

Sample questions:

Which substance is most toxic according to the values of the LD₅₀s?
How would you calculate the amount of methadone that would be lethal to a 120 pound human?

Methadone appears to be the most toxic substance of the three. In order to calculate the exact lethal dose for a 120 pound human it is necessary to first convert 120 pounds to kg. 120 pounds equals 54.5 kg. Thus the lethal dose for methadone is $95 \text{ mg/kg} \times 54.5 \text{ kg} = 5,178 \text{ mg}$.

9. Wrap-up

Assist the students in summarizing what was learned in the class.

- Toxicity is relative to dosage: The toxicity (or therapeutic effect) of a substance depends on the dose in which it is received.
- The lethal dose (or therapeutic dose) of a substance is often expressed as a ratio between a certain mass of the substance and one kilogram of the body weight of an organism exposed to the substance.

Homework**10. Assign homework.**

Use the homework provided with the curriculum or assign your own.

Homework – Investigation I – Lesson 1

Find at least 5 products at home with labels that warn of toxicity. For each product, give the name of the product, and answer the following questions:

1. How does each label advise you to avoid harmful exposure to the product?
2. What does each label tell you to do if a dangerous exposure does occur?
3. Using all of this information, what can you hypothesize about the chemical properties of each product?
4. Look at the recommended treatment for the product. What chemical and physical processes do you think might be involved in the treatment?

Lethal Dose Table

Lethal dose (LD₅₀) is the amount of an ingested substance that kills 50 percent of a test sample. It is expressed in mg/kg, or milligrams of substance per kilogram of body weight.

Common name	Toxin	Lethal doses	Description	Toxic response
aspirin	acetyl- salicylic acid C ₉ H ₈ O ₄	LD ₅₀ 200 mg/kg (rat, oral)	odorless white crystal	gastric distress, confusion, psychosis, stupor, ringing in ears, drowsiness, hyperventilation
table salt	sodium chloride NaCl	LD ₅₀ 3 g/kg (rat, oral) 12357 mg/kg (human, oral)	white cubic crystal	eye irritant, elevated blood pressure
bleach (fumes)	chlorine Cl ₂	LD ₅₀ 850 mg/kg, (rat, inhaled)	greenish colored gas, amber liquid, pungent odor	corrosive to eyes, skin, respiratory tract, nausea, vomiting, pulmonary edema
helium	helium He	not established	odorless colorless gas	dizziness, nausea, simple asphyxiant
lorchel mushroom	gyromitrin C ₄ H ₈ N ₂ O	LD ₅₀ 200 mg/kg (rat, oral)		nausea, vomiting, severe liver damage, coma, convulsions
arsenic	arsenic, arsenic trioxide As, As ₂ O ₃	LD ₅₀ 15 mg/kg (rat, oral)	grey, metallic crystals	acute - irritates eyes, skin, respiratory tract, nausea, Chronic - convulsions, tissue lesions, hemorrhage, kidney impairment,
sugar	glucose C ₆ H ₁₂ O ₆	LD ₅₀ 30 g/kg (rat, oral)	sweet white powder	depressed activity, gastrointestinal disturbances. If diabetic – heart disease, blindness, nerve damage, kidney damage
iron tablets	iron sulfate FeSO ₄	~ 5 adult tablets toxic for a 3 year old	greyish white powder	nausea, vomiting, diarrhea, black stool, liver damage, coma
lead	lead Pb	Lowest published dose 450 mg/kg (human, oral)	bluish or silvery solid	acute - headache, insomnia, joint pain. Chronic-anemia, kidney disease, reproductive and developmental toxin.
snake venom	α-bungarotoxin C ₃₃₈ H ₅₂₉ N ₉₇ O ₁₀₅ S ₁₁	not available	large protein molecule	Paralysis, suffocation, loss of consciousness, seizures, hemorrhaging into tissues
Cola	caffeine C ₈ H ₁₀ N ₄ O ₂	LD ₅₀ 140 mg/kg (dog, oral)	white odorless powder or crystals	acute renal failure, nausea, psychosis, hemorrhage, increased pulse, convulsions
alcohol	ethanol C ₂ H ₆ O	LD ₅₀ 7060 mg/kg (rat, oral)	colorless liquid, pleasant odor	nausea, headache, vomiting, dizziness, nervous system depression, confusion, loss of consciousness
vitamin A	retinol C ₂₀ H ₃₀ O	LD ₅₀ 2000 mg/kg (rat, oral)	yellow crystals, orange solid	convulsions, unconsciousness, reproductive toxin

Lethal Dose



Name: _____
Date: _____ Period _____

Purpose: In this activity you will compare the toxicity of various substances.

Part I: Determining lethal dose

Lethal dose (or LD₅₀) refers to the amount of substance that kills 50 percent of a test sample. LD₅₀ is expressed in mg/kg, or milligrams of substance per kilogram of body weight. Assume LD₅₀ is the same for rats and humans.

To use LD₅₀, you will need to convert measurements of body weight from pounds to kilograms. Noting that **1 kg = 2.2 lbs**, do the following two calculations:

- How many kg does a 132-lb human weigh?
- How many kg does a 22-lb child weigh?

The LD₅₀ for acetaminophen is 2404 mg/kg (rat, oral).

- How many mg of acetaminophen would be lethal to a 132-lb adult?
- How many 500 mg tablets of acetaminophen would be lethal for an adult?
- How many mg of acetaminophen would be lethal to a 22-lb child?
- How many 500 mg tablets of acetaminophen would be lethal for a child?

The LD₅₀ for aspirin is 200 mg/kg (rat, oral).

- How many mg of aspirin would be lethal to a 132-lb adult?
- How many 500 mg tablets of aspirin would that be for an adult?

- How many mg of aspirin would be lethal to a 22-lb child?
- How many 500 mg tablets of aspirin would that be for a child?

Acetaminophen versus aspirin

- Which is more toxic, acetaminophen or aspirin? How great is the difference in their toxicities? Explain.

Part II: Comparing lethal doses

Examine the table of lethal doses for various substances.

- What substance in the table is the most toxic when ingested? Explain.
- Rank the substances as best you can based on their lethal doses for ingestion by putting a number next to each one, "1" being the most toxic.
- Are any substances in the table good for you? Explain.
- Are there any substances in the world that are not toxic? Why or why not?

Making sense:

How is dosage related to toxicity?

If you finish early...

Explain how you would calculate the lethal dosage for vitamin A. Assume each tablet contains 3 mg of retinal.

BEFORE CLASS...**LESSON 2 – Bearly Alive****Key Ideas:**

The concentration of a liquid solution is a measure of the number of moles of a solute (dissolved substance) per liter of solvent (the dissolving substance). The effects of toxins depend on concentration.

What Takes Place:

Students will examine a set of gummy bears that have been soaking in five different sugar solutions and three different salt solutions overnight. They will record the effects of the different concentrations of sugar and salt solutions on the gummy bears.

Set Up:

Prepare the day before. The gummy bears need to soak for at least two hours (preferably overnight) in their respective solutions. Prepare four sets of eight solutions as directed below. (You may use the solutions for several classes on the same day.) Pour 50 mL of each solution into labeled plastic cups. Place one gummy bear in each cup.

Materials: (for a class of 32 students)

- Student worksheet
- Sugar, salt, corn syrup, water (see solutions below)
- 8–13 index cards and glue
- 40–45 red or green gummy bears (32 will be soaked in solution, the remainder should be glued to index cards so students can see the size and color of the original bear)
- 32 clear plastic cups (to make 4 sets of 8 solutions)
- 32 plastic spoons (for lifting the bears from solution to examine them)
- 4 sets of eight labels for the solutions: (water, 2.0 M sugar, 1.0 M sugar, 0.1 M sugar, corn syrup, 1.0 M salt, 0.5 M salt, 0.1 M salt)
- Several 250- or 500-mL beakers for preparing solutions
- 200 mL of each of the following solutions:
 - water
 - 2.0 M sugar solution (136 g sucrose diluted to 200 mL)
 - 1.0 M sugar solution (68 g sucrose diluted to 200 mL)
 - 0.1 M sugar solution (20 mL of 1.0 M sugar solution diluted to 200 mL)
 - 200 mL corn syrup
 - 1.0 M salt solution (12 g salt diluted to 200 mL)
 - 0.5 M salt solution (6 g salt diluted to 200 mL)
 - 0.1 M salt solution (20 mL of 1.0 M salt solution diluted to 200 mL)