

Time

15-20 minutes

Materials and Preparation

- Large popsicle sticks
- Masking tape
- Tissue paper (the kind used for wrapping packages)
- Scissors
- Red, blue, yellow, and green tempura paint (or some other viscous material)
- 4 squirt guns
- Screen
- Garbage bags or drop cloths

Key Question

DNA mutations from radiation can be potentially harmful.

What is the ALARA concept?

What is DNA affected by radiation when the ALARA concept is properly executed?

Background

Where did you get your blue eyes or your size eleven feet? Your genetic makeup determines your shoe size and the color of your eyes.

Deoxyribonucleic acid (DNA) is a molecule that makes up chromosomes. It is composed of four basic units: adenine (A), cytosine(C), thiamine (T), and guanine (G). DNA stores information as a genetic code. As DNA divides, it replicates the same genetic code over and over. What happens if there is a “break” in the code? The DNA will replicate the break. This “break” is called a mutation.

There can be many causes for a mutation. Mutations are not always bad. Sometimes mutations can be good or cause no noticeable effect. Radiation can be a cause of DNA mutations. Therefore, the ALARA concept is used as a guideline to decrease radiation exposure. The ALARA concept uses time, distance, and shielding to aid radiation workers, both on Earth and in space, in keeping their exposure low. Astronauts must be aware of radiation and its potentially harmful effects. The Earth’s atmosphere acts as a shield against radiation. Yet in space, there is no atmosphere. There are many other potentially harmful radiation hazards that can be present in space such as solar flares and coronal mass ejections from the sun.

Part One – Designing Genes

PROCEDURE FOR PART ONE

1. Divide into groups of four. Further divide each group of four into two pairs of two.
2. Each group of two will construct a base pair of DNA. There will be one person that will represent adenine, another thymine. The other two-person group will represent guanine and cytosine.
3. Each group of two will then construct 2 hexagon shapes out of the Popsicle sticks using tape to hold the sticks together. Each hexagon shape will represent one of the four bases (adenine,

thymine, guanine, or cytosine).

4. Cover each individual hexagon shape with tissue paper.

5. Attach the two hexagon shapes together with three Popsicle sticks to represent the hydrogen bonds.

6. The students can then mark on the tissue paper his/her base with the appropriate letter (A- adenine, T-thymine, G-guanine, C-cytosine). It is very important to remember that A is paired with T and G is paired with C.

7. Have one member of the four-member group fill the squirt guns with diluted paint and water. Note: Use red for one gun, blue for another, green for the third, and yellow for the fourth.

8. The first two-person team will place their DNA base pair against a wall or other station where it can stand upright. This area must be okay for splatters of paint. Place a drop cloth or garbage bag underneath and behind it to make clean up easier.

9. Using the yellow squirt gun, one person will stand exactly 8 feet away from the base pairs and squirt one time. (This will be the control).

10. The opposing base pair team will stand exactly 8 feet away from the DNA base pair and shoot the red squirt gun. Only one member of the team will use the squirt gun. (The red paint on the DNA will represent time.)

11. The same group will then stand exactly 16 feet away from the DNA base pairs and shoot the green squirt gun one time at the DNA base pair. (The green paint on the DNA will represent distance).

12. Next, place the screen in front of the DNA pair. Standing exactly 8 feet away, use the blue squirt gun and squirt one time at the DNA base pair. (This represents shielding).

13. Have the other two-person group follow the same steps. (Steps 9-13). Make sure to replace the DNA base pair when it is the alternate team's turn.

CLOSURE QUESTIONS FOR PART ONE

1. How can the astronauts at the space station use the ALARA concept to help them decrease their radiation exposure?
2. Describe your results from this activity. Be sure to explain the relationship between time, distance, and shielding and their effects on DNA.
3. What other resources could the astronauts use to aid them in decreasing their exposures while in space?