e::MISSION
SPACE STATION ALPHA

Lesson 8: Radiation Health II

Preparatory Readings

LP #	Unit 1: Mission Bfg/ App Process
Mission Briefing	
1	The Mission
1	We Need You
1	Space Station Alpha
opt	Verizon
How to Apply	
2	Apply Today
2,3	Personal Essay
2,3	Class Activity: Station Systems
opt	Mission Patch

LP #	Unit 2: Space Weather
4	Specialist Orientation
Chapter 1	
4	Here Comes the Sun
4	Inside the Atom
5	Sheer Magnetism (Hands On)
5	Dr. Z: Inside the Sun

LP #	Unit 3: Radiation Health
Chapter 2	
7	New Frontiers & New Dangers
8	Electromag Rad: Taming the Wild Energies
7	Do You Want the Recipe?
7	In the Kitchen with Poly
7	Measuring Exposure to Radiation
Enrichment Activities	
7	Ready, Aim, Mutate! (Hands On)
7	Sweet Dreams are Made of These (Hands On)
7	Are You Too Hot? (Hands On)

LP #	Unit 4: Power Systems
Chapter 3	
9	The Energy Supply Problem
9	Rechargeable Batteries
10	All About Power
10	Emergency Procedures
10	Practice Ex: Power on the SS (Hands On)
Enrichment Activities	
10	Electrical Current Mag Field (Hands On)
10	Electrical Circuit: Quick Guide (Hands On)
10	Nailing Down Energy (Hands On)
10	A Shocking Discovery (Hands On)
10	Electrolysis (Hands On)
10	It's Electric (Hands On)

LP #	Unit 5: Life Support
Chapter 4	
12	How I Discovered Air
12	A Weighty Discovery
12	Living in a Bubble
12	Breathing on the Space Station

LP #	Unit 6: Pre-Mission Prep
13	Overview of Teams
13	Mission Directives
13	Classroom Setup
Team Preparation Introductions	
13	STORM Team Overview
13	Radiation Team Overview
13	Power Team Overview
13	Life Support Team Overview
13	Communications Team Overview

Other Homework Due:

Closure questions from the hands-on activity

Subject

The forms of radiation and their potential affect upon the astronauts. Safety procedures on the space station.

Description of Student Activities

During this class the students will participate in an *Article Review* activity. Divide your class into 7 student groups. Each group will prepare the answer to one question, report their answers, and respond to questions by classmates. Make sure that each question is assigned to a group.

Duration

45 min. Peer Review Activity (10 min. to prep. 35 min. for reports)

Materials

Articles for review

Main Topics

1. The astronauts are exposed to extremely high levels of ionizing radiation during a severe coronal mass ejection, also called a solar proton event.
2. Radiation and radioactivity are different, but both are dangerous to the astronauts.
3. Dangerous radiation can affect a human's DNA.
4. Dangerous radiation is measured in rads and rems. The Tissue Equivalent Proportional Counters (TEPC) on the space station record exposure to radiation in millirems. (1000 millirem = 1 rem)
5. Based upon the ALARA guidelines, the astronauts can take steps on board the space station to protect themselves from excessive amounts of radiation.

Outcomes

1. Students will explain the dangers of radiation on board Space Station Alpha using the terms "rad," "rem," and "dose."
2. Students will explain the three possible affects that dangerous forms of radiation may have upon human cells and DNA.
3. Students will summarize the variety of energies on the electromagnetic spectrum and identify which of these are ionizing and non-ionizing forms of radiation.
4. Students will explain how the astronauts can apply the ALARA guidelines during a solar proton event.

Special Comments

Article Review activity questions have varying degrees of difficulty. You may wish to assign the more difficult questions to more capable students. We have attempted to rank the questions by difficulty. This ranking is, however, highly subjective.

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Procedure

Article Review activity (45 minutes)
Seven student questions and one teacher question (#4) with answers. Relevant articles are in parentheses. You may or may not wish to guide your students to the appropriate article.

Your careful guidance of this process will help the students stay on task and finish in the allotted amount of time. The process is as follows: 1. All groups prepare their reports. 2. One group at a time A) reads the question B) presents the answer C) invites questions or comments from other students.

Homework for Lesson 9

Complete *Mission Specialist Log* Entry

Read
- *Energy Supply Problem*
- *Rechargeable Batteries*

Explain to the students that the power systems or electrical systems on Space Station Alpha are the single line of defense against the vacuum of space for the astronauts. Ask them why this might be so. Explain that tonight they will read about electrical power on board the space station. They will be introduced to station's photovoltaic arrays (solar cells) and rechargeable batteries (nickel-hydrogen batteries). Reading these two articles will help them prepare for a *Space Station Stumpers* quiz.

Article Review

- New Frontiers & New Dangers
- Electromagnetic Radiation: Taming the Wild Energies
- Do You Want the Recipe?
- In the Kitchen with Poly
- Measuring Exposure to Radiation

Time

10 minutes prep time.
5 minutes for presentation per question

Questions

1. (*New Frontiers-New Dangers*) Summarize briefly and succinctly what happens during a coronal mass ejection and the dangers this form of solar weather poses to the space station and astronauts.

2. (*Radiation: Friend and Foe*) Explain the relationship between frequency, wavelength, and energy. Use specific examples of different frequencies on the electromagnetic spectrum. Sketch a picture to illustrate your answer.

3. (*Radiation: Friend and Foe*) Explain the difference between ionizing radiation and non-ionizing radiation and give examples of each type. Explain the ionization process and give an example of matter that is ionized. Can non-ionizing radiation still be harmful? Give examples. (Suggestion: divide the topics between members of your group.)

4. (Teacher question) Explain the difference between radiation and radioactivity. Illustrate the popular use of the term "radiation," to imply dangerous radiation as used in medicine or nuclear power generation, etc. (This is an important lesson in semantics and in the various uses of such words in different situations and by different groups of scientists. Essentially, the term radiation need not necessarily evoke fear.)

5. (*The Human Recipe*) Briefly describe human DNA, where it resides, what it is made of, and what role it plays in reproducing human cells. (Suggestion: divide the topics between members of your group. Use sketches if possible.)

6. (*The Human Recipe*) Briefly explain what cell mutation is, the three types of mutation, and what systems of the body are most susceptible to damage by ionizing radiation. (Suggestion: divide the topics between members of your group. Use sketches if possible.)

7. (*In the Kitchen with Poly*) Briefly summarize the story of the Christmas Bricks by stating the important facts. Then answer the questions: What does ALARA stand for? What different ALARA options do the astronauts have to protect themselves from dangerous levels of radiation? (Suggestions: divide the topics between members of your group. Use sketches if possible.)

8. (*Measuring Exposure to Harmful Radiation*) How is radiation measured on the space station? Explain the difference between rads and rems. When are we exposed to radiation on earth and to how much are we exposed while participating in normal activities? What is a dose of radiation? (Hint: divide the topics between members of your group. Use sketches if possible.)

Article Review

- *New Frontiers & New Dangers*
- *Electromagnetic Radiation: Taming the Wild Energies*
- *Do You Want the Recipe?*
- *In the Kitchen with Poly*
- *Measuring Exposure to Radiation*

Time

10 minutes prep time. 5 minutes presentation time per question

Questions

1. (EASY review question.) (*New Frontiers-New Dangers*) Summarize briefly and succinctly what happens during a coronal mass ejection and the dangers this form of solar weather poses to the space station and astronauts.

A. CME's eject radioactive particles (protons, beta particles, and alpha particles) and dangerous radiation (X-rays and gamma rays) towards the earth. These solar emissions expose the astronauts to dangerous levels of radiation. Radiation is measured in terms of rads and rems.

2. (MEDIUM review question.) (*Radiation: Friend and Foe*) Explain the relationship between frequency, wavelength, and energy. Use specific examples of different frequencies on the electromagnetic spectrum. Sketch a picture to illustrate your answer.

A. Wavelength is the length of a wave from peak to peak or trough to trough. Frequency is the number of wavelengths that move past a given point at the speed of light in a given period of time. The higher the frequency, the shorter the wavelength, the higher the energy of the radiation. An example of high-energy radiation would be a gamma ray. An example of low energy radiation would be a radio wave.

3. (DIFFICULT review question.) (*Radiation: Friend and Foe*) Explain the difference between ionizing radiation and non-ionizing radiation and give examples of each type of radiation. Explain the ionization process and give an example of matter that is ionized. Can non-ionizing radiation still be harmful? Give examples. (Suggestion: divide the topics between members of your group.)

A. Ionizing radiation (gamma rays and X-rays) has a short wavelength, high frequency, and high energy level. Non-ionizing radiation has a longer wavelength and lower energy level. Energy packets, or photons, of ionizing radiation are powerful enough to penetrate an atom and energize and detach an electron. This leaves the atom with a net positive electrical charge. One example of matter composed of ionized atoms is plasma. Some forms of non- -ionizing radiation that can be dangerous to humans are microwaves, ultraviolet, and intense infrared waves and visual light (lasers). Radio, and TV waves are not normally harmful to humans. Intense forms of non-ionizing radiation can cause changes in molecular structure and are, in this way, dangerous to humans. Lasers are intense visual light and can cause significant damage to humans.

4. (Teacher Question) Explain the difference between radiation and radioactivity. Illustrate the popular use of the term "radiation" to imply dangerous radiation as used in medicine or nuclear power generation, etc.

A: As I have pointed out before, the word "radiation" can be used in two ways. First, it can be used to describe all types of electromagnetic radiation. Secondly, as used in this unit, it can be used to represent just the most harmful forms, or ionizing forms, of radiation. Radioactivity, on the other hand, consists of actual atomic particles that are the byproduct of thermonuclear reactions such as fusion and fission. Some forms of radioactive particles are also emitted during the natural deterioration (half-life) of the nucleus of some atoms, y uranium and plutonium, for instance. The radioactivity emitted by radioactive elements is in forms, alpha and beta particles. An alpha particle is a helium nucleus consisting of 2 protons and 2 neutrons with no electrons). Its two protons give it a double negative charge.). A beta particle is a free electron or positron. Like ionizing radiation, radioactive particles can penetrate the atomic and molecular structure in human cells and cause ionization of atoms and the mutation of human cells. Radiation is not all dangerous, as we now know. Some forms of radiation, like light and TV and radio waves are completely harmless at most levels of intensity. Even ionizing radiation if used under controlled medical circumstances is not dangerous. When we hear the term "radiation," however, it usually connotes a dangerous form of radiation. You students, however, will now be aware of the great varieties of radiation and the common use of the term.

5. (MEDIUM review question.) (*The Human Recipe*) Briefly describe human DNA, where it resides, what it is made of, and what role it plays in reproducing human cells. (Suggestion: divide the topics between members of your group. Use sketches if possible.)

A. DNA resides in the chromosomes of each human cell's nucleus. It is made of four different nucleotides (A,C,T,and G) and two groups of chemicals, namely sugars and phosphates. Each cell's DNA contains the recipes for the entire human body. This recipe is divided into sections. Each section is called a gene. The different genes within DNA contain the instructions, or information, needed to produce all 200 different human cell structures.

Article Review

(Cont)

Time

10 minutes prep time.
5 minutes to resent each question

Questions

6. (EASY review question.) (*The Human Recipe*) Briefly explain what cell mutation is, the three types of mutation, and what systems of the body are most susceptible to damage by ionizing radiation. (Suggestion: divide the topics between members of your group. Use sketches if possible.)

A. Cell mutation occurs when the DNA within a cell is changed such that newly reproduced cells are different from their parent cells. The three types of mutation are neutral mutation, harmful mutation, and helpful mutation. Lymphoid cells, reproductive cells, bone marrow, epithelial cells, epidermal cells, hepatic cells, and kidney cells are particularly susceptible to damage because their cells reproduce at a high rate.

7. (MEDIUM Review question.) (*In the Kitchen with Poly*) Briefly summarize the story of the Christmas Bricks by stating the important facts, then answer these questions: What does ALARA stand for? What different options do the astronauts (ALARA) have in protecting themselves from dangerous levels of radiation? (Suggestion: divide the topics between members of your group. Use sketches if possible.)

A: A woman astronaut requested shielding to ensure she could have children after her mission to the space station during which she was concerned about her possible exposure to dangerous radiation. Engineers picked polyethylene material shaped as bricks to strap together for a sleep shield. "Poly" is light and full of hydrogen, a good shielding agent. For protection, astronauts can go to sleep areas, shield themselves with water tanks on board Zarya, monitor radiation using TEPC device, and realign the space station in relation to the sun.

8. (EASY review question.) (*Measuring Exposure to Harmful Radiation*) How is radiation measured on the space station? Explain the difference between rads and rems. When are we exposed to radiation on earth and to how much are we exposed while participating in normal activities? What is a dose of radiation? (Suggestion: divide the topics between members of your group. Use sketches if possible.)

A: A TEPC measures radiation in terms of rems. Rads are a measure of absorbed radiation. We are constantly exposed to ionizing radiation while watching TV, walking, driving, and during medical procedures. A radiation dose is measured in millirems (remember millimeters) or thousandths of a rem.