PROMOTOR **TRANSFERABLE TRAINING MODULES ON**

Environmental Toxicology

Dean Carter Binational Center for Environmental Health Sciences
National Institute of Environmental Health Sciences Superfund Research Program
The University of Arizona
1110 East South Campus Drive Tucson, Arizona 85721
Phone: 520.626.9049 Fax: 520.626.6782
E-Mail: dmoreno@email.arizona.edu
Websites: https://www.superfund.arizona.edu

Promotor Transferable Training Module on Environmental Toxicology

Instructor's Guide

Statement by the Authors

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Environmental Toxicology Module

Dr. A. Jay Gandolfi
University of Arizona, College of Pharmacy

Denise Moreno Ramírez, M.S.
University of Arizona, NIEHS Superfund Research Program Community Engagement Core

Environmental Toxicology – *Toxicology is the Science of Poisons*

Module Summary

We are all toxicologists! Everything is toxic and the effects on living organisms depend on the dose. *Promotores* will understand the fundamental concepts of toxicology, which include dose-response, exposure routes, biological variation, and toxicity phases.

Learning Objectives

- Understand toxicology and associated terms.
- Learn about everyday toxic substances.
- Interpret a dose-response curve.
- Acquire information about biological variation.
- Define exposure types.
- Familiarity with toxicity episode phases.
- Basic understanding of risk assessment.

Toxicology Background

Everything in the environment is made out of chemicals. These chemicals can either be naturally occurring or **synthetic**. Both types can be toxic to living organisms; thus **natural chemicals** can also cause negative effects. Just because they are "natural," does not mean that they are safe.

People often have a misconception about chemicals. Frequently, they only think about synthetic, toxic compounds. It is important to highlight that we use chemicals in our everyday lives, from the time we wakeup until the time we fall asleep. For example, toothpaste contains fluoride, sodium lauryl sulfate, calcium phosphate, strontium chloride, and hydrogen peroxide just to name a few. Consequently, we come into contact with these substances while brushing our teeth.

Living organisms are generally exposed to more than one chemical substance at a time (**chemical interactions**). These combinations cause different effects than those that would result from exposure to one single substance. Chemical interactions are important when determining health effects from exposure. Yet, their consequences are largely unknown.

Toxicology deals with natural or synthetic chemical substances in relation to the production of abnormal or undesirable results. It focuses on the symptoms, methods, remedies, and detection of a poisoning. The field of **environmental toxicology** studies the consequences of industrial and agricultural chemical substances on human health and the environment.

Toxicity is the quantity to which a substance can have a negative result. In the field of toxicology, the term "**exposure**" is discussed quite a bit. It can be defined as the act of being in contact with something and its availability to be taken into the body. Potential environmental exposures include contaminated water, polluted air, household products, garden soil, and industrial waste. The

effects that result from the exposure to a toxic substance are categorized as **chronic** (long-term exposure and the effects take time to develop) or **acute** (short-term exposure and the effects occur quickly). The amount, the duration, and the type of exposure will determine the toxic outcome.

In order for a chemical substance to have any effect, it must first enter the body. Living organisms can ingest them, inhale them, or absorb them through their skin (Figure 1). They may also travel inside the body via mucous in the nose, eye, or ear canals. These pathways are termed **routes of exposure**.

Absorption is the mechanism by which a substance passes through and enters the body. Yet, before it is absorbed, the substance must be available to be transported and processed by the body. **Bioavailability** describes the extent to which a chemical can be absorbed by the organism's system. For example, in order for salt to increase blood pressure in the body, it must be ingested orally in large quantities. If a large quantity of salt is poured onto the skin, it cannot readily travel inside to cause an increase in blood pressure.

After the chemical substance is absorbed, it is distributed throughout the body. Typically, it is distributed from the bloodstream to cells or a particular storage site(s). A storage site might or might not be where the toxicity occurs. Sometimes, it may be used as a protective barrier since the substance is not freely moving. The absorbed substance can also undergo metabolic changes (**biotransformation**) at the site. Finally, the substance is passed outside of the body (**excretion**) via such means as sweat, tears, saliva, milk, bile, and feces.

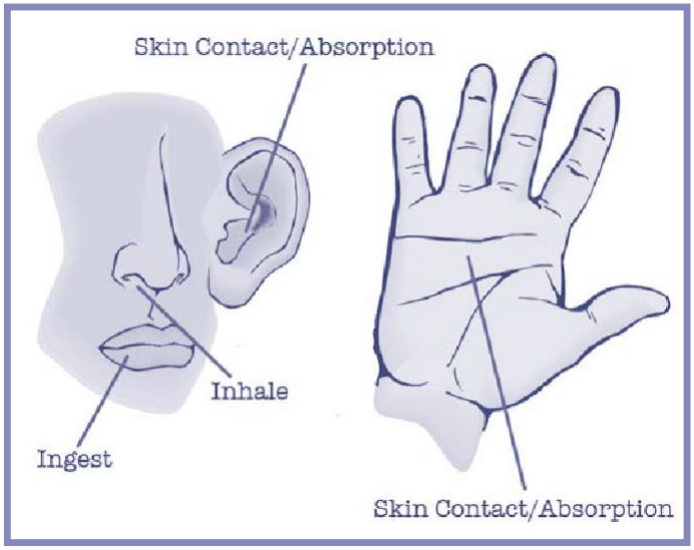


Figure 1. How chemical substances can enter the body.

The toxic effects that manifest from the chemical depend on the way it got into the body. As well, the amount (**dose**) that is actually absorbed into the body (Table 1). Paracelsus, the Father of Modern Toxicology, said, "the dose makes the poison." In other words, the consequences of a substance increase as the amount of that substance also increases. Scientists plot the relationship between the toxicant dose and the health effects on a **dose-response curve** (Figure 2).

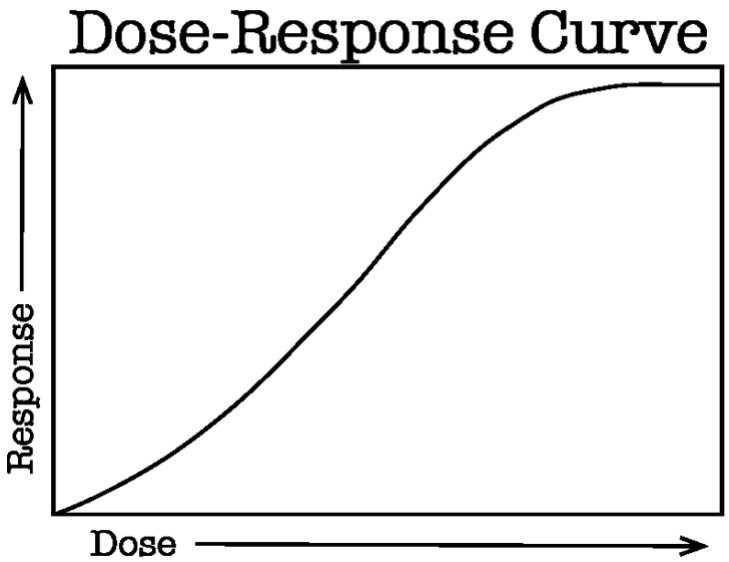


Figure 2. A dose-response curve showing as the dose increases, so does the response.

In addition, a chemical can produce harmful effects to one living organism while not harming another (**selective toxicology**). For example, an antibiotic may kill strep throat bacteria, but it will not kill you. People can also respond to chemical substances in different ways. Some may be exposed and may not develop a negative effect, while others may be more sensitive to a chemical and can develop negative effects from an exposure. No two individuals are the same; therefore the response to a dose varies considering age, lifestyle, and genetics (**biological variation**). Yet, if there is no exposure to a chemical, there will not be an effect.

When an organism is exposed to a toxic substance, it follows **toxicity phases**. The first phase is the **exposure phase**, which is when a toxicant is taken up by the organism's system via the mouth (oral), lungs (inhalation), or skin (dermal). Next is the **processing phase**, where the toxicant is transported and stored inside the body. The rate at how it is processed varies from person to person. Lastly, the **expression phase** describes the resulting effects that appear in the organism (e.g. lesion or headache). Different substances result in different symptoms.

Toxicants change the function of cells in an organism by interfering with normal processes. The reaction of an organism to a toxic substance is called the **response**. Within toxicology, the response is measured by the changes that occur. For instance, changes may range from minor (e.g. headaches) to severe (e.g. convulsions) to adverse effects (e.g. death) (Table 1). The **target tissue** is the location in the body where a chemical causes adverse effects. This location can be an entire organ, a tissue, a cell, or genes. An example of this is when genetic material changes (mutation) due to the effects of a toxic substance.

Table 1 Demonstrates the spectrum of general toxic doses of substances.

Substance	Toxic Dose
Alcohol	An adult weighing 100 pounds who quickly consumes 9 or 10 standard drinks in less than one hour.
Salt	An adult man weighing 220 pounds would need to consume 300 grams of salt.
Pesticide (DDT)	A cat weighting 5 kilogram would need to eat 60,000 cockroaches with DDT residue in one day.
Toxic Chemical (Dioxin)	An adult weighing 150 pounds would need to ingest .07 milligrams.
Botulinum (Botox®)	An adult weighing 154 pounds would need 3,000 units (Botox® injections of 20-70 units per treatment are generally used for cosmetic purposes).

Table 1. Demonstrates the spectrum of general toxic doses of substances.

Determining the risk of exposure to a chemical substance is invaluable to toxicologists. The process that is used to estimate this is called **risk assessment**. Risk assessment is an analysis that uses mathematical equations and scientific information (e.g. health and environmental) to determine the probability of an event occurring and the magnitude of the adverse effect over a specific time. It is used by governmental agencies to determine the unacceptable level of a chemical substance, the risk of exposure to a population at a contaminated site, and the appropriate cleanup method to safeguard human health. The risk assessment process consists of four basic steps, which are the following:

- Hazard Identification – what are the health risks caused by the chemical substance?
- Exposure Assessment – what is the amount of the chemicals substance and how many people are exposed to it?
- Dose-Response Evaluation – what are the health problems associated with the exposure?
- Risk Characterization – what are the health risks caused by the chemical substance in the exposed population?

Additional Resources

Web Resources – More Information on Environmental Toxicology

The "background" section in this module was developed to provide basic knowledge on the theme. In other words, important components and ideas are only highlighted and summarized. The purpose of this section is threefold: 1) provide additional sources of information in order to deliver an alternative way of looking at a theme, 2) expand the general information provided in the "background" to facilitate better training preparation, 3) offer potential training handouts or supplemental material that can also assist training participants. The brevity of the "background" section encourages the trainer to learning more outside of what is presented. The "background" section is a good jumping off

point. Here are some suggested on-line resources that contain relative information, but please feel free to research others:

Table 2 Web Resources – More Information on Environmental Toxicology

Risk Assessment (Spanish/English)	University of Arizona	http://superfund.pharmacy.arizona.edu/contefunnt/informational-materials
Toxicología Ambiental (Spanish)	University of Arizona	http://superfund.pharmacy.arizona.edu/content/toxicologia-ambiental/
Toxicology Data Network TOXNET (English)	U.S. National Library of Medicine	http://toxnet.nlm.nih.gov/
ToxTown (English/Spanish)	U.S. National Library of Medicine	http://toxtown.nlm.nih.gov/
Toxic Substance Portal (English/Spanish)	Agency for Toxic Substances and Disease Registry	www.atsdr.cdc.gov/substances/index.asp
Environmental Health (English/Spanish)	Centers for Disease Control and Prevention	www.cdc.gov/Environmental/ www.cdc.gov/spanish/temas/ambiental.html
Human Health Risk Assessment (English)	U.S. Environmental Protection Agency	www.epa.gov/risk/health-risk.htm
Routes of Exposure (English/Spanish)	Agency for Toxic Substances and Disease Registry	www.atsdr.cdc.gov/training/toxmanual/pdf/module-2.pdf www.atsdr.cdc.gov/es/training/toxicology_curriculum/modules/2/es_module2.html
Skin Deep (English)	Environmental Working Group	http://www.ewg.org/skindeep/
Unmasked: Nine Ugly Truths Behind the Myth of Cosmetics Safety (English/Spanish)	The Campaign for Safe Cosmetics	www.safecosmetics.org/downloads/Unmasked8.pdf www.safecosmetics.org/downloads/Unmasked_espanol.pdf
Toxlearn (English)	U.S. National Library of Medicine	www.atsdr.cdc.gov/csem/csem.asp?csem=1&po=5

Training Tools

Video Resources – More Information on Environmental Toxicology

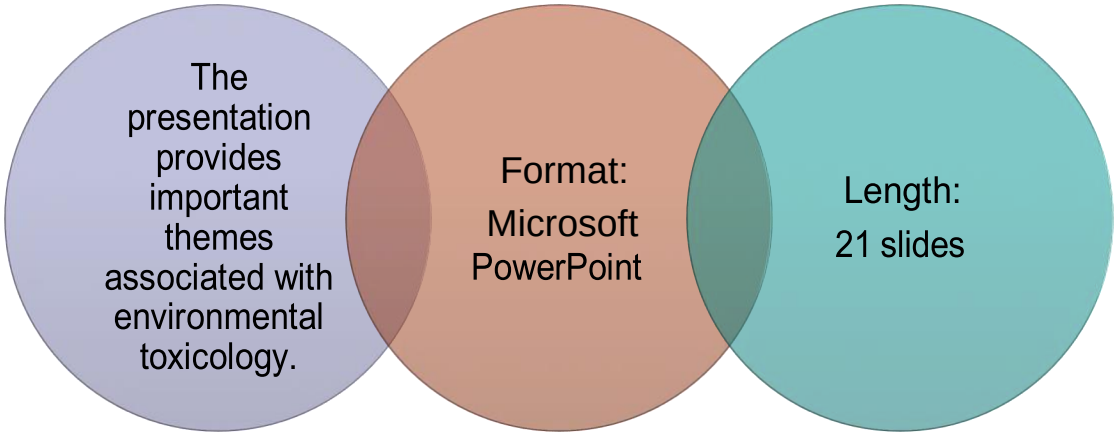
This section provides video suggestions that may help in preparation for the training or can be utilized as a training tool to help trainees understand theme concepts. Some of the videos can also be used as visual demonstrations when you are not able to set-up real-life activities. Here are some suggested video resources that contain relative information, but please feel free to research others:

Table 3 Video Resources – More Information on Environmental Toxicology

Is It Safe? (English/Spanish)	Toxicology Education Foundation	www.toxedfoundation.org/video_pg.htm
Basic Principles of Toxicology (English)	Flinn Scientific	www.youtube.com/watch?v=KbOPLBYGKs8&hd=1
Toxicología Ambiental (Spanish)	A Borde de la Ciencia TV	www.youtube.com/watch?v=jXvBbnC6eRw&hd=1
The Habitable Planet: Risk, Exposure, and Health Unit 6 (English)	Science Media Group	www.learner.org/courses/envsci/unit/text.php?unit=6&secNum=1
Did Environmental Exposure Cause Disease Clusters? (English)	WGBH	www.teachersdomain.org/resource/envh10.health.scleroderma/

Visual Aids – PowerPoint Presentation

The PowerPoint presentation provided is a prepackaged visual aid that can be utilized to train *promotores* on the respective theme of the module. It is meant to be adaptable and should be modified according to the audience needs and knowledge base. The information in the presentation is similar to that in the "background" section of this module. Certain terms and/or ideas may not be in the "background" section, thus a separate glossary is provided in this section to assist in defining.



Concept Glossary

- Strychnine – a highly toxic, colorless poison used as a pesticide to kill small mammals or birds. Usually, strychnine poisoning results in muscular convulsions and/or death. It has been around since the 1700s and is extracted from the plant Strychnos (genus) found in Asia, America, and Africa.
- Ethanol – pure alcohol.
- DDT – or dichlorodiphenyltrichloroethane, is an organchlorine pesticide used to kill various insects. It was developed in 1874 and in World War II it was used to control malaria and typhus.
- Curare – a paralyzing poison used by indigenous groups in South American. It is applied to arrows or blowgun darts that are employed to hunt prey. The paralyzing toxin leads to the inability to breath since lung muscles cannot contract.
- Dioxin – group of chemicals that are formed during the burning of waste and forest fires as well as some industrial processes such as paper pulp bleaching and herbicide manufacturing. They are considered very dangerous chemicals.
- Botox® – is used for various cosmetic and medical procedures. It derived from the bacteria *Clostridium botulinum*. The toxin produced by this bacterium is the most toxic substance known to humans.
- Morphine – is an opiate used to relieve sever pain.
- TCE – or trichloroethylene, is a chlorinated solvent used as an industrial degreaser. It is one of the most common environmental contaminants and commonly found in a majority of the Superfund site (most contaminated sites in the U.S. that are being cleaned-up under the supervision on the US EPA).
- PCE – or tetrachloroethylene, is a chlorinated solvent used mainly as a dry cleaning degreaser/cleaner.

Training Assessments and Extensions

- Have the *promotores* develop a list of toxicants they are familiar with and add beside each toxicant the respective health effects. After they create this list have them label the effects as either acute or chronic.
- Draw a dose-response curve for a familiar substance of their choice. Have them plot the responses in relation to the dose of the substance. Have them share the curve they created with the other promotores.
- Provide the *promotores* with copies of the canned mushrooms, pain relief ointment, deodorant, and aspirin labels. Have them choose which ingredient is the most toxic. An answer key has been developed demonstrating the lethal doses of the ingredients.

Concept Activities

These complimentary activities were designed to provide a hands-on component to the module trainings. They may be used to demonstrate a concept to visual learners or reinforce ideas presented to ensure comprehension. The activities have been divided into three sections (warm up, activity, and wrap up) in order to guide *promotores* through the concept(s). Also, some activities have "cheat sheets" for the trainer or handout materials that can be copied and handed out to the *promotores* at the training. Similar to other components in these modules, they may be adapted as needed considering training time, knowledge base, or available materials.

Activity 1. Every Day Chemical Bingo

Materials

- Copies of the Commercial Products Bingo Cards (one copy per each *promotor*)
- Large lima beans (place the cards on the table; commercial product illustrations facing up)
- Commercial Products Deck of Cards (print out on thick paper stock and create the deck of cards by cutting along dotted lines)
- Prize (optional; provide a small prize to the winner)

Warm Up

Ask the *promotores* to think about the products they have used prior to attending the training (you may want to provide a personal example so they can get the idea).

Activity

1. Promptly hand out the Commercial Products Bingo Cards to the *promotores*.
2. At the same time, give the *promotores* enough large lima beans to cover all the products on the cards (total of 16).
3. Inform the *promotores* that they will be playing bingo. Mention to them that this bingo game is not the traditional one, but instead they will be placing a lima bean on each of the commercial products that you call out and they have used prior to their arrival to the training.
4. Let them know that the person that fills out their card first or has the most products covered at the end of the game wins (optional: prize).
5. Shuffle the Commercial Products Deck of Cards a few times.
6. Select the top card from the Commercial Products Deck of Cards and say out loud the product name. Have them cover the product on their bingo card with the lima bean.
7. Repeat Step 4 until some one covers all their bingo card products or you have finished the cards in the deck (the person that has the most products covered on their card wins).

Wrap Up

Tell the *promotores* that may times we do not consider the products that we use for personal hygiene as chemical substances. Have them discuss their familiarity with the chemicals that are found in these everyday products. Remind them that we live in a world filled with chemicals, and that it is very difficult to avoid exposure. Discuss other items they use or encounter regularly that contain chemicals (Table 2). Do they know what chemicals they contain?

Table 4 Wrap Up Activity

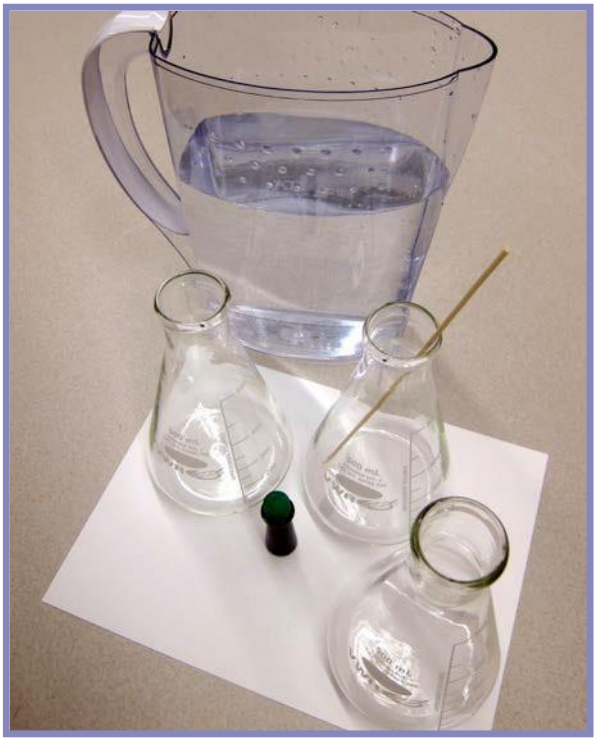
Item	Substances
Stain Repellent Fabric	Perfluorinated chemicals and perfluorooctanoic acid
Cellular Phone	Electromagnetic radiation
Vehicle Exhaust	Carbon monoxide, nitrogen dioxide, sulfur dioxide, suspended particles, benzene, formaldehyde, and polycyclic hydrocarbons
Non-Stick Coated Cookware	Polymer fumes, perfluorinated chemicals, and tetrafluoro-ethelyne
Plastic Containers/Bottles	Polyvinyl chloride, bisphenol a, and phthalates
Pressed Wood Products	Formaldehyde
Dryer Sheets	Benzyl acetate, benzyl alcohol, ethanol, alpha-terpineol, ethyl acetate, camphor, chloroform, linalool, and pentane.
Flame Retardants on Furniture	Polybrominated diphenyl ethers
Vinyl (PVC) Mini-Blinds	Lead, phthalates and vinyl chloride

Table 2. Common household items and the chemicals they contain.

Activity 2. Dose Demonstration*

Materials (Picture 1)

- Three Erlenmeyer flasks (at least 400 milliliters or mL; you can also use large glasses alternatively)
- 900 mL of water
- Food coloring
- One stir stick
- One sheet of white paper



Picture 1. Erlenmeyer flasks, food color, stir stick, white paper, and water.

Warm Up

Tell the *promotores* that a cliché within toxicology is, "the dose makes the poison." Remind them that the information they are learning in the training can help them make informed decisions about environmental contaminants as well as health choices for their families, community, and themselves.

Mention to them that you will be providing a demonstration that will help them understand the concept of dose.

Activity

1. On a table, place the three Erlenmeyer flasks and fill them ¾ full of water (or 300 mL or about 1.25 cups).
2. Add one drop of food coloring to the first Erlenmeyer flasks, five drops to the second beaker, and fifteen drops to the third beaker.
3. Stir each Erlenmeyer flasks with the stir stick.
4. Ask the *promotores* what differences they observe between the three Erlenmeyer flasks. Pick promotores and have them state their observations.
5. Use the white sheet of paper as a backdrop so they can better see the differences between the food color shades in the Erlenmeyer flasks.
6. Let them know that the change in color is a response to the increased amount (or dose) of food coloring in each of the Erlenmeyer flasks.

Wrap Up

* Modified activity from: "The Science Behind Our Food" – Toxicology Lesson Plan

Explain to them that the human body is about 75% water. Let them know that the Erlenmeyer flasks represent the amount of water in a human, while the food coloring represents the different doses of a chemical substance. Have them discuss the cliché, "the dose makes the poison" in relation to the demonstration.

Activity 3. Bioavailability of Salt

Materials

- Table salt
- Clear container (place the table salt in this container)
- "Salt" label (adhere to the container)
- Large piece of paper or plastic tub (this will be used to catch any excess salt in order not to make a mess)

Warm Up

Tell the *promotores* that a toxicant needs to be available in order to cause an effect. Review once again with them the definition of bioavailability (describes the extent to which a chemical can be absorbed into an organism's system). Let them know that the following demonstration will help them visualize this importance.

Activity

1. Take the table salt in the container and show it to the group.
2. Ask them if they are familiar with the health effects of excess salt consumption. Select *promotores* at random and have them list some of these effects.
3. Add other health effects that you are familiar with to the list that they have not already mentioned (Table 3).
4. Now, pour the table salt on your arm.

5. Ask the *promotores* if the salt that you poured on your arm is available for intake into the body or bioavailable (e.g. absorbed by kidney and blood) to potentially produce some of the effects that they have mentioned.
6. Next, shake some salt onto your finger and place it into your mouth.
7. Now ask the *promotores* again if they believe that the salt is now bioavailable for your body to process to cause an exposure.

Table 5 Human health effects of excess salt consumption.

High blood pressure (hypertension)
Dizziness
Electrolyte disturbance
Death
Stroke (cardiovascular disease)
Fluid retention (edema)
Ulcers
Stomach cancer

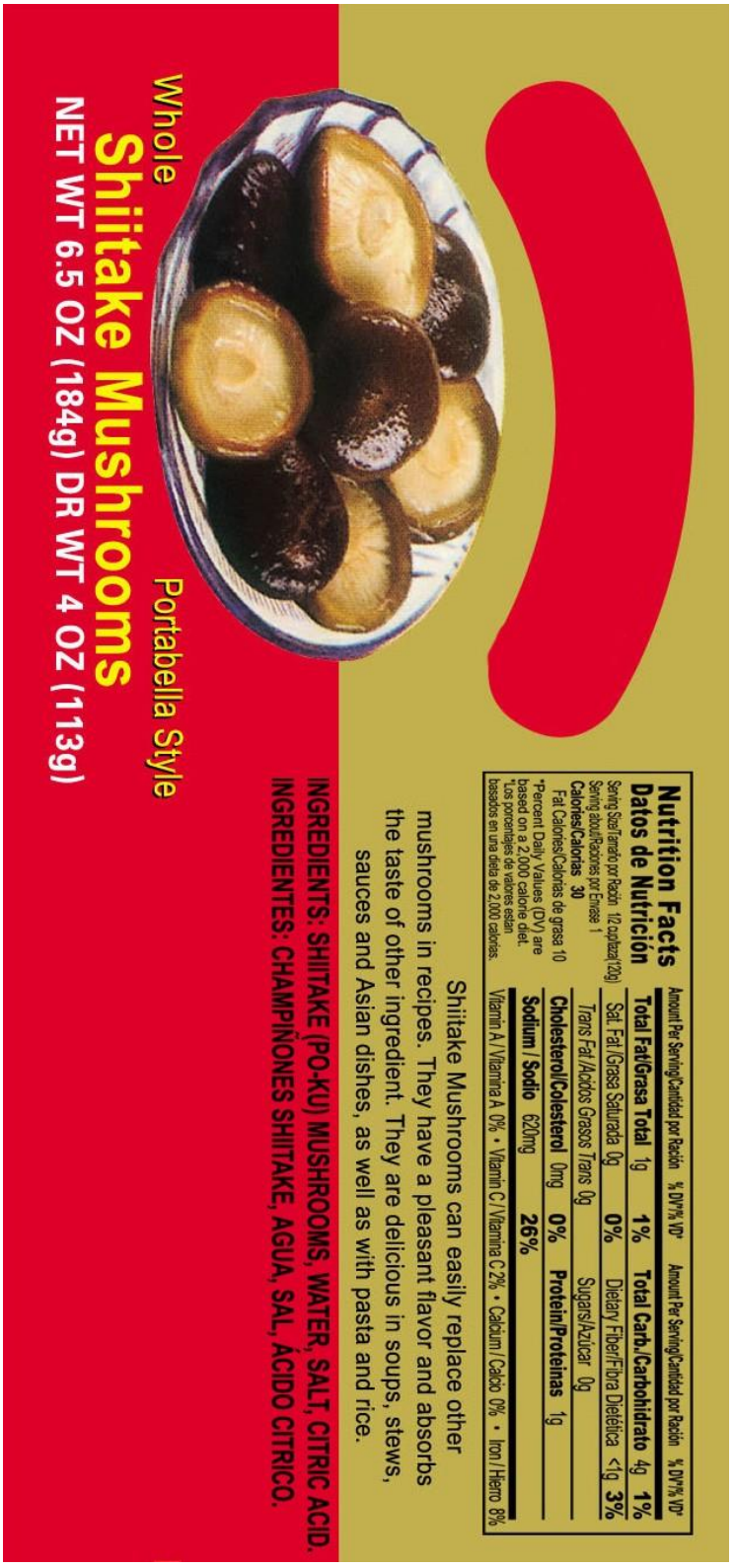
Table 3. Human health effects of excess salt consumption.

Wrap Up

Ask the *promotores* why the salt needs to be taken orally (via the mouth) to be available for the body. Discuss with them that in order for this to happen, it must be "available" for intake. The skin is a protective barrier that does not allow the table salt to reach the circulatory system or organs (e.g. kidneys) easily. The primary reason is that table salt (sodium chloride) does not dissolve readily in fat, which is the primary transport mechanism that allows substances to enter the body via the skin. The skin membrane contains fats and are is highly permeable to fat soluble molecules. In addition, water-soluble molecules have a hard time entering via this route. On the other hand, if you pour a solvent (*e.g.* acetone) that dissolves easily in fat, then it is more readily transported via the skin and into the body.

Supplemental Materials

Label: Canned Mushrooms



Label: Aspirin

ASPIRIN

2 Tablets

Active ingredient (in each tablet) ***Purpose***

Aspirin (NSAID*) 325 mg ..... Pain reliever/fever reducer

**nonsteroidal anti-inflammatory drug*

Uses **Temporarily relieves minor aches and pains associated with**

■ headache ■ muscular aches ■ minor arthritis pain ■ backache ■ common cold ■ toothache ■ menstrual cramps

Temporarily reduces fever

Warnings

Reye's syndrome: Children and teenagers who have or are recovering from chicken pox or flu-like symptoms should not use this product. When using this product, if changes in behavior with nausea and vomiting occur, consult a doctor because these symptoms could be an early sign of Reye's syndrome, a rare but serious illness.

Allergy alert: Aspirin may cause a severe allergic reaction which may include: ■ hives ■ skin reddening ■ facial swelling ■ rash ■ asthma (wheezing) ■ blisters ■ shock

If an allergic reaction occurs, stop use and seek medical help right away.

Stomach bleeding warning: This product contains an NSAID, which may cause severe stomach bleeding. The chance is higher if you: ■ are age 60 or older ■ have had stomach ulcers or bleeding problems ■ take a blood thinner (anticoagulant) or steroid drug ■ take other drugs containing prescription or nonprescription NSAIDs (aspirin, ibuprofen, naproxen, or others) ■ have 3 or more alcoholic drinks every day while using this product ■ take more or for a longer time than directed

Do not use ■ if you have ever had an allergic reaction to any other pain reliever/ fever reducer ■ right before or after heart surgery ■ if you are taking a prescription drug for gout, diabetes or arthritis

Ask a doctor before use if ■ stomach bleeding warning applies to you ■ you have a history of stomach problems such as heartburn ■ you have high blood pressure, heart disease, liver cirrhosis, or kidney disease ■ you are taking a diuretic ▶

Warnings (continued)

Ask a doctor or pharmacist before use if you are

■ under a doctor's care for any serious condition ■ taking any other drug

When using this product ■ take with food or milk if stomach upset occurs

Stop use and ask a doctor if

■ you experience any of the following signs of stomach bleeding: ■ feel faint ■ vomit blood ■ have bloody or black stools ■ have stomach pain that does not get better ■ pain gets worse or lasts more than 10 days ■ fever gets worse or lasts more than 3 days ■ you have difficulty swallowing ■ if ringing in the ears or loss of hearing occurs ■ redness or swelling is present in the painful area ■ any new symptoms appear

If pregnant or breast-feeding, ask a health professional before use. It is especially important not to use aspirin during the last 3 months of pregnancy unless definitely directed to do so by a doctor because it may cause problems in the unborn child or complications during delivery.

Keep out of reach of children. In case of overdose, get medical help or contact a Poison Control Center right away.

Directions

■ **do not use more than directed**
■ the smallest effective dose should be used
■ drink a full glass of water with each dose
■ do not take longer than 10 days, unless directed by a doctor

Adults and children: (12 years and older) Take 1 or 2 tablets with water every 4 hours as needed. Do not take more than 12 tablets in 24 hours, or as directed by a doctor.

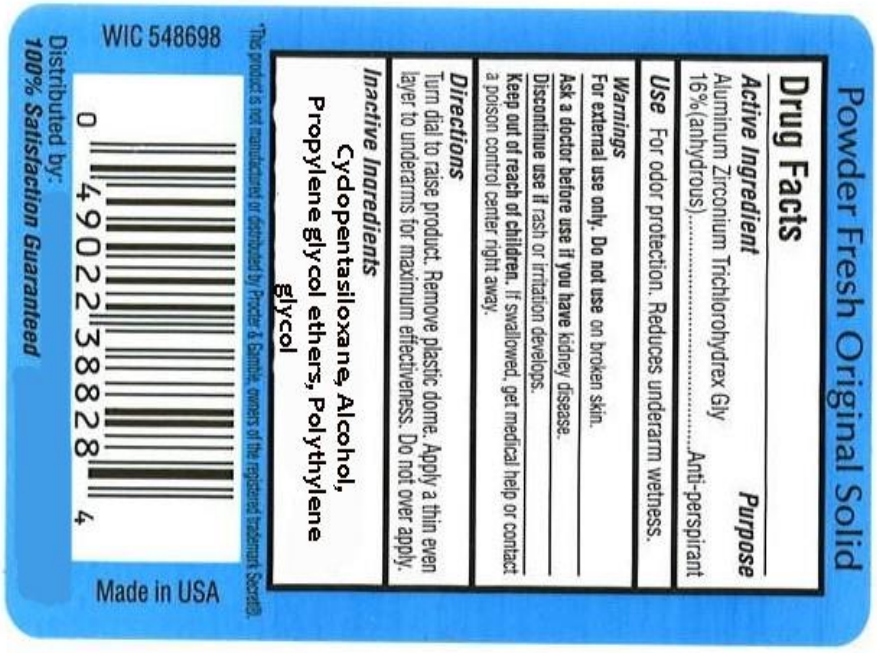
Children under 12 years: Do not give to children under 12 years of age.

Other information ■ store at 59º-86ºF (15º-30ºC) ■ avoid excessive heat and humidity ■ tamper evident sealed packets ■ do not use any opened or torn packets

Inactive ingredients

Carnuba, Starch, Cellulose

Label: Deodorant



Label: Pain Relief Ointment

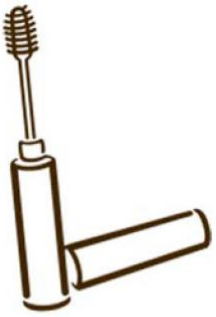
Answer Key: Lethal Doses of the Ingredients

The table below provides approximate lethal doses for the product labels. Note that these values can change based on new evidence and calculations used to estimate. These values can also be extrapolations from animal studies to humans; therefore they can vary depending on the animal species used to estimate lethal dose. As a result, these are not solid numbers but can provide an idea of toxicity. The red highlighted ingredients are the one that require less amount to cause a lethal reaction.

Table 6 Answer Key: Lethal Doses of the Ingredients

Product	Ingredient Lethal Dose
Canned Mushrooms	Salt (3,000mg/kg) Water (90ml/kg) **Citric acid (3g/kg)**
	Aspirin or Acetylsalicylic acid (350 --- 500mg/kg)
Aspirin	Carnauba (unknown)
	Starch (7.3g/kg)
	Cellulose (1g/kg)
Deodorant	Aluminum Zirconium (5g/kg) Cyclopentasiloxane (3g/kg) Alcohol (9g/kg) Propylene glycol ether (unknown) **Polyethylene glycol (1.5g/kg)**
Pain Relief Ointment	**Benzydamine (740mg/kg)** Alcohol (9g/kg)

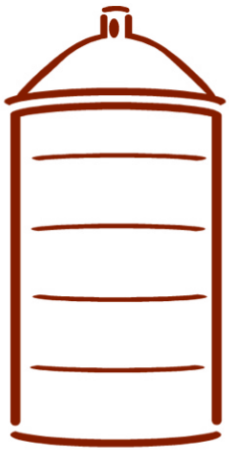
Commercial Products Bingo Card

 Body Moisturizer	 Conditioner	 Deodorant
 Hair Spray	 Lipstick	 Make-Up
 Mascara	 Mouth Wash	 Perfume/Cologne
 Shampoo	 Soap	 Tooth Paste

Commercial Products Deck of Cards

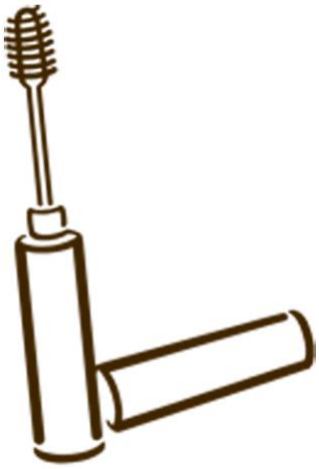
Body Moisturizer

Conditioner



Hair Spray

Lipstick

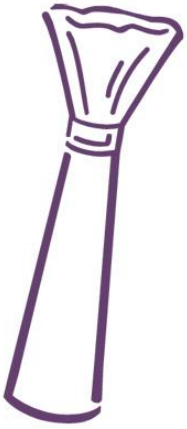


Mascara

Mouth Wash

Shampoo

Soap



Perfume/Cologne

Make-Up

Deodorant

Tooth Paste

Glossary

Glossary

Absorption: mechanism by which a substance passes through barriers (e.g. skin) and enters the body.

Acute: short-term exposure in which the effects occur quickly.

Bioavailability: extent to which a chemical can be absorbed by the organism's system.

Biological variation: response to dose that varies considering age, lifestyle, and genetics.

Biotransformation: absorbed substance that undergoes metabolic changes at a site in the body.

Chemical interactions: environmental exposures mainly involve simultaneous exposure to multiple chemicals in air, water, and food.

Chronic: long-term exposure in which the effects take time to develop.

Dose: amount that is actually absorbed into the body.

Dose-response curve: relationship between a toxic reaction (response) and the levels of exposure (doses).

Environmental toxicology: study of the consequences of industrial and agricultural chemical substances on human health and the environment.

Excretion: substance is passed outside of the body via such means as sweat, tears, saliva, milk, bile, and feces.

Exposure: act of being in contact with something and its availability to be taken into the body.

Exposure phase: first phase of toxicity phases in which a toxicant is taken up by the organism's system via the mouth (oral), lungs (inhalation), or skin (dermal).

Expression phase: last phases of toxicity phases that results in effects that appear in the organism (e.g. lesion or headache). Different substances result in different symptoms.

Natural chemicals: products from plants or animals.

Processing phase: second phase of the toxicity phases where the toxicant is transported and stored inside the body. The rate at how it is processed varies from person to person.

Response: reaction of an organism to a toxic substance.

Risk assessment: analysis that uses mathematical equations and scientific information (e.g. health and environmental) to determine the probability of an event occurring and the magnitude of the adverse effect over a specific time.

Routes of exposure: pathways into the body such as mucous in the nose, eye, or ear canals.

Selective toxicology: substance can produce harmful effects to one living organism while not harming another.

Synthetic: man-made or artificial.

Target tissue: location in the body where a chemical causes adverse effects. It can be an entire organ, a tissue, a cell, or genes.

Toxicants: substance that changes the function of cells in an organism by interfering with normal processes.

Toxicity: quantity to which a substance can have a negative result.

Toxicity phases: stages that develop when an organism is exposed to a toxic substance.

Toxicology: discipline that deals with natural or synthetic chemical substances in relation to the production of abnormal or undesirable result.

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