

# Toxicity Testing: The Effect of Chemicals on Radish Seeds

---

By David Vannier

Office of Science Education, National Institutes of Health, Bethesda, MD

## Grade Levels

Middle School, High School

## Background

The beneficial and harmful effects that a chemical has on an organism depend, in part, on the amount of the chemical that gets into the organism. The total amount of chemical administered to, or taken by, an organism is called a *dose*, and a chemical's effect on a living organism is called the *response*.

The chemical's effect is related to the dose of the chemical and the resulting concentration of chemical in the organism. *Toxicity tests* enable toxicologists to learn about responses of living organisms, especially humans, to doses of chemicals.

In this experiment, students perform toxicity tests on seeds, paying careful attention to the dose and concentration of chemicals.

From this experiment, students can learn:

- The importance of using model systems in science when human subjects cannot be used because of the potential risk.
- That many questions in science suggest a variety of investigation methods.
- That using models in scientific inquiry can help establish relationships based on evidence from students' own observations.

Radish seeds are ideal for the experiment because they are easily found at local garden stores and will germinate in one to three days.

## Purpose

The experiment has three purposes:

1. To test the effects of different doses of chemicals on seed germination and collect data for 2 consecutive days.
2. To show that a chemical's effect on an organism is related to the dose and the resulting concentration of chemical in the organism.
3. To demonstrate how toxicity tests enable toxicologists to learn about responses of living organisms to doses of chemicals (dose-response relationship).

## Hypothesis

Exposure to solutions of increasing concentrations of chemicals will have an effect on the normal germination of radish cells. Students may hypothesize that certain chemicals are more toxic (poisonous) than others.

## Duration

- Set-up time: 45 minutes (one class period)
- Experiment run time/data collection: 2 consecutive days, 15 minutes each day, for observations and data collection
- Take-down time: 5 minutes

## Materials

For a team of three students:

- 6 resealable plastic sandwich bags
- 12 paper napkins
- 6 50-mL beakers of chemical solution, ranging from 0% to 100% concentration\*
- 1 bag of radish seeds (approximately 60 seeds in a bag)
- 1 permanent marker
- latex gloves
- safety glasses
- 1 tray

*\*Safe, easily available chemicals for testing include water-soluble plant food, artificial sweetener, liquid detergent, shampoo, soft drinks, window cleaner, instant coffee, salt, non-toxic environmental cleaner, sugar, tempura paints, fruit and vegetable cleaner, all-purpose disinfectant cleaner (e.g., Lysol).*

## Setting Up the Experiment

For each team of students, prepare 20 mL solutions of each percentage concentration of chemicals (0%, 6.25%, 12.5%, 25%, 50%, 100%) according to the Table 1 below (see the next page).

Assemble materials and set them out.

**Table 1. Percentage concentrations of chemicals to prepare**

Beaker #	Amount of water	Amount of chemical	Total volume of liquid	Concentration of chemical
1	20.00 mL	0.00 mL	20 mL	0%
2	18.75 mL	1.25 mL	20 mL	6.25%
3	17.50 mL	2.50 mL	20 mL	12.5%
4	15.00 mL	5.00 mL	20 mL	25%
5	10.00 mL	10.00 mL	20 mL	50%
6	0.00 mL	20.00 mL	20 mL	100%

### Conducting the Experiment

1. Label all six bags with your team members' initials, plus the bag number and a percent concentration of chemical, like this:

Bag number	Chemical concentration
#1	0%
#2	6.25%
#3	12.5%
#4	25%
#5	50%
#6	100%

2. Put two napkins together and fold them in half so that they fit into the plastic bag. Fill each bag with the two folded paper napkins.
3. Put on the safety glasses and latex gloves. Carefully pour the chemical solutions into the bags, making sure to match the numbers and concentration percentages of the bag and the chemical. Each bag now will contain 20 mL of chemical solution that is absorbed by the paper napkins.
4. Count out 10 seeds. Carefully place the seeds on the moist paper napkins in the control bag (#1), making sure to space them evenly (do not clump them in one spot). Seal the plastic bag, pushing out the air as you go.

5. Repeat Steps 2–4 for the remaining bags.
6. Place the seed bags in a stack, lying flat with the seeds up, on the tray. Put the tray of seeds in the spot designated by your teacher. Put this worksheet in your science notebook.
7. Observe the seeds for 2 days.
8. Fill in the data in Table 2 below.

**Table 2. Response of radish seeds to different concentrations of chemical**

Bag #, dose	Day 1, # seeds germinated	Day 1, # seeds not germinated	Day 2, # seeds germinated	Day 2, # seeds not germinated
1, 0% (control)				
2, 6.25%				
3, 12.5%				
4, 25%				
5, 50%				
6, 100%				

### Taking Down the Experiment

Clean up your work area. Everything can go into the regular trash.

### Analyzing the Data

- On Day 1, predict what you think will happen to the seeds in each bag.
- What was your chemical? Describe what you know about it.
  - Do you consider the chemical harmful, beneficial, or neither?
  - What is it used for?
  - How would a human be exposed to this chemical?
- In which bag was the *dose* of chemical the highest?
- In which bag was the *concentration* of chemical in the solution the highest? Describe how you know.
- Did you see a difference in the effect on seeds of a small dose of chemical compared with the effect of a larger dose?
- What exactly did you see?
- Is there anything else you saw that you'd like to tell us?
- Is there anything else you're still wondering about?

## **Conclusion**

An example of one possible conclusion is: "In our classroom experiment, we were able to observe the dose-response relationship of radish seeds after the seeds were given different types and doses of chemicals."

Students will see that different chemicals have various effects on radish seed germination. They should be able to compare various levels of toxicity of these chemicals to radish seeds.

*This procedure was adapted from "Chemicals, the Environment, and You," a curriculum supplement from the National Institutes of Health Office of Science Education and Biological Sciences Curriculum Study.*