

**Investigative Lab 11A**

## Radical Radishes

### *Quantifying the Effects of Radiation on Radish Seedlings*

**Question** How does radiation affect the germination of radish seeds and the characteristics of the seedlings?

**Lab Overview** In this investigation your class will germinate (grow into seedlings) radish seeds that have been exposed to varying amounts of radiation in a process called *irradiation*. You will calculate the percentage of the seeds that germinate and study the characteristics of the resulting seedlings. Afterward, you will use your data to draw conclusions about how genetic mutations may have affected the radish plants' traits and ability to survive.

**Background** Like all seeds, each radish seed contains a plant embryo. Each seed also contains starch, fats, and proteins that provide energy and building materials for the growing seedling. When a seed first absorbs water, cells in the plant embryo start to divide (by mitosis) and the embryo begins to grow. The young stem and leaves grow upward, and the roots grow downward.

The radish seeds you will use in this investigation have been exposed to cobalt-60, a radioactive isotope of the element cobalt. Cobalt-60 gives off gamma rays, a short-wavelength form of electromagnetic energy with more energy than x-rays. Exposure to gamma rays does not make the seeds themselves radioactive, but many molecules in the seeds can be affected. Gamma rays can break covalent bonds in molecules such as DNA. As a result, the DNA in cells exposed to gamma rays may have many nicks and breaks. Extensive DNA damage can kill a cell. But, living organisms have "repair enzymes" that fix DNA damage.

Genetic mutations can occur if DNA is not repaired correctly. For example, deletions and insertions can occur if a small part of the DNA sequence is lost or misplaced when broken ends are rejoined. When the mutated genes are transcribed and translated, they may produce proteins that do not work properly. When the cell divides, these mutant genes can be passed on to the new cells. Because the seeds used in this lab were exposed to gamma rays, mutations may have occurred that will be passed on as the embryo cells divide in the growing seedlings. You may observe some visible effects of proteins that do not work properly.

**Prelab Activity** Complete the Prelab Activity below. See pages 236–237 in your textbook to review these steps.

- For each base in the DNA sequence in Diagram A, write in the appropriate mRNA base. Then use the genetic code chart to fill in the correct amino acid in the polypeptide for each mRNA codon.

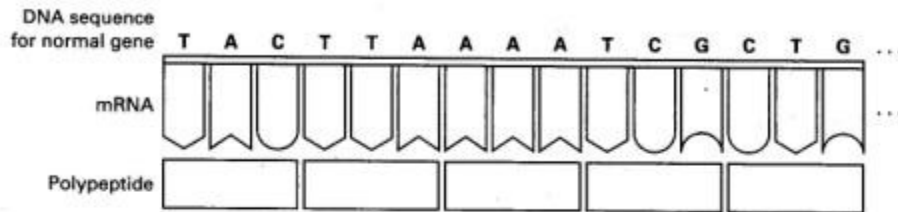


Diagram A

		Second base in codon				
		U	C	A	G	
U	U	UUU } Phe	UCU } Ser	UAU } Tyr	UGU } Cys	U
		UUC } Phe	UCC } Ser	UAC } Tyr	UGC } Cys	C
		UUA } Leu	UCA } Ser	UAA Stop	UGA Stop	A
		UUG } Leu	UCG } Ser	UAG Stop	UGG Trp	G
C	C	CUU } Leu	CCU } Pro	CAU } His	CGU } Arg	U
		CUC } Leu	CCC } Pro	CAC } His	CGC } Arg	C
		CUA } Leu	CCA } Pro	CAA } Gln	CGA } Arg	A
		CUG } Leu	CCG } Pro	CAG } Gln	CGG } Arg	G
A	A	AUU } Ile	ACU } Thr	AAU } Asn	AGU } Ser	U
		AUC } Ile	ACC } Thr	AAC } Asn	AGC } Ser	C
		AUA } Ile	ACA } Thr	AAA } Lys	AGA } Arg	A
		AUG } Met or start	ACG } Thr	AAG } Lys	AGG } Arg	G
G	G	GUU } Val	GCU } Ala	GAU } Asp	GGU } Gly	U
		GUC } Val	GCC } Ala	GAC } Asp	GGC } Gly	C
		GUA } Val	GCA } Ala	GAA } Glu	GGA } Gly	A
		GUG } Val	GCG } Ala	GAG } Glu	GGG } Gly	G

- When the cell containing this DNA was irradiated, damage occurred to the DNA that resulted in changes to its sequence. Fill in Diagram B and compare your results to Diagram A. Then answer the Prelab Questions on the next page.

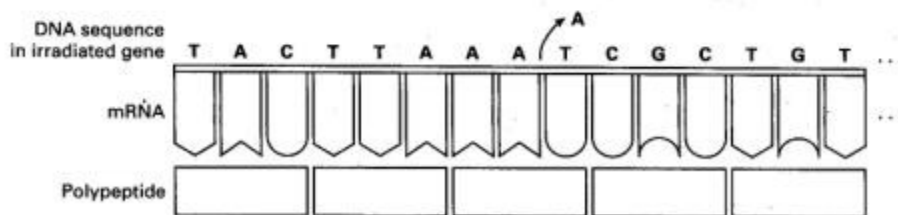


Diagram B

**Prelab Questions**

1. What type of mutation occurred in this strand of DNA? Explain how this may have happened.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

2. Is it likely that these mutated genes could produce a working protein?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

3. If this protein is involved in a radish seed's response to the absorption of water, how might the mutation affect germination?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Materials**

- small growing container
- labeling tape
- marker
- potting soil
- water
- bucket or other drainage container
- 10 radish seeds exposed to cobalt-60
- metric ruler
- calculator (optional)

**Procedure**



**Part A: Planting Seeds**

1. In the space provided above Data Table 1 on the next page, record the amount of radiation exposure your seeds received. Note that radiation exposure is measured in KR (kilorads).
2. Label a growing container with your and your lab partners' initials, class section, date, and the amount of radiation exposure your seeds received.
3. Fill the growing container with potting soil to about 1 cm below the rim. Water the soil well and let the excess water drain into a bucket or other drainage container.
4. Evenly space your 10 seeds on the soil surface. Cover the seeds with a 0.5-cm layer of soil.

5. Make predictions about your radish seedlings based on the amount of radiation exposure the seeds received.

**Predictions:**

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**Part B: Making Observations and Collecting Data**

1. After your seedlings sprout (48–72 hours), observe their general appearance and measure the height of each seedling. Record your data in Data Table 1. (NOTE: If fewer than 10 seedlings sprouted, draw a line through each unused row.)

**Data Table 1: Group Data**

Radiation exposure: \_\_\_\_\_ KR

Seedling	Height of Seedling (cm)	General Appearance, Color, and Leaf Shape
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

2. Calculate the average height of your seedlings that sprouted. (Hint: To calculate the average height, add the height measurements together and divide by the number of seedlings.)

Average height of seedlings: \_\_\_\_\_ cm



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2. How did radiation affect the ability of the seeds to sprout? Support your answer with data from the experiment.

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3. What effect did radiation have on the height of the seedlings?

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4. What effect did radiation have on the general appearance of the seedlings?

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5. Explain on a cellular level how radiation may have led to the effects you observed.

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**Extension**

Allow the radish seedlings to grow for another 3 weeks and continue making observations. Describe any differences you observe in leaves and flowers.