Growing Irradiated Bean Seeds

What happens to seeds that are exposed to very high levels of radiation? Will they grow normally?

Grade Level
5-12

Disciplinary Core Ideas (DCI, NGSS)
5-PS1-3, 5-ESS3-1, 3-5 ETS1-1, MS-ETS1-2, MS-ETS1-3, HS-PS4-4, HS-ESS2-3

Time for Teacher Preparation
30-60 minutes – To gather materials and set-up

Activity Time:
1-2 Weeks Minimum. Passive observations as beans grow.

Materials
- Pen, Marker, or Pencil
- Student Data Collection Sheets
- Mung bean seed
- Irradiated Mung bean seeds (50,000; 100,000; 150,000 rad exposure)
- Potting soil
- Pots (2" to 3" pots)
- Small metric rulers

Safety
- Students should not put bean seeds, soil, pots, or metric rulers in their mouths due to choking hazard.
- Students should not try eating bean seeds or irradiated bean seeds.

Science and Engineering Practices (NGSS)
- Ask questions and define problems
- Plan and carry out investigation
- Analyze and interpret data
- Use mathematics and computational thinking
- Construct explanations
- Argue from Evidence
- Obtain, evaluate and communicate information

Cross Cutting Concepts
- Patterns
- Cause and Effect
- Scale, Proportion, and Quantity
- Energy and Matter: Flows, Cycles, and Conservation
- Structure and Function
- Stability and Change of Systems

Objectives
The students develop a procedure to study the effects of radiation on mung bean seeds and other irradiated seeds. Students will observe and record data on the germination and development of the plants. Student data, results, and conclusions will be presented, supported, and defended by the students to the class.

- To define the terms radiation and irradiation
- To determine how irradiation affects the growth of bean seeds
- To determine how much radiation dose comes from nature and how much comes from the uses of radiation in society.
- To compare data

Background
Irradiation is becoming increasingly more popular in the treatment of foods to kill bacteria, diseases and pests. A fear of radiation causes some people to believe that food that is irradiated becomes radioactive. The irradiated bean seeds in this experiment have been exposed to various levels of gamma radiation, but are not radioactive and are completely safe to handle.

You cannot tell how much radiation the seeds were given by looking at them. These seeds were harvested and irradiated after the plants were mature. However, you will be able to observe differences in the plants growing from these seeds. Each seed contains an embryo plant. When the gamma radiation passed through these seeds, it damaged some of the cells in the embryo. The greater the radiation, the more cells were damaged. Therefore, the resulting plants grown from seeds with greater exposures will show more abnormalities than those with lower exposures.

Teacher Lesson Plan:

Traditional

Split students into groups of four and give each group four sets of bean seeds (control; 50,000; 100,000; 150,000 rad). Have each group plant their seeds in separate pots and set up a table to chart and graph the growth of the seeds over the next couple of weeks. Students should record height and observations of their beans at least twice a week. Remind students to water their beans as frequently as needed in order to take care of their plants.

It might be helpful to stress that the beans have been irradiated, but are not radioactive.

Students may also grow the seeds in test tubes of water and plant them once they have germinated.

NGSS Guided Inquiry

Have students design an experiment to discover about how much radiation each of their seeds was exposed to.

Student Procedure

1. Plant seeds into separate pots and water until the soil is moist.
   - Alternatively, grow the seeds submerged in water inside of test tubes until they germinate and then pot them.
2. Set up a data table to record height and observations of the bean seedlings. Observations should be made at least twice per week.
3. Take care of your plants by watering them as frequently as needed.
4. Graph data from your data table and deduce which seeds received which dose of radiation (control; 50,000; 100,000; 150,000 rad)
5. Add a step to include listing the variables which must be controlled in this experiment.

   Examples of this include:
   - exposure to sun or artificial light
   - temperature of the surroundings
   - whether seed is grown in soil or in water
   - the amount of water added to the soil (students should measure the added water in milliliters).

Data Collection

Attached Student Data Collection Sheets

Post Discussion/Effective Teaching Strategies

Questions provided on the Student Data Collection Sheets

Questions

1. What happened? Why do you think the things you observed occurred? Were your observations and conclusions different from other students? Why? Who's "right?"
2. 100,000 rads or 150,000 rads is enough to kill a human. Did it kill all the plants? What do you think are some possible explanations?

Assessment Ideas

- Test the student's observations against the actual irradiated exposure of each plant.

Differentiated Learning/Enrichment

- Have students make slides of each of the beans for viewing under a microscope.
- Try getting a couple more generations from the plants to observe successive generations.

Enrichment Questions

1. If radiation increases on earth, what effects do you think it will that have on plant growth? On other organisms? On humans?
2. What do you think happened to the cells of the irradiated Mung bean plants?
3. Why do we use irradiation to prevent food from spoiling?

Further Resources

The ANS Center for Nuclear Science and Technology Information

http://www.nuclearconnect.org/know-nuclear/applications/food

Purchase Irradiated Mung Seeds through Ward's Science (#6730926)

https://www.wardsci.com

For similar experiments:

http://www.hometrainingtools.com/images/art/science-fair-guide.pdf

Citations for Reference:

- Los Alamos National Laboratory (1992). **Detecting the Invisible: The SWOOPE Radiation and Radon Discovery Unit**. Los Alamos National Laboratory.

Growing Irradiated Bean Seeds

Student Data Collection ANSWER Sheet

Objectives

- To define the terms radiation and irradiation
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- To compare data

Instructions

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    - Alternatively, grow the seeds submerged in water inside of test tubes until they germinate and then pot them.
2. Set up a data table to record height and observations of the bean seedlings. Observations should be made at least twice per week.
3. Take care of your plants by watering them as frequently as needed.
4. Graph data from your data table and deduce which seeds received which dose of radiation (control; 50,000; 100,000; 150,000 rad)
5. List the variables you will control in this experiment.
6. Record the source of light, temperature of surroundings, amount of soil, amount of water, amount of radiation for each seed planted.

Growing Irradiated Bean Seeds

Student Data Collection ANSWER Sheet

Seed 1 - Control			Seed 2 - 50,000 rad		
Height	**Observation**	**Drawing**	**Height**	**Observation**	**Drawing**

Seed 3 - 100,000 rad			Seed 4 - 150,000 rad		
Height	**Observation**	**Drawing**	**Height**	**Observation**	**Drawing**

Growing Irradiated Bean Seeds

Student Data Collection ANSWER Sheet

Questions

1. What happened? Why do you think the thing you observed occurred? Were your observations and conclusions different from other students? Why? Who's "right"?

   Results will vary.

2. 100,000 rads or 150,000 rads is enough to kill a human. Did it kill all the plants? What do you think are some possible explanations?

   No, it should not have killed all the plants. Possible explanations could include either size of the seed or complexity of the DNA contained in the seed. The seed is non-living and cannot repair DNA whereas humans are alive and can potentially repair DNA.

3. If radiation increases on earth, what effects do you think it will that have on plant growth? On other organisms? On humans?

   What was seen in this experiment is that the greater the radiation, the more plant cells were damaged. Therefore, the resulting plants grown from seeds with greater exposures will show more abnormalities than those with lower exposures.

   Radiation hormesis is the hypothesis that low doses of ionizing radiation (within the region of and just above natural background levels) are beneficial, stimulating the activation of repair mechanisms that protect against disease, that are not activated in absence of ionizing radiation.

Growing Irradiated Bean Seeds

Student Data Collection ANSWER Sheet

Questions

4. What do you think happened to the cells of the irradiated mung bean plants?

   Gamma radiation passed through the seeds, and either had no effect, damaged the cells in the embryo or the actual DNA structure itself.

5. List the controls in this experiment. What is the variable in this experiment?

   The controls are the non-irradiated seed and the amount of water and sunlight supplied to each seed. The variables in the experiment are the amount of irradiation that the seeds were exposed to.

6. What is the general rule about the number of variables which can change when testing the effect in an experiment?

   An experiment is typically carried out by manipulating a variable, called the independent variable, affecting the experimental group. The effect that the researcher is interested in, the dependent variable(s), is measured.

   Identifying and controlling non-experimental factors which the researcher does not want to influence the effects, is crucial to drawing a valid conclusion. This is often done by controlling variables, if possible, or randomizing variables to minimize effects that can be traced back to third variables. Researchers only want to measure the effect of the independent variable(s) when conducting an experiment, allowing them to conclude that this was the reason for the effect.

Name: _____

Date: _____

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Student Data Collection Sheet

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4. Graph data from your data table and deduce which seeds received which dose of radiation (control; 50,000; 100,000; 150,000 rad)
5. List the variables you will control in this experiment.
6. Record the source of light, temperature of surroundings, amount of soil, amount of water, amount of radiation for each seed planted.

Irradiation and Benefits – Growing Irradiated Bean Seeds

Student Data Collection Sheet

Name: _____

Date: _____

Seed 1 - Control			Seed 2 - 50,000 rad		
Height	**Observation**	**Drawing**	**Height**	**Observation**	**Drawing**

Seed 3 - 100,000 rad			Seed 4 - 150,000 rad		
Height	**Observation**	**Drawing**	**Height**	**Observation**	**Drawing**

Irradiation and Benefits – Growing Irradiated Bean Seeds

Student Data Collection Sheet

Name: _____

Date: _____

Questions

1. What happened? Why do you think the things you observed occurred? Were your observations and conclusions different from other students? Why? Who's "right"?

2. 100,000 rads or 150,000 rads is enough to kill a human. Did it kill all the plants? What do you think are some possible explanations?

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Irradiation and Benefits –
Growing Irradiated Bean Seeds
Student Data Collection Sheet

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