimes participate in take-back programs to ensure that these substances are handled only by a pharmacist, physician, or police officer. Take-back events and selected programs at police stations are helpful, but are less accessible.

Hospice

One sector of the health care system that relies most heavily on medication is hospice. Researchers estimated in 2003 that at least $1 billion worth of unused drugs are flushed down the toilet each year.[1] Senior centers and home hospice care should consider several types of disposal systems. Current hospice protocol is to have families dispose of medicine; unfortunately, it is often disposed of improperly. These medicines are typically good quality medicines that could easily be reused for others in need. While regulations prevent hospice workers from reverse handling of medicine, families could return unused medicines to proper disposal facilities, or investigate if long term care facilities in your area accept unused dispensed medications. Senior centers, too, can offer educational outreach and take-back services.

Waste Management Agencies and Environmental Organizations

Waste management agencies have an interest in seeing that PPCPs are disposed of properly. Municipal water agencies in particular are developing policies that maintain proper water quality. Some agencies are proposing regulations that would prevent hospitals from disposing medicines directly into the municipal water system. Solid waste organizations too, have a similar interest, though unused medicines make up a relatively small percentage of solid waste. Most solid waste systems in the U.S. request that unwanted medicines be returned to hazardous waste facilities. However, only a very small percentage of household medicines are hazardous wastes (see page 39), and pound for pound, hazardous waste is much more expensive to handle. Since many medications are not hazardous, significant money can be saved by separating most drugs out of the hazardous waste stream.

Other approaches to drug recycling do exist. For manufacturers, "reverse-distribution," which allows pharmacists to return unsold drugs back to the manufacturer, could be enlarged to include unused medication and expired medication.

While human health is very important, water quality needs to be preserved for nonhuman life as well. Many environmental organizations that support wildlife and aquatic ecosystems are supporting take-back programs. In Oakland, California, for example, Save the Bay is actively involved in preventing PPCP pollution.

Consumers

Finally, consumers need to participate in keeping our environment clean. Each of us has a responsibility for healthy product stewardship of all consumer goods. Rather than throwing medicine down the toilet or in the garbage, bring non-controlled drugs to a take-back site or hazardous waste facility. Buy smaller containers of medicines. Buy products with recyclable packaging. Ask your doctor about environmental impacts of your medication and whether a more sustainable alternative exists. Always choose the smallest prescription amount or refill option unless the medication is for a chronic condition. Encourage your physician or primary care provider to take back unused/expired, non-controlled medicines. Most importantly, commit to health promotion strategies that reduce your need for medication in the first place. When given a choice, always choose sustainable medical treatments first, reserving more problematic choices for more difficult situations.

Unused medications may be donated to nonprofit organizations that redistribute medicines to charitable organizations in non-industrial countries that need basic medications. Green funeral practices are emerging as an alternative to traditional practices that release significant chemicals into the environment.

What you can do

- Dispose of unused or unwanted medications at take-back sites or events only
- Do NOT dispose of any medication down the toilet or in the trash
- Purchase drugs in small amounts, limiting expired medications
- Ask for medications with low environmental impact
- Encourage your provider to take-back non-controlled unused/expired drugs.
- Commit to health prevention strategies to reduce your reliance on medications

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Commit to health promotion strategies that reduce your need for medication in the first place—if there is a choice, always choose sustainable medical treatments first, reserving more problematic choices for more difficult situations.

Who Pays?

Perhaps the most contentious aspect of proper disposal of PPCPs is cost: Who should pay? No one wants to pay the additional cost for proper product disposal. In many sectors of durable goods or consumer goods, particularly electronics, the cost of disposal is beginning to be included in the cost of the product. For consumers, this is the preferred method, although a fee added at time of purchase, called an "advanced recycling fee" (such as the system for beverage bottles and cans), allows users to pay as they go. When this is mandatory, however, it feels like a tax. Many of us remember the struggle to get "bottle bills"—an added fee on bottles—passed in state legislatures. Perhaps medications can be handled that way, although experience shows that the public is not easily persuaded to mandate such fees.

The product stewardship model suggests that the cost be spread throughout the life cycle of the product and that the proportion of cost be distributed by the ability of the party to have a significant impact.[2] Applying this model, pharmaceutical companies would provide the largest proportion of investment. To date, this is how Europe and other industrialized countries are building capacity.

But healthy product stewardship requires everyone's participation. In addition to manufacturer involvement, we need to shift our focus to actions and processes that reduce the need for disposal, thereby reducing household accumulation of unwanted drugs. Currently our focus is on prudent disposal options, but we need to address this problem at the source rather than further downstream at the consumer/patient level. We need to aim for a healthcare-consumer system that results in fewer medications needing disposal. Each one of us can contribute to a healthier home for all of us on planet Earth—just by making the better choice.

Everyone Participates

Green Pharmacy offers an opportunity for social action that will greatly benefit our environment at all levels of our society. With relatively simple yet firm commitments to change our habits, becoming stewards of medicine rather then consumers of medicine we effectively become part of the solution. Ideally, there would be no drugs to return. Until that time, all prescribed medicines would be brought back in subsequent visits to a physician, veterinarian and dentist. Manufacturers and pharmaceutical distributors would facilitate medical, dental and veterinarian offices in disposing of these medicines wisely. Consumers willingly participate by returning unused medication. Green Pharmacy is a commitment we undertake today. Our vision is zero waste. Our simple actions have a positive effect of the health and vitality of our world. It requires a commitment to restore that each of us carries in our hearts a vision of a sustainable healthy future.

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Facts on Pharmaceuticals and the Environment

- **80% of the 139 U. S. streams tested were contaminated with organic wastewater contaminants (OWCs), including pharmaceuticals (hormones, steroids, antibiotics, and other prescription drugs as well as nonprescription drugs).**
  [USGS. Pharmaceuticals, hormones, and other organic wastewater contaminants in U. S. streams, 1999-2000: A national reconnaissance. Environmental Science & Technology. 2002; 3(6):1202-1211] and [toxics.usgs.gov/pubs/FS-027-02/pdf/FS-027-02.pdf. Accessed 11/1/06.]

- **Medications are discontinued by physicians 27% of the time because they are no longer needed or suitable for the patient.**
  [Paone RP, Cogenberg FR, Caporello E, Ruthkowski J, Parent R, Fachetti F. Medication destruction and waste measurement and management in long-term care facilities. Consultant Pharmacist. 1996;11(1). Available from: http://www.ascp.com/public/pubs/tcp/1996/jan/mdwm.html. Accessed September 15, 2006.]

- **Costs associated with long-term care facilities' unused medications are between 4%-10% of the total dispensed costs.**
  Congressman Tim Murphy Web site: RX: Healthcare FYI #10/Stop wasting prescription drugs. 2005. Available at http://murphy.house.gov/News/DocumentSingle.aspx? Document ID= 26255. Accessed 11/04/06

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  AMA. 2001. Report 2 of the Council on Scientific Affairs (I-97) Full Text: Recycling of Nursing Home Drugs. Chicago: American Medical Association. Available at http://www.ama-assn.org /ama/pub/category/13655.html. Accessed August 30, 2006.

- **In a survey on pharmaceutical waste pollution, only 1.4% of people returned medications to a pharmacy; 54% disposed of medications in the garbage; 35.4% flushed medications down the toilet or sink.**
  Columbia University Web site. Pollution prevention measures for unwanted pharmaceuticals 2005. Available at http://www.seas.columbia.edu/earth/wtert/sofos/Gualtero_IETerm.pdf. Accessed November 1, 2006.

- **For medications that are not returnable: 15% are incinerated; 17% are directed to hazardous waste handlers; 68% are disposed to solid waste or the toilet.**
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Ecological Economics and the Drug Life Cycle: The True Cost of Medicine

BY NIYATI DESAI, MA

Ecological economics recognizes that humans and their economies are parts of larger natural ecosystems and coevolve with those natural systems. . . Some concept of value is required for rational activities of human economies within their natural systems.[1]

Deteriorating human and environmental health is forcing us to change how we understand the life cycle of pharmaceuticals and personal care products.

After 15 years, 10,000 compounds, and $8 million, a new drug is born.[2] The life cycle of a drug is typically thought to encompass its journey from conception, design, and manufacture, to its introduction into the marketplace. Now, however, overwhelming evidence of deteriorating human and environmental health is forcing us to change how we understand the life cycle of pharmaceuticals and personal care products (PPCPs).

Forward-thinking individuals in the pharmaceutical industry—and those who use their products—realize that we must embrace "product stewardship," which means becoming accountable for the *entire* life cycle of a medicine, from conception through drug recycling and disposal. A product-centered approach to environmental protection requires industry participants—manufacturers, retailers, users, and disposers—to share responsibility for reducing the environmental impacts of products.[3] In a stewardship model, pharmaceutical manufacturers, doctors, nurses, and consumers are all educated about ecological and social impacts of the life cycle of a drug.

True cost of pharmaceutical drug development is complex to evaluate. The path from understanding an illness to providing a treatment is lengthy, difficult, and expensive. Drug clinical trials involve complex processes of rigorous testing to determine efficacy and toxicity. To ensure the safety and well-being of future patients, such testing proceeds with the precaution and diligence necessary for offering effective medical care. However, this diligence comes at a high price, negatively affecting land, natural resources, and local communities on ecological, social, and spiritual levels. From initial idea conception to drug delivery, the medical industry can benefit by utilizing principles of ecological economics.

Ecological Economics values a product or service according to its ability to enhance human wellbeing while supporting sustainable societies and ecosystems.

The primary principles of ecological economics are social, human, built, and natural capital. This emerging economic perspective values a product or service according to its ability to enhance human well-being while supporting sustainable societies and ecosystems.[4]

Social Capital refers to the web of interpersonal connections, institutional arrangements, rules, and norms that facilitate individual human interactions.

Human Capital includes both the physical labor of humans and the know-how stored in their brains.

Built Capital encompasses machines and other infrastructure such as buildings, roads, and factories that compose the human economy.

Natural Capital refers to land and the many natural resources it contains, including ecological systems, mineral deposits, and other features of the natural world.

As we begin to apply the principles of ecological economics seriously, we are forced to question whether or not modern medicine as it is currently practiced can truly provide sustainable means for healing our communities.

How Ecological Economics Changes our Understanding of the Drug Life Cycle

Pre-discovery

In the first or pre-discovery phase of the drug life cycle, scientists fully understand the disease of interest and begin pharmaceutical design. The first step in the research is target identification[1]—choosing a disease to target with a drug–and the final step is target validation[1]—testing the target and confirming its mechanism in the body. Worldwide, more than $70 billion is spent annually on health research and development (R & D) by the public and private sectors.5 The great interest in drug R & D shows commitment to improving health conditions, but we must ask ourselves, who are these drugs being made for? Of the 1,393 new pharmaceuticals marketed between 1975 and 1999, only 13 were for "neglected" diseases.[6] Neglected diseases include illnesses such as Human African trypanosomiasis (HAT), V. Leishmaniasis, Malaria, and Chagas. Neglected diseases typically occur in developing countries whose patients are too deeply impoverished to constitute a market that can attract investment in drug R & D.[7] Only an estimated 10% of worldwide medical investments are used for research into 90% of the world's health problems.[8] This is what is called "the 10/90 gap.[5] The consequences of that profound imbalance are evident around the world.

In addition to this blatant disregard for social capital, pharmaceutical companies fail to consider the consequences of not valuing human relationships and interactions. For a moment, consider what an economic system would look like if it took the principle of valuing social capital seriously. Physicians might be more likely to accept uninsured, impoverished patients. Employers might be more inclined to provide better coverage to employees. Various sectors of the health care system, such as physicians and hospitals, might more efficiently coordinate care, and patients might be willing to absorb higher out-of-pocket costs because they trusted and valued the quality of their health care organizations.[9] Integrating the value of social capital into medical economics improves the health and economy of so-called "developing" nations. For example, the World Health Organization estimates Africa's gross domestic product (GDP) would be up to $100 billion greater annually if malaria had been the focus of pharmaceutical research years ago.[10] The complete integration of social capital into all stages of the pharmaceutical industry would undoubtedly serve to fulfill a vision of high quality health care for all.

Only 10% of the world's medical investments are used for research into 90% of the world's health problems

Drug Discovery

Drug discovery, the next phase of developing a drug, a candidate, or a "lead compound"[2] is identified. The sources for lead compounds vary and change considerably over the course of time. Nature is a primary source for drug discovery. Scientists and public health experts traditionally have paid little attention to either the relationship between human health and the health of other species, or the value of natural capital; neither have these topics been addressed in the education of health care professionals.[11] Take, for example, Taxol. During the 1960s, a potent anti-cancer compound, known as Taxol, was discovered on the bark of the Pacific Yew tree. Following considerable depletion of these valuable trees and additional research, scientists found that each patient would need 60 pounds of Yew bark to produce enough Taxol to sustain the course of their treatment. The problem was that one tree provided only 20 pounds, and over 40,000 women needed the remedy.[12] Due to the impact of this resource depletion on the local ecosystem and communities, scientists developed a synthetic and more powerful form of this groundbreaking cancer drug from the leaves of the Pacific Yew.

As pharmaceutical companies worldwide are becoming more aware of the need to conserve biodiversity and natural capital, some are developing local biodiversity action plans (BAPs) aimed at conserving natural resources, and where possible, increasing local diversity on and around the company's land. For example, Glasko-Smith Kline is creating or maintaining refuges and "green corridors" for flora and fauna and reintroducing indigenous species. Some pharmaceutical manufacturing operations are now requiring sites to evaluate its impact on the environment:[13]

- identify and assess potential impacts of their activities on local habitats
- minimize adverse effects of their activities on important habitats
- enhance biodiversity where feasible
- monitor impacts to ensure action remains effective in protecting and enhancing local biodiversity

Prioritizing sustainability is a respectable step towards resource conservation, but it is only the beginning of actions the medical industry must take.

While the natural world is a primary source for drug discovery, scientists also develop medicine *de novo,* creating molecules from scratch using advanced computer modeling. A recent survey found that 30% of new drugs were completely synthetic in origin. The other 70% were derived from or were similar to chemicals found in nature.[13] But whether the compounds are synthetic or natural, the pharmaceutical industry's efficiency rate relative to use of raw materials is abysmal. Typically, about 100 kg of material raw material is used for every 1 kg of active pharmaceutical

Top 20 Prescriptions for 2006

1 Lipitor – Cholesterol lowering agent
2 Toprol XL – Antihypertensive
3 Norvasc – Antihypertensive
4 Synthroid – Thyroid hormone
5 Lexapro – Antidepressant
6 Nexium – Gastroinestinal
7 Singulair – asthma prophalaxis
8 Prevacid – Gastrintestinal
9 Ambien – Sedative
10 Zoloft - Antidepressant
11 Advair Diskus – Corticosteroid
12 Zyrtec – Antihistamine
13 Effexor XR – Antidepressant
14 Fosamax – Bisphosphonate
15 Plavix – Anticoagulant
16 Protonix – Proton pump inhibitor
17 Vytorin – Cholesterol lowering agent
18 Zocor – Cholesterol lowering agent
19 Diovan – Angiotensin blocker
20 Lotrel – Calcium channel blocker

Source: Drug Topics. Top 200 Brand-Name Drugs by Units in 2006. www.drugtopics.com

ingredient produced[13]—a miserable 1% material efficiency, compared to the production of fine chemicals (20%) and bulk chemicals (50%). This inefficient process, which wastes valuable resources and has negative environmental and financial consequences, demonstrates the industry's lack of regard for the worth of natural capital.

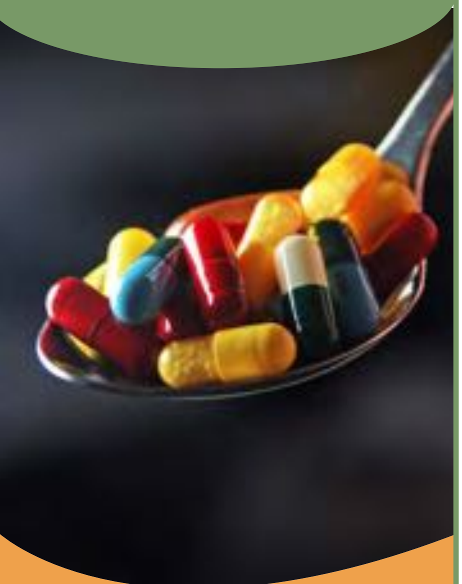
The brighter side is that the industry *is* initiating a variety of conservation methods to extend the life of raw materials and reduce the impact drug development on the environment. High throughput screening is currently the most common form of drug development.[2] Using robotics and computational power, researchers test hundreds of thousands of compounds in a relatively efficient manner. In addition, scientists are using biotechnology to genetically engineer living systems to produce the disease-fighting compounds in medicine.

Pre-clinical and Clinical Phases, and Approval

Following discovery, drugs undergo extensive lab and animal testing in the pre-clinical phase to determine safety and efficacy for human testing.[2] In this stage, the pharmaceutical manufacturer submits an Investigational New Drug Application (IND) to obtain FDA approval to test on human subjects. This testing may reveal unanticipated weaknesses of the medicinal compound. The number of potential medicinal compounds is drastically reduced from 10,000 to 5 or fewer in this phase.[2] Problems can arise when the need to determine a potential drug's safety and efficacy overrides the welfare of living animals; because of concerns about abuse and maltreatment of animals, testing gets strong scrutiny from the public. Integrating the value of natural capital in the pharmaceutical industry would advance sophisticated technology development and replace harmful testing protocols.

In the next phase of drug development, which can last up to 6 or 7 years, researchers conduct clinical trials, or tests on humans, to determine if a drug is safe and effective. A clinical trials starts with Phase I tests on a small group of healthy volunteers and concludes with Phase 3 tests on a large group of patients. Some treatments may have unpleasant or even serious side effects. Often these are temporary and end when the treatment is stopped. Others, however, can be permanent. Side effects may appear during treatment, or not show up until after the study is over.[14]

Drug companies that are not committed to human capital fail to consider individual and community knowledge and may contribute to already deteriorating health conditions. In the previous decade or two, investigations by both public and private sectors have uncovered the fact that some researchers conduct unethical testing of impoverished peoples in the developing world. Without internal ethical review committees, such as research institutes or scientific panels, drugs continue to be tested without consent, on men, women, and children of developing nations. In 1996, Pfizer treated 100 Nigerian children with the antibiotic Trovan in order to determine the drug's effectiveness.[15] Eleven children in the trial died, and others suffered brain damage, were partly paralyzed, or became deaf.[16] Pharmaceutical industry researchers failed to acknowledge the inherent value of human life and became witnesses, and in some cases perpetrators of, unnecessary and unjustifiable deaths. It is imperative that the pharmaceutical industry reclaim its stance on human and social capital and insist on providing humane and effective care to all people, regardless of social or economic status.



Once clinical tests prove a drug to be effective, it goes through the approval phase. Once approved by the FDA, the drug goes into the manufacturing process. This phase is responsible for the majority of damage to natural capital within the drug development process.

Drug Production and Natural Capital

In order to scale up production, pharmaceutical manufacturers rely on excessive use of the natural capital of energy. Water, and toxic chemicals can be excessive, resulting in significant air, water, and land pollution.

Energy

Perhaps the hottest topic right now among those concerned with sustainability is energy. Evidence that shows an increase in greenhouse gases, such as carbon dioxide, in the atmosphere is causing a rise in the Earth's temperature—global warming[13]—is spurring the search for alternative forms of energy production. The U.S. pharmaceutical industry consumes almost $1 billion in energy annually.[17] In 2002, the industry generated over $140 billion in output, up from $108 billion in output in 1999.[17] In an attempt to curb energy usage, pharmaceutical companies have implemented a number of conservation methods, including solar-powered streetlights, wind turbines, and solar-heated water canteen and temperature control.

Ecological economics poses the question, Is modern medicine as it is currently practiced a truly just and sustainable way to truly heal our communities?

Water

Water is the most abundant liquid on our planet, covering 70% of the Earth's surface and making up 60% of the human body. Of this, only 1% is freshwater. Freshwater is used in the drug development in manufacturing (for processes, products, cooling, and cleaning) and for general uses such as drinking, food services, and sanitation.[2] In 2005, the average pharmaceutical company used 22 million cubic meters of freshwater,[17] which is sourced mainly from municipal water supplies (59%) or wells or boreholes (40%),[13] with a small amount from other sources.

Many pharmaceutical manufacturing facilities are located in countries where water resources are classified as "highly stressed."[18] Beyond excessive resource consumption, threats to water include the unknown effects associated with active ingredients in the drugs being produced on nontarget species.[2] In addition, environmental pressures on water negatively impact the surrounding society's access to food and drinking water and lessen the opportunities for those in the affected areas to build sustainable communities.

Conservation measures the pharmaceutical industry has taken to date include rainwater collection for sanitary purposes and recycling up to 90% effluent process water for landscaping, with an eventual goal of zero-wastewater (no discharge to water bodies or municipal sewers).

Typically, about 100 kg of material raw material is used for every 1 kg of active pharmaceutical ingredient produced.

Air

Clean air is essential for overall well-being and good health. The heavy use of solvents in drug research, development, and manufacturing results in the emission of Hazardous Air Pollutants (HAPs), such as volatile organic compounds (VOCs). The emissions of VOCs can give rise to ground level ozone in the presence of UV light, which has adverse effects on human and plant life. Some VOCs are also greenhouse gases and may contribute to climate change.[19] In order to curb air pollution, pharmaceutical industries are increasing the reuse and recycling of solvents during drug manufacturing and installing VOC abatement equipment. A reduction in the manufacture and prescription of CFC-driven inhalers could further decrease the release of ozone-depleting substances.[20]

Solid Waste

More than 80% of the hazardous waste in drug development consists of solvents that are used in production processes,[13] and a daunting number of regulations guide and restrict the way hazardous waste is handled. Regulations vary widely around the world, and the primary disposal option is incineration. In 2005, GlaxoSmithKline disposed of 68 million kg of hazardous waste (excluding demolition and construction waste): 44% of this was incinerated with energy recovery, and 54% was incinerated without energy recovery. During that year, the company recycled 72% of the total waste it generated, an increase of 2% since 2004. This is far from reaching its seemingly simple goal of 10% increase in the proportion of waste recycled since 2001.[13] In 2003, Roche incinerated 23% of its general waste, and the rest (77%) was sent to landfill.[17]

Packaging is a significant source of solid waste in the drug life cycle. Conservation initiatives include increasing the amount of recycled and renewable material used in packaging, and eliminating the presence of harmful products such as PVCs associated with plastics. For example, companies in Japan are replacing PVC packaging material with polypropylene (PP) blister packaging and optimizing blister packaging, which will eliminate approximately 20 tons of cardboard and 5 tons of aluminum bags.[13]

The latest research on the life cycle of pharmaceuticals and personal care products exposes the serious environmental consequences associated with pharmaceutical use and improper disposal (See Pharmaceutical Pollution on p.5). Solid waste conservation efforts include waste minimization and recycling initiatives. Ecological economics would prioritize and require recycling of solvents.

Land

Land is an increasingly scarce resource due to population increase, urban sprawl, and the impact of modern society on land productivity. In order to sustain future generations, every industry's use of land should be analyzed. For many pharmaceutical manufacturers, operations at processing sites have taken place for nearly 100 years.[19] Often manufacturers need to build a new facility or reconstruct old ones, since every drug has different and varying needs.[2] Inefficient building construction and poor management of solid waste, water, and energy at these facilities harm the land on which operations take place.

12 Principles of Green Chemistry

1. Prevent waste
2. Design safer chemicals and products
3. Design less hazardous chemical syntheses
4. Use renewable feedstock
5. Use catalysts, not stoichiometric reagents to minimize waste
6. Avoid chemical derivatives
7. Maximize atom economy
8. Use safer solvents and reaction conditions
9. Increase energy efficiency
10. Design chemicals and products to degrade after use
11. Analyze in real time to prevent pollution
12. Minimize the potential for accidents

Increasing concern about environmental sustainability is prompting some manufacturers to minimize environmental impact and promote sound land management policies as they construct or select new facilities. During project planning, soil surveys inform decisions about facility construction and appropriate disposal methods for surplus soil resulting from construction.

Transportation

Once developed, a drug must reach appropriate dispensaries. In 2005, Glasko-Smith Kline products were transported a total of 195 million kilometers, the majority (82%) by air freight. Business-related travel accounts for a great majority of CO_2 emissions and include plane (232 million kg), employee plane travel (112 million kg of CO_2), and global sales fleet by car (102 million kg of CO_2).[13] In addition to business travel, manufacturers also transport products from manufacturing plants to distributors.

Efforts to advance sustainability in regards to transportation include "green travel plans", encouraging employees to carpool, drive fuel efficient vehicles, and provide showers for cyclists.[13] In addition, teleconferencing is made available to employees to reduce travel.

Summary

If the pharmaceutical industry integrates and addresses the true cost of drug development, a healthier world and more sustainable way of living can and will emerge. The four principles of value of the ecological economics model—social, human, built, and natural capital—offer an integral perspective for drug development and administration. If we inform our economic analyses, strategies, and policies with an understanding of the interdependency of these four types of capital, we can better meet our goals of sustainable human health and contentment.[4]

The emerging field of green chemistry and environmentally sound improvements in hazardous waste management suggest that the gate to environmental sustainability is open wider than ever before. Two important steps the pharmaceutical industry can take are committing to environmental protection and advocacy, and implementing a cradle-to-cradle approach to the life cycle of drugs. To reach true sustainability, however, the industry—and all of us—will need to expand our understanding of product stewardship to value the social, human, built, and natural capital outlined in ecological economics model. We have a great opportunity.

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What Pharmacists and Providers Can Do

- Do not prescribe more medications than can be used
- Prescribe starter packs and refill packs
- Review and regularly reassess the patient's total consumption of medication
- Consider environmental impact when prescribing medications
- Learn more about which drugs have large environmental impacts
- Educate consumers about the importance of proper disposal of pharmaceutical waste

Pollution Prevention Partner

PharmEcology, LLC.

"Healthcare should be leading the country by providing a pollution prevention example of best management practices."

— Charlotte Smith, President of PharmEcology, LLC

Since the RCRA was enacted in 1976, the EPA has not updated the categories of hazardous waste management in health care. This obsolete classification system is inadequate for the many new drugs released every year since the bill was passed, including over 100 highly toxic chemotherapy agents. The widespread need for hospitals to manage pharmaceutical waste in a cost-effective, compliant, and environmentally friendly manner inspired pharmacist Charlotte Smith to develop PharmEcology Associates LLC, an environmental consulting firm headquartered in Brookfield, Wisconsin.

"Most healthcare professionals have no training in environmental law, and I had the feeling hospitals and other healthcare providers would begin facing greater scrutiny from the regulatory community in coming years," explains Smith.

PharmEcology is committed to providing the healthcare and pharmaceutical industry with the information and tecnhology to minimize the destructive impact of pharmaceutical waste on the environment and to insure compliance with state and federal regulations in a cost-effective manner. PharmEcology improved current listings by developing the criteria necessary for identifying additional drugs that pose a serious threat to human health and/or the environment. Their database currently includes over 150,000 drug products and is updated weekly with about 200 new items.

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Resource Conservation and Recovery Act (RCRA)

A 1976 cradle-to-grave regulatory program that will infringe penalties and statutes on health care industry for improper disposal of hazardous waste.

Hazardous Waste:
Chemicals or formulations deemed to be so detrimental to the environment that they must be segregated for special waste management and cannot be sewered or land filled.

Four characteristics of hazardous waste:
- Ignitability
- Toxicity
- Corrosivity
- Reactivity

The primary goals of RCRA are:

- To protect human health and the environment from the potential hazards of waste disposal
- To conserve energy and natural resources
- To reduce the amount of waste generated
- To ensure that wastes are managed in an environmentally sound manner

Unused and Expired Medicines: A National Pandemic

BY MATTHEW C. MIRELES, PH.D., M.P.H.

President and CEO, Community Medical Foundation for Patient Safety

Mission

The mission of the Community Medical Foundation for Patient Safety is to promote patient safety and healthcare quality through education, research, and the demonstrated practice of patient-centered healthcare within a supportive culture of safety. We aim to educate and empower patients and their families to enable them to be more actively involved in making decisions to improve the quality, equity, timeliness, and safety of their own healthcare

What you find in your medicine cabinet may shock you. If you are like most people, you have a store of unused and expired prescription and over-the-counter (OTC) medicines. Do you recall why you no longer use a particular medicine? Do you know which medicines have expired or may be toxic? Throughout the U.S., the unused and expired medicines (UEM) stockpiled in our homes are rapidly becoming a major source of danger to our communities. Unfortunately, there is no systematic program for legally and safely dealing with these medicines.

Each month, more than 135 million Americans use prescribed medicines;[1] when people stop taking them or keep them beyond their expiration date, staggering quantities of unused medicines accumulate. To promote personal and community safety, some communities have begun to organize collection events to take back unwanted medicines. However, there are wide variations in how the collected medicines are classified and destroyed. What one group labels "medical waste" another might call "household waste." Programs involving retail pharmacies typically involve reverse distributors, programs allowing return of unused pharmaceuticals to the manufacturer, and others simply transport the medicines to a landfill. Studies on the best classification system, as well as which method of destruction is most efficacious for various products, are urgently needed, but prudent individuals would do well to follow the "precautionary principle" to protect the environment.

The Community Medical Foundation for Patient Safety has established the only national database on UEM—the Unused and Expired Medicines Registry.

The Community Medical Foundation for Patient Safety strongly recommends and supports collection programs that directly involve law enforcement, which has the authority to collect and destroy unwanted controlled substances. For example, the *TRIAD Program* in Indiana and the *Maine Benzodiazepine Study Group* (MBSG) are collection events in which medicines are returned to law enforcement officers for processing and incineration. A planned pilot study, *Get Rid of Unused Medicines* (GROUP) in Houston, Texas, also will involve law enforcement officers.

Further, the Community Medical Foundation for Patient Safety has established the only national database on UEM—the Unused and Expired Medicines Registry. To date, we have entered and analyzed data from collection organizers on more than 3,000 UEM. A recent study in Maine reported that 40% of medicines that had been prescribed and purchased had never been used.[2] In that study, antidepressants (12%) were the most common UEM and the usual reason they had not been used was that the "doctor discontinued the medicine." Another sample from Maine showed that analgesics (13%) were the most common UEM because of "expiration."[2] Of the analyzed UEM (n=400), 15% was categorized as potentially hazardous to the environment (PBT Index: 4-9). Most of these were antibiotics.

While our ambitious effort to learn about UEM addresses the problem of this pandemic after the fact, our ultimate goal is to address the root causes of the problem by learning more about the reasons for the excessive prescription, production, and demand for medicines in our society. With our partners and collaborators, we are committed to solving this problem through awareness, education, research, and cost-effective interventions and preventive measures. However, as more medicines are manufactured, marketed, and consumed faster than at any time in our history, stemming the tide of a pandemic in the making is a formidable challenge.

Matthew Mireles is an injury and occupational epidemiologist, and is applying his training and expertise to the study of medical errors and patient safety through Community of Competence. He has an adjunct faculty appointment at the University of St. Thomas, Houston, Texas, and at the Center for International Studies.

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Dispose of Unused Medicines Safely

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Statistics about Unused and Expired Medicines

- Of the 4 billion prescriptions to be filled in the U.S. in 2007, the elderly population will waste more than $1 billion of drugs.[3,4]
- Approximately 15 million people misused pharmaceuticals in 2005.[5]
- One of the most common sources of illicit pharmaceuticals is the home medicine cabinet.[5]
- Medication errors result in 700,000 emergency room visits each year.[6]
- Of non-institutionalized seniors, 90% used at least one medicine and 40% used 5 or more medicines weekly.[7]
- The average person over 65 takes between 2 to 7 prescription medicines daily and consumes more than 30% of all medicines prescribed nationally.[8]
- Medicines at home are a major source of accidental poisoning of children—36% occurs in grandparents' homes.[8]
- 19% (4.5 million) U.S. teenagers abuse prescription medicines—such as Vicodin and OxyContin—by engaging in "pharming," which involves combining cocaine and other narcotics with painkillers. Ingesting these sometimes results in an overdose or death.[9]
- Illegal possession, theft, and diversion of prescription medicines and narcotics from homes to the streets contribute to crime.[1]
- Four out of five patients leave their doctor's office with at least one prescription.[11]

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Pediatric Environmental Health Toolkit

www.psr.org

Students in medical school must master a dizzying array of facts and figures, possess prodigious stamina, and learn about seemingly innumerable diseases and treatments. Yet despite these demands, very few schools address a serious and growing health problem: the negative effects of toxicants in the environment on human health.

Physicians for Social Responsibility (PSR), an organization that shared the Nobel Peace Prize with International Physicians for the Prevention of Nuclear War in 1985, is concerned about the lack of an environmental health component in the training of future doctors. PSR—which is committed to creating a world free of nuclear weapons, global environmental pollution, and gun violence—aims to "educate and activate the medical and broader health community, and the public, through research, analysis, collaboration, and targeted communications and to advocate for government and societal change at the local, state, national, and international levels."

PSR notes that only one in five pediatricians in the United States report that their training included how to take an environmental history as it may affect health. To address concerns of practitioners and parents about issues such as pesticide residues on foods, mercury in fish, and arsenic in drinking water and on play structures, the San Francisco Bay Area and Greater Boston PSR chapters are hosting a series of workshops in 2006-2007 to introduce practitioners to a new clinical tool which they developed called the Pediatric Environmental Health Toolkit. The first workshop in this series took place in Oakland, California in October, and subsequent workshops were held in Minnesota, Oregon, Washington and Massachusetts this spring.

The Pediatric Environmental Health Toolkit provides health care professionals with information that helps them to identify various routes of exposure to common toxic chemicals and substances including metals (mercury, lead, arsenic), solvents, pesticides, and other persistent organic compounds such as PCBs. It also addresses the health effects associated with these environmental exposures, with particular attention to the unique vulnerabilities of children. Practitioners learn specific practical and effective communication skills relative to environmental health issues, including the risks and precautions associated with the "built" and "food" environments.

Mission

Guided by the values and expertise of medicine and public health, Physicians for Social Responsibility works to protect human life from the gravest threats to health and survival.

Only one in five pediatricians in the United States report that their training included how to take an environmental history as it may affect health.

The Pediatric Environmental Health Toolkit is a useful tool for preventing or reducing a child's exposure to toxic chemicals. By addressing the connection between human and environmental health, PSR is training health care professionals to become environmental health advocates. Integrating environmental health guidelines into everyday practice enhances practitioners' ability to educate parents to reduce children's exposure to toxins in the environment.

The Toolkit addresses key concepts and principles in pediatric environmental health. It provides a summary of children's unique susceptibilities to toxic substances, a brief Environmental History Intake form, summaries of major toxicants and their potential health effects, and a pocket reference card outlining "priority anticipatory guidance" relative to specific developmental stages. Resources for parents explain how to prevent toxic threats to their child(ren)'s development and create a healthy environment for their child(ren).

Physicians for Social Responsibility believes that social justice and public health depend on a safe and healthy environment. This principle is the foundation for a range of programs and projects that inspire physicians to engage with patients in a way that enriches and supports a healthy relationship with the environment.

To learn more about Physicians for Social Responsibility and PSR's Pediatric Environmental Health Toolkit, contact:

Greater Boston Physicians for Social Responsibility
727 Massachusetts Avenue - 2nd Floor
Cambridge, MA 02139
Phone: 617-497-7440
E-Mail: psrmabo@igc.org
http://psr.igc.org/ped-toolkit-project.htm

San Francisco Bay Area PSR contact information:

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Spotlight on Green Pharmacy

Stockholm County Council

Assessing and Classifying Drug Ecotoxicity

Have you ever wondered what happens to medicine after you ingest it? Since pharmaceutical medicines are often only partially metabolized in the body, many residues and metabolites enter unchanged into wastewater facilities or directly into open waterways. Pharmaceutical drugs are often adapted to resist biodegradation, allowing medicines to remain in the environment for a significant length of time. Current research suggests that a variety of medicines are found in drinking water samples—a warning sign that existing pharmaceutical management and disposal practices may lead to future health and environmental problems.

Because we still know very little about the effects on humans and the environment of continuous, long-term exposure to trace quantities of pharmaceuticals and other chemicals, precaution is advisable. In Sweden, the Stockholm County Council (SCC) is pressuring the pharmaceutical industry to address environmental issues in the manufacturing process itself. An important aspect of this work is assessing and classifying pharmaceutical medicines according to their impact on the environment.

The SCC's ultimate goal is to eliminate the county's input of persistent residues of medicinal products to the soil, water, and air.

Assessing and Classifying Drugs

In 2005, the Swedish Association of the Pharmaceutical Industry conducted a preliminary environmental risk assessment on marketed pharmaceutical drugs. During the 5-year course of study (ending in 2009), this pollution prevention project will conduct a comprehensive assessment of all medications on the Swedish market. Then researchers will classify the medications according to the drugs ability to harm environment and human health. The SCC's ultimate goal is to eliminate the county's input of persistent residues of medicinal products to the soil, water, and air.

The SCC's novel classification system assesses pharmaceutical substances with respect to *environmental hazard* and environmental risk. An environmental hazard assessment is based on the three characteristics: *persistence*—the capacity for resisting degradation in the aquatic environment; *bioaccumulation*—the degree of accumulation in adipose tissue in aquatic organisms; and toxicity for aquatic organisms. The term *environmental risk* refers to the level of possible threat to the aquatic environment; categories are *insignificant, low, moderate or high.*

Environmental Hazard Assessment

(P) Persistence: ability to resist degradation in aquatic environment

(B) Bioaccumulation: accumulation in adipose tissue of aquatic organisms

(T) Toxicity: potential to poison aquatic organisms

When comparing the environmental impact of two substances, both risk and hazard—the PBT value—must be considered, because bioaccumulation and persistence are not included in the initial risk assessment. The classification system includes information for patients, those who prescribe medicine, and health care specialists about the least harmful choices for care.

As European leaders in the movement toward a more sustainable health care system, the SCC provides a model of pharmaceutical pollution prevention that benefits human and environmental health. By engaging participants along the broad spectrum of health care, the assessment and classification program educates practitioners, consumers, and communities about pollution reduction and prevention.

To learn more, visit www.janusinfo.se/environment

What Physicians Can Do

from the Stockholm County Council

- Consider cost-effectiveness and environmental impact when choosing from comparable medications.
- Prescribe starter packs.
- Prescribe refill packs if available.
- Encourage patients to return unused medications to local take-back events or programs, and controlled substances to local police.
- Urge patients to also return used estrogen patches to pharmacy and avoid flushing them down the toilet, since most of the estrogen remains in patch after use.
- Do not prescribe more medications than can be used; if in doubt, repeating the prescription is preferable.
- Review and regularly reassess patient's total consumption of medication to reduce waste.
- Visit *www.janusinfo.se/environment* and ask pharmaceutical company representatives to learn which drugs have the worst environmental impacts.

Web Site Review

Pharmaceuticals and Personal Care Products (PPCPs) as Environmental Pollutants

from U.S. Environmental Protection Agency

REVIEWED BY NIYATI DESAI, MA

Visit the EPA Web site at www.teleosis.org/epa/ppcp

Whether you are someone who is concerned about the environmental and health impacts of your daily beauty products, or a health care provider who wishes to dispose of prescription drugs without causing harm to people or nature, the U.S. Environmental Protection Agency (EPA) Web site offers "news you can use" through its comprehensive section on pharmaceuticals and personal care products—PPCPs—which include prescription and over-the-counter therapeutic drugs, fragrances, cosmetics, sunscreen agents, diagnostic agents, nutraceuticals, biopharmaceuticals, and more.

In 2000, the American Chemical Society sponsored the first ever full-day conference in North America on the subject of PPCPs as environmental pollutants. Interest in the ACS conference was conceived by Daughton and Ternes as a result of their 1999 review article, spurred the creation also in 2000 of the world's first website devoted to the environmental issues surrounding PPCPs. Work on this site (developed by EPA's Office of Research and Development in Las Vegas) stopped in March of 2005, in anticipation of creating a EPA-wide website which will be released in 2007. The new site focuses primarily on research sponsored by the EPA. The general public, researchers, and health professionals now have access to a dense

amount of information that, in addition to research, covers general questions and suggests ways to actively engage with the issues.

The site offers easy access to published data on the health effects of PPCPs in the environment. As one of the primary resources on the subject, users must exercise diligence to comb through the vast amount of data, but the materials density reveals the importance of the topic and is sparking much needed scientific dialog and debate. It also enhances the public's understanding of the origins of chemical pollution, as well as how individuals can help to decrease the proliferation of PPCPs.

The EPA Web site defines the full scope of the complex scientific issues related to PPCPs in the environment, including the need for better coordination among researchers to fill in gaps in the research. Acknowledged gaps include incomplete information on PPCP sources and origins, occurrence, fate and transport, hydrology, exposure, toxicology, and environmental stewardship.

The primary criticism of the site is that since 2005, the site has been inactive and does not reflect any research conducted since that time. However, due to its comprehensive coverage of topics, it maintains its position as the primary resource for research on pharmaceuticals and personal care products. The most positive aspect of the site is that it offers solutions to the problems associated with the proliferation of PPCPs, not only defining the issues, but also outlining out how the medical, scientific, and public communities can work together to reduce the impact of PPCPs in the environment.

Acknowledged gaps in research include incomplete information on PPCP sources and origins, occurrence, fate and transport, hydrology, exposure, toxicology, and environmental stewardship.

Office of National Drug Control Policy Federal Guidelines:

- Take unused, unneeded, or expired prescription drugs out of their original containers and throw them in the trash.
- Mixing prescription drugs with an undesirable substance, such as used coffee grounds or kitty litter, and putting them in impermeable, non-descript containers, such as empty cans or sealable bags, will further ensure the drugs are not diverted.
- Flush prescription drugs down the toilet only if the label or accompanying patient information specifically instructs doing so.
- Take advantage of community pharmaceutical take-back programs that allow the public to bring unused drugs to a central location for proper disposal. Some communities have pharmaceutical take-back programs or community solid-waste programs that allow the public to bring unused drugs to a central location for proper disposal. Where these exist, they are a good way to dispose of unused pharmaceuticals.

Book Review

Macroshift: Navigating the Transformation to a Sustainable World

BY ERVIN LASZLO, PHD

REVIEWED BY JOEL KREISBERG, DC, MA

Macroshift: Navigating the Transformation to a Sustainable World
by Ervin Laszlo, PhD
Berrett-Koehler,
San Francisco
2001
218 pages
ISBN-10: 1576751635
ISBN-13: 978-1576751633

Why bother reviewing a book that is 6 years old? What is a *macrcoshift* anyway? Reading *Macroshift: Navigating the Transformation to a Sustainable World* reminds us that some cultural changes occur more slowly then cell phone technology or the latest in renewable energy. And author Ervin Laszlo is one of the most qualified and articulate individuals to teach us about a shift in social consciousness—one that will decide the future of our children and grandchildren—that is happening at this very moment. An expert in systems theory and evolutionary theory and author of 69 books, Laszlo is also the editor of *World Futures: The Journal of General Evolution*. His book *Macroshift* offers a compelling analysis of the process of social evolution of the human species on planet Earth.

Laszlo begins by describing what a macroshift is, outlining macroshifts that have occurred in the past, and examining the macroshift that is happening now. The author explains, "A Macroshift is a process of societal evolution in which encounters with the system's limits of stability initiates a bifurcation—a process of rapid and fundamental change in complex systems."[p9] Macroshifts have 4 phases: the trigger phase, the transformation phase, the critical or chaos phase, and the breakdown/breakthrough phase (see Sidebar on page 50). The decisive factors in our current macroshift echo the familiar call of progressive political, environmental, and social justice communities for ecological and social sustainability.

Beyond analyzing our current macroshift, Laszlo offers compelling solutions to current beliefs and practices that lead to an unsustainable future. He urges us to eliminate obsolete beliefs—e.g., nature is inexhaustible, nature is a giant mechanism, life is purely a struggle for survival, the market distributes benefits, the more you consume the better you are. Other fundamental solutions include learning to live with diversity, embracing a planetary ethic, and meeting our responsibilities. Laszlo sees the current macroshift as an evolution from Logos consciousness to Holos consciousness: "Logos-inspired evolution was materialistic and conquest- and consumption-oriented. The

Four Phases of Current Macroshift

1. Trigger Phase (1860-1960)

Innovations in hard technologies (tools, machines, operations systems) result in greater efficiency in manipulating nature for human ends

2. Transformation Phase (1960 to present)

Hard technology innovations irreversibly change social/environmental relations, resulting in:

- higher level of resource production
- faster growth of population
- greater societal complexity
- growing impact on social and natural environments

3. Critical or Chaotic Phase (The Decisive Epoch 2001-2010)

Changes in social and environmental relations result in:

- pressure on established culture
- questioning of time-honored values and worldviews
- challenge to "given" ethics and ambitions
- society that is extremely sensitive to fluctuations—"chaotic" in the chaos theory sense
- changes in dominant culture/mode of consciousness determine new developmental trajectory

4. Breakdown/Breakthrough Phase (2010 and beyond) [evidence of both breakdown and breakthrough exist concurrently]

Elements of breakdown:

- values, worldviews, and ethics of a critical mass resists change
- established, rigidified institutions resist timely transformation
- social complexity and degenerating environment create unmanageable stresses
- social order undergoes series of crises that degenerate into conflict and violence

co-exist with

Breakdown events:

- consciousness of a critical mass evolves in time
- culture shifts towards more sustainable worldviews, practices, ethics
- improved social order establishes itself
- social system stabilizes in changed conditions—the human species chooses a positive future!

alternative to it is evolution centered on human development and development of human communities."(p110) Holos is globally whole but locally diverse. People live more simply, striving for a healthy lifestyle rich in contact with others and with nature, rather than living an ostentatious lifestyle. Laszlo declares, "At the levels of the vast and complex system in which people participate, self-reliance is the goal and voluntary cooperation the means to achieve it. People recognize their unity within their social and cultural diversity and become conscious architects of their destiny."(p119)

Laszlo continues with details about what you and I can do to make a difference. The simplest principle and my favorite is "Live in a way that allows others to live as well." If this seems too lofty and abstract, Laszlo offers simply ways of doing this: eat less meat, don't smoke, and drive less. *Macroshift* begins with lofty theory that fulfills our need for a theoretical intellectual construct, continuing with an excellent summary of the inadequacies and damaging effects of modern American and European lifestyles. Laszlo goes on to articulate actions we can take to reach a genuinely higher quality of life—in our personal lives, business, art, science, and government.

Read the "Ten Benchmarks of Holos Consciousness" (See list below)—you may discover you are already playing a significant role in the current macroshift towards the next level of human social evolution. And perhaps you will be inspired to find additional ways to contribute to a more sustainable world!

Ten Benchmarks of Holos Consciousness

You have Whole-brain Holos Consciousness when you:

1. Live simply, satisfying your own needs while taking into account others' needs.
2. Live in a way that respects the lives and socio-economic development of all peoples.
3. Safeguard the intrinsic right to life and life-supportive environment for all living things.
4. Pursue happiness, freedom, and personal fulfillment in harmony with the integrity of nature other people.
5. Require government to relate to other nations peacefully and cooperatively; recognize that all peoples have the right to strive for a better life and healthy environment.
6. Require businesses to adopt sustainable practices that do not detract from local enterprises and developing economies.
7. Require media to provide reliable information that enables citizens and consumers to reach informed decisions.
8. Help those less privileged than yourself to move out of poverty and live with dignity.
9. Work with like-minded people to preserve/restore environmental balance.
10. Encourage others to empower themselves to make ethical decisions on issues that will decide their own and their children's future.

Order back issues

- *Symbiosis* Vol. 3, No. 1-3 **Food, Health and Healing**
- *Symbiosis* Vol. 2, No. 3 **Mercury in the Environment**
- *Symbiosis* Vol. 2, No. 2 **Economics of Health Care**

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Green Pharmacy Campaign

Participate in the solution

The Teleosis Institute is launching our Green Pharmacy Pollution Prevention Campaign. Our goal is zero pharmaceutical waste in the environment! You are invited to bring your unwanted and expired medicine for proper disposal.

The Teleosis Institute campaign works to create partnerships with the health care community to build a movement for positive social and environmental change. Through collaboration with local pharmacies, health providers, and consumers, we will reduce pharmaceutical pollution and the "footprint" of pharmaceutical medicine. Our Green Pharmacy Program provides the education and the opportunity for everyone who produces, sells, prescribes, or consumes medicines to participate in the solution. We are providing an environmentally positive alternative to throwing unwanted drug waste down the drain, toilet, or the trash.

Partner with the Teleosis Institute in creating a cleaner, healthier environment. By supporting our campaign and our growing health care community, you can build a positive future with us. Seemingly small actions by many individuals will help us realize our goal of zero waste.

Support Green Pharmacy

Yes, I want to support the Teleosis Green Pharmacy Campaign

I will:

- Return unwanted medicine and supplements to take-back sites
- Make a donation to support Green Pharmacy
- Help expand a take-back program to a pharmacy near me
- Encourage my provider to take back unused drugs
- Spread the word through forwarding this journal to colleagues and friends
- Ask my provider to prescribe drugs with the least environmental impacts
- Practice healthy product stewardship

Donate Today!

Visit www.teleosis.org to donate to the Green Pharmacy Campaign. We depend on community members and organizations to support the development of our programs and environmentally sound solutions. Your tax deductible gift supports the operation of our pilot take-back sites, educational materials, and advocates for prevention of pharmaceutical pollution.

A not-for-profit organization, the Teleosis Institute was founded by Dr. Joel Kreisberg, DC, CCH, a health care practitionerand environmental educator. The Institute is based in Berkeley, California.

The word *Teleosis* is derived from the Greek and may be translated as "greater self-realization."

Our Mission

TELEOSIS INSTITUTE

The Teleosis Institute is devoted to effective, sustainable health care provided by professionals who serve as environmental stewards.

The Institute has three major goals:

To educate health professionals about the principles and practices of Ecologically Sustainable Medicine (ESM)

To build a community-based network for professionals providing Green Health Care

To provide access to high quality, cost-effective, sustainable medical services benefiting underserved populations and the environment in which we live

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Please share this journal with your health provider, colleagues, family and friends. Don't let our message go to waste!

The Teleosis Institute
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There is Medicine in These Waters

BY JOEL KREISBERG, DC, MA

We drank of every variety of water excepting pure water—sometimes iron, sometimes sulphur; and, indeed, every kind of chalybeate, for every rill was impregnated in some way or another. At last, it occurred to me that there were such things as chemical affinities, and that there was no saying what changes might take place by the admixture of such a variety of metals and gasses, so I drank no more. I did not like, however, to interfere with the happiness of others, so I did not communicate my ideas to my fellow-passengers, who continued drinking during the whole day; and as I afterwards found out, did not sleep very well that night; they were, moreover, very sparing in the use of them the next day.

— Captain Frederick Marryat. (1839)[1] A Diary in America, with Remarks on Its Institutions.

Joel Kreisberg, DC, MA

Dr. Kreisberg holds a Doctor of Chiropractic from New York Chiropractic College and a Masters of Arts in Integral Ecology from Prescott College. He currently is adjunct faculty in JFK University's Masters Degree in Holistic Health Education. Author of several books on Homeopathy, Dr. Kreisberg has been teaching for twenty years and maintains a private practice in Berkeley, CA.

The medicinal effects of mineral water have been touted for millennia. Famed healing springs include Baden-Baden in Germany, Vichy in France, Piestany in Slovakia, and Saratoga in upstate New York—all places where the sick sought relief from chronic illness and pain. Today we can stay at home; there is medicine in the water. Persistent concentrations of hormones, antidepressants, and antibiotics end up in our waterways and our drinking water according to the U.S. Geological Survey.[2,3] Perhaps this is a cheap public health measure for keeping everyone healthy! Unfortunately, a recent study[4] found that a mixture of 13 common medications found in drinking water inhibits cell growth and causes negative changes to human embryonic cells. Simply put, by-products of industrial society are not the only endocrine disruptors; medications for humans and livestock have negative consequences on our health as well. Casual disposal of medicinal hormones creates water-borne pollution. Proper disposal of pharmaceutical medications is a must.

Today, in the U.S. and Europe, municipal drinking water typically has 100 or so pharmaceutical medicines and personal care products in significant concentrations.[5] Various hormones, antidepressants, and antibiotics end up in our waterways, the most common being aspirin, statins, hypertension medications, and hormones of women.[6] In fact, 80% of the waterways sampled included such common medicines as acetaminophen (24%), the hormone estradiol (16%), Ditiazem, a blood pressure medication (13%), Codeine (11%), and antibiotics (10%). The risks of this chemical pollution go relatively unrecognized and certainly unanticipated. Nevertheless, the Strategy Plan 2000 for the U.S. EPA Office of Research and Development makes identifying the risks of pharmaceutical and personal care products (PPCPs) one of top five goals for protecting human and ecological health.[7]

Ecosystem changes through human activities occur primarily via three routes: habitat fragmentation, alteration of community structure, and chemical pollution. Since the work of Rachel Carson, scientist and author of Silent Spring, the impact of chemical pollution has centered on the conventional "priority" pollutants due to their

Today, in the U.S. and Europe, municipal drinking water typically has 100 or so pharmaceutical medicines and personal care products in significant concentrations.

long-term persistence in the environment. Little attention has been given to the active ingredients of pharmaceuticals and personal care products (PPCPs) because they break down more quickly in the environment compared to more traditional chemicals, such as PCBs and dioxin. However, since the exponential growth of pharmaceutical use by consumers, the quantities of PPCPs being disposed of are on par with agricultural chemicals. The ecological consequences of most of (PPCPs) are poorly understood. Since most of these substances are disposed of continually via the sewage system, PPCPs are essentially persistent in the environment. The transformation/removal rates for these substances are compensated by their replacement through continuous consumer use—they are present, at significant concentrations, all the time.

Due to various routes of discharge, PPCPs occur as complex mixtures in the environment. These discharge routes include treated domestic and industrial wastewater, commercial animal feeding operations, and surface applications of manure. However, the two largest sources of PPCPs discharge into the sewer system are residential and hospital waste streams. Depending on the medicine, a significant percentage of the bioactive ingredients may pass through the body unchanged while others are partially metabolized into other bioactive metabolites. This results in the direct excretion of metabolites into the sewer system, where they go largely untreated. Without proper education, patients dispose of pharmaceutical drugs, further contaminating the water system.

Attempting to understand the effects of pharmacological agents on aquatic life isn't particularly easy. Research on pharmaceuticals primarily focuses on the individual effect of each medicine. However, drugs are typically found in complex combinations in the environment. The recently published study on 'Effects of a Complex

Reducing Pharmaceutical Pollution

WHAT PHYSICIANS CAN DO:

- Always take cost-effectiveness and environmental impact into account when comparing medications that are equally safe and suitable for the purpose.
- Prescribe starter packs.
- Prescribe refill packs if available.
- Encourage patients to return unused medications to the pharmacy.
- Inform patients of the importance of even returning used estrogen patches to the pharmacy and avoid flushing them down the toilet, since most of the estrogen remains in the patch after use.
- Do not prescribe more medications than can be used; if in doubt, repeating the prescription is preferable.
- Review and regularly reassess the patient's total consumption of medication in order to reduce waste.
- Learn more about which drugs have large environmental impacts by using this website (see below) and by asking for information from the pharmaceutical companies' representatives.

From Janus: Environment and pharmaceuticals http://www.janusinfo.se/imcms/servlet/GetDoc?meta_id=7240

The two largest sources of these products entering the sewer system are residential and hospital waste.

Mixture of Therapeutic Drugs at Environmental Levels on Human Embryonic Cells' in Environmental Science Technology[8] investigated the effects of 13 drugs at low concentrations. The purpose of this study was to mimic the association and concentration of various drugs found in the natural environment. In the study, the drug cocktail showed a 30% decrease in cell proliferation compared to controls, as well as cellular activated stress response and morphological changes. The studies concluded that "water-borne pharmaceuticals can be potential effectors on aquatic life."[9]

Public agencies are beginning to consider the problem seriously. In fact, the Stockholm County Council in Sweden has identified the presence of medicinal products in the ground water and air as one of the five most important environmental issues.[10] Several solutions are underway, including prioritizing medications that are less harmful to the environment. To do this the Swedish Association of the Pharmaceuticals Industry has begun an environmental risk assessment of all medications marketed in Sweden. The primary evaluation occurs on a scale of insignificant (0), low (1), moderate (2) and high (3) for three of the areas under consideration: persistence—the ability to resist degradation in the aquatic environment, bioaccumulation (accumulation in adipose tissue of aquatic organisms), and toxicity—the potential to poison aquatic organisms.[11] The published report also considers the volume of daily doses delivered. Estradiol, a female hormone, scored a high risk for persistence, bioaccumulation and toxicity, giving it a total score of 9 on a scale from 0-9. In Sweden, there were 25 million doses of Estradiol delivered daily, making it the fourth most common medicine on the list after aspirin, Simvastatin (cholesterol-lowering) and Furosemide (an antihypertensive).

The Stockholm County Council created recommendations for physicians to participate in the safe disposal of medications (see page 5). One of the most important is: "Inform patients of the importance of even returning used estrogen patches to the pharmacy and avoid flushing them down the toilet, since most of the estrogen remains in the patch after use."[12] The environmental impact of pharmaceutical medicines designed to treat human female reproductive issues include endocrine disruption on an ecological level—the life cycle of aquatic life. Though there is not well designed evidence to date, this may also affect human endocrine activity as well. Consequences may include the steady decline in the age of puberty onset over time.[13] Simply put, human pharmacological hormones can act as endocrine disruptors in the environment!

The first principle of the Stockholm County Council states "Always take cost-effectiveness and environmental impact into account when comparing medications that are equally safe and suitable for purpose."[14] This is reminiscent of the 'Principles of Ecological Healing: "All healing has ecological consequences."[15] In California, the Emerging Contaminants Workgroup of the Santa Clara Basin Watershed Management Initiative published a white paper discussing the environmental impact of pharmaceutical disposal.[16] In it they summarize the potential actions we can take to reduce this serious problem. For example, unused residential and expired pharmaceuticals should not be disposed of in toilets and sinks. To inculcate this practice, we should encourage proper disposal through organized "take-back" events at local senior centers, pharmacies, and police and fire departments. Ultimately, legislation and funding is required to most effectively promote these programs.

From a professional perspective, it is our responsibility to understand the ecological consequences of the practices we use every day in our work. With rising

Environmental Risk Assessment for medications includes:

- persistence
- bioaccumulation
- toxicity

populations of modern cities and states, pharmacological agents will continue to emerge as unsuspected chemical pollutants. It is our job as health professionals to create ‘clean medicine,’ a part of Green Health Care. Green Health Care requires not only a workplace that is healthy for its occupants; it involves medical practices that do no harm to ourselves or the environment. While current medicinal practices generate significant pollution, we do have health care options that generate little if any waste. We can and must choose these more enlightened practices.

Our health depends on the health of the environment in which we live. As well, it depends on the medicines we use for illness, meant for returning us to wellness. Precaution is essential for human health as well as the health of the environment. Due to people living longer and an increasing population, ecosystems are continuously contaminated by medicines and personal care products. Low concentrations of modern medicines can and do act as endocrine disruptors in our ecosystems and may potentially damage human health. Our medical system has the technology and the know how to make significant changes that will be good for people and the environment. The time to act is now!

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DISPOSAL ACT: GENERAL PUBLIC FACT SHEET

On September 8, 2014, the Drug Enforcement Administration (DEA) made available for public view a final rule regarding the disposal of pharmaceutical controlled substances in accordance with the Controlled Substance Act, as amended by the Secure and Responsible Drug Disposal Act of 2010 ("Disposal Act"). The final rule is available for public view at http://www.federalregister.gov/public-inspection. The final rule will officially publish in the *Federal Register* on September 9, 2014, and will be available on http://www.regulations.gov, and our website, http://www.DEAdiversion.usdoj.gov. This General Public Fact Sheet contains a general summary of some of the effects of the new rule on the general public. For detailed information, please visit our website or contact your local DEA office.

1. What is the Disposal Act?

- The Disposal Act amended the Controlled Substances Act (CSA) to give the DEA authority to promulgate new regulations, within the framework of the CSA, that will allow ultimate users to deliver unused pharmaceutical controlled substances to appropriate entities for disposal in a safe and effective manner consistent with effective controls against diversion. The goal of the Disposal Act is to encourage public and private entities to develop a variety of methods of collection and disposal in a secure, convenient, and responsible manner.

2. Who is an "ultimate user"?

- The CSA defines an "ultimate user" as "a person who has lawfully obtained, and who possesses, a controlled substance for his own use or for the use of a member of his household or for an animal owned by him or a member of his household."

3. Are my options for disposing of pharmaceuticals more limited now?

- No. These regulations don't limit the ways that ultimate users may dispose of pharmaceutical controlled substances—they expand them. The DEA's new regulations outline the methods by which pharmaceutical controlled substances may be transferred to authorized collectors for disposal. Ultimate users now have expanded options to safely and responsibly dispose of their unused and unwanted, lawfully-possessed pharmaceutical controlled substances: through collection receptacles, mail-back packages, and take-back events.

4. May I continue to dispose of pharmaceutical controlled substances using methods that were valid prior to this final rule?

- Yes. Any method of pharmaceutical disposal that was valid prior to these regulations continues to be valid.

- For example, ultimate users may continue to utilize the FDA and EPA guidelines for the disposal of medicines, available through the DEA website at http://www.deadiversion.usdoj.gov/drug_disposal/index.html.

5. **Will there still be take-back events every six months?**

- Law enforcement may continue to conduct take-back events at any time. Any person or community group, registrant or non-registrant, may partner with law enforcement to conduct take-back events. The DEA encourages communities to partner with law enforcement to continue to conduct take-back events.

- The next DEA-sponsored nationwide take back event will be on September 27, 2014. The DEA will not continue to sponsor nationwide take-back events in order to prevent competing with local take-back efforts conducted in accordance with the new regulations.

6. **Can I dispose of a friend or family member's pharmaceutical controlled substances for them?**

- You may dispose of a member of your household's unused or unwanted pharmaceutical controlled substances. But, if they are *not* a member of your household, you may not dispose of their pharmaceutical controlled substances on their behalf. Only ultimate users may dispose of pharmaceutical controlled substances. An ultimate user, which includes a household member of the person or pet who was prescribed the medication, may transfer pharmaceutical controlled substances to authorized collectors or law enforcement via a collection receptacle, mail-back package, or take-back event.

- Exceptions:

  - If someone dies while in lawful possession of pharmaceutical controlled substances, any person lawfully entitled to dispose of the decedent's property may dispose of the pharmaceutical controlled substances; and

  - A long-term-care facility may dispose of a current or former resident's pharmaceutical controlled substances.

7. **My mother has pharmaceutical controlled substances delivered to her home. She passed away, and I would like to dispose of her unused pharmaceutical controlled substances. I did not live with her. Can I dispose of them?**

- Yes, so long as you are lawfully entitled to dispose of her property, you may dispose of her unused pharmaceutical controlled substances.

8. **How can I find a collection receptacle location near me?**

- Members of the public may call the DEA's Registration Call Center at 1-800-882-9539 to find a collection receptacle location near them.

9. **I live in a rural location. There are no collection receptacles, mail-back programs, or take-back events in the vicinity. How can I safely and securely dispose of my unwanted pharmaceutical controlled substances?**

- There are no restrictions on using a mail-back package obtained from another state. You may dispose of your unwanted pharmaceutical controlled substances in a mail-back package that you received from another state, even if the mail-back package is delivered to a location outside of your state.

- Additionally, these regulations expand—not limit—the options that ultimate users have to dispose of unwanted pharmaceutical controlled substances. You may continue to dispose of your unwanted pharmaceutical controlled substances using the lawful methods you used prior to the effective date of the new regulations, as long as those methods are consistent with Federal, State, tribal, or local laws and regulations, including surrendering pharmaceutical controlled substances to law enforcement.

10. Can I dispose of illicit drugs through a collection receptacle, mail-back package, or take-back event? How can I safely and securely dispose of my unwanted marijuana?

- No. Persons may not dispose of illicit drugs (*e.g.*, schedule I controlled substances such as marijuana, heroin, LSD) through any of the three disposal methods.

- Persons may not dispose of any controlled substances that they do not legally possess. This includes schedules II-V controlled substances that are illegally obtained and possessed.

11. I don't have a mail-back package, but I remember the address from the last mail-back package I used. Can I mail pharmaceutical controlled substances to that address without an official mail-back package?

- No. Persons must use the mail-back package that was provided by an authorized collector or one of their partners. The mail-back package must meet certain specifications, to include having a unique identification number. If an authorized collector receives a sealed mail-back package that they did not provide, the collector must reject it, or if they inadvertently accept it, they must notify the DEA.

- If persons would like to use a mail-back package and don't possess one, they may contact an authorized collector to obtain one.

12. Can I dispose of my insulin syringes through one of the disposal methods? What about my child's asthma inhaler?

- No. Persons may not dispose of any dangerous, hazardous, or non-compliant items in a collection receptacle or a mail-back package. This includes medical sharps and needles (*e.g.*, insulin syringes), and compressed cylinders or aerosols (*e.g.*, asthma inhalers).

- Other non-compliant items that may not be placed into a collection receptacle or mail-back package include iodine-containing medications and mercury-containing thermometers.

- Accepting these materials places the collector at risk, and might cause a dangerous situation. You should continue to use any valid methods you currently utilize to dispose of those medications and medical implements.

- Carefully review the authorized collector's instructions for what is and is not acceptable to place into the collection receptacle or mail-back package. If you have any questions, you should ask an employee of the authorized collector.

13. Can my pharmacy or other collector force me to give personal information, like my name, my prescription information, or my physician information?

- No. A collector may not force anyone to provide any personal information about themselves, their prescription, or their physician.

- In order to protect personally identifiable information, the DEA encourages persons not to place prescription bottles in collection receptacles or mail-back packages.

14. What happens to my pharmaceuticals after I dispose of them? Can they be sold, given away, re-packaged, or re-dispensed for use by another patient? Can they be otherwise recycled?

- Pharmaceutical controlled substances transferred from ultimate users to authorized collectors via either collection receptacles or mail-back programs shall be securely stored or transferred until rendered non-retrievable. They may not be re-sold, donated, repackaged, or re-dispensed. Currently, the most common method of rendering pharmaceutical controlled substances non-retrievable is incineration.

15. Are there environmental impacts?

- Disposed pharmaceuticals must be rendered non-retrievable in compliance with all applicable Federal, State, tribal, and local laws, including those relating to environmental protection. By expanding options on how ultimate users may dispose of their pharmaceutical controlled substances, fewer of these substances may end up in our nation's water system.

06 GLOSSARY

Words, words, words. Here's a little help with jargon that may not be familiar to your students.

Glossary

Accidental poisoning: When any substance interferes with normal body functions after it is inadvertently swallowed, inhaled, or absorbed.

Bacteria: Microscopic organisms that can aid in pollution control by metabolizing organic matter in sewage, oil spills or other pollutants. However, bacteria in soil, water or air can also cause human, animal and plant health problems.

Bioaccumulation: The increase in concentration of a substance in an organism over time; i.e.; a general term for the accumulation of substances, such as pesticides, methylmercury, or other organic chemicals in an organism or part of an organism. Bioaccumulative substances tend to be fat soluble and not to be broken down by the organism.

Biodegradation: Decomposition or breakdown of a substance through the action of microorganisms (such as bacteria or fungi) or other natural physical processes (such as sunlight).

Biomagnification: the concentration of toxins in an organism as a result of its ingesting other plants or animals in which the toxins are more widely disbursed.

Biota: Plants and animals in an environment. Some of these plants and animals might be sources of food, clothing, or medicines for people.

Chemical compound: A distinct and pure substance formed by the union or two or more elements in definite proportion by weight.

Chemical load: The amount of harmful chemicals present in a person's body.

Chronic exposure: Repeated, continuous exposure to a hazardous substance over an extended period.

Collection programs: Organized opportunities for people to turn in unwanted medications for proper disposal to improve public safety and ecosystem health.

Community stewardship: An ethic that embodies the responsibility of cooperative planning and management of resources; for organizations and communities to actively engage in the development and maintenance of its people, property, and financial assets. Relates to the care and/or management of resources for which one has no ownership.

Concentration: The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, breath, or any other media.

Contaminant: A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.

Contamination: Introduction of chemicals, toxic substances, wastes, or wastewater into water, air, and soil in a concentration that makes the medium unfit for its next intended use.

Controlled substance: A drug or chemical whose manufacture, possession, and use are regulated by a government.

Direct disposal of unwanted medicine: The disposal of pharmaceuticals directly to a sewage system or landfill by flushing, pouring down a sink, or discarding in the trash.

Discharge: The amount of water flowing through a river or aquifer.

Domestic Wastewater: Used water from houses and apartments; it is also called sanitary sewage.

Ecological harm: This occurs when an action results in habitat alteration and degradation or directly harms native animals, such as altering the endocrine system of species.

Ecosystem: The interacting system of a biological community (plants, animals) and its non-living environment.

Effluent: Wastewater—treated or untreated—that flows out of a treatment plant, sewer, or industrial outfall. Generally refers to wastes discharged into surface waters.

Endocrine disruptors: Chemicals that may interfere with the body's endocrine system and produce adverse developmental, reproductive, neurological, and immune effects in both humans and wildlife.

Environmental education: Organized efforts to teach how natural environments function and, particularly, how humans can interact sustainably with their environments.

Environmental hazard: Any situations or events that poses a threat to the surrounding environment.

Environmental health: Aggregate of conditions, forces, and substances in an environment that affect the physical and mental well being of the people living in it.

Environmental impact: Possible adverse effects caused by the release of substances in the environment, which may be due to industry as well as building or infrastructure projects.

Environmental persistence: The ability of a chemical substance to remain in an unchanged form. The longer a chemical persists, the higher the potential for human or environmental exposure.

Excretion: The elimination of waste material from the body.

Exposure pathway: The route a substance takes from its source to its end point. This includes how people or wildlife come into contact with or get exposed to the substance.

Feminization of fish: This occurs when compounds released into water systems affect how male fish develop, causing them to produce eggs.

Groundwater: The supply of freshwater under the Earth's surface in an aquifer or soil.

Habitat: Specific environment in which an organism lives, which provides food and shelter to sustain the organism.

Hazardous waste disposal: The act of safely discarding any solid, liquid, or gaseous waste materials that, if improperly managed or disposed of, may pose substantial hazards to human health and the environment.

Health risks: Any factor that increases the chance of disease or injury.

Identity theft: Obtaining a person's personal and financial information through criminal means.

Industrial wastewater: A group of unit processes designed to separate, modify, remove, and destroy undesirable substances carried by wastewater from industrial sources.

Inert ingredient: Pesticide components such as solvents, carriers, dispersants, and surfactants, which are not active against target pests. Not all inert ingredients are innocuous.

Life-cycle assessment: A technique to assess the environmental aspects and potential impacts associated with a product, process, or service, by compiling an inventory of relevant material inputs and environmental releases and evaluating the potential environmental impacts associated with identified inputs and releases.

Medicine take-back programs: A way for consumers to return unused or unwanted medications to a pharmacy or other collection location for proper disposal.

Monitor: To measure a characteristic, such as the population of aquatic life, using uniform methods to assess change over time.

Municipal sewage: Wastes (mostly liquid) originating from a community; may be composed of domestic wastewaters and/or industrial discharges.

Nonpoint source pollution: Diffuse toxic waste, generated from large areas with no particular point of contaminant origin, but rather from many places.

Personal care products: A diverse set of products that includes cosmetics and items for personal hygiene.

Pharmaceutical: Drug or medicine that is prepared or dispensed in pharmacies and used in medical treatment.

Pharmacokinetics: The branch of pharmacology concerned with the movement of drugs within the body.

Point source pollution: A discharge of water contaminant to a stream or other body of water via an identifiable pipe, vent, or culvert.

Precautionary principle: The introduction of a new product or process where the ultimate effects are disputed or unknown should be resisted. It has mainly been used to prohibit the importation of genetically modified organisms and food.

Prescription drug: A drug that can be obtained only by means of a physician's prescription.

Resource Conservation and Recovery Act: A federal law controlling the management and disposal of solid and hazardous wastes that are produced by a wide variety of industries and sources. The law regulates hazardous pharmaceutical wastes produced by manufacturers and the health care industry.

Reverse distribution: Collecting damaged, outdated, or unsold goods and bringing them back to the supplier or manufacturer.

Sampling: The process of taking a portion of water for analysis or other testing.

Septic system: An on-site system designed to treat and dispose of domestic sewage. A typical septic system consists of a tank that receives waste from a residence or business and a system of tile lines or a pit for disposal of liquid effluent (sludge), which remains after decomposition of the solids by bacteria. The tank and must be pumped out periodically.

Service learning: A method of teaching, learning, and reflecting that combines academic classroom curriculum with meaningful service in the community.

Toxic: Able to poison or harm an organism. Toxic substances can cause adverse health effects.

Unintended consequences: Outcomes that are not the ones intended by a purposeful action.

Unwanted medicine: Unused prescriptions or over-the-counter medications that are expired or no longer needed.

Wastewater treatment: Process that modifies wastewater characteristics such as biological oxygen demand (BOD), chemical oxygen demand (COD), pH, etc., to meet effluent standards.

DSRP Vocabulary

DSRP Vocabulary is a method of student thinking to improve learning using distinctions, systems, relationships, and perspectives. Students have to think about a topic, what it is, what it isn't, what the parts of the topic are—what the relationships of the topic to other things are, and how it is thought of in other perspectives (metacognition). For a more complete description, please see http://en.wikipedia.org/wiki/DSRP or http://www.cabreraresearch.org/.

A student worksheet can be found in the Glossary.

Example:

Distinctions:

> **Cars** are: vehicles that have four wheels and an engine and that are used for carrying passengers on roads.
>
> My source is: Merriam Webster Dictionary
>
> **Cars** are not: trains, buses, or ships
>
> How would you distinguish between cars and the things you just listed? Trains travel on rails, buses are bigger and have distinct routes, and ships have no wheels and travel on oceans.

Systems:

> What are the parts of a **car**? (Name 3) Engine, tires, chassis

Relationships:

> What are the relationships among **cars** and the other vocabulary words? Give an example. Perhaps other transportation means were given as words: train, bus, ship, airplane. All are used as transportation; however all have different ways of transporting people.

Perspectives:

> How are **cars** viewed from perspectives of different people? Wealthy people may view them as collection items. Poor people may look at them as something out of reach. Homeless people may see them as a source of shelter. Middle class people may see them solely as a source of transportation. Car salespeople see them as a source of income.

DSRP Vocabulary

DSRP is a method to help you defend knowing what you know about a word or topic. Insert your word or topic in the sentences to complete each thought.

Distinctions:

______________________________ is/are:

____

____

My source is: ____

_________________________________ is/are not:

____

____ (How do you know?)________________________

____

How would you distinguish between a ________________ and the things you just listed?

____

____

Systems:

What are the parts of __________________? (Name 3) _______________________________________

____

Relationships:

What are the relationships among ____________________ and the other vocabulary words? Give an example.

____

____

Perspectives:

How are _________________ viewed from perspectives of different people? ____________

____

____

____

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Community Partnerships – Meeting Community Needs (fact sheet)
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Chemicals, the Environment, and You: Explorations in Science and Human Health – Lesson 1 & Lesson 5 (classroom lessons)
The Discovery Channel

Watershed Patch Project (classroom lesson)
U.S. EPA
http://water.epa.gov/learn/resources/upload/2002_08_27_adopt_patch_watershedpatch.pdf

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Reflection Activities (activity), *Post Reflection Activities* (activity), *Reflection Activities to be Used Throughout* (activity), and *Reflection Opportunities – Segments 1-6* (activity)
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The Power to Change the World

"Never doubt that a small group of thoughtful,
committed citizens can change the world;
indeed, it's the only thing that ever has."

– Margaret Mead