



Persistent Bioaccumulative Toxicants (PBT)

Facilitator Guide

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Midwest Consortium for Hazardous Waste Worker Training

Acknowledgments

The Midwest Consortium developed this material under cooperative agreement number U45 ES06184 from the National Institute of Environmental Health Sciences.

We encourage you to comment on these materials. Please give any comments to your Program Director.

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The material was prepared for use by experienced instructors in the training of persons who want information about chemicals released into their environment. Users are cautioned that the subject is constantly evolving. Therefore, the material may require additions, deletions, or modifications to incorporate the effects of that evolution occurring after the date of this material preparation.

Content was updated June 26, 2023. All web links are active as of March 2018; if you find an error, please inform the facilitator so that it can be updated.

Disclaimer

This training is intended raise awareness of residents and workers to chemicals from workplaces and other uses that may pose a health risk, consistent with the OSHA Hazardous Waste Operations and Emergency Response (HAZWOPER). The program covers sources of exposure in your community and methods to use to find more information and reduce exposures in your home or workplace and those of neighbors and coworkers. It does not provide the necessary hazard recognition and protective skills required to work in hazardous waste remediation or emergency response or perform emergency response activities. To undertake any of these activities, additional training is necessary. For further information about this matter, consult the training facilitator.

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Facilitator Overview Guidance

Introduction

This program is designed for community members who are concerned about the quality of their environment and how its quality affects their health and the health of their family and community. The topic is PBT chemicals: Persistent in the environment for long periods of time, Bioaccumulate in the food chain and posing Toxic risks to human health and ecosystems.

Suggested Agenda

Welcome and Introduction	15 minutes
How chemicals enter, change ...	20 minutes
PBTs—What are They?	20 minutes
Are People in Your Community Exposed?	60 minutes
Break	20 minutes
Health effects of PBTs	30 minutes
Strategies for Reducing Exposure	60 minutes
Closing	15 minutes

Lesson Plan Form 1

<p>Teaching Methods for This Lesson Plan</p>	<p>Audiovisual Requirements</p>
<p> <input type="checkbox"/> Presentation <input type="checkbox"/> Discussion <input type="checkbox"/> Question and answer <input type="checkbox"/> Hands-on simulation <input type="checkbox"/> Team teaching <input type="checkbox"/> Small-group exercises <input type="checkbox"/> Case study <input type="checkbox"/> Other (describe): </p>	<p> <input type="checkbox"/> Training handbook <input type="checkbox"/> Supplemental handbook material <input type="checkbox"/> Websites: <input type="checkbox"/> Whiteboard <input type="checkbox"/> Hands-on simulation <input type="checkbox"/> Other (describe): </p>
<p>Reference Materials</p>	<p>Special Space or Facility Requirements</p>
	<p>(List any room size or special facility regulations here, such as set-up areas, equipment storage concerns, etc.)</p>
<p>Suggested Discussion Questions</p>	<p>Suggested Instructor Preparation</p>

Lesson Plan Form 2

Subject Area or Element	Detail	Reference Number or Citation
Major subject heading or Roman numeral item from outline format.	Detailed breakdown of subject area or element. This area will necessarily occupy more space than the column to the left.	e.g., page number in training notebook, section number of regulation, or audiovisual material.

Presentation Notes

Discussion

- Work in small groups. If the discussion group is large, divide it into smaller units.
- Encourage participants to talk with one another, rather than you.
- Use an icebreaker - ask a question for which there is no single correct answer and go around the table with it. (Example: On a scale of 1 to 10, what is the most serious environmental exposure that concerns you?) With this strategy, you can begin the discussion with 100 percent participation, and you can avoid the awkward need to invite the more passive students to participate.
- Know your audience. Learners are not hazardous workers and may have limited knowledge of chemistry and biology. Tailor agenda to match background and meet needs.
- Show the respect the participants deserve – Community residents generally have a wealth of experience, honor that knowledge, and allow them to voice their opinions freely and without judgement.
- Use the participant's experiences as a basis from which to teach
- Limit use of PowerPoint slides to complex figures from the Participant Guide
- Make use of NIEHS and other web resources, as appropriate
- Adjust teaching speed – be conscientious of the rate the material is presented and stay within the program time schedule. Participants will expect to leave on time; if some wish to stay for further discussion, it should be done after the published time.
- The attention of participants will drift if there are long periods of lecture or reading from PowerPoint. Try to get the participants engaged in the discussion by asking leading questions, for example, ask: 'What is a toxic chemical?'. Follow up with whether all toxic chemicals are man-made (synthetic) and lead the participants to define PBT.

- An interactive alternative to PowerPoint is to say: ‘Turn to page xx and discuss what you learn from the figure at the bottom of the page.’.

Suggested Facilitator Preparation

- Review Participant Guide, Exercises, and on-line resources
- Test web links prior to the session and if any are inoperative please notify the Midwest Consortium at hilbertj@ucmail.uc.edu
- Review the agenda to assure that it matches the needs expected; if this is open-enrollment, be prepared to move away from the agenda, as needed to respond to local, diverse issues. Do not hesitate to respond ‘I don’t know’—this is better than offering information that may be incorrect or incomplete.
- Download the evaluation forms
- Review this EPA webinar https://www.epa.gov/sites/production/files/2017-09/documents/pbt_public_webinar_-_9-5-17.pdf
- Review any PowerPoint slides to be certain they are accurate and up-to-date
- Review Green Exercise Participant and Facilitator Guides here: <https://mwc.umn.edu>
- Successful completion of the program is defined as ‘Attendance’. Assure that you have a sign in sheet to document attendance for the program file.
- Prepare certificates if you award them at the end of the program.

Welcome and Introduction

Time Requirement: 15 minutes

Number of Instructors: 1 for up to 24 participants

Materials

- Registration materials
- Participant Guide
- Whiteboard or equivalent; marker
- Internet access

Objectives

When finished with the program, participants should better be able to:

- Recognize PBT chemicals and access the Priority PBT list
- Describe how PBT chemicals spread throughout the environment and enter the food chain
- Determine if PBT exposure sources are in your community
- Select strategies to reduce exposure

These are the overall program objectives. The second objective above is part of this Welcome and Introduction. Others are in sections that follow.

Teaching Methods

Discussion

Suggested Facilitator Preparation

- Assure that you have registration materials for everyone
- Print evaluation forms, so that they are ready at the end of the program
- Review agenda and modify as needed for the expected needs or interests of participants
- Prepare copies of agenda, if a handout is to be used; otherwise post.

Minimum Content Requirements

- Introductions
- Agenda and overall learning objectives

Questions you may be asked

1. Where can I look up words that I don't recognize?

Refer participants to the EPA website <https://www.epa.gov/toxics-release-inventory-tri-program/persistent-bioaccumulative-toxic-pbt-chemicals-rules-under-tri>. Many participants will be familiar with using Google to find definitions.

2. I have heard about fish advisories. Are these related to PBTs?

'Yes'. If fish advisories are included in the agenda, put the topic on a running list of 'parking lot' items that you will address as the program goes forward. If it has not been included in the agenda, refer participants to the first page of Strategies for Reducing Exposure in the Participant Guide, explaining that there is more information than can be covered, but that it is included as a resource; offer to discuss after the program ends.

3. Besides mercury, does any other compound accumulate in food?

Food and food-chain may be interpreted differently. Pesticides accumulate on/in food. Pesticides also can accumulate in the food chain. A classic example is DDT and birds.

Ask if anyone has read 'Silent Spring'.

DDT was used widely as a pesticide applied by airplane, land-based mobile spraying, hand-held sprayers at home. Accumulation in soil and water resulted in uptake by worms and aquatic plants and animals that were the foodstuffs of birds. Eventually, a relation was made between DDT and decline in bird hatching—the DDT resulted in changes in calcium metabolism and thin shells in the eggs laid. The shells were too thin to protect the incubating bird resulting in few offspring. Declines were remedied when DDT was banned, after publication of ‘Silent Spring’.

Presentation of the Session

This session can be presented as follows:

- Welcome everyone and facilitate brief introductions
- Complete registration, as needed
- Note that a program evaluation will be conducted at the end of the training
- Review the agenda and overall learning objectives

Turn to the PBT definition and review

Ask: why are these characteristics important as you think about exposures throughout your lifetime?

Persistent—does not go away

Accumulate—in living systems (bio), from small plants and animals in water or soil to humans (many will know that lead is stored in teeth and bones)

Toxic—causes harm to humans, and perhaps ecosystems

Ask: Are these learning objectives what you expected? Need?

List feedback. Identify topics that will be covered, and where there is not a match, provide guidance on where to find information on those topics not included in your agenda. Is there another program that would help the participants obtain the knowledge and skills that are sought?

Turn to the groups of chemicals table in the Participant Guide

Ask: what do you all think of the numbers of chemicals in commerce?

Turn to the Participant Guide page showing 'Wide range of Exposures'.

Ask: What potential hazards are represented by each figure?

Write the responses on a white board or easel paper, where all can see.

How Chemicals Enter, Change, and Move throughout the Environment - part 2 of the Introduction

One of the features of these chemical compounds is movement through the environment. In this part of the Introduction, there is a brief review of how chemicals enter, change and move through the environment, eventually impacting people.

Objective

After completion, participants should be able to:

- Explain how chemicals enter, change and move throughout the environment

Materials

- Participant Guide
- Whiteboard or equivalent; marker

Teaching Methods

- Discussion

Suggested Instructor Preparation

Review Participant Guide, exercises and resources

Minimum Content Requirements

- Illustrate how chemicals enter, change and move throughout the environment

Questions You May Be Asked

1. Where can I find more information that is accurate and reliable?

It is best to use multiple resources and compare them. Government (federal and state) websites are generally reviewed by others, so that the information is correct. The information generally has been documented, that is, reflects work by more than one group so has been duplicated and that helps assure accuracy. There is a list of resources in the Participant Guide.

2. Can we trust government websites?

The National Institutes of Health, like the National Cancer Institute and National Institute of Environmental Health Sciences are trusted resources. Recently, some government agencies have removed content on some science subjects, but by comparing what is found across several agencies, the absence of information on one site does not affect what you find on other government sites. For example, EPA no longer supports the PBT Profiler, but has other tools that can be used to inform Persistence (P), Bioaccumulation (B) and Toxicity (T) assessments. See [Predictive Models and Tools for Assessing Chemicals under the Toxic Substances Control Act \(TSCA\)](#).

Presentation of the Session

Discuss fate and transport of PBTs via air, water and soil. Many members of the community are interested in heavy metal contaminants in the community. This is an important issue for Environmental Justice as many of the hazardous waste sites are placed in underserved communities.

This session can be presented as follows:

Turn to the page with the figure of the industrial facility, tree, drum and fish to frame a discussion of source and transport.

Ask: What does each figure represent regarding source and transport of a chemical in the environment?

Turn to the page with Living Systems and PBTs. Ask participants to look at the numbers while noting that these are one example of bioaccumulation up the food chain, with birds at the top.

Ask: can you think of a situation where the birds are not the final link in the chain?

Examples, birds used for food by people or animals

Turn to the page with the figure of bioaccumulation.

Ask: What do you take home as message from this figure?

Define: Biomagnification is illustrated in the figure. Higher concentration in higher levels of the food chain, as by closeness of the dots in the boxes in each higher level.

Compare: bioaccumulation and biomagnification.

Biomagnification is the concentration of PBTs in an organism after it ingests other plants or animals in which the PBTs are more widely distributed. (concentration increases)

Bioaccumulation is the increase of a PBT in various tissues of an organism. Bioaccumulation takes place within the organism when the rate of intake is greater than the rate of excretion or metabolic transformation of that substance (stored).

Additional notes:

Water pollution of PBTs occurs by runoff from contaminated soils, deposition from the air, releases by man-made operations into the water, and deposition onto the soil to contaminate groundwater. Chemicals and microorganisms in the water can chemically change pollutants in the water.

Many pollutants come from us as consumers. A good example of this is the chemical Triclosan, which has been a widely used antibacterial agent in consumer products. In the natural environment, Triclosan can be converted to forms of dioxin. This is an example of a chemical that is not a PBT, being converted to one in the environment.

<https://www.sciencenews.org/blog/science-public/new-source-dioxins-clean-hands>

In addition, Triclosan itself has toxic actions on animals and possibly in humans.

<http://articles.mercola.com/sites/articles/archive/2012/08/29/triclosan-in-personal-care-products.aspx>

The United States Food and Drug Administration banned antimicrobial soaps, including Triclosan on September 2, 2016

<https://www.fda.gov/NewsEvents/Newsroom/PressAnnouncements/ucm517478.htm>

<https://www.npr.org/sections/health-shots/2016/09/02/492394717/fda-bans-19-chemicals-used-in-antibacterial-soaps>

Air and PBTs

A reliable web resource, which is relatively generic is:

<https://www.pca.state.mn.us/air/air-pollutants-and-sources>

NIEHS provides background on Air Pollution at:

<https://www.niehs.nih.gov/health/topics/agents/air-pollution/index.cfm>

Soil and PBTs

Pollution of the soil by PBTs occurs by improper disposal of waste chemicals, spills, deposition from the air and water, or through application of pesticides.

Heavy Metals

There are many resources for heavy metals and their actions on the ATSDR (Agency for Toxic Substance and Disease Registry) website: <https://www.atsdr.cdc.gov/> is an excellent resource. In this section. Because of the prevalence, relative toxicity, and the disproportionate exposure impact on poor and undeserved communities, it is important to describe the relative toxicity and health impacts from these four toxic heavy metals: arsenic, cadmium, lead, and mercury. Aside from generalized description of toxicity in a community, use the Flint Michigan case of environmental lead exposure to illustrate a case of Environmental inJustice following cost-saving measures that resulted in exposure to children through change in the water supply. A resource on Flint Michigan and lead from the NIEHS is:

<https://www.niehs.nih.gov/health/topics/agents/lead/index.cfm>

The table below is from link above

Blood Lead Level	Health Effects
<5 µg/dL	Children: Decreased academic achievement, decreased IQ, decreases in specific cognitive measures, increased incidence of attention related behaviors and problem behaviors Adults: Decreased kidney function, maternal blood lead associated with reduced fetal growth
>5 µg/dL	Children: Delayed puberty, reduced post-natal growth, decreased IQ and hearing loss Adults: Increased blood pressure, increased risk of hypertension, and increased incidence of essential tremor

NIEHS Lead fact sheet summarizes health effects of lead:

https://www.niehs.nih.gov/health/materials/lead_and_your_health_508.pdf

https://ntp.niehs.nih.gov/ntp/ohat/lead/final/monographhealtheffects/lowlevellead_newissn_508.pdf

Summary

PBTs defined

Chemicals enter the environment

Chemicals may be transported in soil, air, water, fish/mammals

Chemicals can be transformed in the environment

Exposure can occur through soil, air, water, food

What are PBTs?

PBTs is a category of chemicals identified by the US Environmental Protection Agency (EPA) as **P**ersistent, **B**ioaccumulative and **T**oxic. Other chemicals may have these three properties but have not been included in the EPA list - yet.

Objectives

After completion, participants should be able to:

- Recognize PBTs
- Access the EPA PBT website
- Identify classes of PBTs

Materials

Participant Guide
Exercise answers (below)

Teaching Methods

- Discussion
- Small group exercise

Suggested Instructor Preparation

Review Participant Guide and exercise
Review related websites:

<https://www.epa.gov/toxics-release-inventory-tri-program/persistent-bioaccumulative-toxic-pbt-chemicals-rules-under-tri>

<https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/persistent-bioaccumulative-and-toxic-pbt-chemicals-under> (see 2017 webinar on PBTs)

Review answers to exercise (below)

Minimum Content Requirements

- Discussion about chemicals and PBTs
- Small group Exercise

Questions You May Be Asked

1. How often are new chemicals added to the list?

See: <https://www.epa.gov/toxics-release-inventory-tri-program/persistent-bioaccumulative-toxic-pbt-chemicals-covered-tri> for listing of the 16 PBT chemicals and 5 PBT chemical compound categories that are subject to Toxics Release Inventory (TRI) reporting under Section 313 of the Emergency Planning and Community Right-to-Know Act (EPCRA). A list showing when each chemical was added to the Toxic Release Inventory (that includes PBTs) is shown here:

https://www.epa.gov/sites/production/files/2016-11/documents/tri_chemical_list_changes_11_28_16_0.pdf. It apparently has not been updated since 2016.

2. What is EPA doing about PBT exposure.

Reduction in exposures is under study and EPA must put forward proposals by June 2019.

Presentation of the Session

This session can be presented as follows:

Ask participants to turn to the page of the Participant Guide that shows the EPA list of chemicals and categories of compounds.

Ask: Which ones on the list are familiar to you?

Tick them off on a list all can see.

Access the EPA PBT website: <https://www.epa.gov/toxics-release-inventory-tri-program/persistent-bioaccumulative-toxic-pbt-chemicals-rules-under-tri>.

Turn to the page that shows PBT/Source/Uses.

Ask: Do you have any of these sources in your neighborhood?

Refer to the list of hazards made and posted earlier. Be prepared to relate the PBTs to that list. For example, someone may have listed pesticides as a possible hazard on food. Note that some of the PBTs are pesticides.

Ask: Can any of these PBTs be grouped because they have similar use or are similar in another way?

List groups that are identified by participants.

Go over any additional terms used as categories or classes of chemicals:

For example, ask participants to explain

Synthetic (man-made)

Organic (contains carbon in the chemical structure)

Naturally-occurring (an element such as lead or 'existing in nature' such as PAHs as products of combustion)

Note: pesticides are synthetic organic compounds

Ask: Does anyone have old pesticides stored that might be banned PBTs, such as DDT?

Exercise: Matching/Completion

Time Requirement: 10 Minutes

Number of Instructors: 1

Materials: Participant Guide

Objective: Identify important facts about environmental PBTs

Ask participants to work together in small groups to complete the table in the Participant Guide. The correct answers are shown below:

PBT	Uses	Sources	Class
Mercury	Electronics	Batteries, switches, Fluorescent, and CFL, Light bulbs	Metals
Polychlorinated biphenyls (PCBs)	Dielectric fluid for transformers	Waste sites, old transformers	Synthetic organic compound
DDT	Pesticide banned in 1972	Hazardous waste sites	Synthetic organic compound
Tetraethyl lead	Fuel additive	Gasoline (although phased out of automobile use, it is present in some fuels)	Synthetic organic compound
Benzo(a)Pyrene and other poly aromatic compounds (PAHs)	None	Combustion	Naturally occurring Organic compound

Review the answers during a report back.

Summary

16 PBT chemicals

4 PBT categories

Sources are everywhere; widely dispersed in the environment

Are People in your Community Exposed to PBTs?

Most PBTs are emitted from worksites. Some of the chemicals no longer available for purchase like DDT may be stored in garages or uncovered in dump sites. In this section participants will identify sources in the community.

Objectives

When completed, participants will be better able to:

- Identify sources of PBTs in their community
- Describe how people may be exposed

Materials

- Participant Guide
- Whiteboard or equivalent; marker
- Internet access

Teaching Methods

- Small group exercises
- Discussion

Suggested Instructor Preparation

Review Participant Guide, exercises, and resources

Are people in your Community exposed to PBTs?

Prepare map of the area, or assure access to electronic map
Draft expected exposure sources and PBTs by chemical or chemical class
Identify state-specific resources (example: MN 'What's in Your Neighborhood?')

Minimum Content Requirements

- Discussion about sources of PBTs
- Exercises
- Introduction of resources for additional information

Questions You May Be Asked

1. How do I avoid exposure to PBTs?

This is a question that can be put in the 'parking lot'. Note that one of the exercises will be to develop a plan to avoid/reduce potential exposure.

Other information can be found here: <https://www.epa.gov/toxics-release-inventory-tri-program/what-you-can-do>.

Presentation of the Session

This session can be presented as follows:

Ask: From the list of PBTs, which ones do you think may be exposures in your community or around your home or garage?

Make a list of responses; post where all can see.

Exercise: Access a Map of your Community

Time Requirement: 15 minutes

Number of Instructors: 1

Materials

- Participant Guide
- Internet connection for an electronic map
- Google Maps
- Google Earth, <https://www.google.com/earth/desktop/>
- Use EPA mapping tools, as needed to identify locations of the above types of sources. See <http://www.epa.gov/myenvironment/>. If you have not used this website, see <http://mwc.umn.edu> and complete the My Environment by Zip Code exercise near the bottom of the page, under Community Programs.

NOTE If you are training in Minnesota: The Minnesota Pollution Control Agency provides a tool, “What’s in My Neighborhood”

<https://www.pca.state.mn.us/data/whats-my-neighborhood> to access a variety of neighborhood information. A map search may be done by location, Name of Business, City, County, Watershed or Zip Code, Street Address Township / Range.

A short YouTube video on how to use this application is located at:

https://www.youtube.com/watch?v=li7iYAlxZ_A&list=PLC474AD5BB1E42158

View the video to prepare for this exercise.

If an interactive electronic map will not be possible, save an image for display or provide a print copy of a map

Exercise: Match PBTs to Exposure Sources

Objective: Identify exposure sources of PBTs by class.

Time required 30 Min.

Number of Instructors 1

Materials: Participant Guide, worksheet in the manual

Map of the community (electronic or hard copy)

Colored markers or crayons

Refer to the listing of sources made by participants, above.

Have the participants work in small groups to complete the Table in the Participant Guide, then mark locations of sources on the map.

PBT	Exposure Sources
Example: Mercury	Hospital, schools Fish Dump site Industrial pressure gauges

After identifying PBTs or classes of PBTs to which participants may be exposed, ask them to mark each on the group map, using different colors for easier reading; include a color key to assist others in understanding your markings.

Facilitate a report back, with each group sharing what has been identified.

Exercise: More information needed

Time required: 20 min
No. of Instructors: 1
Materials: Participant Guide

Continue working in small groups

Ask: Is the table complete, or are there other possible sources for which you need more information?

Ask the group to record questions you need to answer to make the table of sources more complete. Have the groups brainstorm how to find the answers.

Internet: Where would you look? What search words would you use?

Suggest sources, state, local health departments or environmental protection groups. Federal sites such as the National Institute of Environmental Health Science (NIEHS), <https://www.niehs.nih.gov>

Environmental Protection Agency (EPA), <https://www.epa.gov>

Centers for Disease Control (CDC), <https://www.cdc.gov>

Observations around the community: For what would you look?

Suggest what the participants should be observant of, such as cans of paint, solvents, gasoline, pesticides in basements or garages; piles of refuse; trash left in yards.

Ask questions: Whom would you ask?

Summary

Potential sources can be identified using MyNeighborhood and knowledge of community

For some PBTs, home storage may be an exposure source (DDT)

Resources are available to obtain additional information

Health Effects of PBTs

The level of information discussed will depend on the knowledge of the facilitator and the background of participants. Do not attempt to cover topics that you have low confidence in (example: genetics and mutations). If participants want this level of knowledge, facilitate a search for resources. Providing a resource rather than incorrect or incomplete information is always best; or put the question in the 'parking lot' and get contact information. Seek a response from others in the MWC and then forward it to the participant.

Objectives

After completion, participants should be able to:

- Describe the types of health effects that may occur from exposure
- Describe how the body can react to PBTs
- Provide reasons the health of children is at greater risk from exposure compared with adults

Materials

- Participant Guide
- Whiteboard or equivalent; marker

Teaching Methods

- Presentation
- Discussion
- Group Activity

Suggested Instructor Preparation

Review Participant Guide and on-line resources
Prepare answers to Exercise

Minimum Content Requirements

Introduce terms and concepts related to potential health effects of PBTs such as:

- Routes of exposure—skin/eye contact, ingestion, inhalation, injection)
- Absorption, storage, excretion
- Metabolism, biotransformation

Questions You May Be Asked

1. How will PBTs affect my health and the health of my family?

Ask participants: What factors could impact the answer to this?

Age, level of exposure, other exposures, other health conditions,
genetics....

See <https://www.atsdr.cdc.gov/ToxProfiles/index.asp> and other resources included in the Facilitator Guide.

Presentation of the Session

This session can be presented as follows:

Turn to the figure showing PBT exposure→Health Effects.

Ask: What is illustrated?

Summarize that it shows exposure can occur at any age, work or at play.

Review the routes of entry by pointing to each in the illustration of 'How do PBTs Enter the Body?' in the Participant Guide.

Ask: What is the route of entry for (go through the list of PBTs).

Summarize that some have multiple routes of entry (example, a pesticide could be air (applicator), water (contaminated system from run off), skin (applicator), ingestion (applicator, consumers), injection (applicator). Note: the illustration is a hypodermic needle; exposure by this route may also occur when working or playing with a hose containing liquid that has enough pressure to puncture the skin.

Ask: How do PBTs get to other parts of the body, after initial entry?

A chemical is transported in the blood through the circulatory system to all parts of the body, where there may be a toxic effect; where the effect occurs is called the site of action.

Introduce the change in chemicals after entry by asking participants to look at the figure about PBT → Chemical Metabolism.

Once in the body, chemical reactions may occur; PBTs may be biotransformed to a more toxic or a less toxic form.

Some of the original chemical may also be excreted or stored.

Depending on the background of participants, review the schema for metabolism of Benzo(a)pyrene shown in the Participant Guide.

Turn to the page showing several effects.

Ask: What are effects of exposure?

Show the complexity of gene-environment interaction.

Use the figure from the Participant Guide to illustrate these actions.

Ask: When do effects of exposure occur?

Turn to the page in the Participant Guide on acute and chronic—'When Will Effects Appear?'

Example: PCB is irritating to the skin or eyes when the exposure is acute (route of entry review: skin/eye contact)

Example: chronic exposure to PCBs may alter liver function

Ask: Where do these effects occur?

Reference "Where will Effects Appear?" in the Participant Guide.

Skin= local

Liver=systemic

Ask: for the PCB effects discussed above as acute and chronic, which are local and which are systemic?

It is frequently noted that children are not just small versions of adults. Discuss why children are at greater risk than adults by turning to the figures in the Participant Guide.

Ask: What do you notice in these three figures?

Water and food intake vary by age

Food patterns change with age (note apples!)

NOTE: amount of air inhaled, adjusted for body weight, also changes with age

Turn to the page on endocrine disruptors - chemicals that interfere with hormones (the endocrine system)

Ask: Which ones are PBTs?

Discuss endocrine disruptors and how we may be exposed via plastics, pesticides through air or water.

Exercise: Health Effects Review

Time required:	10 min
No. of Instructors:	1
Materials:	Participant Guide

Work as a group to complete the exercise.

Summary

- Chemicals may be transformed after entry into the body, stored or excreted
- Health effects vary and may not occur for many years
- Children are not just small adults
- PBTs that are endocrine disruptors alter hormone production

Notes for other topics for discussion, as time allows and there is knowledge and interest:

NIEHS provides many resources on the health effects of environmental agents. See Resources section at the end of this Guide

Discuss concepts of Life-Cycle Risk Assessment; ask participants to list PBT-caused diseases. You are likely to hear, Lead Poisoning, Cancers, lung diseases such as Asthma, COPD, Autism, ADHD, Obesity, Diabetes, Heart Disease, endocrine disruption.

Ask: ‘Think about all the things you are exposed to during the day, in the past week, since you were born. Do you think all of these could have an impact on your current health? Or is your current health related to exposures during the past few days?’

Discuss the concept of the exposome as the totality of human environmental (i.e. non-genetic) exposures from before conception throughout the life cycle. While current health status is based on all of the previous exposures, some of them may not have resulted in a change of health. For example, a person who has been exposed to air pollution for 30 years may not develop asthma during those 30 years, but several years

later. This is similar to the development of an allergy to nuts after 40 years of eating nuts.

An important concept to convey is that exposure to PBTs *in utero* is important in determining health outcomes. PBT exposure is responsible for many health effects.

These can include diseases such as cancers of various kinds, birth defects, obesity, heart disease, diabetes, or learning deficits, such as ADHD, or can program an infant in the womb to present with a disease later in life. This is called Developmental Origins of Adult Health and Disease (DOHaD).

https://www.niehs.nih.gov/research/programs/geh/geh_newsletter/2014/12/articles/dohad_addressing_determinants_of_health_through_the_life_course_around_the_world.cfm

The question is: How does this happen? Explain the differences between mutation and epigenetic expression of genes after exposure to PBTs,

<https://www.niehs.nih.gov/health/topics/science/epigenetics/index.cfm>

Discuss Environmental Exposure Assessment, the part of environmental health science that focuses on the interaction of PBTs and the living organisms. These are the final steps in the path from release of an environmental contaminant, through transport to uptake and effect in a biological system. Exposures assessment can be concentration in the air, soil, water or internally (biomonitoring of uptake/absorption) or tissue concentration or a change detected in the body (example, changes in the blood) that indicate an adverse health effect. The following may be useful: external exposure->internal dose->effective dose->early biological effect->altered function->clinical disease, first put forward by Paul Schulte in 1989.

Strategies for Reducing Exposure

This section is designed to facilitate discussion and action regarding exposure control or reduction. The focus is tailored to the interests of the group and exposure sources identified in previous exercises.

Objective

- Identify a strategy to reduce PBT exposure

Materials

- Participant Guide
- Whiteboard or equivalent; markers
- Green exercise, Participant and Facilitator Guides

Teaching Methods

- Discussion
- Group Activity
- Small Group Activity

Suggested Instructor Preparation

Review Participant Guide and on-line resources (assure that the links are up-to-date for Fish Advisories)

If using the Green exercise, print a Participant Guide for each person

Minimum Content Requirements

Types of exposure reduction strategies

Identification of approach(es) that could be used to reduce community or personal exposure.

Questions You May Be Asked

1. Everything costs money. How can big changes be paid for?

Acknowledge that large changes like an industrial emission system are very costly.

Ask: Do community residents have a role to play in emissions? Refer back to the 'need more information' exercise for a structure to find out how to work with community residents to find out information and determine appropriate actions.

Be prepared to facilitate a discussion on small changes that can be accomplished by one person or a community group. Examples include replacing a gas-powered lawn mower with a push mower or establishing anti-idling zones near schools—both would reduce exhaust that may contain B(a)P.

Presentation of the Session

Based on the sources identified and the concerns of the participants, tailor the discussions.

The session can be presented as follows:

Ask: Is anyone concerned about fish consumption?

If yes, ask participants to turn to the first page, where fish advisories are detailed. Access the appropriate advisory for your state, or where fishing may be conducted.

Provide a few minutes for participants to read the advisory and discuss depending on interest. If there is no interest, note that it may be useful to friends or family and go to the first exercise.

Exercise: Matching Strategies to Sources

Time Required: 10 minutes as a Group Activity

Number of Instructors: 1

Materials: White Board or easel paper
Form in participant Guide

Facilitate group input to strategies for each of the situation/sources that were identified earlier. If the number of sources is large,

Ask: What 5 sources do you want to address in this exercise?

Then proceed to identify strategies for reducing exposure from each source.

Post the results from the group where everyone can see.

Exercise: Act to Reduce Exposure by Building Resources to Green the Home, Community and Work

Time Required: 30 minutes for a Plan, and 10 for report back

Number of Instructors: 1

Materials: Green Facilitator and Participant Guide
PBT Participant Guide

Work in small groups to develop an implementation plan for each of the strategies developed by the group. If some participants want to develop a personal plan, that is fine.

Follow the instructions in the Green Facilitator Guide, noting that many of the early parts of that exercise have already been completed. Go directly to making considering barriers, ownership and making the plan. After completion of the exercise, have groups report back on their plans. If anyone or group plans to implement the actions, please ask if progress can be tracked as described in the Green Facilitator Guide, get contact information, copy the plan and send to Tim Hilbert at UC.

Summary

Strategies are tailored to location and resources

Closing

Review the learning objectives

Ask: Based on this training, what takeaways do you have

For example: Are you better able to recognize potential PBT sources?

Did you identify ways to reduce exposure?

List them on a writing surface viewable by all

Alert participants to the Resources in the final pages of the manual.

Answer any remaining questions

Participants will complete the evaluation form. Collect forms and thank all participants; provide certificate/documentation of training, according to training center policy.

Facilitator Follow up

Assure that agenda and other materials are placed in the required Program File; include posted lists or take a picture to include in the File.

Make this program better:

Forward suggestions to UC

Are there other 'Questions you may be asked' that should be included? Please forward these to UC.

Organize the listing of 'takeaways' and forward to your program director. These are very important impacts to report to NIEHS.

Send any Plans to Tim Hilbert at UC to assist you in tracking.

Resources

Pesticides – NIEHS <https://www.niehs.nih.gov/health/topics/agents/pesticides/index.cfm>

DDT and birds --

https://web.stanford.edu/group/stanfordbirds/text/essays/DDT_and_Birds.html

Water Pollution – NIEHS <https://www.niehs.nih.gov/health/topics/agents/water-poll/index.cfm>

Our Chemical Lives (28-minute ABCTV video)

<https://www.youtube.com/watch?v=J9SWBAUIAvw>

NIEHS - Advancing Environmental Justice

https://www.niehs.nih.gov/research/supported/assets/docs/a_c/advancing_environmental_justice_508.pdf

NIEHS – Children’s Health

<https://www.niehs.nih.gov/research/supported/health/childrens/index.cfm>

U.S. Department of Health & Human Services Household Products Database

<https://householdproducts.nlm.nih.gov/>

An excellent resource is available from NIEHS:

<https://www.niehs.nih.gov/health/topics/agents/endocrine/index.cfm>

Link to the EPA Guide to Risk Assessment -

https://www.niehs.nih.gov/about/events/pastmtg/hazmat/assets/2008/wetp_spg_2008_workshop_hofmann_508.pdf

Another free resource is the journal, *Environmental Health Perspectives*, published by NIEHS that has a special section on Children’s Environmental Health. Review articles and environmental news articles are very readable by the community

An excellent resource for Environmental Health and Toxicology information is:

<https://sis.nlm.nih.gov/enviro.html>

A resource for endocrine disrupting chemicals is

<https://www.niehs.nih.gov/health/topics/agents/endocrine/index.cfm>

Applications for mobile phones:

NIOSH Pocket Guide to Chemical Hazards (NPG), WISER, Emergency Response Guidebook (ERG)

NOTE: Through WISER, you can access other resources including the Household Products Database, New Jersey Hazardous Substance Fact Sheets, EPA Chemical Fact Sheets