APES- Environmental Effects of Radiation Laboratory Activity

Purpose: *To see the effect of the seed irradiation on germination and plant growth*

Background: The *irradiation* of seeds may cause a sudden and well-marked change in the plant, which is called a ***mutation.*** The production of mutations by irradiation is not a new phenomenon. Cosmic rays have been and are responsible for so-called, "natural mutations". For a scientific investigation of the effects of irradiation on the germination of seeds and the subsequent growth of the plants, seeds are irradiated with *gamma rays* in order to produce many more changes than would occur due to cosmic rays in the same period of time.

Irradiation often may prove to be *detrimental* to the seeds, but sometimes it may be beneficial to the plant. Experimentation with several generations of plants from irradiated seeds is helpful to this study. As to the actual growth of any seed, it must be known that about 80% of the control group of seeds will germinate and grow. If then more than 80% of the irradiated seeds germinate and grow, or grow faster than the plants from the control seeds, a beneficial effect of irradiation would be demonstrated. If, one the other hand, most of the irradiated seeds would not germinate, or after germination their growth would be retarded or stopped, a detrimental effect of irradiation would be demonstrated. It may happen that the same dose of irradiation will produce beneficial mutations in some seeds and detrimental mutations in others. ***Some of the beneficial mutations may be resistance to diseases and abnormal weather conditions, increase in rate of growth, or better quality and quantity of the fruits produced by the plant; the detrimental mutations may be loss of chlorophyll, growth retardation, decrease in viability, or change in color and size of flowers.***

Gamma Radiation is a form of energy similar to x-rays, which is limited from a variety of environmental sources. Another other kind is alpha radiation. Radiation is of concern, because its' type, total amount, or rate of delivery, radiation can cause changes in the genetic material. In very high doses, it kills cells directly. Radiation dosage is measured in **rads, (radiation absorbed dose),** which is equal to **100 of energy absorbed**

by 1 gram of material. *Most human radiation doses are measured in millrads (m rad= 1/1000 of a rad).*

Procedures:

1: Fill potting soil to within ¾ " of the top of each pot using a marker to identify each pot:

- *#1- Rye seeds- Control*
- *#2- Rye seeds- 50,000 Rads*
- *#3- Rye seeds- 100,000 Rads*
- *#4- Rye seeds- 150,000 Rads*
- *#5- Mung beans- Control*

- *#6- Mung beans- 50,000 Rads*
- *#7- Mung beans- 100,000 Rads*
- *#8- Mung beans- 150,000 Rads*

2: Distribute approximately 50 control Rye seeds onto the soil in the appropriately labeled pot. *Repeat for the 3 groups of Rye seeds.*

3: Plant approximately 10 Mung bean seeds about 1cm deep in the soil in the appropriate pot. *Repeat for the 3 groups of irradiated Mung bean seeds.*

4: Gently water each pot to moisten the soil (approximately 100ml of water)- *be careful not to overwater!*

5: Place the containers near a window or under grow lamps. *Water every few days as needed.*

6: Twenty-four hours later, remove one germinated seed from each group and measure the roots and stems of each seedling. *Discard measured seedlings*

7: Repeat step 6 every other day for the next week. Record the total number of seeds that germinated in each group and record on the data table. Continue to record observations from day to day.

8: At the end of the suitable growing period (about 3 weeks), study the results indicated on the data sheet. Determine the above average height for the control group (h_o), and the average height (h), for the experimental group; calculate the reduction in growth for the irradiation dose given. **(h_o-h/h_o.)**
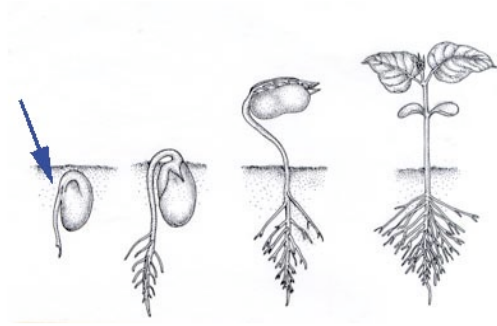
9: Continue to measure the increase in growth of all plants for 3 more weeks.

10: After 3 weeks, *repeat step #8 to determine if the effect of growth is greater in the early stages of growth or later.*

11: If changes are observed, insure self-pollination by placing transparent bag over each flower *(only with the Mung seeds).*

APES- Radiation Lab Data Sheet

Name: _____

(Make a data table for EACH TYPE= 8 data tables)

Type of Seed:

Time after seeds were planted	Length of primary root (cm)	Length of stem (cm)	Other observations
24 hours			
48 hours			
72 hours			
96 hours			
5 days			
6 days			

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Time after seeds were planted	Length of primary root (cm)	Length of stem (cm)	Other observations
24 hours			
48 hours			
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Mung Seeds- % Germinated by Day

Control	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
50,000 rads						
Average ht of plants (cm)						
100,000 rads						
Average ht of plants (cm)						
150,000 rads						
Average ht of plants (cm)						

Rye Seeds- % Germinated by Day

Control	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
50,000 rads						
Average ht of plants (cm)						
100,000 rads						
Average ht of plants (cm)						
150,000 rads						
Average ht of plants (cm)						

Data Analysis: *For each group of Rye or Mung Bean Seeds, plot the % germination (vertical axis) against time in days (horizontal axis). Make sure to label your graph correctly and use a key.*

Results and Conclusions:

Calculate the average height for the control group (h_0 in cm) and average height for experimental group (h in cm).

Period of growth	Average height of control group (h0 in cm)	Average height for experimental group (h in cm)
Week #1		
Week #2		
Week #3		
Total growth (3 weeks)		

Calculate the reduction in growth: h_o-h/h_o = _____ for each dose of rads

Mung Seeds

Control: _____   50,000 Rads: _____

100,000 Rads: _____   150,000 Rads: _____

Rye Seeds

Control: _____   50,000 Rads: _____

100,000 Rads: _____   150,000 Rads:_____

Data Analysis:

1: Is there a dose at which no effect of germination is seen?

2: What dose carried the greatest reduction on germination percentage?

3: What dose carried the highest change in root length?

4: What dose caused the greatest change in shoot length?

5: Are there any dosages at which the (a) times of germination, (b) total percentage germinated, (c) average root lengths, (d) average shoot lengths, do not differ from the control? **Explain.**

6: As a result of this simulation, what do you think happened to the plants near a nuclear accident such as that happened to Chernobyl in the Soviet Union? *Explain using your data.*

Conclusion: *What can you conclude about the effects of radiation on cell growth? Explain.*