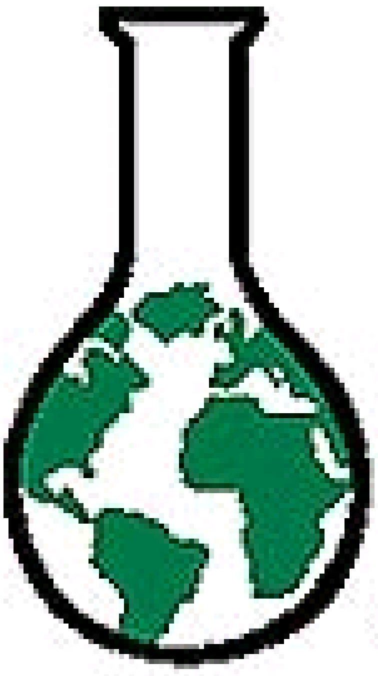
Decoding Green Chemistry for Workers



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Chemicals pervade nearly every aspect of our society. Although chemicals are responsible for numerous advances in industry, health care, and daily life, they have also caused serious harm to human and environmental health over the years. Workers in many cases are the most exposed and most vulnerable to hazards posed by toxics in manufacturing, delivery, and disposal. Unfortunately, a chronic illness, environmental contamination, or death has to happen in order to spark action. And as we have seen, sometimes even that is not enough.

Green chemistry offers an alternative proactive approach that calls for safe, efficient, and effective chemical products from the beginning to the end of a chemical product. Green chemistry is a tool to:

- Reduce and eventually eliminate the use of toxic materials;
- Reduce the environmental impact on waste water and dispersion of contaminants in the atmosphere;
- Design products for easier recycling and reuse;
- Reduce water and energy usage in chemical manufacturing; and
- Use renewable raw materials.

Workers are essential to the successful implementation of green chemistry approach: they know what the jobs entail, and they will be the ones performing the work tasks. As in all matters of occupational health and safety, worker participation in addressing hazardous conditions is indispensable for finding effective solutions.

In this training, we discuss the need for green chemistry, its basic principles, successful real life examples, and implications for worker health and safety. This 8 hour course is designed to be interactive and dynamic, incorporating various teaching methods and activities, and providing some tools for workers to be applied in their worksites.

How this curriculum is organized

This curriculum contains six modules that cover background information, lesson plans, and handouts. The objectives for each module are described as follows:

Session 1 – Getting Started/ Sustainability

- Show how workers' health is affected by toxic chemicals in the workplace
- Recognize workers' efforts to improve health and safety conditions for workers
- Define in their own words what sustainability is
- Identify the tree pillars of sustainability

Session 2 – Chemical Hazard Awareness

- Describe in their own words what chemicals are, how they enter our bodies, and what their health effects are.
- Identify how the environment is polluted
- Be aware of labels and MSDS as sources of information for chemicals.

Session 3 – Regulations

- Explain what rights workers have under the Hazard Communication regulation
- Describe what TSCA does and how it affects how chemicals are regulated in the USA
- List the existing gaps that make difficult to assess and manage chemicals of concern
- Identify what is happening in Europe and how REACH works

Session 4 – What Green is Chemistry

- Identify how conventional chemistry affects sustainability
- Define in their own words what green chemistry is

Session 5 – Principles of Green Chemistry

- Review the hierarchy of controls for chemical hazards.
- Become familiar with the precautionary principles of green chemistry.
- List limitations that the green chemistry initiative may encounter.

Session 6 – Green Chemistry and Workers

- Identify various resources that can help workers and those interested in staying aware of green chemistry issues.
- Develop a plan for next steps to address chemical hazards using the green chemistry approach.

Teaching Approach

The teaching approach used in this curriculum is interactive. It is based on the view held by labor educators that people learn by: Group Discussion

Hearing + Seeing + Discussing + Practicing

90% Retained

In each of the sessions participants will be engaged in:

- **Analyzing** and understanding the risks of chemical hazards in **their workplace**
- **Learning new** information and **skills**
- **Planning** how to bring about changes to address chemical hazards

At the end of each session, the group will see how the topic helps them take steps towards the goal of supporting and applying green chemistry at their workplaces.

Preparing to Teach

These are things you need to do to get ready to teach each module. **The first step is to become familiar with the material –background information, lesson plan, visual aids, and handouts.** Read them over and make sure you understand all the information. Think about how you will present the module. If you wish, write down important points from the lesson plan for easy reference while teaching.

Practice how you will deliver the information in such a way your audience can understand the concepts taught.

Remember: One level is to understand the concepts; another level is to teach/communicate the concepts to your audience.

Below is a checklist to help guide you through the process of settling up and conducting a module.

Before training is scheduled:

☐ Work with specific agency and/or management to identify the date and location for your training.

☐ Make sure to learn the material well before teaching it and that you know the objectives and key messages for the lesson plan.

☐ Practice, practice and practice.

☐ Decide which materials you need for the training, duplicate and organize your visual aids (Masters for duplication are in this manual.) Get help from the organization if needed.

☐ Prepare a course agenda that provides the dates and times the course will be taught.

☐ Obtain an easel pad, flipchart paper, markers, and masking tape.

☐ Make a materials packet for each participant. For each packet, photocopy handouts and evaluation form

☐ Make sure a computer, projector and screen are available at the training site. Use these tools to present visual aids that complement the training guide.

During training:

☐ Bring copies of the sign-in sheet and registration form If course is longer than 4 hours have participants sign-in and fill in the registration form. If course is less than 4 hours, only have participants sign-in.

☐ Bring copies of the handouts that go with the lesson plan you are teaching (one for each participant.)

☐ Bring visuals to support the teaching part.

☐ Make sure you have flipchart paper and markers to use during the sessions.

☐ Provide copies of the evaluation form (one for each participant) and have participants complete it at the end of the session.

☐ Have extra pencils/pens for participants to write on the evaluations.

☐ Prepare a roster for distribution for course participants.

After training:

☐ Discuss with the organization and/or supervisors how workers concerns can be discussed with management to look for improvements.

☐ Review evaluation forms to improve your presentation and materials.

Tips for trainers

The green chemistry curriculum works best if participants are actively involved. This makes the sessions more interesting and it is more likely workers will remember the information you have provided. Here are some ways to encourage everyone to get involved:

- Ask questions instead of simply giving participants all the information. After you ask a question, wait a short time to let them think. Then call volunteers to answer. After workers have provided their answers, use the information in the background or lesson plan to add any points the workers missed.

- Ask about personal experience. This may help the group to see how the topic is relevant to them. You could ask: has anyone heard the term of green chemistry? What is being done at your workplace in terms of green chemistry? How do you get involved as a worker, community member, and consumer?

- Limit the amount of time a participant can talk. If a worker is talking too much, invite someone else to speak.

- Never make fun of anyone or put anyone down, especially for asking questions.

- If you do not know the answer to a question, do not guess or fake the answer. Write the question down and promise to get back to them.

- Stick to the topic. If workers' questions and comments move too far from the topic, tell them that their concerns can be addressed later, either privately or in another safety meeting.

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Decoding Green Chemistry for Workers

Instructors Training Forms

Setting Up and Conducting a Training

Before each session:

- ☐ Work with specific agency and/or management to identify the date and location for your training.
- ☐ Make sure to learn the material well before teaching it and that you know the objectives and key messages for the lesson plan.
- ☐ Practice, practice and practice.
- ☐ Decide which materials you need for the training, duplicate and organize your visual aids (masters for duplication are in this manual). Get help from the organization if needed.
- ☐ Prepare a course agenda that provides the dates and times the course will be taught.
- ☐ Obtain an easel pad, flipchart paper, markers, and masking tape.
- ☐ Make a materials packet for each participant. For each packet, photocopy handouts and evaluation form
- ☐ Make sure a computer, projector and screen are available at the training site.

List of course materials needed for each training:

- ☐ Sign-in sheet and registration forms
- ☐ Copies of evaluation form (one for each participant)
- ☐ Green Chemistry Curriculum (Your copy)
- ☐ Factsheets/Handouts (one for each participant)
- ☐ Timeline and cards with facts
- ☐ Post-it table top easel pad
- ☐ Sets of flipchart markers (red, black, blue, green)
- ☐ Extra pens/pencils (for participants)
- ☐ Name tags

GREEN CHEMISTRY TRAINING
SIGN-IN SHEET

Name (Please Print)	Organization/Workplace	E-mail	Telephone	Zip Code

EVALUATION

DATE: ____________________

1. Overall, how would you rate this program?
   □ **Excellent** □ **Good** □ **Fair** □ **Poor**

2. Were there any sections or activities that you liked in particular?
   □ **Yes** □ **No**

   If yes, which ones and why?

____

____

____

3. What are the two most important things you learned in this class?

1.____

2.____

4. Were there any sections or activities that you think you will have little use for?
   □ **Yes** □ **No**

   If yes, which ones and why?

____

____

____

5. What could make this a better/more useful training program?

____

____

Decoding Green Chemistry for Workers

Time	Session Objectives	Activities	Materials
30 min	**Course Introduction** • Inform participants why they are here and what topics will be covered • Create a friendly environment to have an open dialogue among participants • Define the purpose of the timeline and how it will be used during training	Introductions – Facilitators; Participants - Icebreaker - Name, organization Ground rules [FC] Registration Form Overview of course – objectives, timeline	• Registration form and signup sheet • Timeline • Name Tags
60 min	**Session 1: Getting Started** • Show how workers' health is affected by toxic chemicals in the workplace and connect it with participants' reality. (REACH Video) • Timeline - Visualize different events in history that have impacted the environment and human health in a negative way. • Define in their own words what sustainability is. • Identify the three pillars of sustainability. (Group activity) • Briefly summarize what people (workers and community members) have done to improve conditions	**Getting Started** • Show & discuss REACH video clip 1. Do you use chemicals? Where? What has been your experience? Tape event on the timeline **Sustainability** o Major events related to chemicals in the USA 2. What environmental pollution or human health problems have you heard about? Summarize facts and show them in the timeline o Discussion 3. What things would you like to see last beyond your lifetime? Group answers by similarities and use them when talking about the pillars o What do you understand sustainability is? 4. How do you define sustainability? 5. Show the pillars of sustainability and refer to examples from Q#3. o People do fight back 6. Participants tape images on timeline and	• REACH video clip (1' 37") • Timeline • Images of events o Bhopal o DBCP o Exxon Valdez oil o Diacetyl • Cards, markers, and tape • Handout – o Pillars of sustainability

		facilitator ask them to write down his/her story during lunch and place it on the timeline	
60 min	**Session 2 - Chemical hazard awareness** • Describe what chemicals are, how they enter our bodies, and what their health effects are. (Evelyn's Story) • Be aware of labels and MSDS as sources of information for chemicals • Identify how the environment is polluted	**Chemical hazard awareness** • **Discussion** 1. What do you think when you hear the statement *all chemicals are harmful?* • **Case study to explain how chemicals affect worker's health and safety** 2. From the story, what was the problem? What are the routes of exposure? Health effects? Use a toxic t-shirt or a body map to point out routes of exposure/target organs Use PPT to summarize key points of chemical hazards • **Hazard Identification** 3. What information do you receive from your employer before working with chemicals? Are you familiar with labels and/or MSDSs? What information can you obtain from these sources of information? Use MSDS for PineSol to explain what relevant information these sources provide • **Chemicals and the environment** 4. How do chemicals affect the environment? Use slide to show chemicals pathway in the environment • **Wrap up**	• Mini case: *Evelyn's Story* • Toxic T-shirt/Body map • PPT • MSDS/Labels • Handouts – o TRIC/Toxic Effects o Chemicals and the environment
60 min	**Session 3 - Regulations**	**Regulations (RTK,TSCA, REACH)** • **Let us talk about Hazard Communication**	• Video - *Song of the Canary* • Case study and MSDS

	• Explain what rights workers have under the HazCom regulation (Use Timeline) • Describe what TSCA does and how it affects how chemicals are regulated in the USA. • [OPTIONAL] List the existing gaps that make difficult to assess and manage chemicals of concern. (Case Study OR use the DBCP story) • Identify what is happening in Europe and how REACH works. (REACH Video)	1. Do know how many chemicals are currently in commerce? 2. Do you know what documents/procedures should be available to workers when working with chemicals? 3. Play the video clip – *Song of the Canary* what rights do you have? • **Let us talk about Toxic Substances Control Act** 4. Do you think chemicals that represent a threat to our health and environment are always tested for their health/environmental effects before they are put into the market? Tape TSCA facts on the timeline and use the handout to give an overview of this regulation • ***[Optional]* Case study to explain policy gaps OR use the video clip to explain gaps.** 5. After using the MSDS discuss the following questions: What type of protection Jimmy should wear? What chemical hazards the product has? Any PEL? How does this product affect the environment? 6. How often you read MSDS at your workplace? What are the strengths of MSDSs as a way to get information about a chemical? What are the limitations of MSDSs? Use MSDS example to present the existing gaps (lack of information, accountability and capacity) to regulate chemicals and manage chemicals in the USA. • **Show & discuss REACH video clip** 7. What do you think about this approach? Who benefits from it? What can be done in the USA? • Talk about CA regulations regarding green chemistry (AB1879, SB509, AB289)	• [Optional] Video – *REACH* (starts at 1’41”) • Bills in CA • Cards (RTK, TSCA, REACH) • Timeline • Handouts – o Gaps in US policy o Table – Distinctions between TSCA and REACH o Chemicals Policy and CA

		• Wrap up – Summarize key points by taping cards on the timeline	
60 min	**Session 4 - Green Chemistry (45 min) -** • Identify how the conventional chemistry affects sustainability (Video – The Story of Stuff – Production starts 4'40" end 8' 05"). • Become familiar with the life cycle of a product and identify who might be at risk of exposure (Optional). • Articulate in their own words what green chemistry is.	**Green Chemistry** o **Show & discuss The Story of Stuff – Production video clip** 1. What did you think of the video? Any initial impressions? Anything surprising? New? 2. "Toxics in, Toxics out" --What does this mean? What is the effect? Why do industries use toxic materials in the first place? 3. Annie mentions a chemical called BFR's: Brominated flame retardants. Have you heard of them before? How can we get industry to stop putting these notoriously toxic chemicals in our household items? Why are so few products containing toxic materials labeled to warn the shopper about the risks? 4. [Optional] Earlier we talked about the safety gap – people and environments have to be exposed to toxics – nothing to protect them. Data - we see here that these 100,000 chemicals are not tested for health or environmental impacts. Technology Gap – BFR example 5. Positive and negative impacts of chemistry on the environment, human health, and economics. What are the effects of conventional chemistry? o **Brainstorm - Product life cycle** 6. Who might be at risk of exposure through the	• Video – *The Story of Stuff* • Conventional Chemistry chart • Life cycle of a product chart • Green Chemistry Chart • Success stories (cases)

		life cycle of a product? o **Discussion on Green chemistry** 7. Use green chemistry chart to visualize the goal of the green chemistry initiative. What are the advantages of applying green chemistry? Who wins with this approach?	
90 min	**Session 5 - Precautionary Principles in Green Chemistry** • Review the hierarchy of controls for chemical hazards (Give examples). • Become familiar with the precautionary principles of green chemistry. • Recognize that substitution is the best control for toxic chemicals (Present successful stories/safer alternatives). • List limitation that the green chemistry initiative may encounter.	**Precautionary Principles in Green Chemistry** o **Let us talk about hazard controls** 1. In conventional chemistry, what do you do to control chemical exposure in the workplace? Use PPT to highlight key points to control job hazards o **Brainstorm - Substitution** 2. What do you think the best control /approach is to eliminate exposure to toxic chemicals? 3. Case Study – Luis' Story Participants answer the following questions: o Thinking of the hierarchy of controls (or ways to protect workers), how could this have been prevented? o Why was a chemical known to be hazardous put into a brake product used by workers and consumers? o How did this NOT follow the principles of green chemistry related to safety? **Connect chemical substitution with green chemistry as a best approach.** o Limitations/ Challenges Use Luis' Story to visualize what happens when	• Pyramid of controls • Luis' Story (n-Hexane) • Handouts – o Hierarchy of controls o 12 principles of green chemistry

		"green" products focus solely on the environment.	
60 min	**Session 6 - Green Chemistry and Workers** • Recognize participants' efforts to improve health and safety conditions for workers, community and environment and put efforts in larger context of chemical production and organizing to improve workplace and environmental policies. (Use Timeline) • Access various resources that can help workers and those interested in staying aware of green chemistry issues. • Develop a plan for next steps to address chemical hazards using the green chemistry approach.	**Green Chemistry and Workers** • **Sharing participatory experiences** 1. When and how did you get involved in working for better conditions at work, community, etc? Participants tape their answers on the timeline. • **Brainstorm – what can be done?** 1. What can you do with this information as a worker, community member, union representative, and consumer? 2. How can you help the legislation? • **Action Planning – participants can work in groups or by themselves** o What is my goal? What will help me? What are some obstacles I may face? What are the specific steps I will take? (Chronogram)	• **List of resources** • **Action plan worksheet** • **Handout – List of resources**
15 min	**Conclusion & Evaluation**	• Go back to the timeline and summarize what you see. Summarize training main points • Green chemistry strives to minimize the harmful effects of a chemical-based society. Integral to this effort is minimizing harmful exposure to workers *at every stage* of the product lifecycle. • As environmental hazards are "designed out" of products, we have to ensure that worker health is not traded off. Unless worker health is explicitly integrated into the green chemistry approach, we may inadvertently put workers at	

		risk. • Making green chemistry principles the norm in our society will not happen overnight, and depend on workers (unions, worker centers, non-profit organizations) staying informed, voicing their concerns, and taking action. • Participants fill out the evaluation form or facilitator asks what was positive and/or negative during the course; any changes to the activities?	

NOTES:

Session 1 – 60min

Getting Started/What is Sustainability?

Objectives

At the end of this session, participants will be able to:

- Show how workers' health is affected by toxic chemicals in the workplace
- Recognize workers' efforts to improve health and safety conditions for workers
- Define in their own words what sustainability is
- Identify the three pillars of sustainability

Background

This session is the opening of the program; the idea is to use the REACH video clip to help participants connect how chemicals are part of their daily life and visualize what events have been harmful to people's health and environment.

The concept of sustainability is discussed through an activity. The purpose is that participants come up with the definition as "Sustainability is meeting the needs of the present without compromising the ability of future generations to meet their own needs".

The three pillars of sustainability are: economy, environment, and health. These are not mutually exclusive but mutually reinforcing and revolve around equality for all. *Economy* refers to money such as cost, human hours, jobs, etc; *Environment* refers to natural and built world such as water quality, air quality, open space, etc; and *Health* refers to health care, safety.

Lack of sustainability affects us all. It is not just an issue for workers, for communities, or environmentalists. The planet is losing its natural resources, workers are getting sick or injured, and communities are being polluted without having a responsible party clean up the mess.

Lesson Plan

- Show and discuss REACH video clip (only up to 1'37'') by asking participants **do you use chemicals? Where? What has been your experience?** Use an index card to record answers and tape them on the timeline.It shows what participants have done to improve conditions at their workplaces or communities.

- [Optional Icebreaker] "Show Me the Chemicals" Activity

    1. Pass out a piece of blank paper to each person. - First give some examples from your own life so people get an idea of the pervasive examples of chemicals in their lives.

2. Ask everyone to take a minute to make a list of all the chemicals they've encountered or used throughout the day, leading up to the meeting.
   E.g. "Start in the morning. What products do you use in the shower? Do you pass any factories, dry cleaners, or auto shops on your way to work? Do you drive or walk to work? Do you use cleaning supplies in your line of work?"

3. Ask if anyone had more than 10? More than 20? Etc., till you reach the person with the highest number of chemical incidences/experiences in their daily life.

3. Have the person with the largest list read their chemicals to the group. Briefly discuss how they came up with everything or if anyone had anything significantly different.

4. Encourage them to read out their list, maybe even pull out anything in their purse or bag that contain some of these chemicals.

Optional w/ more presentation time:

5. *Ask for responses:*
   - Were people surprised (or not) by the number of chemicals in their lives?
   - Are there any other hidden pockets of chemicals in our lives?

6. Go over "Chemicals in Our Lives" Visual

7. Afterwards, ask the group if they can identify any big polluters in their community, either near where they live, work, play and/or worship. Who are they? Do you know what kind of chemicals they use?

- Put answers in a larger context of chemical production. State some of the facts using the timeline *[Handout cards to the participants and ask them to read the text when the image comes up on the screen. Each card is posted on the timeline]*

1920 – Companies began producing chemicals for oil - Research in organic chemistry in the 1910s allowed companies in the 1920s and 30s to begin producing chemicals for oil. Today, petrochemicals made from oil are the industry's largest sector.
1921 – 21 million pounds petroleum-based chemical production in USA
1930s – Synthetic rubber came into existence during World War I, when war cut off supplies from abroad.
1939 – 3 billion pounds petroleum-based chemical production in USA
1950s – Growing concern about toxic waste produced by chemical industries - Since the 1950s growing concern about toxic waste produced by chemical industries has led to increased government regulation and the establishment of the Environmental Protection Agency (1972).

1990 - 397 million tons production of 100 chemicals
1997 – Production index = 100 **2006** – Production index = 131 **2022** – Production index = 231 The production index is a baseline number that represents chemical production on a specific year. **Global Chemical Production is Expected to Double Every 25 Years**

- Ask people to brainstorm environmental pollution or human health problems they have heard about. *[Handout cards to the participants and ask them to read the text when the image comes up on the screen. Each card is posted on the timeline]*

1969 - The Cuyahoga River in Ohio became so polluted with chemicals it caught fire.
1977 - The DBCP pesticide exposure event occurred at the Occidental Chemical pesticide plant in Lathrop, California when workers exposed to DBCP became sterile.
1984 - A plant accident in Bhopal, India, released methyl isocyanate. Nearly 4,000 people died.
1989 - The Exxon Valdez Oil Spill was one of the largest manmade environmental disasters ever to occur at sea, seriously affecting plants and wildlife. The oil tanker Exxon Valdez departed the Valdez oil terminal, Alaska on March 23 with 53 million gallons of crude oil bound for California. On March 24 it struck Bligh Reef. The accident resulted in the discharge of approximately 11 million gallons of oil, 20% of the cargo, into Prince William Sound.
1999 – Diacetyl, butter flavoring chemical, was determined to be the culprit in an outbreak of bronchiolitis obliterans (a serious lung disease) among Missouri microwave popcorn plant workers.
2010 – (Early April) Mine explosion in West Virginia at the Upper Big Branch mine. 29 miners died. Methane gas was the problem; methane monitors were calibrated every three months instead of 31 days. Maybe monitors did not detect what they were suppose to detect. Officials have speculated that it may have been caused by a spark from a mantrip.
2010 – (April 20) An oil rig called the Deepwater Horizon exploded off the coast of Louisiana, killing 11 workers. More than 200 millions of gallons were spilled in the Gulf, and researchers said that in they discovered miles-long underwater plumes of oil that could poison and suffocate sea life across the food chain, with damage that could endure for a decade or more.

- Ask what things would you like to see last beyond your lifetime?
  - Participants write their answers on a piece of paper. In groups, ask them to collect their answers by similarities. The idea is to have three groups show the pillars of sustainability.

- State efforts to live more sustainably; should include the three pillars of sustainability – environment, economy, and health revolving around equity for all.

- Ask participants to work in groups of two or four (depending how many participants you have) to develop their own definitions of sustainability. Use the index cards to write. Ask one participant of each group to share their answers with the larger group.
- At the end, summarize that **sustainability means to meet the needs of the present without compromising the ability of future generations to meet their own needs.** Needs mean basic human needs including food, shelter, clean water, and a healthy environment. We want to make sure that the way we live our lives is sustainable – that it can continue and keep improving for a long, long time.

- Chemistry pervades nearly all aspects of economy, environment, and health. It comprises the building blocks of nearly all products that we consume, work with, depend on medically, construct with, etc. It is foundational. Depending on how things are structured at the molecular level, they can either be unfavorable or beneficial to our world as we know it. Therefore, to truly work towards sustainability, we must support and employ an alternative to sustainable goals in terms of environment, economy, and health known as "green" chemistry.

- Recognize participants' efforts to improve health and safety conditions for workers, community and environment by asking participants to share experiences. State some facts using the timeline:

1915 – Oil workers in Bayonne, NJ strike over heat stress, citing temperatures as high as 250 degrees.
1980 – President Carter declared a state of emergency at Love Canal after scientific investigations proved that chemicals were responsible for the ill health of residents
2004 – Pascual campaigns with other victims and relatives of victims, such as Chello Ragues to prevent a repeat of the Ardystil tragedy.

- Ask **when and how did you get involved in working for better conditions at work, community, etc.?** Answers are taped on the timeline to visualize and recognize what people have done through the years.

<u>Session Materials</u>

- Power point presentation
- Timeline and cards with facts
- Index cards; easel flipchart; markers; tape

<u>References</u>

1. Beyond Benign. *Solutions in Green Chemistry.* www.beyondbenign.org/K12education/highschool.html

2. EPA Region 10. *Sustainability definition.*

http://yosemite.epa.gov/r10/oi.nsf/sustainability/sustainability/

3. REACH Video clip
http://ec.europa.eu/environment/chemicals/reach/publications_en.htm

General Timeline for Green Chemistry Curriculum

Categories in the timeline	Events
Chemical Production	• **1909** – Introduction of synthetic fertilizers • **1920** – companies began producing chemicals for oil • **1921** – 21 million pounds petroleum-based chemical production in USA • **1928** - creation of nylon by DuPont • **1939** – 3 billion pounds petroleum-based chemical production in USA • **1950s** – growing concern about toxic waste produced by chemical industries • **1990** - 397 million tons production of 100 chemicals • **1997** – Production index = 100 (baseline production in this year) • • **2000** - 502 million tons aggregate production of 100 chemicals • **2006** - Production index = 131 • **2010** - The U.S. produces or imports close to 3,000 chemicals (excluding polymers and inorganic chemicals) at over 1 million pounds per year http://www.epa.gov/HPV/pubs/general/hazchem.htm • **2022** - Production index = 231 http://www.dtsc.ca.gov/PollutionPrevention/GreenChemistryResources/upload/02_Wilson.pdf
Major Incidents	• **1969** – The Cuyahoga River in OH became so polluted with chemicals it caught fire • **1977** – The DBCP pesticide exposure event occurred at the Occidental Chemical pesticide plant in Lathrop, CA. Workers exposed to DBCP became sterile • **1978** - Love Canal neighborhood in Niagara Falls, NY. It was used as a chemical waste disposal landfill, first by the city and then by chemical companies. 22,000 tons of toxic waste buried in the area. • **1982** – Time Beach town in Missouri was evacuated due to dioxin exposure • **1984** -A plant in Bhopal released methyl isocyanate. Nearly 4,000 people died • **1988** – Introduction of hexane- Luis' Story • **1989** - Exxon Valdez Oil Spill was one of the largest manmade environmental disasters ever to occur at sea,

	seriously affecting plants and wildlife • **1992** - A textile company called Ardystil instructed its workers to spray a dyestuff which was designed to be applied by a roller. Six young employees later died from having inhaled the toxic substance and 80 more contracted serious lung diseases. • **1999** – Diacetyl, butter flavoring chemical, was determined to be the cause in an outbreak of bronchiolitis obliterans (a serious lung disease) • **2003** - A Spanish court ruled that Ardystil had used dangerous chemicals in its factory and had failed to show its workers how to handle them. In addition, it concluded that the serious lung damage suffered by the workers was directly related to the lack of preventative measures and exposure to a cocktail of chemicals. • **2005** - BP explosion occurred when re-starting a unit that had been down for repairs. Workers began to fill a tower with gasoline. The tower overflowed, and the excess gas flowed into a back-up unit, which then also overflowed and sent a geyser of gasoline into the air. The plume of gas had formed a massive vapor cloud on the ground, and an idling truck likely had ignited the fumes. • **2010** – (Early April) Mine explosion in West Virginia at the Upper Big Branch mine. 29 miners died. Methane gas was the problem; methane monitors were calibrated every three months instead of 31 days. Maybe monitors did not detect what they were supposed to detect. Officials have speculated that it may have been caused by a spark from a mantrip. • **2010** – (April 20) An oil rig called the Deepwater Horizon exploded off the coast of Louisiana, killing 11 workers. More than 200 millions of gallons were spilled in the Gulf, and researchers said that in they discovered miles-long underwater plumes of oil that could poison and suffocate sea life across the food chain, with damage that could endure for a decade or more.
Regulation and policies	• **1920** - Employers establish basic health and safety principles, which place responsibility for workplace safety on workers. • **1966** - The The National Labor Relations Board (NLRB) rules that health and safety is a mandatory subject of bargaining. • **1970** - The Occupational Safety and Health Act passes with the active support of the Oil Chemical and Atomic Workers,

	the Steelworkers, the UAW, and the AFL-CIO respectively. The Act places certain duties on employers and employees to ensure safe and healthful working conditions. • **1971** - The state Occupational Safety and Health Administration (Cal/OSHA) Created • **1971**- The AFL-CIO requests that OSHA adopt an emergency standard on asbestos. • **1972** - The Environmental Protection Agency (EPA) was established • **1974** - OSHA adopts health standards for 14 carcinogens. • **1976** - Jimmy Carter is elected President. Eula Bingham is appointed head of OSHA. The New Directions grant program helps fund training for thousands of workers about workplace hazards and their legal rights. • **1976** – The Toxic Substance Control Act (TSCA) under EPA is established to oversee industrial chemicals in the USA. Currently, there are more than 80,000 chemicals in commerce • **1980** - Ronald Reagan is elected president. A proposed federal Right to Know standard is shelved; activists effectively push cities and states to begin passing local Right to Know laws. • **1986** - After years of lawsuits and local legislation, a Federal Right to Know standard is established. • **1990** - The city of San Luis Obispo, California, became the first city in the world to ban indoor smoking at all public places, including bars and restaurants • **1990** - The Clean Air Act Amendments mandated the elimination of lead from all U.S. motor fuel by Jan 1996. • **1998** - The success of the smoking ban enacted by the state **of California** • **2004** - Methyl Ter Butyl Ether (MTBE) ban started in CA • **2005** - Cal/OSHA adopts the "Heat Illness Prevention" standard to protect workers from the dangers of working in outdoor heat. • **2006** – Research, Evaluation, and Authorization of Chemicals (REACH) is passed in the EU • **2008** – Bills passed in California AB 1879, SB 509, and AB 289
Participants' Stories/Activism	• **1915** - Oil workers in Bayonne, NJ strike over heat stress, citing temperatures as high as 250 degrees. • **1935** - The National Labor Relations Act (Wagner Act) is passed. The NLRA protects workers who organize into unions to bargain collectively, but excludes farm workers and domestic workers.

	• **1954** - Racial segregation is ruled illegal. • **1959**- Struggles to remove lead from gasoline began • **1980** – President Carter declared a state of emergency at Love Canal after scientific investigations proved that chemicals were responsible for the ill health of residents • **1987** – United Church of Christ Commission for Racial Justice published the famous "Toxic Wastes and Race in the United States" report. It correlates waste facility sitting and race. Milestone to develop the environmental justice movement • **2004** - Pascual campaigns with other victims and relatives of victims, such as Chello Ragues to prevent a repeat of the Ardystil tragedy.

Use in the Power Point

Chemical Production – Session 1 (Interactive)

1921 – 21 million pounds petroleum-based chemical production in USA
1939 – 3 billion pounds petroleum-based chemical production in USA
1990 - 397 million tons production of 100 chemicals
1997 – Production index = 100 **2006** – Production index = 131 **2022** – Production index = 231 The production index is a baseline number that represents chemical production on a specific year. Global Chemical Production is Expected to Double Every 25 Years

Major Events – Session 1

1977 - The DBCP pesticide exposure event occurred at the Occidental Chemical pesticide plant in Lathrop, California when workers exposed to DBCP became sterile.
1984 - A plant accident in Bhopal, India, released methyl isocyanate. Nearly 4,000 people died.
1989 - The Exxon Valdez Oil Spill was one of the largest manmade environmental disasters ever to occur at sea, seriously affecting plants and wildlife. The oil tanker Exxon Valdez departed the Valdez oil terminal, Alaska on March 23 with 53 million gallons of crude oil bound for California. On March 24 it struck Bligh Reef. The accident resulted in the discharge of approximately 11 million gallons of oil, 20% of the cargo, into Prince William Sound,
1999 – Diacetyl, butter flavoring chemical, was determined to be the culprit in an outbreak

of bronchiolitis obliterans (a serious lung disease) among Missouri microwave popcorn plant workers.
2003 - A Spanish court ruled that Ardystil had used dangerous chemicals in its factory and had failed to show its workers how to handle them. In addition, it concluded that the serious lung damage suffered by the workers was directly related to the lack of preventative measures and exposure to a cocktail of chemicals.
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Activism – Session 1

1915 – Oil workers in Bayonne, NJ strike over heat stress, citing temperatures as high as 250 degrees.
1980 – President Carter declared a state of emergency at Love Canal after scientific investigations proved that chemicals were responsible for the ill health of residents
2004 – Pascual campaigns with other victims and relatives of victims, such as Chello Ragues to prevent a repeat of the Ardystil tragedy.

Regulations – Session 3

1974 - OSHA adopts health standards for 14 carcinogens.
1976 - Jimmy Carter is elected President. Eula Bingham is appointed head of OSHA. The New Directions grant program helps fund training for thousands of workers about workplace hazards and their legal rights.
1976 – TSCA under EPA is established to oversee industrial chemicals in the USA. Currently, there are more than 80,000 chemicals in commerce.
1980 - Ronald Reagan is elected president. A proposed federal Right to Know standard is shelved; activists effectively push cities and states to begin passing local Right to Know laws.
1986 - After years of lawsuits and local legislation, a Federal Right to Know standard is

established.
2006 – REACH is passed in the EU.
2008 – Bills passed in California AB 1879, SB 509, and AB 289

Principles of Green Chemistry

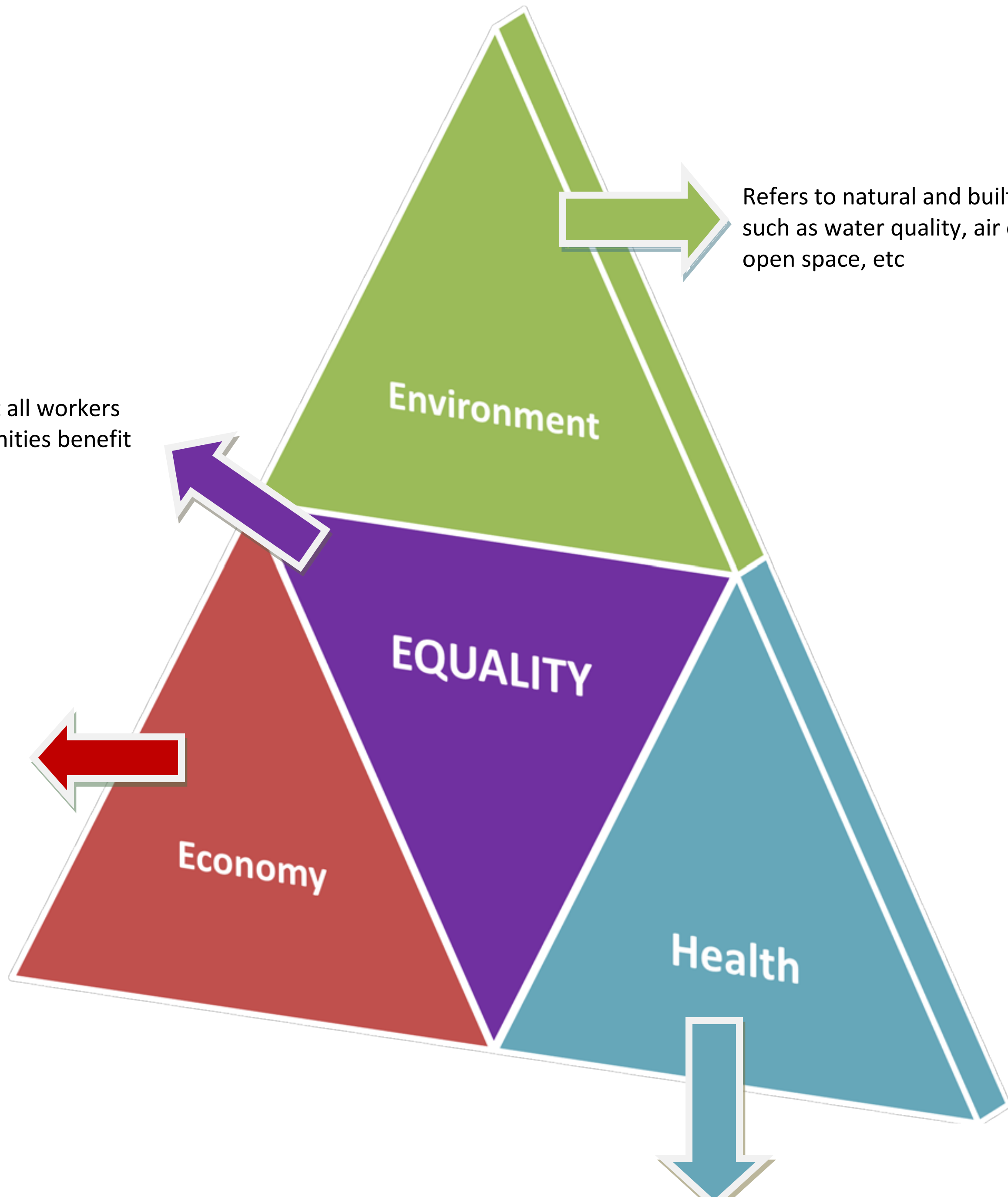
- **1988** – Introduction of hexane- Luis' Story

Handout

The Pillars of Sustainability

Sustainability means to meet the needs of the present without compromising the ability of future generations to meet their own needs.

Our Goal: Good jobs, green jobs, safe jobs.



Refers to natural and built world such as water quality, air quality, open space, etc

Ensures that all workers and communities benefit equally

Economic benefits include good jobs, cost savings from energy efficiency, water conservation, etc

Refers to safe working conditions - Protecting workers' health and safety should be as important as protecting the environment

Session 2 – 60 min

Chemical Hazard Awareness

Objectives

At the end of this session, participants will be able to:

- Describe in their own words what chemicals are, how they enter our bodies, and what their health effects are.
- Identify how the environment is polluted
- Be aware of labels and MSDS as sources of information for chemicals.

Background

- General information

Some chemicals are threatening our health and global environment because many of these chemicals are known to be toxic or carcinogenic while others remaining untested for their health effects. Unfortunately, chemicals are created with the expectation that they are safe and that any chemical hazards can be controlled or reduced by establishing “safe” concentrations and exposure limits. Lamentably, existing law favors continued use of hazardous substances without enforcing detailed safety information.

A hazardous chemical is any substance that can do harm to your body. It could be natural or synthetic (man-made). The number of chemicals produced in industry now exceeds 87,000 and 500 new chemicals are introduced in industry every year without being thoroughly tested. Most industrial chemicals can harm your health and environment at some level of exposure and dose.

It is important to understand how chemicals can enter your body and what effects they may have on your health and the environment.

Chemicals enter the body by four main routes:

- *Inhalation,* which is the most common route of chemical exposure. You inhale the chemical, which would go into your lungs and then would enter the blood stream.
- *Absorption through the skin and eyes* is the second most common route of chemical exposure. For certain chemicals, once it is absorbed through the skin, it goes into the blood stream.
- *Ingestion* is the third most common route of chemical exposure. Chemicals enter your body through your mouth and are absorbed through the digestive tract. Good hygiene practices should be observed to minimize ingestion exposure.
- *Injection* is the last most common type of chemical exposure where the chemical enters the body through a contaminated sharp object.

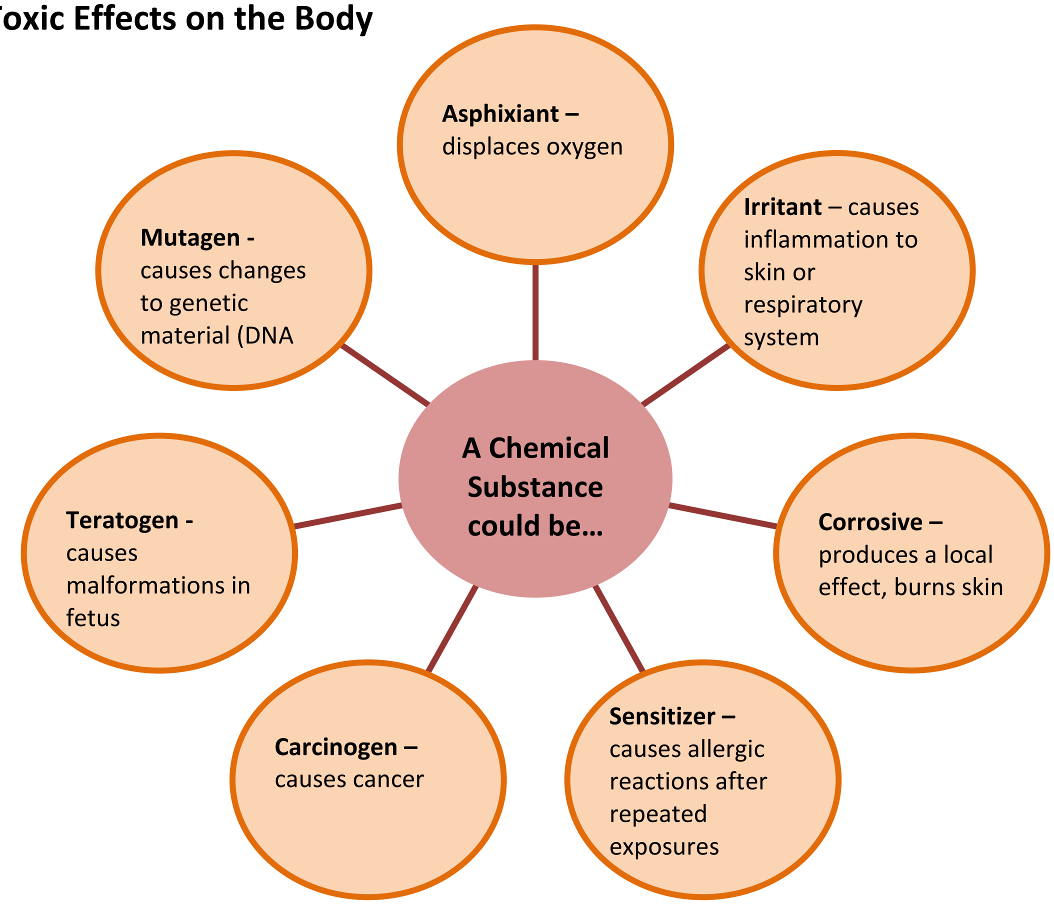
A chemical's effect on the body depends on several factors, the physical form of the chemical (solid, liquid, gas); how the chemical enters the body; chemical toxicity; the amount of chemical that actually enters the body (dose); duration of exposure; and individual characteristics (sex, race, weight, medical condition, etc).

The health effects could be ***local***, which takes place at the point or area of contact. The site may be skin, mucous membranes, the respiratory tract, etc; or ***systemic***, which takes place at a location distant from the body's initial point of contact and presumes absorption has taken place. Examples: arsenic effects to the blood, nervous system, liver, kidneys, and skin; benzene effects to the bone marrow.

Based on the exposure, chemical substances may produce an **acute effect,** which occurs when one feels symptoms within a short time, such as within minutes or hours. Some examples are irritation, coughing, dizziness, fatigue, etc.

In contrast, a **chronic effect** or illness develops slowly and may last for a long time. Chronic poisoning is usually due to continued exposure of a harmful chemical for months or years. Examples of chronic effects include organ damage, cancer, reproductive effects on human health.

Toxic Effects on the Body



Also **chemicals get in the environment** as a result of their manufacture, processing, and use. Chemicals enter air as emissions and water as effluent. Industrial and motor vehicle emissions of nitrogen and sulphur oxides cause acid rain, which poisons fish and other aquatic organisms in rivers and lakes and affects the ability of soil to support plants. Some toxic chemicals find their way from landfill waste sites into our groundwater, rivers and oceans and induce genetic changes that compromise the ability of life to reproduce and survive.

Some examples are: Carbon dioxide causes the greenhouse effect and climate change. Chlorofluorocarbons (CFCs) cause the destruction of ozone in the stratosphere and create the possibility of serious environmental damage from ultraviolet radiation. Chemical fertilizers and nutrients run-off from farms and gardens cause the buildup of toxic algae in rivers, making them uninhabitable to aquatic organisms and unpleasant for humans.

- Hazard Identification

Federal and state OSHA programs give workers the right to know what hazardous materials they could be exposed to by requiring employers to set up:

LABELS on all hazardous materials	o Name of the hazardous substance (the same name as on the MSDS) o Specific warnings about potential hazards and short/long term health effects o Name and address of the chemical manufacturer, importer, or other responsible party
MSDSs (Material Safety Data Sheets) for all hazardous materials	o Product name and ingredients o Physical and chemical characteristics o Fire, explosion, and reactivity hazards o Health hazards: symptoms, routes of exposure, potential to cause cancer o Legal exposure limits o Precautions for safe handling and use o Protective control measures and personal protective equipment o Emergency, first aid measures, spill and leak procedures
TRAINING for all employees	o Physical and health effects of the hazardous substances o Methods used to detect the presence or release of hazardous chemicals o Measures employees can take to protect themselves from hazards (including how to read and use labels and MSDSs to protect themselves)

Lesson Plan

- Start this session pointing out the objectives and then ask participants what they think when they hear the following statement: *all chemicals are harmful.* Wait for answers and add, not all chemicals are harmful to human health and/or the environment. For each harmful chemical to health and environment, there are dozens of chemicals that benefit the society such as nylon, penicillin, vinegar. There are different factors that make a chemical hazardous, for example its own characteristics, how react with other chemicals, the chemical form, how much enters the body, time of exposure, etc. Give 1 minute to complete the activity.

- Pass around the *mini case: Evelyn's Story*. Ask participants to work in groups and answer the questions on the worksheet. Each group will have to present to the larger group their answers.

  Questions are:
  - What was the problem?
  - What are the routes of exposure? *Optional*- Facilitator can have a body map hanging on the wall and ask participants to put color dots showing how chemicals enter the body. Then, summarize findings using the information below.

    The four routes of exposure are *inhalation, absorption, ingestion, and injection*.

    Inhalation is the main way workers are exposed to chemicals on the job. Through skin and eyes a chemical can pass and get into the bloodstream, this is known as **absorption**. Chemicals can be swallowed when they are carried on food, unwashed hands or cigarettes and they are absorbed from the digestive tract into the blood. This route is known as **ingestion**. Last but not least is **injection**, although infrequent in the industry, a substance can be injected into some part of the body by skin puncture.

  - What symptoms did Evelyn experience when she was exposed to the floor cleaner? Write down their answers, and then group those symptoms that belong to short term health effects (Acute) and long term effects (Chronic).

    Explain what **acute and chronic** means. Add that health effects can be at ***local level***, which takes place at the point or area of contact. For example, a chemical cause redness or itchiness on the skin.

    Systemic level, which takes place at a location distant from the body's initial point of contact and absorption has taken place. Examples: arsenic effects to the blood, nervous system, liver, kidneys, and skin; benzene effects to the bone marrow.

Use the chart to describe the toxic effects of chemicals on the body. Bring up names of chemicals that match each effect.

Health Effect	Some Examples of Chemicals
Asphyxiants	Carbon monoxide, hydrogen sulfide
Irritants	Organic solvent, detergents, chlorine
Corrosives	Sulfuric acid, caustic soda
Sensitizers	Formaldehyde, epoxy resins
Carcinogens	Vinyl chloride, cadmium, arsenic, asbestos
Teratogen	Radiation, alcohol, mercury
Mutagen	Benzene, ethylene oxide

- Ask participants how chemicals may enter the environment. For example, how the floor cleaner from Evelyn's story may pollute the environment. Wait for answers and then add the information below

  Chemicals enter air as emissions and water as effluent. Industrial and motor vehicle emissions of nitrogen and sulphur oxides cause acid rain, which poisons fish and other aquatic organisms in rivers and lakes and affects the ability of soil to support plants. Some toxic chemicals find their way from landfill waste sites into our groundwater, rivers and oceans and induce genetic changes that compromise the ability of life to reproduce and survive.

  Some examples are: Carbon dioxide causes the greenhouse effect and climate change. Chlorofluorocarbons (CFCs) cause the destruction of ozone in the stratosphere and create the possibility of serious environmental damage from ultraviolet radiation. Chemical fertilizers and nutrients run-off from farms and gardens cause the buildup of toxic algae in rivers, making them uninhabitable to aquatic organisms and unpleasant for humans.

- Ask participants what information you receive from your employer before working with chemicals? Are you familiar with labels and/or MSDSs? What information can you obtain from these sources of information? Wait for answers and summarize points by saying:

  Federal and state OSHA programs give workers the right to know what hazardous materials they could be exposed to by requiring employers to set up Labels, MSDS and Training for all employees using chemicals in the workplace.

LABELS on all hazardous materials	o Name of the hazardous substance (the same name as on the MSDS) o Specific warnings about potential hazards and short/long term health effects o Name and address of the chemical manufacturer, importer, or other responsible party
MSDSs (Material Safety Data Sheets) for all hazardous materials	o Product name and ingredients o Physical and chemical characteristics o Fire, explosion, and reactivity hazards o Health hazards: symptoms, routes of exposure, potential to cause cancer o Legal exposure limits o Precautions for safe handling and use o Protective control measures and personal protective equipment o Emergency, first aid measures, spill and leak procedures
TRAINING for all employees	o Physical and health effects of the hazardous substances o Methods used to detect the presence or release of hazardous chemicals o Measures employees can take to protect themselves from hazards (including how to read and use labels and MSDSs to protect themselves)

- Distribute handouts and state that in next session we will discuss how chemicals are regulated in the USA and in Europe.

Session Materials

- Power point presentation
- Mini case – Evelyn's Story
- Body map, color dots or Toxic T-shirt
- Handouts: TRIC/Toxic Effects; Chemicals and the Environment; MSDS

References

1. Hazard Communication Standard http://www.osha.gov/html/faq-hazcom.html http://www.dir.ca.gov/title8/5194.html Cal/OSHA

2. Basic Hazards. http://learn.caim.yale.edu/chemsafe/references/dose.html

Harmful chemicals in our environment. http://www.planetagenda.com/chemicals.htm

Evelyn's Story

Evelyn a housekeeper in her 30s worked in a hospital for eight years. She had a 2 year history of wheezing, cough, shortness of breath and chest tightness that were worse at work. She particularly noted symptoms when she used a floor cleaner that contained quaternary ammonium salts, ethyl alcohol, and sodium hydroxide. Evelyn's supervisor did not explain to her how to use the cleaner or how it could affect her health, and let alone how to read the MSDS. One day Evelyn's co-workers was reading aloud the MSDS for ethyl alcohol, which stated that it could damage the respiratory system, liver, Central Nervous System, and skin. Evelyn got suspicious of her symptoms.

Evelyn had no history of asthma, bronchitis or allergic rhinitis prior to the onset of symptoms at work and had never smoked cigarettes. She quit her job because of her illness. After six weeks away from work her symptoms had markedly decreased.

Questions:

1. What happened?

2. How does the chemical enter the body? What were Evelyn's symptoms?

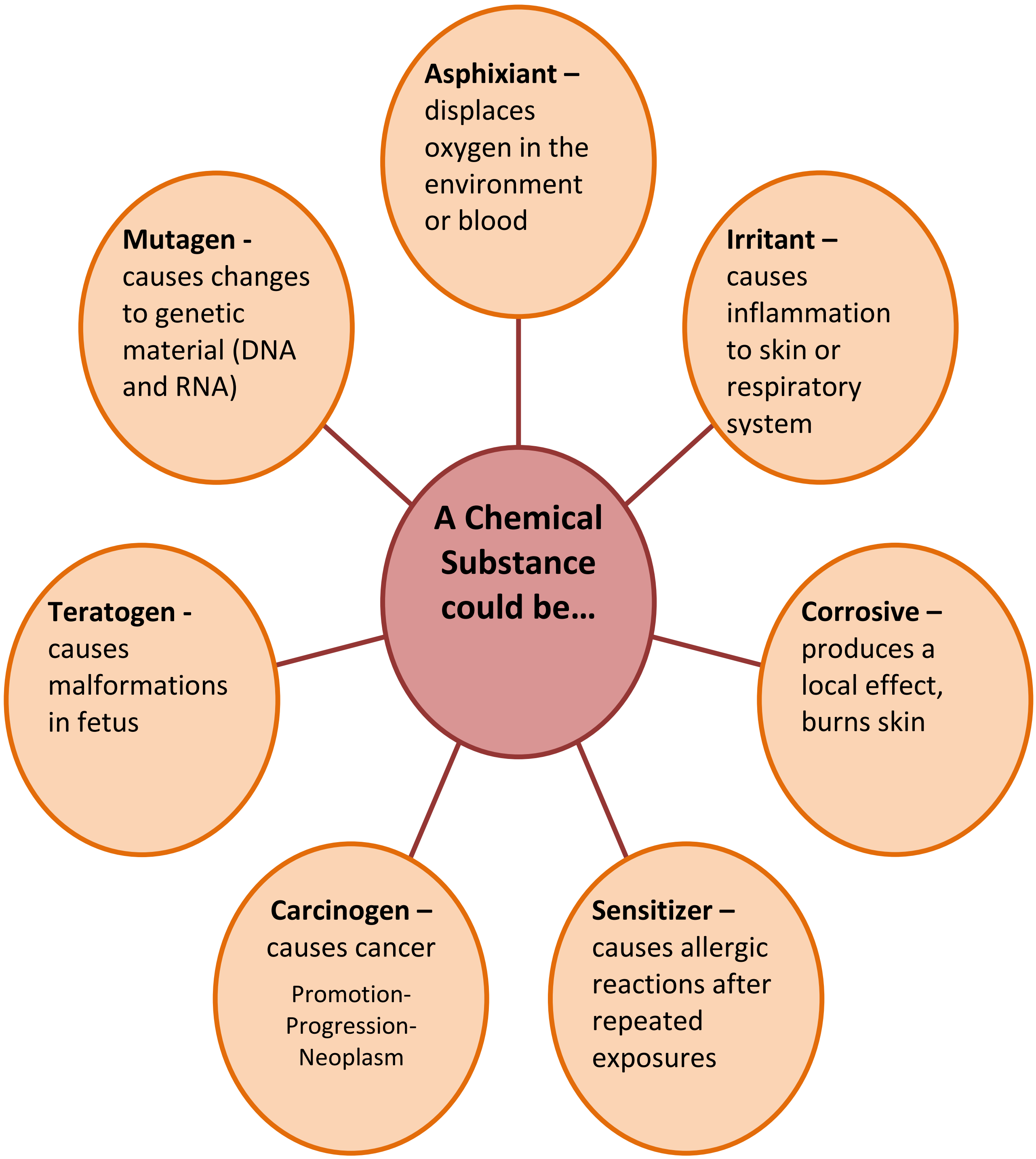
3. Are you familiar with MSDS and /or labels? What information can you get out of them?

Hazardous Chemicals

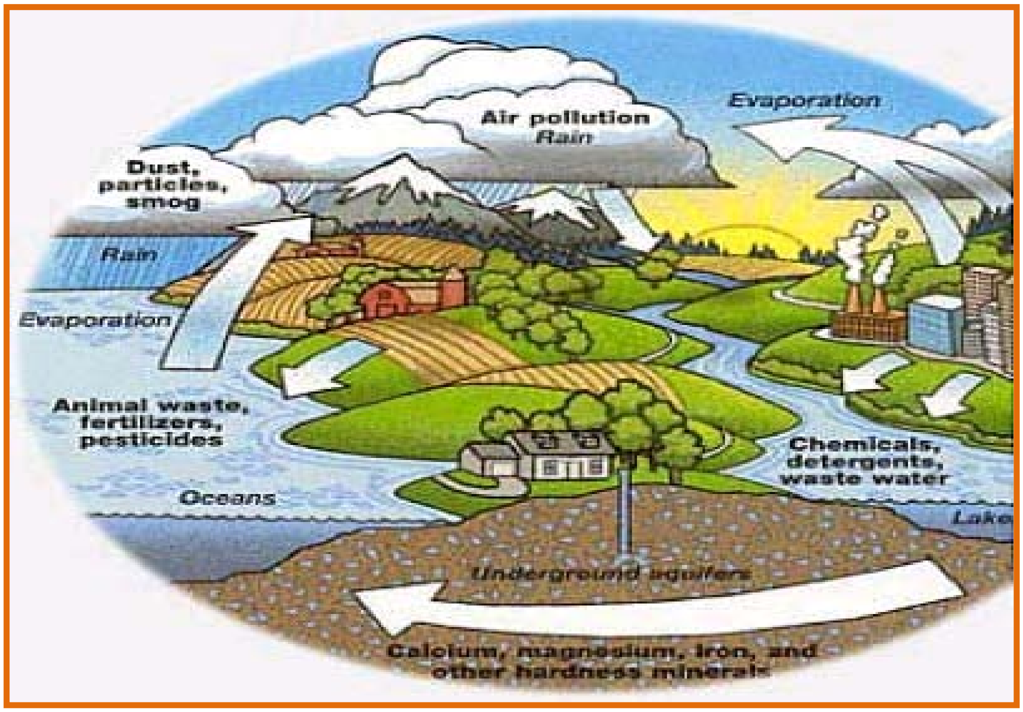
A chemical is hazardous if it has one or more of the following characteristics: **TRIC**

Toxic 	Substances that affect organs in the body or the environment. *Examples*: benzene, lead, chromium, mercury, trichloroethylene, asbestos *Persistent and bio-accumulative* – **chemicals that do not break down** when released into the environment and accumulate in living things *Examples*: PCB (polychlorinated biphenyls), dioxin
Reactive 	Chemical that reacts with water, air, or other chemicals to ignite, generates toxic gases, or produces heat or releases oxygen that enhances combustion. A **Pyrophoric chemical** ignites spontaneously when exposed to air. *Examples*: caustic soda and water react to produce intense heat; concentrated solution of hydrogen chloride and some common metals react to produce flammable hydrogen gas; concentrated solution of nitric acid and metal powders reacts to produce an explosion; etc.
Ignitable 	This is measured in terms of the lowest temperature required for a material to ignite (catch fire). A **flammable material** can be solid, liquid, or gas. A flammable liquid has a flash point less than 141°F. A **combustible material** can be solid or liquid. A combustible liquid has a flash point greater than 141°F. *Examples:* solvents such as alcohols, acetones, toluene; oxidizers such as hydrogen peroxide, sodium nitrate; acids that produce oxygen when heated nitric acid, chromic acid; wood, plastic, metal dusts.
Corrosive 	Chemical that causes visible changes or damage living tissue at the site of contact and corrodes steel. It is aqueous and has a pH ≤ 2 or ≥ 12.5. A chemical is **extremely acidic** if pH is ≤ 2. *Examples*: sulfuric acid, nitric acid, hydrochloric acid A chemical is a strong alkaline if pH is ≥ 12.5. *Examples:* sodium hydroxide (caustic soda), potassium hydroxide

Toxic Effects on the Body



Chemicals and the Environment



Source: www.awtflorida.com/faqs.html

Some Examples are:

Chemicals	Effect on	Consequences
Emissions of nitrogen and sulphur oxides	Air and water	Acid rain, which poisons fish and other aquatic organisms in rivers and lakes
Toxic chemicals from landfill wastes – aromatic hydrocarbons	Ground water, rivers, and oceans	Genetic changes that compromise the ability of life to reproduce or survive
Carbon dioxide	Air	Green house effect and climate change
Chlorofluorocarbons (CFCs)	Ozone	Serious environmental/health damage from UV radiation
Chemical fertilizers and nutrients run-off from farms and gardens	Algae in rivers	Uninhabitable to aquatic organisms, unpleasant for humans, and disrupts the food chain.

Session 3 – 60 min

Chemicals Policy

Objectives

At the end of this session, participants will be able to:

- Explain what rights workers have under the Hazard Communication regulation
- Describe what TSCA does and how it affects how chemicals are regulated in the USA
- List the existing gaps that make difficult to assess and manage chemicals of concern
- Identify what is happening in Europe and how REACH works

Background

- General Information

Federal and state OSHA programs give workers the **Right-to-Know** (RTK) what hazardous materials they could be exposed to by requiring employers to set up a "Hazard Communication Program (HazCom)" that includes Labels, MSDSs, and Training for all employees working with chemicals.

The HazCom gives employees the right to information that can answer the following questions:

1. What is hazardous in this material?
2. How can this affect my health?
3. What other hazardous materials are used at my workplace?

In November **1983**, OSHA issues its Hazard Communication Standard and it was implemented in November **1985**. Manufacturers and importers of hazardous materials are required to label containers and give MSDS to purchasers with first shipments. Distributors are required to begin transferring information (MSDS and Labeling) downstream to end users.

Unfortunately, HazCom is often ranked fairly high on OSHA's "top 10 list" of violations. The violations typically result from either neglecting to have a written HAZCOM program or failing to provide information and training on hazardous chemicals.

As citizens we expect certain protections from harm at work, from harm on our communities and as consumers but there is lack of available information. Some examples:

- There are over 100,000 chemicals in commerce, and little safety information exists for 90+ percent of chemicals.
- Over the past 30 years, chemical companies have provided health impacts for only about 15% of the total chemicals on the market. Chemical manufacturers do not have to prove that a chemical is safe or would pose significant harm before it enters the market.
- Under federal law, health impact information is voluntary.

As we may be aware, the regulatory and legal requirements of federal and state laws have problems managing chemical production and use.

The US does not have a system to find out what toxins are contained in commerce products. As a result, toxic chemicals in the US are used as ingredients in chemical products without adequate testing and it is perfectly acceptable according to the US only regulation, the **Toxic Substances Control Act** (TSCA)

TSCA is the primary mechanism to oversee chemicals in the US. It was established in **1976** under the Environmental Protection Agency (EPA). **Unfortunately, most health and ecological risks associated with industrial chemicals are poorly understood because TSCA does not require producers to generate basic information on chemical uses, health effects, or exposures.**

The way TSCA is presently written creates overwhelming limitations that have kept EPA on a tight restriction as it attempts to ban harmful chemicals manufactured and distributed in the US. So much so, that since TSCA was established 34 years ago, EPA has issued regulations under the act **to limit the use of only five existing chemicals out of the 82,000** present in the TSCA inventory.

Several academics, health and safety professionals, and workers in California have provided us with specific reasons why we are in the present situation. These problems are characterized as:

> **Data gap** – EPA is unable to assess the potential hazards of nearly all chemicals in commerce. Meanwhile, there are no toxicological data required for introducing new chemicals.
>
> **Safety gap** – Data gaps and complexities of characterizing exposure make obtaining evidence and building a case impossible. EPA has formally regulated five existing chemicals or chemical classes since 1976.
>
> **Technology gap** - As a result of the data and safety gap, the Toxic Substance Control agency has failed to encourage public/industry investment in cleaner chemical technologies known collectively as green chemistry.

These three policy gaps together have resulted in a flawed market for chemicals and products in which:

- The effects on humans or ecosystems of most chemicals are poorly understood. There is not enough nor reliable data available.
- The costs associated with human and environmental health effects are borne by the public. Currently, under the Toxic Substances Control Act, regulators and the people who are affected have to prove that a chemical is dangerous and/or linked to their health in order for any kind of action on dangerous chemicals.
- There is minimal public/private investment in cleaner chemical technologies and development. Funding is easiest to justify when the outcome is highly visible.
- Government regulations do not provide the necessary protection to workers, consumers, and the community due to weakness in generating information, regulating known hazards, motivating investment in green chemistry.
- There is little attention placed upon safer alternatives in academic institutions. US universities that offer a BS, MS or PhD in chemistry do not require a basic understanding of toxicology, exposure, ecotoxicology, principles of green chemistry.

- *What is happening in Europe?*

REACH - Registration, **E**valuation, **A**uthorization, and Restriction of **Ch**emicals

The European Union (EU) passed a new chemical regulation known as **REACH** in **2006**. REACH requires producers to disclose some hazards and exposure information on an estimated 30,000 industrial chemicals. These requirements, for data and for providing safe use, are expected to promote the development and use of safer chemicals. **The goal is to shift burden of proof of safety to manufacturers/producers; which will change chemicals management globally.**

It is needed to change the culture: *If there is no data, there is no market.* It creates company's responsibility to develop safety data; help to withdraw substances from the market; and take a look at the imports as well. REACH applies equally in most aspects to manufacturers in the EU and foreign importers. Therefore, the United States has a unique opportunity to make use of the data and to revisit its own chemicals policy.

The US is taking a close look at chemical regulations to close the data, safety, and technology gaps. A new chemicals policy in the US has the potential to raise global demand for safer chemical substances and processes, increasing the incentive for research and development in safer products and technologies while improving human and environmental health.

The following table outlines the distinctions between chemicals policies of the US (TSCA) and the EU (REACH):

	TSCA	REACH
Burden of proof	Producers are not required to generate and disclose hazard data; government bears the burden of proof of harm.*	Producers must – supply hazard data for eligible chemicals on the basis of volume in commerce and – demonstrate safety or adequate control of certain chemicals of concern.
New chemicals	Producers must submit pre-manufacture notification, but there is no minimum required set of hazard data.	Chemicals introduced since 1981 are subject to volume-based data requirements.
Existing chemicals	Chemicals in use before 1976 were assumed to be safe and were not subjected to the regulation.	Chemicals in use before 1981 are subject to the same volume-based data requirements as new chemicals
Prioritizing chemicals for regulatory action	The lack of data requirements prevents effective prioritization.	Chemicals are prioritized by hazard and exposure potential; chemicals of concern are subject to use-by use authorization.
Supply chain transparency	No requirements	Two-way flow of hazard and exposure information is required between chemical producers and commercial users.
Public access to information	Extensive trade secret, are allowed, including chemical names and uses.	A database of registered chemicals with clear criteria for trade secret claims will allow public access to a yet-to-be-determined body of information.

*TSCA does give EPA authority to require a producer to test a chemical for health and environmental effects. But EPA must first establish that the substance poses “an unreasonable risk” to human health or the environment, or that there is significant environmental release or human exposure potential.

These restrictions in the statue place EPA in a logical paralysis to require information for assessing a chemical’s risk, EPA needs risk information that producers are under no obligation to provide.

Source: http://coeh.berkeley.edu/docs/news/science_policy_forum_112009.pdf

- *What is happening in California?*

California has launched the Green Chemistry initiative, which plans to regulate product’s chemical toxicity and inform costumers on how products sold in CA are manufactured and transported and how health and environment benefit from their safer ingredients. The whole idea is to pay attention when the product is designed, manufactured, used, and recycled instead of paying attention when it comes time to throw them away in the landfill.

California is a progressive state, showing its leadership on chemicals policy by passing two bills in 2008. **AB 1879** adopts regulations to identify and prioritize chemicals of concern, to evaluate alternatives and to specify regulatory responses where chemicals of concern are found in products. **SB 509** requires an online database that includes information on the toxicity and hazards traits of chemicals used in daily life.

There is also a third bill**, AB 289,** that gives the Department of Toxic Substances and Control authority to require manufacturers of chemicals to develop fate and transport, analytical test methods and other information on the chemicals they make or sell in California.

These three bills start building the capacity in the future workforce and in businesses for green chemistry innovation and economic growth. They will provide the information (on ingredient data and toxicity data) needed to identify opportunities and select safer materials in products. They provide the tools and metrics to make the transition to safer, more sustainable products.

The implementation of the Initiative is an ongoing, political process. Its effectiveness may ultimately depend on how much political pressure exists from worker/consumer/environmental advocacy groups. DTSC, for example, does not have a budget that is anywhere comparable to the EU's European Chemicals Agency (ECHA). Industry interests could weaken the scope of the Initiative.

<u>Lesson Plan</u>

- Start this session by saying that the purpose of this presentation is develop awareness on the different regulations affecting how chemicals are managed or will be managed in California, the country, and the world.

- Ask participants if they know how many chemicals are currently in commerce? Tape the answer on the timeline. *There are over 100,000 chemicals in commerce, and little safety information exists for 90+ percent of chemicals.*

- Show the video clip *Song of the Canary* and from that the discussion develops. Ask if they know what document should be available to workers when working with chemicals. Wait for answers and then add:

    - As we said in the last session, the employer should have in place labels, MSDSs, and training for all workers handling chemicals. This is enforced under the RTK standard, which was implemented in 1985. **Tape cards on the timeline.**
    Tell participants that this standard gives them the right-to-know what hazardous chemicals are in the product; how these chemicals can affect their health; what other hazardous materials are used at their workplace. The DBCP case was a critical case to have the Right-to-Know standard.

- Then ask participants if they think chemicals that represent a threat to our health and environment are always tested for their health/environmental effects before they are put into the market. Make connection with the video clip. Wait for answers and introduce **TSCA.**
    - o As citizens we expect certain protections from harm at work, from harm on our communities and as consumers but there is lack of available information. As a result, toxic chemicals in the US are used as ingredients in chemical products without adequate testing and it is perfectly acceptable according to the US only regulation, the **Toxic Substances Control Act** (TSCA), which was established in **1976** under EPA to regulate industrial chemicals in the US. **Tape card on the timeline.** Give an overview on TSCA using the handout *Distinctions between TSCA and REACH.*

- [Optional] Distribute the worksheet: *Jimmy's Story* and the MSDS for ***GOC* Grill & Oven Cleaner*;*** make small groups and ask participants to answer the following questions:
    - o What type of protection Jimmy should wear when using the *GOC*?
    - o What chemical hazards the product has? Any PEL?
    - o How does this product affect the environment?
    - o How often you read MSDS at your workplace? What are the strengths of MSDSs as a way to get information about a chemical? What are the limitations of MSDSs?

  Ask each group to report back to the larger group. Then ask them how useful was the MSDS; did they find all the information? Do they feel comfortable to use the chemical without all the facts?

  Summarize what participants share by saying that the way TSCA is presently written creates overwhelming limitations that has kept EPA on a tight restriction. TSCA does give EPA authority to require a producer to test a chemical for health and environmental effects. But EPA must first establish that the substance poses "an unreasonable risk" to human health or the environment, or that there is significant environmental release or human exposure potential. As a result, toxic chemicals in the US are used as ingredients in chemical products without adequate testing and it is perfectly acceptable according to TSCA. During the last 34 years, EPA has issued regulations under the act **to limit the use of only five existing chemicals out of the 82,000** present in the TSCA inventory.

  Producers are not required to generate and disclose hazard data; government bears the burden of proof of harm.

- Tell participants that not having access to complete information creates policy gaps to regulate and manage chemicals. Use the handout *Gaps in US Policy* to refer to data, safety, and technology gap. The exercise we did with the MSDS is an example of the data gap.

- Introduce REACH - REACH means Registration, Evaluation, Authorization, and Restriction of Chemicals. It was established in 2006 in the European Union. REACH requires producers to disclose some hazards and exposure information on an estimated 30,000 industrial chemicals. These requirements, for data and for providing safe use, are expected to promote the development and use of safer chemicals. The goal is to shift burden of proof of safety to manufacturers/producers; this will change chemicals management globally. **Tape card on the timeline.**
    - Tell participants that they are going to keep watching the video clip on REACH, which has a good overview of this regulation in the EU. http://ec.europa.eu/environment/chemicals/reach/reach_intro.htm

  Ask participants what they think about this approach? Who benefits from it? What can be done in the USA?

- Ask if someone knows any legislation supporting new chemicals policy in California – Add to the answer: there are bills with respect to chemicals policy:

  AB 1879 - adopts regulations to identify and prioritize chemicals of concern, to evaluate alternatives and to specify regulatory responses where chemicals of concern are found in products.

  SB509 - requires an online database that includes information on the toxicity and hazards traits of chemicals used in daily life.

  AB289 – requires manufacturers to determine fate and transport of chemicals in the environment and health, analytical test methods, and other information on chemicals they make or sell in CA

- Conclude by saying this is the reality, as long as we do not have stringent regulations, not only in the States but also in the world, companies will keep producing toxic chemicals that create environmental problems such as climate change, water depletion, waste and toxic pollution as well as health problems for workers, consumers, community members, and the general public.

  We are in the present situation because there are **gaps in safety, data, and technology.** This has resulted in a flawed market for chemicals and products in which the effects of most chemicals are poorly understood on humans and the environment; there is minimal public/private investment in cleaner chemical technologies and development; government regulations do not provide the necessary protection to workers, consumers, and the community; and there is little attention placed upon safer alternatives in academic institutions.

Session Materials

- Power Point Presentation
- Song of the Canary
- Timeline
- Cards (RTK, TSCA, and REACH)
- REACH Video http://ec.europa.eu/environment/chemicals/reach/publications_en.htm
- Bills in CA
- Handouts: Gaps in US Policy; Distinctions between TSCA and REACH

References

1. Song of the Canary Video Clip. http://www.answers.com/topic/song-of-the-canary

2. What is REACH? http://ec.europa.eu/environment/chemicals/reach/reach_intro.htm

3. California Green Chemistry Initiative Final Report http://www.dtsc.ca.gov/PollutionPrevention/GreenChemistryInitiative/upload/GREENChem.pdf

4. Schwarzman, M., Wilson, M., New Science for Chemicals Policy. Science Vol 326 1065-1066 (2009) http://coeh.berkeley.edu/docs/news/science_policy_forum_112009.pdf

Jimmy's Story *[Optional]*

Jimmy is a restaurant worker in his mid 20s. One of Jimmy's tasks is to clean the grill and oven at the end of his shift. He uses GOC product. Jimmy's supervisor gave him the product's MSDS to read before using the product. Answer the following questions

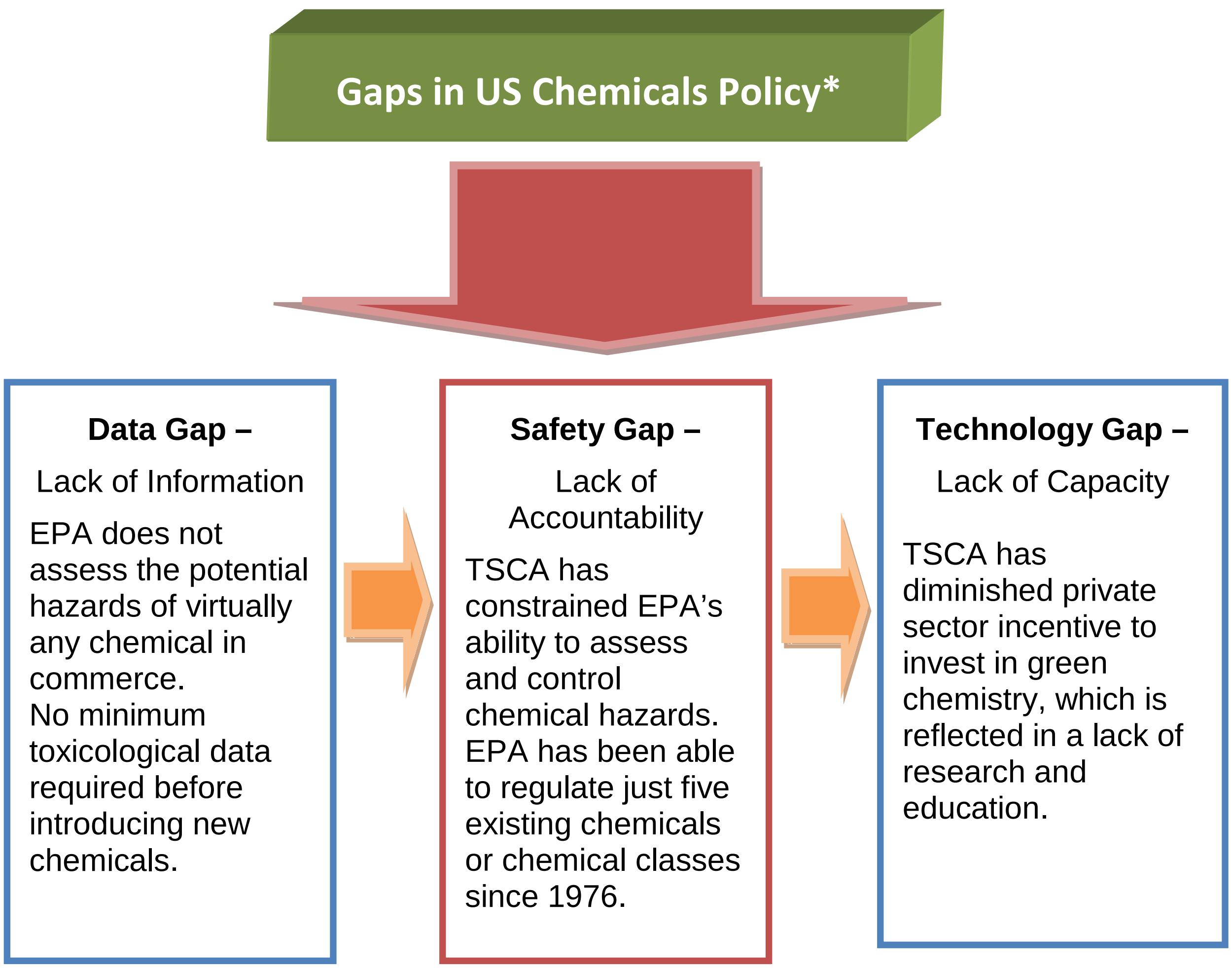
Questions:

1. What type of protection Jimmy should wear when using the *GOC*?
2. What chemical hazards does the product have? Any PEL?
3. How does this product affect the environment?
4. How often you read MSDS at your workplace? What are the strengths of MSDSs as a way to get information about a chemical? What are the limitations of MSDSs?

Handout 1

What is the problem?

- The vast majority of the thousands of chemicals in use have never been adequately evaluated for their effects on human and environmental health. There are over 100,000 chemicals in commerce, and little safety information exists for 90+ percent of chemicals.
- The US Toxic Substances Control Act (TSCA) of 1976 provides the EPA with authority to require reporting, record-keeping and testing, and restrictions relating to chemical substances and/or mixtures. Under TSCA, health impact information is voluntary.



- The environmental and health costs are not born by the chemical industry; consequently, the US chemicals market has undervalued the safety of chemicals relative to their function, price, and performance, with the result that hazardous chemicals have remained competitive and in widespread use.

***Source: Green Chemistry and Workers. New Solutions, Vol 19(2) 239-253, 2009**

Chemicals Policy and California

- TSCA has (1) not required producers to generate and disclose information on toxicity to downstream businesses, workers, the public, or government; (2) not given government, the public, or workers the tools necessary to effectively identify, prioritize, and take action on chemicals of concern; and (3) not motivated industry to invest in green chemistry in any substantive way.

- REACH (Registration, Evaluation, Authorization, and Restriction of Chemicals) is a European Community regulation on chemicals and their safe use, which was established in 2006. REACH requires producers to disclose some hazards and exposure information on an estimated 30,000 industrial chemicals.

- There are 3 bills with respect to chemicals policy in CA:

AB 1879	SB509	AB289
Adopts regulations to identify and prioritize chemicals of concern; and evaluate alternatives where chemicals of concern are found in products.	Requires an online database that includes information on the toxicity and hazard traits of chemicals used in daily life.	Requires manufacturers to determine: • fate and transport of chemicals in the environment, • the impact on health, and • other information on chemicals they make or sell in CA.

- As long as we do not have stringent regulations, companies will keep producing toxic chemicals that create environmental problems such as climate change, water depletion, waste and toxic pollution as well as health problems for workers, consumers, community members, and the general public. Production can be clean, just and sustainable. Products can be designed to be more durable, less toxic and wasteful. It is critical to be informed and participate when changes are taking place at a legislative level.

Handout 2

Differences between TSCA and REACH

	TSCA	REACH
Burden of proof	**Producers are not required to generate and disclose hazard data; government bears the burden of proof of harm.***	**Producers must – supply hazard data for eligible chemicals on the basis of volume in commerce and – demonstrate safety or adequate control of certain chemicals of concern.**
New chemicals	**Producers must submit pre-manufacture notification, but there is no minimum required set of hazard data.**	**Chemicals introduced since 1981 are subject to volume-based data requirements.**
Existing chemicals	**Chemicals in use before 1976 were assumed to be safe and were not subjected to the regulation.**	**Chemicals in use before 1981 are subject to the same volume-based data requirements as new chemicals.**
Prioritizing chemicals for regulatory action	**The lack of data requirements prevents effective prioritization.**	**Chemicals are prioritized by hazard and exposure potential; chemicals of concern are subject to use-by use authorization.**
Supply chain transparency	**No requirements**	**Two-way flow of hazard and exposure information is required between chemical producers and commercial users.**
Public access to information	**Extensive trade secret, are allowed, including chemical names and uses.**	**A database of registered chemicals with clear criteria for trade secret claims will allow public access to a yet-to-be-determined body of information.**

*TSCA does give EPA authority to require a producer to test a chemical for health and environmental effects. But EPA must first establish that the substance poses “an unreasonable risk” to human health or the environment, or that there is significant environmental release or human exposure potential.

These restrictions in the statue place EPA in a logical paralysis to require information for assessing a chemical’s risk, EPA needs risk information that producers are under no obligation to provide.

Source: http://coeh.berkeley.edu/docs/news/science_policy_forum_112009.pdf

Session 4 – 60 min

What is Green Chemistry?

Objectives

At the end of this session, participants will be able to:

- Identify how conventional chemistry affects sustainability
- Define in their own words what green chemistry is

Background

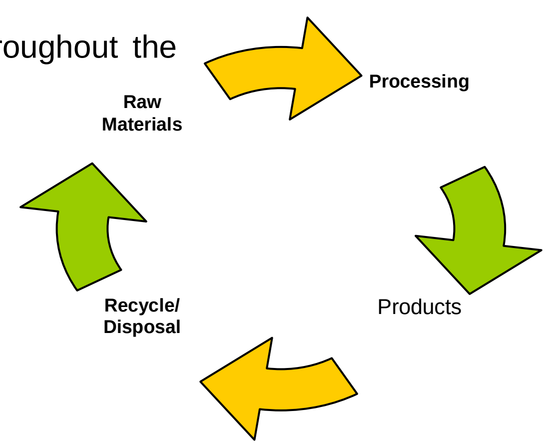
This session will explain what green chemistry means and what benefits green chemistry brings to the society, the environment, and the economy.

Toxic chemicals are all around us – in our workplaces and communities. While many chemicals serve useful purposes and bring benefits to our lives, many are known to harm human health and the environment. Thousands of others have never been assessed for safety.

Green Chemistry is a worldwide term to **describe the design, development, and implementation of more environmentally friendly, sustainable chemical products and processes.** The green chemistry framework provides a powerful tool to advocate for increased chemical security in manufacturing facilities by substituting safer chemicals for those that are hazardous. Thousand of industrial facilities currently use or store substances capable of harming human health and the environment, and a routine accident on one of these facilities could endanger both worker and communities.

Green Chemistry requires fundamental changes to ensure reductions in risk and hazards, waste, non-renewable sources, energy, materials, and cost; as well as guarantee products that are sustainable and environmentally benign.

The **benefits** of green chemistry reduce risks throughout the life cycle of chemical production and use.



A transformation to green chemistry techniques would result in safer workplaces for industry workers, greatly reduced risks to fence line communities and safer products for consumers. Also, green chemistry processes would consume less raw materials and energy as well as save money on waste disposal making a company most efficient.

Chemists have access to many sources of information to determine the potential toxicity of the molecules they design and the ingredients they choose to avoid or reduce toxic properties. For example, green chemists may design a molecule large enough that it is unable to penetrate deep into the lungs, where toxic effects can occur. Or they can change the properties of a molecule to prevent its absorption by the skin or ensure it safely breaks down in the environment.

The approaches to green chemistry should view communities, workplaces, and environment not as isolated areas but as fluid and very much interrelated aspects of a social health system where materials, safer work processes and chemicals are good for all.

Success Stories

- **Plywood -** Columbia Forest Products, one of the largest manufacturers in North America, is using a soy-based adhesive instead of urea-formaldehyde-based adhesive to produce layered plywood. The conversion of all Columbia Forest plants to the soy adhesive would reduce operating emissions by 50-90%. The soy based adhesive cost less than the formaldehyde adhesive, which is a probable carcinogen.
  Excerpts from Chasing Molecules by Elizabeth Grossman

  The Soy-based adhesive was developed by Dr Kaichang Li, a research scientist at Oregon State University in collaboration with the Hercules Company, a chemical manufacturer.

- **Nail Polish** – The Toxic Use Reduction Institute at the University of Massachusetts has created a polymer based on thyamine, which binds easily to food-grade dyes. This demonstrates the compound has the potential to create a nontoxic nail polish. The potential nontoxic polish can be removed with an enzyme that is also nontoxic, eliminating the need to use hazardous acetone and other volatile organic solvents typically used to remove nail polish.
  Excerpts from Chasing Molecules by Elizabeth Grossman

- **Growing plastics from plants** - Polylactides (PLAs) are fully biodegradable, completely recyclable plastics derived entirely from a widely available and renewable resource: corn. The process uses 30 to 50 percent less fossil resources and results in 50 to 70 percent lower carbon dioxide emissions than the typical polyethylene and nylon manufacturing processes for plastics. The production process also uses internal recycling to eliminate waste, preventing pollution at the source and resulting in greater than 95 percent yields.
  www.epa.gov/ncer/science/tse/success.html

Lesson Plan

- Start the session pointing out the objectives. Then show the video clip *The Story of Stuff – Production,* which captures what is happening in the industry using toxic chemicals. Make the connection to safety, data, and technology gaps. http://www.youtube.com/watch?v=HoJDDiJohKY

  Have a discussion using the following questions:
  1. What did you think of the video? Any initial impressions? Anything surprising? New?
  2. “Toxics in, Toxics out” --What does this mean? What is the effect? Why do industries use toxic materials in the first place?
  3. Annie mentions a chemical called BFR’s: Brominated flame retardants. Have you heard of them before? How can we get industry to stop putting these notoriously toxic chemicals in our household items? Why are so few products containing toxic materials labeled to warn the shopper about the risks?
  4. Earlier we talked about the safety gap – people and environments have to be exposed to toxics – nothing to protect them. Data - we see here that these 100,000 chemicals are not tested for health or environmental impacts. Technology Gap – BFR example

- *[Optional]* Ask participants to write down positive and negative impacts of chemistry on the environment, human health and economics. Then let participants share their answers. Some of the answers could be:

	Chemistry – Positive Impacts	***Chemistry – Negative Impacts***
Environment	*Clean up oil spills*	*Chemical spills*
Human health	*Medicine for sick people*	*People ingest chemicals that they shouldn’t – like cleaning products*
Economics	*People buy chemical products*	*The above costs everyone money*

Source: Beyond Benign – What is Green Chemistry? www.beyondbenign.org

- Show the slide on conventional chemistry and discuss what its effects are.

- *[Optional]* Then, draw the life cycle of a product and ask participants to identify who might be at risk of exposure and why. Ask participants to share their information. You can add who is at risk – bring up the existing gaps to manage chemicals (safety, data, and technology gaps) and say We must protect workers, as we see they are some of the most exposed and vulnerable populations to chemical exposure throughout the life-cycle of chemicals. As we saw in the life-cycle process, workers cannot be separated from consumers, as they are a vital part in the manufacturing, disposal, and recycling of all of our consumer products and waste.

Raw Materials	Chemical Production	End Products	Recycling/Disposing
• workers • suppliers • shippers • communities near manufacturing sites • local and global environment	• workers • communities near manufacturing sites • local and global environment	• workers • shippers • waste handlers • communities near manufacturing sites • consumers • local and global environment	• workers • communities near manufacturing sites • waste sites and communities near them • local and global environment

- Ask participants what thoughts they have when they hear the term *Green Chemistry.* Wait for answers and discuss the concept. Then add - **Green chemistry is the design of chemical products and processes that reduce or eliminate the use or generation of hazardous substances.** It saves companies' money by using less energy and fewer/safer chemicals, thus reducing the costs of pollution control and waste disposal. Show the slide – Green chemistry

- Have participants brainstorm how green chemistry may positively affect their lives. Some examples are: have access to toxicity data, reduce lead pollution, safer dry cleaning products; putting out fires using less toxic foams. Then refer to the poster listing some of the successful stories using green chemistry. **Emphasize that green chemistry's goal is to prevent pollution before it happens rather than clean up the mess.**

- Use the power point to summarize the concepts and talk about successful stories. Mention that green chemistry focuses on the "***cradle-to-cradle***" approach.

Some examples are: Ask participants about the problem and possible solution

TURI - Nail Polish (E. Grossman pp 171-174)

- o Most of nail polishes contain The "Toxic Trio" – toluene (repro and developmental toxicant), dibutyl phthalate (endocrine disruptor) and formaldehyde (carcinogen, asthmagen)
- o The University of Massachusetts-Lowell's Toxics Uses Reduction Institute (TURI) has been working with local beauty and nail salons to reduce use of hazardous materials (e.g. formaldehyde, toluene, phthalates, and acetone) and thereby improve conditions for workers since there are substantial chemical exposures for beauty salon workers as well as customers.
- o Cosmetics use flexible, waterproof films and coating as well as hazardous chemicals (e.g. polymers that use phthalates) to achieve the flexible films that make nail polish and mascara adhere to and bend with curved surfaces.
- o Instead of forcing molecules to do something they wouldn't do on their own, green chemistry tries to build function into new molecule's design. A polymer based on thymine, a constituent of the compounds that make up the nucleic

acids in DNA, was created. The thymine compound binds easily to food-grade dye. Once it is painted on a nail-substitute surface and exposed to light, the green water-soluble polymer successfully coats the surface, demonstrating that this compound has the potential to create a nontoxic nail polish.

- Not only is the potential polish nontoxic but it can be removed with an enzyme that is also nontoxic like the hazardous acetone and other volatile organic solvents typically used to remove nail polish.

Dry cleaning – Perchloroethylene (PERC)

- PERC has long been recognized as an effective dry cleaning solvent and it is by far the most commonly used solvent in dry cleaning shops.
- As a volatile organic solvent, PERC poses serious health hazards if exposure is not properly controlled. Dry cleaning workers who routinely breathe excessive amounts of the solvent vapor or spill PERC on their skin are at risk of developing health problems.
- There are nontoxic cleaning alternatives that are just as effective as dry cleaning with PERC, professional wet cleaning and liquid carbon dioxide (CO2) cleaning.

Columbia Forest Products – Plywood (E. Grossman pp 165-166)

- Largest plywood manufacturer in North America has converted all of its plants from producing layered plywood that uses a urea-formaldehyde-based adhesive to one with a soy-based adhesive. This would reduce operating emissions here by 50-90%.
- The soy–based adhesive costs less than the formaldehyde adhesive and is environmentally friendly. The adhesive was developed by Dr Kaichang Li, a research scientist at Oregon State University in collaboration with the Hercules Company, a chemical manufacturer.
- The outcome is that formaldehyde is no longer used in the process since it is a probable carcinogen. Formaldehyde emanated from paneling in the notorious New Orleans FEMA mobile homes and travel trailers, and it has prompting lawsuits.

Session Materials

- Power point presentation
- Handout - What is Green Chemistry

References

1. Hughes, J., LeGrande, D., Zimmerman, J., Wilson, M., Beard, S. Green Chemistry and Workers. New Solutions, Vol 19(2) 239-253, 2009

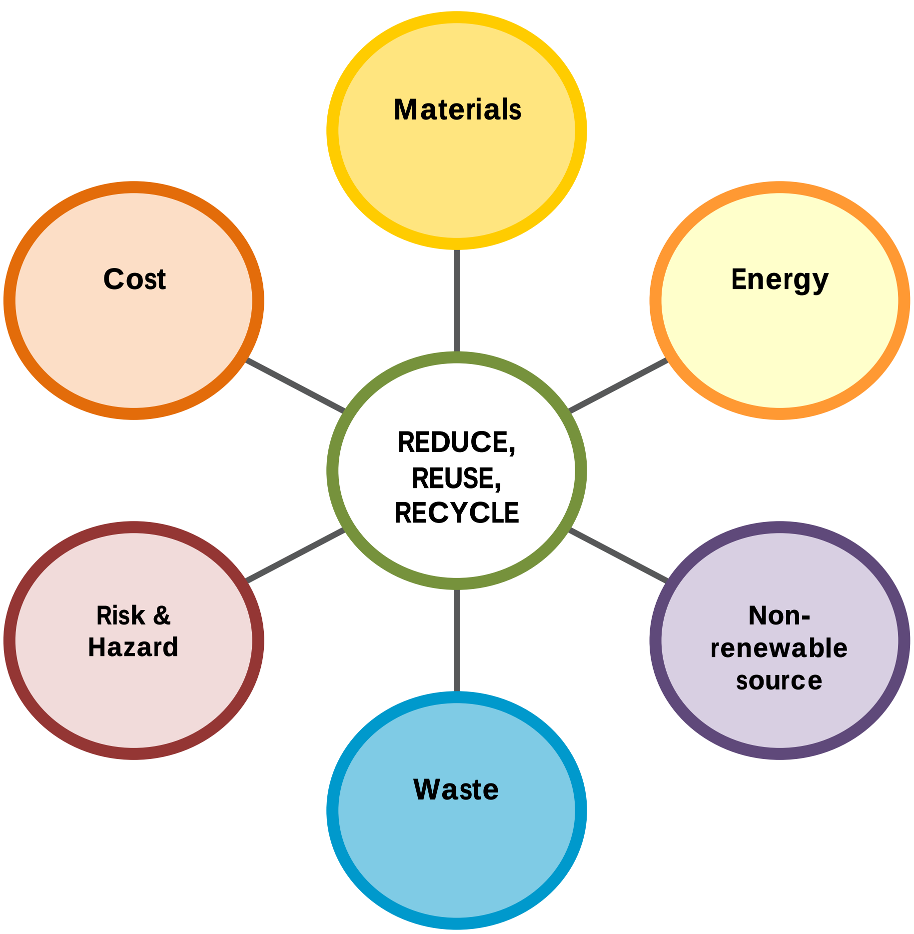
2. The Green Chemistry Revolution – An interview with Paul Anastas http://www.multinationalmonitor.org/mm2009/032009/interview-anastas.html

3. Why we need green chemistry? http://www.cleanproduction.org/library/cpa%20green%20need%20fact.pdf

4. What is green chemistry? www.dtsc.ca.gov/PollutionPrevention/GreenChemistryResources/index.cfm#What_is_green_chemistry?

What is Green Chemistry?

- Green chemistry is the design of chemical products and processes that reduce or eliminate the use or generation of hazardous substances. Green chemistry applies across the lifecycle, including the design, manufacture, and use of a chemical product.
- Green chemistry is a tool to:
    1. Reduce and eventually eliminate the use of toxic materials;
    2. Reduce the environmental impact on waste water and dispersion of contaminants in the atmosphere;
    3. Design products for easier recycling and reuse;
    4. Reduce water and energy usage in chemical manufacturing; and
    5. Use renewable raw materials.



Session 5 – 90min

Precautionary Principles in Green Chemistry

Objectives

At the end of this session, participants will be able to:

- Review the hierarchy of controls for chemical hazards.
- Become familiar with the precautionary principles of green chemistry.
- List limitations that the green chemistry initiative may encounter.

Background

The founders of Green Chemistry in the USA, Paul Anastas and John C. Warner, developed 12 principles of green chemistry, which help to explain what green chemistry means in practice and aid one in assessing how green a chemical, reaction, or process is. The principles cover such concepts as:

- the design of processes to maximize the amount of raw material that ends up in the product;
- the use of safe, environment-benign substances, including solvents, whenever possible;
- the design of energy efficient processes;
- the best form of waste disposal: not to create it in the first place.

Green chemistry attempts to reduce and preferentially eliminate the hazard thus negating the necessity to control Exposure. The bottom line is, if we don't use or produce hazardous substances then the Risk is zero, and we do not have to worry about the treatment of hazardous substances or limiting our exposure to them.

The 12 principles are:

1. It is better to **prevent waste** than to treat or clean up waste after it is created. By preventing waste generation, we minimize hazards associated with waste storage, transportation, and treatment.

2. Synthetic methods should be designed to **maximize the incorporation of all materials** used in the process into the final product. Choosing transformations that incorporate most of the starting materials into the product is more efficient and minimizes waste.

3. Wherever practicable, **synthetic methods** should be designed to use and generate substances that **possess little or no toxicity** to human health and the environment. This principle focuses on choosing reagents that pose the least risk and generate only benign by-products.

4. Chemical products should be designed to **preserve efficacy of function while minimizing their toxicity.** New products can be designed in academic labs that are inherently safer, while highly effective for the target application.

5. The use of **auxiliary substances** (e.g., solvents, separation agents, etc.) **should be made unnecessar**y wherever possible and safe when used. Reduction of solvent volume or complete elimination of the solvent is often possible. In cases where the solvent is needed, less hazardous replacements should be employed.

6. **Energy requirements** of chemical processes should be recognized for their environmental and economic impacts and **should be minimized**. If possible, synthetic methods should be conducted at ambient temperature and pressure.

7. A raw material or **feedstock should be renewable** rather than depleting whenever technically and economically practical. Examples of **renewable feedstock** include agricultural products or the wastes of other processes. Examples of **depleting feedstock** include raw materials that are mined or generated from fossil fuels (petroleum, natural gas, or coal).

8. **Unnecessary by-products** (use of extra chemicals that temporarily change or stops things, protection/deprotection, and temporary modification of physical/chemical processes) should be minimized or **avoided** if possible, because such steps require additional reagents and can generate waste.

9. **Catalytic reagents** (as selective as possible) **are superior** to stoichiometric (exchanging chemicals and a chemical reaction takes place) reagents. Catalysts can serve several roles during a transformation. They can make reaction happen faster without changing the final result; they reduce reagent-based waste; and reduce temperature of a transformation.

10. Chemical **products should be designed** so that at the end of their function they **do not persist** in the environment and **break down into harmless degradation products**. This principle focuses in the molecular design of chemicals.

11. Analytical methodologies need to be further developed to allow for **real-time, in-process monitoring and control** prior to the formation of hazardous substances. It is always important to monitor the progress of a reaction to know when the reaction is complete or to detect the emergence of any unwanted by-products.

12. Substances and the **form of a substance used in a chemical process should be chosen to minimize the potential for chemical accidents, including releases, explosions, and fires**. Risks associated with these types of accidents can sometimes be reduced by altering the form (solid, liquid, or gas) or composition of the reagents.

As any new initiative, green chemistry faces **challenges** such as the lack of global harmonization on regulation and environmental policy; additional cost taking into account that investment is needed short term; the low profile of safer, more sustainable chemistry in school and university teaching; the difficulty of obtaining research and development funding; and lack of universally agreed metrics that allow chemicals and products to be assessed and compared across their life cycle.

It is critical to have government support to ease obtaining funds for research as well as to push manufacturers to move toward safer and sustainable products not only for the environment but also for human health.

A case to document an unfortunate situation – what is good for the environmental may not be good for human health- is the use of hexane-based cleaning solvents in the California repair industry. This chemical was supposed to be less toxic to the environment than methylene chloride. Unintended occupational health consequence resulted from industry's response to environmental regulations. Occupational exposure to n-hexane is associated with peripheral neuropathy, a potentially debilitating nerve disease. The California Department of Public Health identified automotive technicians with diagnose of n-hexane related nerve disease after substituting for n-hexane.

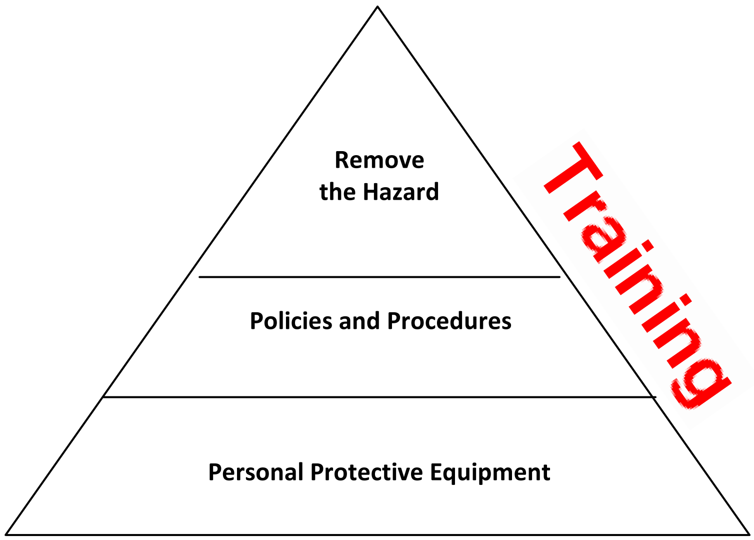
<u>Lesson Plan</u>

- Introduce the session by reviewing the objectives for this session.

- **Hierarchy of Controls** - Introduce the concept of hierarchy of controls:

In occupational health and safety, when trying to correct a hazard, there are a number of possible approaches. The hierarchy of controls is a general way to categorize these strategies. The best type of solution is to remove the hazard completely if possible. These are known as engineering controls. If elimination is not possible, then implementing safer policies and procedures, or administrative controls. The least effective controls are personal protective equipment (PPE).

Draw this triangle with categories on a flipchart or show it in the PPT. Review the hierarchy, or pyramid, of controls:



The best way to protect workers is to remove the hazard from the workplace altogether or at least keep the hazard away from workers. Some examples of "removing the hazard" are:

- Substituting safer chemical products, such as water- based products, for more toxic ones
- Installing ventilation to remove chemicals from the air workers breathe
- Putting guards on machines to prevent injuries

These are called **Engineering Controls**. They are considered most effective because they get rid of the hazard at the source, they don't rely on people to follow procedures, and they don't allow for shortcuts.

Explain possible ways to use ***"policies and procedures"*** *to control hazards, which* are called Administrative Controls

Another way to protect workers is to set up work policies and procedures that cut down exposure to hazards by changing how the job is done. Examples are:

- Providing breaks.
- Requiring that two people always lift heavy objects.
- Training workers in safe work practices.

Tell the class about ***Personal Protective Equipment****:*

Personal protective equipment, or PPE, is worn on the body and protects you from exposure to a hazard. It includes gloves, goggles, respirators, earplugs, hard hats, coveralls, safety shoes, etc. Wear PPE when other methods of controlling hazards aren't possible or don't give enough protection. Try to remove the hazard or change work policies or procedures first.

- Explain the link of green chemistry to the hierarchy of controls:

In **conventional chemistry**, hazard elimination, or substituting the toxic substance for one that is less or non-toxic, is not always prioritized. Often, there is pressure to prioritize the function of the product over everything, without paying enough attention to safety. The control is put after the exposure.

Green chemistry, as a way of controlling the hazard, prioritizes substitution of hazardous chemicals with safer chemicals/substances, alongside function and efficiency. The control is put before exposure takes place.

"The 12 principles of Green Chemistry" reflect an emphasis on substitution, which is an example of an engineering control. We will discuss these twelve principles in more detail next.

- **12 Principles of Green Chemistry**

These are important guidelines especially to chemists when trying to employ a safe and sustainable process. The principles are listed in the handout "12 Principles of Green Chemicals", but that they represent a level of technical detail that goes beyond the objectives of this training. For our purposes, **we will focus on the main concepts** upon which these principles are based, which are the following:

In any manufacturing process that involves chemicals, **one should try to:**
(Have these categories on a poster)

- Minimize or eliminate the use of hazardous materials.
- Be as efficient as possible. This means using all the materials in the process in the finished product.
- Produce less or no waste in the process.
- Regularly monitor and evaluate using green chemistry principles throughout the stages of the manufacturing process, with the understanding that it may be necessary to adjust the process to ensure true for safety, efficiency, sustainability.

Green chemistry attempts to reduce and ideally eliminate the hazard, thus negating the need to control exposure. The 12 principles are aimed at eliminating the hazard, being as efficient as possible, and producing little to no waste. The bottom line is, if we don't use or produce hazardous substances then the risk is zero, and we do not have to worry about the treatment of hazardous substances or limiting our exposure to them.

- ***[OPTIONAL]* 12 Principles Green Chemistry Activity: Recipe Rescue**

(Beyond Benign, a Warner Babcock Foundation, Copyright © 2003-2009 Pfizer Inc. All rights reserved.)

Goal: To introduce students to the 12 Principles of Green Chemistry and how it relates to a recipe they may use at home or a recipe for a chemical process.

The Recipe Rescue Student Recipe Sheet is a joke and the students will soon realize that it is poorly written as it involves a lot of waste and silly procedures that are not needed. Take your cue from the students and stop the process and begin the rewriting process whenever you feel it is appropriate.

PREP: Gather all materials and make two stations at the front of the room.

IN CLASS

- Hand out copies of the Recipe Rescue Student Recipe Sheet. You may also want to have a copy on the overhead or LCD projector.
- Explain to the students that you found a great recipe for lemonade. As a treat, explain that you'd like them to make some as a group today.
- Ask participants to pair up in teams of two. Note how many groups you have (you may need to give groups two steps depending on the number of participants).
- Explain that each group will get to perform one of the steps. Explain that this process relies on them following the steps to the "T", so they need to pay special attention to the measurements and the directions.
- Begin following the recipe on the Participant Sheet by having each group come to the front of the room and follow their numbered step. Participants should begin to exclaim that it is really stupid and that it doesn't make sense. Get to the end of the recipe if you can.
- Tell the class that you agree that some of the steps seem wasteful, dangerous, unhealthy, or unnecessary.
- Hand out the Lemonade Revised Sheet. Give participants ten minutes to rewrite their step and let them know that they will be asked to explain why they changed their step and why it helps the process. Tell them also to take a look at the things they will need at the beginning of the process as they may need to make some changes there as well.
- Have participants share their revised step with the class.
    - *Optional:* Remake the lemonade recipe using the revised steps.
- Ask participants to brainstorm a list of ways that their new version either minimized the impact on the earth or maximized the conservation of energy or materials. Write these ideas on the board.
- Explain to the students that they just used the 12 Principles of Green Chemistry without knowing it.

- o Give each participant a copy of the 12 Principles of Green Chemistry. Use the power point or the poster as a guide to discuss the 12 principles of green chemistry.

- **12 Principles Wrap-Up:**

Chemistry is Cooking -- In a kitchen, you could have eggs, flour, butter, sugar. If you combine them in a certain way and use heat, you could make bread or a cake. Chemistry is like cooking. The molecules are the ingredients. Some molecules are not so good for living cells (petroleum based chemicals). We should not use them, but we have and still do because they have created very useful products (PVC, polycarb plastics). But there are synthetic chemicals without bad effects [MENTION EXAMPLES- penicillin; some preservatives in vaccines; nylon; Velcro; glue; etc. We should not use materials that are inherently hazardous in the first place. Green chemistry urges the use of safe or less hazardous chemicals.

- **Focus on Substitution**

One example of an engineering control that completely removes a chemical hazard is substitution. This refers to the removal of the toxic substance in exchange for a less or non-toxic substance.

For example, the green chemistry framework provides a powerful tool to advocate for increased chemical security in manufacturing facilities by substituting safer chemicals for those that are hazardous.

- **Luis' Case Study**

Divide the class into 5 small groups. Have one person in each group read the story aloud and take 10 minutes to discuss and answer the following questions. After groups are finished, discuss responses in large group.

1. Thinking of the hierarchy of controls (or ways to protect workers), how could this have been prevented?
2. Why was a chemical known to be hazardous put into a brake product used by workers and consumers?
3. How did this NOT follow the principles of green chemistry related to safety?

Wrap - Up

N-hexane had been put into brake cleaners as a substitute for methylene chloride, a toxic chlorinated solvent. At that time, new environmental regulations to protect the public were implemented to reduce solvents in the air and wastewater. However, no one considered the health hazards of n-hexane, the substitute chemical—especially its effect on workers, who use it in much larger quantities than the average consumer.
Luis's story demonstrates what can happen when we fail to include worker health in our efforts to protect the community and the environment from toxic chemicals.

- Conclude by saying that the idea is to **contribute to a more sustainable world** where there are **environmental benefits** through reduced greenhouse emissions and pollution; **economic benefits** through cost savings, job creation, and investment in new technologies; and **health benefits** for workers and the community improving and using safer products

Session Materials

- Power Point Presentation
- Handouts: Hierarchy of Controls and The Principles of Green Chemistry
- Worksheet: Luis' Story
- Lemonade ingredients *[Activity is Optional]*

References

1. Twelve Principles of Green Chemistry http://www.epa.gov/greenchemistry/pubs/principles.html

2. Green Chemistry http://www.epa.gov/greenchemistry/

3. Green Chemistry: Cornerstone to a Sustainable California http://www.greenchemistryandsustainabledesign.org/ch3article2.pdf

4. E Grossman. *Changing Molecules: Poisonous Products, Human Health, and the Promise of Green Chemistry*. Island Press/Shearwater Books. Washington. 2009. 203-204.

5. Fisher Science Education http://www.fishersci.com/wps/downloads/segment/ScienceEducation/pdf/green_ChemicalCrossRef.pdf

[Optional Activity]

Lemonade Recipe http://www.beyondbenign.org/K12education/highschool.html

Ingredients/Materials

- 1 cup sugar
- 1 cup water
- 10 lemons
- 1 can of coke
- 3 to 4 cups cold water
- 1 bag of ice
- 1 knife
- 1 cutting board
- Hotplate
- 1 lemon squeezer
- Small saucepan
- 1 wooden spoon
- Disposable cups for serving

Directions

1. Make sure that you have a gallon of water cooling in the refrigerator for at least 5 hours prior to making your lemonade. Open up the bag of sugar and measure one cup into the pan. Discard the rest of the sugar in a trash can.
2. Open the can of coke and set it aside. Measure one cup of the chilled water into a pitcher and then transfer the water from the pitcher into the pan.
3. Set the hot plate on medium and set the pan on the burner. Stir the mixture until it dissolves completely without burning while someone else in your group says the alphabet backwards. When the mixture is completely dissolved, set the mixture aside.
4. Place 8 of the lemons on a cutting board. Hold one up to your ear and see if you can hear the ocean. Slice the lemons in half.
5. Using the juicer, squeeze the juice from the lemons. Discard the lemon peels in the trash can.
6. Measure 1 cup of the lemon juice into a large pitcher. Discard the leftover lemon juice in the sink.
7. Add the sugar water to the pitcher as well.
8. Then add 4 cups of cold water to the pitcher.
9. Slice the remaining lemon and add the slices to the pitcher as a garnish.
10. Swing the bag of ice vigorously around your body. Add two handfuls of ice to the pitcher.
11. Clean up your cooking area with a bleach wipe. Do two jumping jacks and push-ups.
12. Serve in plastic cups.

[Optional Activity]

Lemonade Revised Sheet - Remember to think of all the things that would help to make the recipe easier, less wasteful, and healthier.

You will need:

Directions:

[Optional Activity]

Teacher Sheet - Lemonade Recipe

Below are the 12 principles with the recipe changes aligned to them so that you are able to connect the recipe rewrite to the 12 Principles of green chemistry:

1. It is better to prevent waste than to treat or clean up waste after it is formed.

Use of disposable cups – you could use glass

2. Synthetic methods should be designed to maximize the incorporation of all materials used in the process into the final product.

Lemon slices being thrown away. All materials should be in the finished product.

3. Wherever practicable, synthetic methodologies should be designed to use and generate substances that possess little or no toxicity to human health and the environment.

Not using the bleach wipes therefore not using things that are toxic

4. Chemical products should be designed to preserve efficacy of function while reducing toxicity.

Does the lemonade still taste as good if we change the process? For example maple syrup could be used instead of sugar therefore cutting out the heating process.

5. The use of auxiliary substances (e.g. solvents, separation agents, etc.) should be made unnecessary whenever possible and, innocuous when used.

Do we need all of the lemons etc. could we cut some of the ingredients out and still have it taste as good?

6. Energy requirements should be recognized for their environmental and economic impacts and should be minimized. Synthetic methods should be conducted at ambient temperature and pressure.

Do we need to use the hotplate? Do we need a gallon of water to be getting cold in the fridge or is tap water OK? And the running etc

7. A raw material feedstock should be renewable rather than depleting whenever technically and economically practical.

Should we use these plastic disposable cups to serve the lemonade in? What about a glass?

8. Unnecessary derivatization (blocking group protection/no protection, temporary modification of physical/chemical processes) should be avoided whenever possible.

Discarding the sugar is an unnecessary bi-product

9. Catalytic reagents (as selective as possible) are superior to stoichiometric reagents.

The ice is a catalyst. We didn't have to refrigerate the water because the ice made it cold and stayed in the product.

10. Chemical products should be designed so that at the end of their function they do not persist in the environment and break down into innocuous degradation products.

We could compost the lemon peels or maybe someone has another recipe we could use them in.

11. Analytical methodologies need to be further developed to allow for real-time in-process monitoring and control prior to the formation of hazardous substances.

We cut out steps and looked for ways to make the formula simpler.

12. Substances and the form of a substance used in a chemical process should be chosen so as to minimize the potential for chemical accidents, including releases, explosions, and fires.

We looked at safety the whole time. Gloves when putting in ice and maybe not using a heat source.

Luis' Story

Luis, an auto mechanic in his 20s, noticed one day that his hands and feet tingled and felt numb. His symptoms got worse over the following months, spreading up his arms and legs and into his torso. He was examined by a doctor of occupational medicine, who suspected that Luis had nerve damage caused by exposure to chemicals he used at work.

Every day for nearly two years, Luis had used from one to nine spray cans of a brake cleaner. Further investigation showed that the product he used contained 50–60% n-hexane, a chemical known since 1964 to cause nerve damage.

Luis's doctor reported his case to the California Department of Public Health (CDPH). Occupational health specialists there investigated the possibility that other auto mechanics had suffered nerve damage. They studied a large auto dealership and surveyed California neurologists, and quickly found two similar cases.

Question:

1. Thinking of the hierarchy of controls (or ways to protect workers), how could this have been prevented?

2. Why was a chemical known to be hazardous put into a brake product used by workers and consumers?

3. How did this NOT follow the principles of green chemistry related to safety?

HIERARCHY OF CONTROLS

Eliminate Hazards

Replace dangerous chemicals with safer chemicals; remove ignition sources, sharp edges, any sources of slips, trips, falls.

Engineering Controls

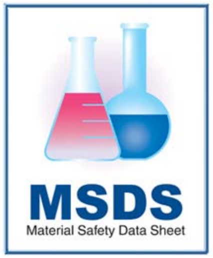
Use heavy equipment or mechanical devices to handle material; ventilation fans for confined spaces; overpacks to prevent leaks; non-sparking tools; dikes and berms to prevent runoff; segregate incompatible drums; apply water to suppress dust.

Personal Protective Equipment

First, always attempt to reduce exposure to levels not requiring use of PPE. Use appropriate respiratory protection (SCBA, airline, air purifying respirator); appropriate skin protection (gloves, suit, boots), hard hat, hearing protection.

Administrative Controls

Set up work zones; establish safe work practices, such as buddy system, proper communication and security; provide training and frequent information updates; use appropriate equipment; ensure medical monitoring.



The Principles of Green Chemistry

1. Create no waste

2. Use ingredients efficiently

3. Reduce toxicity

4. Green products have to work as well as non-green products

5. Eliminate all non-essential additives

6. Reduce energy usage

7. Use renewable materials

8. Eliminate as many steps as possible

9. Use a method to speed up a reaction

10. Use materials that break down in the environment (Biodegradable)

11. Check everything you do against the other principles

12. Put Safety first

Some Green Chemistry Questions

- Do they pose health hazards for exposed workers and community residents?
- Do they pollute the environment?
- How are the solvents produced?
- What is the feedstock/raw material? Is it renewable?
- Are any unwanted by-products produced?

Green Chemistry prompts us (chemists and workers) to ask questions that take into account efficiency, waste, and safety.

Precautionary Principles in Green Chemistry*

1. It is better to prevent waste than to treat or clean up waste after it is created. By preventing waste generation, we minimize hazards associated with waste storage, transportation, and treatment.

2. Synthetic methods should be designed to maximize the incorporation of all materials used in the process into the final product. Choosing transformations that incorporate most of the starting materials into the product is more efficient and minimizes waste.

3. Wherever practicable, synthetic methods should be designed to use and generate substances that possess little or no toxicity to human health and the environment. This principle focuses on choosing reagents that pose the least risk and generate only benign by-products.

4. Chemical products should be designed to preserve efficacy of function while minimizing their toxicity. New products can be designed in academic labs that are inherently safer, while highly effective for the target application.

5. The use of auxiliary substances (e.g., solvents, separation agents, etc.) should be made unnecessary wherever possible and safe when used. Reduction of solvent volume or complete elimination of the solvent is often possible. In cases where the solvent is needed, less hazardous replacements should be employed.

6. Energy requirements of chemical processes should be recognized for their environmental and economic impacts and should be minimized. If possible, synthetic methods should be conducted at ambient temperature and pressure.

7. A raw material or feedstock should be renewable rather than depleting whenever technically and economically practical. Examples of renewable feedstock include agricultural products or the wastes of other processes. Examples of depleting feedstock include raw materials that are mined or generated from fossil fuels (petroleum, natural gas, or coal).

8. Unnecessary by-products (use of extra chemicals that temporarily change or stops things, protection/deprotection, and temporary modification of physical/chemical processes) should be minimized or avoided if possible, because such steps require additional reagents and can generate waste.

9. Catalytic reagents (as selective as possible) are superior to stoichiometric (exchanging chemicals and a chemical reaction takes place) reagents. Catalysts can serve several roles during a transformation. They can make reaction happen faster without changing the final result; they reduce reagent-based waste; and reduce temperature of a transformation.

10. Chemical products should be designed so that at the end of their function they do not persist in the environment and break down into harmless degradation products. This principle focuses in the molecular design of chemicals.

11. It is always important to monitor the progress of a reaction to know when the reaction is complete or to detect the emergence of any unwanted by-products.

12. Substances and the form of a substance used in a chemical process should be chosen to minimize the potential for chemical accidents, including releases, explosions, and fires. Risks associated with these types of accidents can sometimes be reduced by altering the form (solid, liquid, or gas) or composition of the reagents.

Decoding Green Labels

Label	Who is behind it	What it means
usgbc.org/LEED	The US Green Building Council, a nonprofit group whose members are architects, contractors, and building professionals.	Homes or buildings that are LEED-certified are built or renovated according to benchmarks for energy efficiency, waste reduction, and other criteria. They're given a rating of certified, silver, gold, or platinum based on how many benchmarks are achieved. Note that building products and materials do not qualify for LEED certification, a common misconception.
fsc.org	The Forest Stewardship Council, a nonprofit group whose members include foresters, activists, and native peoples in countries where wood is harvested.	Auditors assess how a forest or mill is managed against quality standards set by FSC; if certified; wood can be sold with the FSC label. Using lumber that bears the label means forests were not harmed to make your ceilings joists or subflooring.
greenseal.org	Green Seal, a nonprofit group that brings together research institutions and experts from around the world to evaluate green products.	Green Seal – certified products, which include paints, floor stripers, windows, and doors, are audited against scientific standards to determine that they have less environmental impact than noncertified products. The group evaluates products across their entire life cycle, from raw material to manufacture, use, and disposal or recycling.
buildinggreen.com/menus	BuildingGreen, a company that publishes information about efficient building practices. Their publications carry no advertising and are not sponsored by industries and manufacturers.	The GreenSpec Guide for homes is a directory of products that have been evaluated against 26 environmental standards. Products fit into one of five broad categories, including those made with recycled content or that avoid toxic emissions. BuildingGreen aims for the directory to list the "top 5 to 10 percent of environmentally preferable products."
epa.gov/watersense	The Environmental Protection Agency, in partnership with retailers, manufacturers, utilities, and government agencies.	Fixtures and irrigation systems that carry the WaterSense label are about 20 percent more water-efficient than non labeled-products, while functioning as well as or better than them.

*Source: http://www.epa.gov/greenchemistry/pubs/principles.htm

Session 6 – 60min

Green Chemistry and Workers: What's in it for us?

Objectives

At the end of this session, participants will be able to:

- Identify various resources that can help workers and those interested in staying aware of green chemistry issues.
- Develop a plan for next steps to address chemical hazards using the green chemistry approach.

Background

Introduce the final session by reviewing the objectives and the following information:

Green chemistry strives to minimize the harmful effects of a chemical-based society. Integral to this effort is minimizing harmful exposure to workers *at every stage* of the product lifecycle, from the inception of chemical substances, to their use in manufacturing, to all forms of consumption, and disposal. "Benign by design" should refer to impact not just on consumers and the environment, but also to the workers who create and handle all chemicals directly and indirectly.

As environmental hazards are “designed out” of products, we have to ensure that worker health is not traded off. For example, a manufacturer could decide to remove Chemical X from a product to prevent children from ingesting it and instead replace it with Chemical Y, which is safer for children but has serious inhalation exposure risks for workers at the raw material/processing stage. Unless worker health is explicitly integrated into the green chemistry approach, we may inadvertently put workers at risk.

Green chemistry is not yet the default approach to production, but as resources dwindle, economies change, and awareness grows, it is becoming clearer that our current system is not sustainable. As we search for ways to preserve our environment and promote sustainability, workers will benefit from participating in this process. In fact, their involvement is crucial to ensuring that health and safety is a priority in innovation. Making green chemistry principles the norm in our society will not happen overnight as well as not including workers' health in the equation. Therefore, it depends on workers (unions, worker centers, non-profit organizations) to stay informed, voice their concerns, and take action so that the green chemistry initiative is a success at all levels: health, environment, and economy.

What Can Workers Do? . . .

Ask participants to brainstorm: What can you do as a worker, community member, union representative, health and safety committee member, etc.? (See headings below).

Post responses on labeled flipcharts. Possible responses could include:

At work?

- Investigate your workplace for chemical hazards. Identify recognized and possible hazards. Create or update inventory of substances.
- Research information on chemicals used in your industry. There are a number of strategies for investigating hazards – MSDS sheets, hazard mapping, worksite inspections. There will be chemicals for which sufficient hazard information does not exists, hence the need for better research, regulations, and systems. Identify gaps and report them. There may be safer known alternatives.
- Talk to your coworkers about green chemistry. Creating awareness around these is the first step in taking action. Host a discussion group or training (there are a number of curricula available about the basics). Focus training on the problem posed by chemicals, defining green chemistry, and how to start asking questions about potential hazards. (See Resource organizations below for assistance, such as the UC Berkeley Center on Green Chemistry) "Molecular Design Pyramid Questions").
- Make sure workers examine the toxicity of "green" products as much as they would conventional products. There is an abundance of "green-washing" in the market, so it is smart to question labels and dig deeper.
- Provide recommendations to protect all workers.
- Petition for use of safer products whenever available.
- Negotiate safer processes/products into contracts. Union-represented workers often have opportunities to bargain directly over health and safety issues. Chemical hazards could be highlighted and revisited as new products are introduced. Promote engineering controls whenever possible.

In the community?

- Encourage vocational training programs that integrate green chemistry applications. Upgrade skills to advance in a greener economy. Adjusting to safer, more sustainable practices can be way to increase workers' marketable skills.
- Pressure manufacturers to design out toxic chemicals to minimize impact to consumers, workers, local communities, and the environment

At the legislative level?

- Speak at green chemistry stakeholder meetings. State initiatives in California came to fruition as a result of multi-stakeholder interests. Workers can be powerful advocates for legislative progress in chemicals policy.
- Advocate for better data collection on occupational exposures.
- Talk to your representative about green chemistry related issues in your community.

- Write a letter to the Department of Toxic Substance Control from your perspective as a worker, union member, and community member about the impact of chemicals in your life.
- Push for stronger enforcement of laws that protect workers from exposure.
- Push agencies/policymakers to respond quickly if there is emerging data that a chemical or product harms worker. In the face of incomplete information, agencies should act according to the precautionary principle.

At the economic level?

- Pressure employers to create a demand for green products by actively seeking out and purchasing products that are safe for all.
- Provide tax incentives to green businesses.

As consumers?

- Purchase less toxic or non toxic products whenever possible.
- Share information on chemical hazards and the green chemistry initiative with family members and friends.
- Follow changes in the legislation to stay informed and make appropriate decisions.

<u>Resources</u>

Review this list of resources with participants.

The following resources can help you stay aware of green chemistry issues:

- **CHANGE Coalition (Californians for a Healthy & Green Economy) -** A growing coalition of environmental health, policy, labor, environmental justice, interfaith, and other organizations who are working to create a better system for regulating toxic chemicals in California. http://changecalifornia.org
- **Safer Chemicals, Healthy Families –** A national campaign calling for stronger federal standards on toxic chemicals. http://www.saferchemicals.org/
- **Coming Clean Network -** A network of organizations working on various issues who share the goal of cleaning up toxic chemicals and moving toward safer alternatives. http://www.chemicalbodyburden.org
- **Beyond Benign -** A non-profit organization that promotes sustainable science in order to create an environmentally, socially and economically prosperous world. Driven by the 12 Principles of Green Chemistry, a universal sustainable approach to any science; we creates tools, opportunities and partnerships to support the implementation of community involvement initiatives, workplace training, cooperative programs and K-12 education resources. http://www.beyondbenign.org/greenchemistry/greenchem.html

- **USW Tony Mazzochi Center -** A consortium between the United Steelworkers Health, Safety & Environment Department and the Labor Institute to provide health, safety & environment education to USW members. The goal is to prevent work-related harm. USW-TMC programs are supported by grants from the NIEHS, DOE, and OSHA. - http://www.usw.org/resources/hse/page?type=hse_mazzocchi&id=0001
- **Environmentally Preferable Purchasing (EPP)** helps the federal government "buy green," and in doing so, uses the federal government's enormous buying power to stimulate market demand for green products and services. http://www.epa.gov/epp/index.htm
    - **EPP issues for the State of California**: www.green.ca.gov/EPP/
- **Green Seal -** A non-profit, third-party certifier and standards development body. It is an ecolabeling organization. A Green Seal Certification Mark on a product indicates that it has purportedly undergone a process to show that it has less impact on the environment and human health. This website offers a search tool for "greener" products. [1] http://www.greenseal.org/
- **SF Approved List of Green Products & Services**

  The San Francisco Department of the Environment maintains a list of "SF Approved" products that have been screened for their environmental benefits, cost, reduced toxicity, and performance. Purchases, whether direct or through a service contract that fall under certain designated categories must be selected from the appropriate "SF Approved" list. http://www.sfenvironment.org/our_programs/interests.html?ssi=9&ti=22&ii=154
- **The UC Berkeley Center for Green Chemistry –** A campus-wide effort involving the School of Public Health, the College of Chemistry, the College of Natural Resources, the Lawrence Berkeley National Lab, the Haas School of Business, and the School of Law. http://bie.berkeley.edu/greenchem

<u>Next Steps</u>

- Develop a plan for personal next steps to address chemical hazards using the green chemistry approach. Distribute worksheet "Next Steps for Green Chemistry"
- Ask participants to answer the worksheet questions and to keep these following points in mind:

    1. Decide on your goal. Identify the problem(s) you want to address, think about all the possible solutions, and decide what changes would be best.

[1] This is not an endorsement of Green Seal. It is included here as a possible source of information on green products.

2. Figure out what supports are in place that will help you reach your goal and what obstacles exist that could make achieving your goal difficult. How can you build on your support and decrease your obstacles?

3. Determine what information you need to help you reach your goal. Figure out where and how you will get this information.

4. List the specific steps you will need to take to reach your goal. Decide how long each step will take and who needs to be involved in each step.

5. Decide who you need to talk with to make your plan work and what specific approach will work with them. Practice in advance what you will say. Who else do you need to approach to get buy-in and support

Worksheet Questions:
- What is my goal?
- What will help me?
- What are some obstacles I may face?
- What is the information I need?
- What are the specific steps I will take (timeline)

Debrief and Conclusion

- Have participants share their ideas for next steps. See of there are any questions or feedback on plans.

Summarize main points:

- Green chemistry strives to minimize the harmful effects of a chemical-based society. Integral to this effort is minimizing harmful exposure to workers *at every stage* of the product lifecycle.
- As environmental hazards are "designed out" of products, we have to ensure that worker health is not traded off.
- Unless worker health is explicitly integrated into the green chemistry approach, we may inadvertently put workers at risk.
- Making green chemistry principles the norm in our society will not happen overnight, and depend on workers (unions, worker centers, non-profit organizations) staying informed, voicing their concerns, and taking action.

Session Materials

- Power Point Presentation
- "Next Steps" Worksheet
- Green Chemistry Resources Handout

Green Chemistry and Workers: What's in it for us?

Name: ______________________________ **Employer:** ______________________________

Job Title: ______________________________ **Years of Experience:** ____________________

What is my goal?	What will help me?	What are some obstacles I may face?	What is the information I need?	What are the specific steps I will take (timeline)

Handout

RESOURCES

- **Coalition for Clean Air -** is committed to restoring clean, healthy air to all of California and strengthening the environmental movement by promoting broad-based community involvement, advocating responsible public policy and providing technical expertise. http://www.coalitionforcleanair.org
- **CHANGE Coalition (Californians for a Healthy & Green Economy)** - A growing coalition of environmental health, policy, labor, environmental justice, interfaith, and other organizations who are working to create a better system for regulating toxic chemicals in California. http://changecalifornia.org
- **Safer Chemicals, Healthy Families – A** national campaign calling for stronger federal standards on toxic chemicals. http://www.saferchemicals.org/
- **Coming Clean Network -** A network of organizations working on various issues who share the goal of cleaning up toxic chemicals and moving toward safer alternatives. http://www.chemicalbodyburden.org
- **Beyond Benign -** A non-profit organization that promotes sustainable science in order to create an environmentally, socially and economically prosperous world. http://www.beyondbenign.org/greenchemistry/greenchem.html
- **USW Tony Mazzochi Center -** A consortium between the United Steelworkers Health, Safety & Environment Department and the Labor Institute to provide health, safety & environment education to USW members. The goal is to prevent work-related harm. http://www.usw.org/resources/hse/page?type=hse_mazzocchi&id=0001
- **Environmentally Preferable Purchasing (EPP)** helps the federal government "buy green," and in doing so, uses the federal government's enormous buying power to stimulate market demand for green products and services. http://www.epa.gov/epp/index.htm
    - **EPP issues for the State of California:** www.green.ca.gov/EPP/
- **Green Seal -** A non-profit, third-party certifier and standards development body. It is an eco-labeling organization. A Green Seal Certification Mark on a product indicates that it has purportedly undergone a process to show that it has less impact on the environment and human health. This website offers a search tool for "greener" products. [1] http://www.greenseal.org
- **SF Approved List of Green Products & Services**

  The San Francisco Department of the Environment maintains a list of "SF Approved" products that have been screened for their environmental benefits, cost, reduced toxicity, and performance.

  http://www.sfenvironment.org/our_programs/interests.html?ssi=9&ti=22&ii=154
- **The UC Berkeley Center for Green Chemistry –** A campus-wide effort involving the School of Public Health, the College of Chemistry, the College of Natural Resources, the Lawrence Berkeley National Lab, the Haas School of Business, and the School of Law. http://bie.berkeley.edu/greenchem
- **The UCLA Law and Environmental Health Sustainable Technology & Policy Program** - The Program aims to clear the path for effective, balanced chemical policies, and to assist in the use of safer chemicals and alternative manufacturing processes in the marketplace. http://www.ioe.ucla.edu/reportcard/article.asp?parentid=5726

[1] This is not an endorsement of Green Seal. It is included here as a possible source of information on green products.

This is a project if the Western Region Universities Consortium (WRUC), which provides health and safety training to workers engaged in activities related to hazardous materials, hazardous waste, and/or emergency response. Since 1987, WRUC has been a trusted provider of English –and Spanish- language training throughout the Western United States.

The Consortium consists of five university-based programs. LOSH is the lead organization that receives funds from the National Institute of Environmental Health Sciences (NIEHS) for the collaboration:

- UC Los Angeles Labor Occupational Safety and Health Program
  http:// losh.ucla.edu/index.html

- UC Berkeley Labor Occupational Health Program
  http://www.lohp.org

- UC Davis Extension
  http://extension.ucdavis.edu/unit/environmental_health_and_safety/

- Arizona State University
  http://www.poly.asu.edu/seminars

- University of Washington
  http://depts.washington.edu/ehce/NWcenter/index.html

- National Institute of Environmental Health Sciences (NIEHS)
  http://www.niehs.nih.gov/health/topics/exposure/haz-waste/index.cfm