NAME THAT IAQ HAZARD

Description

In this activity, students are introduced to a variety of common indoor air quality hazards. They will learn sources of hazards, route(s) of exposure, associated health symptoms, and methods for hazard control.

Student Outcomes

Students will:

- Communicate general information about common indoor air quality hazards.
- Define and understand the hazard type (biological, chemical, physical).
- Identify routes of human exposure.
- Categorize indoor air quality hazards by their health effects.
- Select effective methods to control specific indoor air quality hazards.

Student Products

IAQ Hazards (WS-3)
Toxicology Assessment (WS-4)

Prerequisite

None

National Standards

Standards covered in the following subjects: *Geography, Health, Language Arts, Science, and Social Studies*
See Appendix A for the complete list of national content standards.

Teamwork Skills

Give and receive feedback in a positive manner.

Activity Timing

Time Estimate	IAQ Complete	IAQ Enriched
60-90 min	Prep Time	Prep Time
Homework	√ (Pre-activity)	√ (Pre-activity)
Day 1	IAQ Hazard Game	Toxicology Lecture Toxicology Assessment
Day 2		IAQ Hazard Game

Materials and Supplies

IAQ Hazard Game: Instructions for making one game (print on different-colored card stock and laminate). You will need one game per pair of students.

- IAQ Hazard Game Keys—print one blue paper and cut page in half to make two game keys
- IAQ Hazard Game Sheets—print two on green paper. Do not cut apart.
- IAQ Hazard ID Cards—print on yellow paper and cut apart to make 12 individual cards.
- Beans, squares of paper, or sticky notes
- Manila envelope to hold game cards

 **Tips from Teachers:** Allow yourself enough time to photocopy, laminate, and cut out game pieces.

Teacher Information

What is Toxicology?

Humans have known for centuries that some natural substances are poisonous. Hazardous chemicals are also man-made, and technology in the last few centuries has resulted in the creation of millions of various toxic substances, some created on purpose (pesticides) and some created accidentally (dioxin).

Knowledge of toxins has proven useful to humans. Toxins have been used to kill predatory animals and even to get rid of human enemies. As the 16th century physician Paracelsus noted, some toxins are also remedies and have been used to cure ailments. **Toxicology** is the science of poisons—how they work, what they do, and how to counteract their harmful effects. Toxicologists study exposure to toxic substances and the health effects that result from such exposure.

Hazardous substances vary in their **toxicity**, the degree to which a substance or mixture of substances can harm an organism. The amount of a given substance that enters the organism's body—the **dose**—makes a difference in that substance's effect on the organism. Paracelsus recognized that the same substance could have both therapeutic and toxic properties, depending on how much of it was used. He wrote, "All substances are poisons; there is none which is not a poison. The right dose differentiates a poison from a remedy." You may have heard this paraphrased as "The dose makes the poison."

The harmful effect of a substance depends not only on the toxicity of the substance but also the degree of the organism's exposure to the substance. Exposure takes into consideration three factors:

- **Route**—how the substance entered the body (ingestion, inhalation, or absorption)
- **Frequency**—how often the organism was exposed (many times or one time)
- **Duration**—how long the organism was exposed

Individual susceptibility will also affect the degree of harm resulting from exposure to a toxic substance. An organism's health status, age, and genetics play a role in susceptibility.
For more information about the basics of toxicology, consult the Background Reading, *Toxicology*.

Hazardous Substances in Indoor Air

Poor ventilation is a culprit in almost all indoor air quality problems. As you learned already, carbon dioxide (CO_2) concentrations in indoor air may be used as an indicator of room ventilation. If the CO_2 is above 1000 ppm, ventilation is poor enough that the air accumulates unpleasant odors and the air is "stale and stuffy." If it is above 1500 ppm, occupants may experience headaches, dizziness, tiredness, and difficulties in concentrating. Besides being an indoor air quality problem in itself, CO_2 in high concentrations may indicate high levels of other indoor air pollutants.

In schools, the most commonly measured indoor pollutants are total volatile organic compounds (TVOC) and biological hazards (Daisey et al. 2003).

Volatile organic compounds

Volatile organic compounds (VOCs) are organic chemicals used as ingredients or solvents in products such as carpeting glue, particle board resin, and dry-erase markers. High levels of VOC concentrations have been associated with symptoms of "sick building syndrome" such as airway irritation or congestion, onset of cold-like symptoms, nausea, and eye irritation. There is little scientific confirmation of an association between such symptoms and total VOCs in a building. It can be useful to look at individual VOCs separately to understand how their presence at high levels affects human health.

Biological hazards

Biological hazards, sometimes also referred to as bioaerosol contaminants, include viruses, bacteria and their products, allergens from dust mites or animals, and fungi.

Viruses and bacteria: Poor ventilation increases the incidence of respiratory or flu-like illnesses caused by viruses and bacteria (Daisey et al. 2003). Bacterial counts tend to increase as dust levels, number of building occupants, and activity levels increase.

Allergens: Dust mites or animal dander can trigger asthma or allergy attacks in susceptible individuals. House dust mites thrive in high-humidity environments. Cat or dog allergens found in house dust and hair can be tracked into classrooms; carpeted classrooms typically collect more dust and allergens than those with bare floors.

Fungi: Mold spores can cause allergic reactions in susceptible individuals, including runny or stuffy nose, sore throat, respiratory illness, itchy or watery eyes, coughing, and sneezing. Water damage in buildings is the biggest cause of mold growth and release of mold spores into the air.

Indoor Air Hazards Used in the Hazard Game			
Hazard or Pollutant Name	**Description**	**Source**	**Health Effect after Acute Exposure**
Asbestos	Mineral particle or fiber	Deteriorating or damaged building materials that contain asbestos	Lung cancer
Biological Hazards **Cockroaches** **Dust mites** **Animal dander** **Pollen** **Mold**	Living organism or material from living organism such as animal dander or cockroach parts)	Rooms with high humidity and wet or moist walls, ceilings, furniture, bedding, and carpets; air conditioning systems and humidifiers; household pets	Allergic reactions (eye, nose, and throat irritation, coughing, sneezing); asthma and asthma-like symptoms (respiratory illness, shortness of breath)
Carbon Monoxide	Colorless, odorless poisonous gas	Caused by incomplete burning of any fuel. Unventilated space heaters; tobacco smoke; fireplaces and chimneys	Fatigue/lethargy, chest pain, headache, dizziness, confusion, nausea and, in cases of high exposures, death
Diesel Exhaust	Mixture of chemicals (sulfur), particles (carbon soot) and gases (carbon dioxide, carbon monoxide, nitrogen) from diesel engines	Diesel engines on large vehicles like school buses	Eye, nose, and throat irritation; asthma; allergic symptoms; coughing; wheezing
Environmental Tobacco Smoke (ETS)	Mixture of chemicals, particles and gases from smoke	Cigarettes, pipes or cigars; exhaled smoke	Eye, nose, and throat irritation; headaches; wheezing; cough; sneezing; asthma; and, with long-term exposure, lung cancer
Lead	Toxic metal	Lead-based paint and dust; solder on pipes and food cans; contaminated soil or drinking water	Confusion, learning problems, lack of coordination, and hyperactivity in children; kidney damage and digestive and reproductive damage in adults
Radon	Colorless, odorless radioactive gas	Rocks and soil beneath the home, well water	Long-term exposure can lead to lung cancer
Volatile Organic Compounds (VOCs)	Liquid solvents that evaporate rapidly at room temperature such as formaldehyde toluene, xylene, 2-butoxyethanol, and acetone	Household products such as paints, hobby supplies, aerosol sprays, cleaners; automotive products; dry-cleaned clothing; disinfectants	Variety of health effects based on the specific chemical. Can include eye, nose, and throat irritation; headaches; dizziness; memory disorders; central nervous system disorders; kidney damage; cancer risk

References:

- Daisey, JM, WJ Angell, and MG Apte. 2003. "Indoor air quality, ventilation and health symptoms in schools: An analysis of existing information." *Indoor Air* 13: 53-64.
- Garrett, MH, MA Hooper, BM Hooper, PR Rayment, and MJ Abramson. 1999. "Increased risk of allergy in children due to formaldehyde exposure in homes." *Allergy* 54: 330-337.
- Office of Environmental Health Hazard Assessment. 2000. *Air Toxics Hot Spots Program Risk Assessment Guidelines Part III. Technical Support Document for the Determination of Non-cancer Chronic Reference Exposure Levels for Airborne Toxicants, Appendix C.* California Office of Environmental Health Hazard Assessment. Sacramento, CA. See Hydroville website (http://www.hydroville.org/links/iaq_resources.aspx) for an up-to-date link.
- Samet, JM, MC Marbury, and JD Spengler. 1988. "Health effects and sources of indoor air pollution, Part II." *American Review of Respiratory Disease* 137: 221-242.

Terminology

Absorption
Dose
Duration
Exposure
Frequency
Hazard
Individual susceptibility
Ingestion
Inhalation
Physical properties
Risk
Routes of exposure
Signs
Source
Symptoms
Toxicity
Toxin

Suggested Lesson Plan

Getting Started

1. Decide on the timing for this activity. If you assign the background reading and worksheet as homework, you can do the activity in one day.

2. Prepare one IAQ Hazard Game per pair of students. Laminate the game cards if you intend to reuse them.

3. Review the Background Reading, *Toxicology*, and go over the answers to *Reading for Understanding Questions* (WS-1).

Doing the Activity

As a one-day activity:

1. **Assign Journal Prompt-8:** Give students some examples of ways that they may have been exposed to environmental hazards. Examples listed on the transparency include pollen, environmental tobacco smoke, toxins from bacteria, and chemicals as examples. If you wish, spark discussion by asking students to read their journal entries to the class.

In one or two paragraphs, give an example of a time when you were exposed to a chemical, biological, or physical hazard. Describe your symptoms and tell how long you experienced them. Use these highlighted words in your written description: **hazard**, route of exposure (**inhalation, absorption, or ingestion**), **duration**, and **frequency**.

Here is a good example of a student answer to the Journal Prompt:
I have asthma and whenever I am exposed to dander and hair from cats or dogs I have trouble breathing, my nose runs, my eyes water and I begin coughing and sneezing. Animal dander and hair is a biological hazard, and I get asthma because I breathe the dander into my lungs. That route of exposure is inhalation. I start having symptoms within about 30 minutes and they last until I leave the house. The frequency of my exposure to animal dander is whenever I go to my friend's house, about twice a week. The duration of my exposure to animal dander is however long I stay at my friend's house which is about 2 or 3 hours at a time.

Doing the Activity

As a one-day activity:

1. Review the Background Reading, *Toxicology*, and go over the answers to *Reading for Understanding Questions* (WS-1).

2. Go over the instructions for the *Name That IAQ Hazard* game (WS-2)

3. Working in pairs, students should play at least four rounds of the game (eight hazards).

4. After the game, students should complete *IAQ Hazards* (WS-3).

As a two-day activity:

Day 1:

1. Show and review the Toxicology Lecture Transparencies (TM-1 through 6). These cover the concepts of toxicology and the symbols and vocabulary associated with the IAQ Hazard Game. Students should be familiar with these concepts:
   - **Hazard type:** biological, chemical, physical;
   - **Route of exposure:** inhalation, absorption, ingestion;
   - **Signs and symptoms:** health effects caused by exposure to the hazard; and
   - **Control methods:** increase ventilation, control humidity, reduce exposure.

2. Have students work individually or in pairs to complete the *Toxicology Assessment* (WS-4).

Day 2:

1. Review the Instructions for the *Name That IAQ Hazard* game (WS-2).

2. Working in pairs, students should play at least four rounds of the game (eight hazards).

3. After the game, students should complete *IAQ Hazards* (WS-3).

Wrap-up

As a class, discuss students' answers to the worksheet.

Assessment

Assess students' writing by evaluating their journal prompt entries.

Have students review and answer reading comprehension questions on the optional *Toxicology Assessment* (WS-4). The worksheet features a reprint of an April 6, 2004 *New York Times* article entitled "Jittery? Peevish? Can't sleep? What are you drinking?" by Richard A. Friedman, MD.

Resources

- *Teacher's Guide to Indoor Air Quality*. National Safety Council's Environmental Health Center. Section 4 on Major Indoor Pollutants. Pp: 22-24.
- Ottoboni, MA. 1984. *The Dose Makes the Poison*. Vincente Books, Berkeley, CA.
- Francis, BM. 1994. *Toxic Substances in the Environment*. Wiley-Interscience Publication. John Wiley & Sons, Inc., New York.
- Klassen, CD. 1996. *Toxicology*. McGraw-Hill, New York.
- Timbress, JA. 1995. *Introduction to Toxicology*. Taylor & Francis, London.
- Rodricks, JV. 1992. *Calculated risks*. Cambridge University Press, New York.
- Oregon-OSHA Training Manual. *Industrial Hygiene for the Non-Industrial Hygienist*. Occupational Safety and Health Administration.
- See the Hydroville IAQ Resources website (http://www.hydroville.org/links/iaq_resources.aspx) for an up-to-date link.

Teacher Key

***Reading for Understanding Questions* (WS-1)**

1. Define risk.
   Risk is the probability of harm due to exposure to a hazard.

2. It is winter, and the Johnson family (two adults, two teenagers, a toddler, and a dog) has been trying to conserve energy by keeping windows and doors closed. Their home is heated by a gas furnace. Family members have been complaining of headaches, fatigue, and difficulties concentrating and sleeping. Mrs. Johnson stays home most of the day with the toddler. They discover that they are experiencing carbon monoxide poisoning. Explain why some family members may have more severe symptoms than others.
   - ***Dose:*** *small body size leads to a higher dose (dog, toddler)*
   - ***Exposure:*** *toddler, dog and mom stay home all day and have greater exposure*
   - ***Individual susceptibility:*** *some family members may be more sensitive to carbon monoxide poisoning than others.*

3. What makes a chemical toxic?
   A chemical is toxic when it causes harm to an organism.

4. Name the three main categories of hazards and give an example of each.
   Chemical—example: VOC
   Biological—example: pollen
   Physical—example: asbestos fibers

5. Explain the statement: **The dose makes the poison**.
   All substances are toxic if dose and exposure are great enough.

6. What three variables determine the extent of your exposure to a hazard?
   *These three factors are **route**, **frequency**, and **duration**.*

7. Describe the three main routes of exposure to a hazardous substance.
   a. *Absorption through the skin*
   b. *Inhalation into the lungs*
   c. *Ingestion by mouth*

8. Describe three main ways to control indoor air quality hazards.
   a. *Reduce exposure/control the source*
   b. *Reduce humidity*
   c. *Increase ventilation*

***IAQ Hazards* (WS-3)**

1. Put check marks next to hazards that can cause symptoms of both Asthma (As) and Allergies (Al).

X	*Animal dander*		*Environmental tobacco smoke*
	Asbestos		*Lead*
X	*Carbon monoxide*	X	*Mold*
X	*Cockroaches*	X	*Pollen*
X	*Diesel exhaust*		*Radon*
X	*Dust mites*		*Volatile organic compounds*

2. Look at the hazards you checked in Question 1. What is the most common category of hazard that can cause symptoms of both Asthma (As) and Allergies (Al)?
   Biological hazards

3. Put check marks next to hazards that can cause both Headache (He) and Eye, nose, and throat irritation (Ir).

	Animal dander		*Environmental tobacco smoke*
	Asbestos		*Lead*
	Carbon monoxide	X	*Mold*
	Cockroaches		*Pollen*
	Diesel exhaust		*Radon*
	Dust mites	X	*Volatile organic compounds*

4. Physical hazards cause damage by irritating and damaging tissue in the respiratory tract (nose, throat, and lungs). Put check marks next to all the physical hazards.

	Animal dander	X	*Environmental tobacco smoke*
X	*Asbestos*		*Lead*
	Carbon monoxide		*Mold*
	Cockroaches		*Pollen*
X	*Diesel exhaust*		*Radon*
	Dust mites		*Volatile organic compounds*

5. Chemical hazards are absorbed into the body and can cause damage at the site of exposure or elsewhere in the body. Put check marks next to all the chemical hazards.

	Animal dander	*X*	*Environmental tobacco smoke*
	Asbestos	*X*	*Lead*
X	*Carbon monoxide*		*Mold*
	Cockroaches		*Pollen*
X	*Diesel exhaust*	*X*	*Radon*
	Dust mites	*X*	*Volatile organic compounds*

6. How can a hazard be both a chemical and physical hazard?
   A hazard can cause physical damage because it is a solid physical particle that can irritate the respiratory tract. It can also be made of chemicals that are absorbed into the body and have toxic effects.

7. What methods of control will reduce the amount of mold indoors?
   Reduce exposure, control humidity, increase ventilation.

8. Which indoor air hazards can cause cancer?
   Asbestos, radon, and environmental tobacco smoke can cause cancer after chronic (long-term) exposure.

9. What do all the hazards have in common?
   All hazards can be inhaled and all can be controlled at the source.

Toxicology Assessment **(optional) (WS-4)**

1. Of the signs and symptoms listed below, which one did Adam *not* suffer from?
   c. *Headache*

2. How was Adam exposed to caffeine (what was the route of exposure)?
   c. *Ingestion*

3. What other chemical hazards did Adam's doctor think he might have been exposed to?
   d. *All of the above*

4. One cup of coffee contains about 100 milligrams (mg) of caffeine. If Adam weighs 150 pounds (= 68 kilograms), what is the dose of caffeine that Adam drinks in each cup of coffee? (Per-cup dose = Total mg consumed in one cup of coffee divided by a person's weight in kilograms).
   d.*1.47 mg/kg*

5. One cup of coffee contains about 100 milligrams (mg) of caffeine. Adam usually consumed 10 cups of coffee per day (about 1000 milligrams of caffeine per day). If Adam weighs 150 pounds (68 kilograms), what is Adam's daily dose of caffeine? (Daily dose = Total mg consumed in one day divided by a person's weight in kilograms.)
   a.*14.7 mg/kg of caffeine per day*

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 **PAGES TO PHOTOCOPY†**

Note: For ease of photocopying, Transparency Masters appear first in the student pages.

Handouts and Transparency Masters

Day	What is Needed	Type*
Pre	*Toxicology*	BR
	Reading for Understanding Questions	WS-1
1	Journal Prompt	JP-8
	Hazards	TM-1
	Physical Properties of Hazards	TM-2
	Exposure	TM-3
	Controlling Indoor Air Quality Hazards	TM 4- 6
	Name that IAQ Hazard Game	WS-2
	IAQ Hazard Game Pieces	
	IAQ Hazards	WS-3
2	*Toxicology Assessment*	WS-4

* Type = Journal Prompt (JP), Transparency Master (TM), Background Reading (BR), Worksheet (WS)

† Electronic copies of all Handouts, Journal Prompts, and Transparency Masters are found on the Indoor Air Quality Curriculum CD

JOURNAL PROMPT-8

In one or two paragraphs, give an example of a time when you were exposed to a chemical, biological, or physical hazard. Describe your symptoms and how long you experienced them.

Use these highlighted words in your written description:

- Hazard (**biological**, **chemical**, or **physical**)
- Route of exposure (**inhaled**, **absorbed**, or **ingested**)
- **Duration** (how long you were exposed)
- **Frequency** (how often you were exposed)

Some examples of ways that you might have been exposed to an environmental hazard:

- Pollen: You might be allergic to pollen and have itchy eyes, runny nose, and sneezing during hay fever season.
- Environmental Tobacco Smoke: You may have been exposed to second-hand smoke in a restaurant or at home.
- Toxins from Bacteria: You may have had food poisoning after consuming food contaminated with *Salmonella* and the toxins it produces.
- Chemicals: There may have been a time when you were bothered by the smell of some kind of chemical (such as perfume or another personal-care product) that caused you to have health effects like headache, nausea, or dizziness.

HAZARDS

Hazards are substances that can produce an adverse biological effect or damage biological systems.

Three main categories of health hazards:

Chemical

Chemical hazards (carbon monoxide, volatile organic compounds, lead, diesel exhaust, ETS, and radon)

Biological

Biological hazards (cockroach parts, pollen, animal dander, dust mites, and mold)

Physical

Physical hazards (asbestos, particles in ETS, and diesel exhaust)

PHYSICAL PROPERTIES OF HAZARDS

Hazards can be described by their **physical properties** when they are found in air.

Solid Particles—Solids have a definite shape and volume at room temperature. Solid particles are typically either biological hazards (e.g., bacteria and molds), or physical hazards (e.g., asbestos, ETS, and diesel exhaust).

Liquid Particles—Liquids have an indefinite shape at room temperature. Liquid particles in air vary in size from aerosols to mists and much larger drops.

Vapors—Vapors are formed when liquids evaporate (e.g., liquids such as acetone that evaporate easily into the air at room temperature form vapors).

Gases—Gases have widely spaced molecules that are mixed in air. Carbon monoxide and radon are examples of gaseous hazards at room temperature.

EXPOSURE

Exposure is the amount of contact a person has with a hazard.

Exposure depends on the following three factors:

Route—How a hazard enters the body or comes in contact with the body. There are three main **routes of exposure**:

Skin Absorption

Lung Inhalation

Mouth Ingestion

Frequency—How often a person comes in contact with a hazard.

Duration—The length of time of exposure. Duration can be acute (short-term or < 24 hours) or chronic (long-term or > 24 hours).

CONTROLLING INDOOR AIR HAZARDS

Control the Source: Actions that prevent or stop air hazards or pollutants from getting into the indoor air environment in the first place.

There are three main ways to control hazards at the source:

1. **Remove the source of the hazard:** Remove the source of the hazard from the environment.

2. **Substitute the source of the hazard:** Replace the source of the hazard with something less hazardous.

3. **Contain the source of the hazard:** Put a physical barrier over the source to prevent the hazard from getting into the air.

CONTROLLING INDOOR AIR HAZARDS

Reduce the Exposure: Actions to limit how much of a hazard is in the air and reduce the amount of the hazard that gets into the body.

There are three main ways to control the amount of exposure to a hazard:

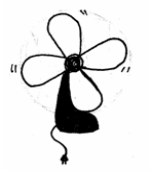
1. **Control the timing of use:** Change the time that a hazard is used so building occupants are not exposed.

2. **Control the amount of the hazard:** Decrease the amount of a hazard that is used. The source of the indoor air hazard is the same, but the amount of exposure is less.

3. **Control the location of the hazard:** Move the location where you use a hazard source so that fewer people are exposed.

CONTROLLING INDOOR AIR HAZARDS

Reduce Humidity: Maintain the relative humidity levels of classrooms between 40-60% to minimize indoor air pollutants like biological contaminants (mold, dust mites, and cockroaches).



Increase Ventilation: Introduce outdoor air into the indoor environment to increase the amount of fresh air inside. Ventilation also decreases levels of indoor air pollution by diluting the concentration of pollutants in the air.

Name_____
Date_____Period____

TOXICOLOGY

The 16th-century physician Paracelsus, also called the Father of Toxicology, stated in 1493 that:

- All substances are poisons
- There is none which is not a poison
- The right dose differentiates a poison from a remedy

TOXICOLOGY

Toxicology is the study of exposure to toxic substances and the health effects that result from such exposure.

Risk

Risk is the probability of harm due to exposure to a hazard. Many factors influence risk from exposure to a hazard:

- Toxicity—the harmful effects from a hazardous substance.
- Dose—the amount of the substance that enters the body.
- Exposure—route, frequency, and duration.
- Individual susceptibility—differences in reaction after exposure.

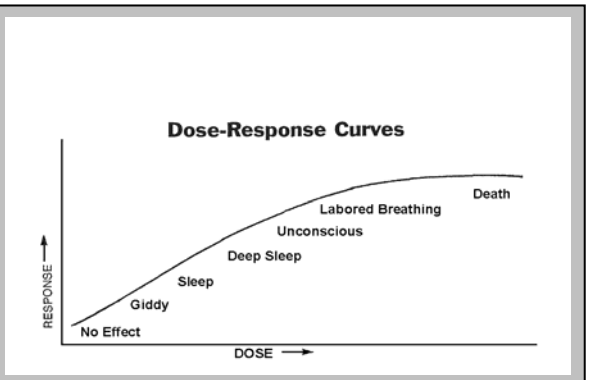
Toxicity

Toxicity is the degree to which a substance or mixture of substances can harm an organism. **Hazards** are substances that can produce an adverse biological effect or damage biological systems. There are three main categories of health hazards from toxic substances:

Chemical hazards such as lead and volatile organic compounds (VOCs).

Biological hazards such as cockroach parts, pollen, animal dander, dust mites, and mold.

Physical hazards such as asbestos and diesel exhaust.



A dose-response curve for alcohol exposure.

Dose

Dose is the specific amount of a chemical, physical or biological hazard that enters the body. Dose is expressed as an amount per unit of body weight. A 10-milligram pill of penicillin given to a 10-kilogram (22-lb.) child equals a dose of 1 mg/kg of body weight. The same 10-mg pill of penicillin given to a 100 kg (220-lb.) adult equals a dose of 0.1 mg/kg. Although the same pill was given to each person, the dose is very different. There is a dose-response relationship with all hazards entering the body: usually, the higher the dose, the more severe the effect.

Name_____
Date_____Period____

Exposure

In addition to the dose, the ability of a chemical, biological, or physical substance to damage the human body depends on the **exposure**. Exposure is the amount of contact a person has with a hazard. Exposure is based on:

- How a hazard gets into a person's body (the **route** of exposure).
- How often a person comes into contact with a hazard (the **frequency** of exposure).
- How long a person comes into contact with a hazard (the **duration** of exposure).

Route is how a toxin enters the body. There are three main **routes of exposure**: the skin (**absorption**), the lungs (**inhalation**), and the mouth and gastrointestinal tract (**ingestion**).

Skin absorption

Lung inhalation

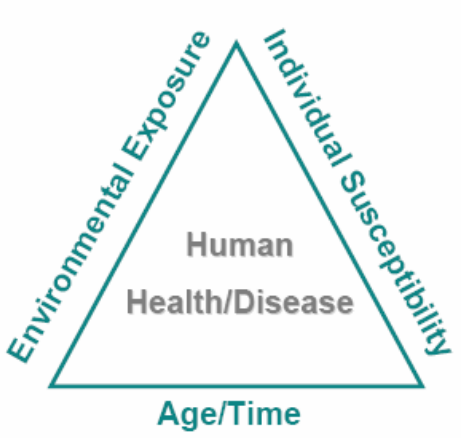
Mouth ingestion

Frequency is how often a person comes into contact with a hazard or how often a hazard gets into a person's body. Drinking several alcoholic drinks over one hour will produce symptoms of intoxication more quickly than ingesting the same number of drinks over five hours.

Duration is the length of time of exposure. Duration can be short-term, or acute; or it can be long-term, or chronic. For example, drinking several alcoholic drinks in one evening will cause an acute temporary effect of sleepiness or giddiness, while repeatedly drinking alcohol over a lifetime can cause chronic liver damage.

Individual Susceptibility

Certain personal factors influence the severity of a toxic effect on a particular person. These include age, diet and nutritional status, inherited differences (genetics), sex, exposure to other chemicals, and health condition.

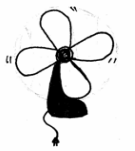


Name_____
Date_____Period____

Controlling Indoor Air Hazards

Control the source/
Reduce exposure

Reduce
humidity



Increase
ventilation

Control the Source

These are actions that prevent or stop air pollutants or hazards from getting into the indoor air environment in the first place. There are three main ways to control hazards at the source: (1) remove the source, (2) substitute the source of the hazard with something less toxic, or (3) capture the source so it doesn't become airborne.

Remove the Source of the Hazard

For example, if there are moldy water-damaged ceiling tiles in a classroom, removing and replacing the moldy tiles with new ones will remove the source of the hazard. Alternatively, if one teacher suffers from sensitivity to mold and another does not, the two teachers might agree to switch classrooms.

Substitute the Source of the Hazard

For example, use art supplies and markers that have less volatile organic compounds (VOCs) and are less toxic.

Contain the Source of the Hazard

Sometimes it is possible to put a physical barrier over the source to prevent the hazard from getting into the air. For example, if a house has lead-based paint, painting over the old paint will prevent chips from coming loose and entering the air.

Reduce the Exposure

If it is not possible to remove an indoor air pollutant from the environment, people can take action to limit their exposure:

Control the Timing of Use

Change the time that a hazard is used so building occupants are not exposed. For example, painting or varnishing the floor during the summer when students are not present.

Control the Amount of the Hazard

Decrease the amount of a hazard that is used. For example, building managers should use non-toxic cleaners whenever possible in place of more toxic chemicals.

Name_____
Date_____Period____

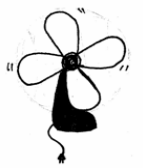
Control the Location of the Hazard

Work in a location where there is some way to contain the hazard. For example, when working with chemicals in class, students should use a flow hood rather than working out in the open.

Reduce Humidity and Temperature

Maintaining classroom relative humidity levels between 40% and 60% will minimize many indoor air pollutants, especially biological contaminants (bacteria, viruses, fungi, dust mites, and cockroaches). It is also a good idea to eliminate sources of moisture such as dripping faucets, water condensation on pipes, leaks, spills, or flooding. Maintaining room temperature between 68 and 74ºF will also help keep indoor air pollution down.

Increase Ventilation



Ventilation is the introduction of fresh outdoor air into the indoor environment. It is one of the key methods for decreasing levels of indoor air pollution by diluting the concentration of pollutants in the air. This method is useful for reducing the amount of hazards that cannot be removed by other methods. For example, since carbon dioxide is introduced into the environment when people or animals exhale, it is always present in the air. Carbon dioxide concentration is a a good indicator of room ventilation. Increasing ventilation will decrease the concentration of carbon dioxide and other hazards in a classroom.

Other Methods to Consider

Maintaining Equipment

Keeping equipment for taking care of buildings and grounds in good repair will help prevent or correct many indoor air quality problems. For example, all gas-powered equipment should be serviced on a regular schedule to reduce the risk of carbon monoxide pollution.

Keeping Buildings Clean

Good sanitation—dumping trash, wiping down tables, and cleaning floors—prevents pests such as cockroaches and mold growth and reduces building odors.

Filtering the Air

Filters capture unwanted solid and liquid particles in the air. Filters can be used as a part of building ventilation systems and also may be installed in vacuum cleaners. Some filters, such as High Efficiency Particulate Air (HEPA) filters, will capture animal allergens, dust mites, and pollen. Other types such as activated carbon filters can remove VOCs and other chemicals from air.

Name_____
Date_____Period____

READING FOR UNDERSTANDING QUESTIONS

1. Define risk.

2. It is winter, and the Johnson family (two adults, two teenagers, a toddler, and a dog) has been trying to conserve energy by keeping windows and doors closed. Their home is heated by a gas furnace. Family members have been complaining of headaches, fatigue, and difficulties concentrating and sleeping. Mrs. Johnson stays home most of the day with the toddler. They discover that they are experiencing carbon monoxide poisoning. Explain why some family members may have more severe symptoms than others.

3. What makes a chemical toxic?

4. Name the three main categories of hazards and give an example of each.

Category of Hazard	Example

Name_____
Date_____Period____

5. Explain the statement: **The dose makes the poison**.

6. What three variables determine the extent of your exposure to a hazard?

7. Describe the three main routes of exposure to a hazardous substance.

   a.

   b.

   c.

8. Describe three main ways to control indoor air quality hazards.

   a.

   b.

   c.

Name_____
Date_____Period____

NAME THAT IAQ HAZARD GAME RULES

Objective: Guess the indoor air quality hazard on your partner's card.

Scoring: You will receive one point for each question you ask. The person with the fewest points wins the game.

Materials
- 2 IAQ Hazard Game Sheets (Green)
- 12 IAQ Hazard ID Cards (Yellow)
- 2 IAQ Hazard Game Keys (Blue)

Game set-up:
1. Work in pairs.
2. Lay the *Game Sheet* (green) face up on the table in front of you. These cards will help you determine which indoor air quality hazard your partner has drawn.
3. Lay a stack of *ID Cards* (yellow) face down on the table.
4. Review the *Game Key* (blue). The key summarizes information that could be used to describe a hazard:

How to play:
1. One student draws an ID Card from the pile and does not show his/her partner the hazard. This card describes the hazard the guesser is trying to identify.
2. The other student asks *"yes"* or *"no"* questions to guess which IAQ hazard their partner has drawn. **Example:** *Is the hazard caused by a biological agent?*
3. Players must ask questions using the correct vocabulary. If a player does not use correct vocabulary, then add an extra point to their score card.
   - *Wrong* way to ask a question: *Is it a hand?*
   - *Right* way to ask a question: *Is the route of exposure through absorption?*
4. On the scorecard on the back of this page, keep track of the number of questions it takes to correctly guess the hazard.
5. The player asking the questions uses the green game sheet to keep track of the hazards that have been eliminated. Mark each eliminated hazard with a bean or sticky note.
6. Continue playing until the player is ready to guess his or her partner's hazard. If the player guesses incorrectly, add one point to the score and continue playing.
7. When one partner is finished guessing, it is the other partner's turn to guess.
8. When each player has guessed his or her partner's hazard correctly, the round is over and the number of questions is totaled on the score card.
9. Play a total of four rounds: one practice round and three counting rounds.
10. The winner is the player who has the fewest points or questions asked.

Name_____
Date_____Period____

SCORECARD

Round 1

Player Name	Number of Questions Asked
WINNER OF ROUND 1:	

Round 2

Player Name	Number of Questions Asked
WINNER OF ROUND 2:	

Round 3

Player Name	Number of Questions Asked
WINNER OF ROUND 3:	

Round 4

Player Name	Number of Questions Asked
WINNER OF ROUND 4:	

Name_____
Date_____Period____

IAQ HAZARDS

Introduction

Students and teachers in Hydroville Middle School are suffering health effects from an unknown indoor air quality hazard or hazards. You are an occupational physician (a physician who investigates environmental health concerns that occur in the workplace) and you have been called to investigate.

Materials

IAQ Hazard Game (one per pair of students)

Instructions

Use the IAQ Hazard Game Key(blue) and IAQ Hazard ID Cards (yellow) to answer the following questions:

1. Put check marks next to hazards that can cause symptoms of both Asthma (As) and Allergies (Al).

	Animal dander		*Environmental tobacco smoke*
	Asbestos		*Lead*
	Carbon monoxide		*Mold*
	Cockroaches		*Pollen*
	Diesel exhaust		*Radon*
	Dust mites		*Volatile organic compounds*

2. Look at the hazards you checked in Question 1. What is the most common category of hazard that can cause symptoms of both Asthma (As) and Allergies (Al)?

3. Put check marks next to hazards that can cause both Headache (He) and Eye, nose, and throat irritation (Ir).

	Animal dander		*Environmental tobacco smoke*
	Asbestos		*Lead*
	Carbon monoxide		*Mold*
	Cockroaches		*Pollen*
	Diesel exhaust		*Radon*
	Dust mites		*Volatile organic compounds*

Name_____
Date_____Period____

4. Physical hazards cause damage by irritating and damaging tissue in the respiratory tract (nose, throat, and lungs). Put check marks next to all the physical hazards.

	Animal dander		*Environmental tobacco smoke*
	Asbestos		*Lead*
	Carbon monoxide		*Mold*
	Cockroaches		*Pollen*
	Diesel exhaust		*Radon*
	Dust mites		*Volatile organic compounds*

5. Chemical hazards are absorbed into the body and can cause damage at the site of exposure or elsewhere in the body. Put check marks next to all the chemical hazards.

	Animal dander		*Environmental tobacco smoke*
	Asbestos		*Lead*
	Carbon monoxide		*Mold*
	Cockroaches		*Pollen*
	Diesel exhaust		*Radon*
	Dust mites		*Volatile organic compounds*

6. How can a hazard be both a chemical and physical hazard? Give examples.

7. What methods of control will reduce the amount of mold indoors?

8. Which indoor air hazards can cause cancer?

9. What do all the hazards have in common?

Name_____
Date_____Period____

TOXICOLOGY ASSESSMENT (OPTIONAL)

Directions

Reread Background Reading: *Toxicology* before doing this assignment. Read the entire article below and review the questions that follow. Read each question carefully before circling the *best* answer.

JITTERY? PEEVISH? CAN'T SLEEP? WHAT ARE YOU DRINKING?

BY RICHARD A. FRIEDMAN, M.D.

The patient was led reluctantly into my office by his girlfriend. Over the course of the past month, she explained, Adam had become uncharacteristically nervous and snappish. He hardly slept, and when he did she noticed that his muscles twitched. Adam's own account did not differ from his girlfriend's. He was a graduate student and he needed to study for his qualifying exams, he said, explaining his irritability.

I noticed during the consultation that Adam was sweaty and nervous and that the muscles around his eyes twitched. He had already seen his internist, who told him that his physical exam and routine lab tests were entirely normal. This is nothing more than stress, his doctor declared. In my office, Adam's resting heart rate was 110, which is on the fast side for a fit 31-year-old man. His blood pressure was mildly elevated at 140/80, but just talking to a psychiatrist can be nerve-racking for many people.

After a review of his psychiatric history, which was entirely negative, I asked him whether he was using any recreational drugs. Aside from experimenting with marijuana as a teenager, he said he had not. I never stop at the first denial, so I inquired about specific drugs like cocaine and amphetamines, which are well known to cause anxiety states. "No way," he said, and I believed him.

Maybe this was just plain old-fashioned anxiety. After all, Adam was facing enormous academic pressure in a prestigious institution, and he felt that his future was riding on the outcome of an exam. So I gave him some reasonable advice about dealing with stress, and sent him on his way with a clean psychiatric bill of health.

Two weeks later, I got a call from Adam's girlfriend saying that he was worse than ever. When I saw him, he looked haggard and anxious, and I was convinced that I had missed something important the first time around. Did he have an undiagnosed medical disease? Covert substance abuse? Exposure to an environmental toxin?

In painstaking detail, we reviewed his medical and psychiatric history, but nothing stood out. Exasperated, I asked him to tell me what he did from the moment he got out of bed until he went to sleep: activities, diet, everything. Then I got it. After the habitual two cups of Starbucks coffee, Adam set to work. So far, so good. But as the academic pressure mounted, he had to work longer hours, and that meant more coffee—a lot more coffee than he had ever consumed in his life. In fact, for six weeks, he had been drinking up to ten cups of Starbucks coffee daily.

That is a lot of caffeine, considering that each large cup contains on average about 375 milligrams, according to a 2003 study of caffeinated coffee published in The Journal of Analytical Toxicology. With ten cups a day, Adam was turbocharged with nearly four grams of caffeine. So Adam was not just nervous about his academic work; he was also suffering from caffeine intoxication.

How, you might wonder, could such a ubiquitous substance be toxic? With an average of one to three cups of coffee a day, most people get 100 to 300 milligrams of caffeine. With chronic exposure, though, people become accustomed to the stimulant effects of caffeine. In contrast, a sudden increase in caffeine consumption can easily produce caffeine intoxication. In general,

Name_____
Date_____Period____

more than 1.5 grams of caffeine a day can cause the typical symptoms of caffeine: anxiety, insomnia, irritability and palpitations.

Caffeine is far and away the most widely used stimulant in the world. It is actually a member of a class of compounds called xanthines that includes theobromine, which is abundant in chocolate and theophylline, the major xanthine in tea. Caffeine works by blocking the calming and analgesic effects of the neurotransmitter adenosine in the brain. In moderate doses, caffeine enhances arousal and performance. At higher doses, caffeine blocks a majority of adenosine receptors and can produce anxiety and hypersensitivity to pain. Of course Adam's response to caffeine was an extreme example. But the effects of this popular stimulant encompass a broad spectrum, from the pleasant activation of morning coffee to the extreme agitation and anxiety of caffeine intoxication.

Judging from the sheer number of consumer products spiked with caffeine, one would think we were a nation of narcoleptics, desperately trying to stay awake. From “enhanced” water to sports drinks to dietary supplements, caffeine is a common additive. And as the food and supplement industries search for new stimulants following the recent ban on ephedrine, it would hardly be surprising to find caffeine use on the rise. After all, the hectic pace of our modern life practically demands that we can switch ourselves on and off. Sure, we can stave off fatigue with caffeine, but sometimes nature pays us back richly—with anxiety and sleeplessness if we are lucky or caffeine intoxication if we indulge in excess.

Questions

1. Of the signs and symptoms listed below, which one did Adam *not* suffer from?

   a. Muscle twitches
   b. Anxiety
   c. Headache
   d. Sweating

2. How was Adam exposed to caffeine? What was the route of exposure?

   a. Inhalation
   b. Absorption
   c. Ingestion
   d. Injection

3. What other chemical hazards did Adam’s doctor think he might have been exposed to?

   a. Cocaine
   b. Amphetamines
   c. Some other undetected environmental toxin
   d. All of the above

4. One cup of coffee contains about 100 milligrams (mg) of caffeine. If Adam weighs 150 pounds (= 68 kilograms), what is the dose of caffeine that Adam drinks in each cup of coffee? (Per-cup dose = Total mg consumed in one cup of coffee divided by a person’s weight in kilograms).

   a. 100 mg/kg
   b. 10 mg/kg
   c. 5 mg/kg
   d. 1.47 mg/kg

5. One cup of coffee contains about 100 milligrams (mg) of caffeine. Adam usually consumed 10 cups of coffee per day (about 1000 milligrams of caffeine per day). If Adam weighs 150 pounds (68 kilograms), what is Adam’s daily dose of caffeine? (Daily dose = Total mg consumed in one day divided by a person’s weight in kilograms.)

   a. 14.7 mg/kg of caffeine per day
   b. 147 mg/kg of caffeine per day
   c. 100 mg/kg of caffeine per day
   d. 1000 mg/kg of caffeine per day