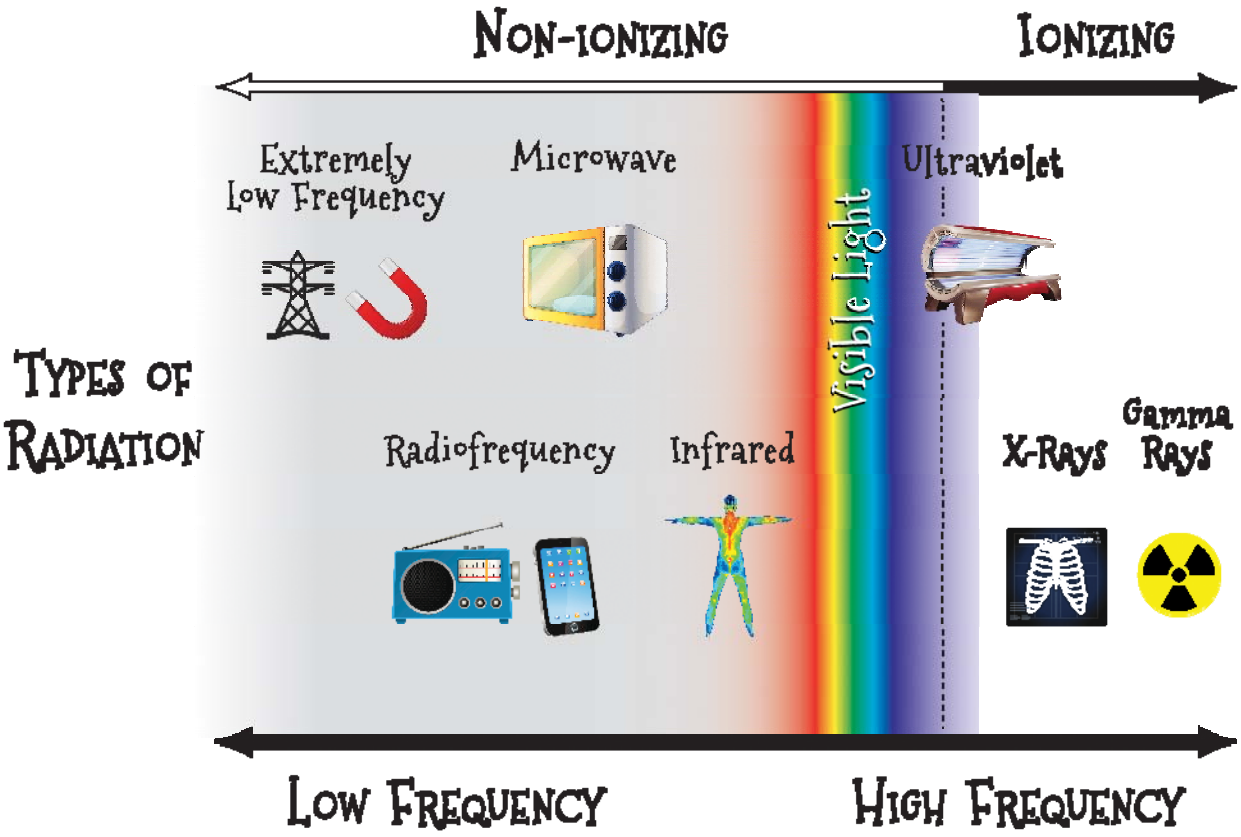
Radiation Exposure: Teacher Background Information

Radiation is part of our daily lives. It is all around us and has been present since the birth of this planet. Two main types of radiation — non-ionizing and ionizing — form the electromagnetic spectrum. We are routinely exposed to naturally occurring (background) radiation that comes from outer space, the sun, the ground, and even from within our own bodies, as well as man-made sources of ionizing and non-ionizing radiation.



Non-Ionizing Radiation

Non-ionizing radiation includes both low frequency radiation and moderately high frequency radiation, including radio waves, microwaves and infrared radiation, visible light, and lower frequency ultraviolet radiation. Non-ionizing radiation has enough energy to move around the atoms in a molecule or cause them to vibrate, but not enough to remove electrons.

Non-ionizing radiation is used in many common tasks. We use:

- Microwave radiation for telecommunications and heating food.
- Infrared radiation for infrared lamps to keep food warm in restaurants.
- Radio waves for radio broadcasting.

High frequency sources of non-ionizing and ionizing radiation (such as the sun and ultraviolet radiation) can cause burns and tissue damage with overexposure.

Ionizing Radiation

Ionizing radiation includes higher frequency ultraviolet radiation, x-rays and gamma rays. Ionizing radiation has enough energy to break chemical bonds in molecules or remove tightly bound electrons from atoms, creating charged molecules or atoms (ions).

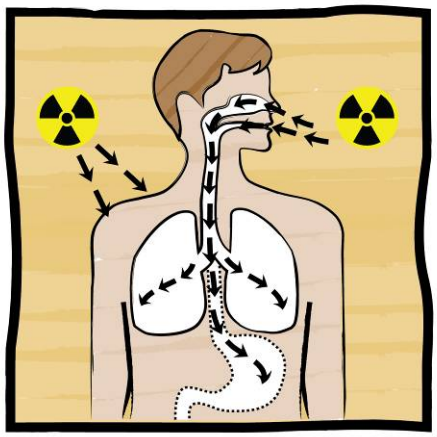
Ionizing radiation can pose a health risk by damaging tissue and DNA in genes. The amount of damage depends on the type of radiation, the exposure pathway, the radiation's energy, and the total amount of radiation absorbed. Because damage is at the cellular level, the effect from small or even moderate exposure may not be noticeable. Most cellular damage is repaired. However, some cells may not recover as well as others and could become damaged or cancerous. Radiation also can kill cells.

Sources of Radiation Exposure

The word "radiation" generally brings to mind man-made sources of ionizing radiation such as nuclear power plants, nuclear weapons or medical procedures, tests and treatments. However, we are routinely exposed to:

- Natural (background) radiation including naturally occurring ionizing and non-ionizing radiation sources from outer space, the sun, the ground, and even from within our own bodies.
- Man-made ionizing and non-ionizing sources such as smoke detectors, microwaves, cell phones and electrical power lines.

Exposure Pathways and Contamination



The three basic radiation exposure pathways are:

- Direct or external exposure (radioactive substances coming into contact with the skin).
- Inhalation (breathing radioactive gases, smoke, dust or particles into the lungs).
- Ingestion (eating or drinking substances that contain radioactive elements).

Contamination occurs when a person makes direct contact with, ingests or inhales radioactive materials. Contamination may occur when radioactive materials are released into the environment as the result of an accident, an event in nature or an act of terrorism. After direct contact, people and personal property must be decontaminated.

Penetrating Power of Ionizing Radiation

When radioactive atoms decay, they give off energy in the form of ionizing radiation. The major types of ionizing radiation emitted during radioactive decay are alpha particles, beta particles and gamma rays. Other types, such as x-rays, can occur naturally or be machine-produced.

Alpha particles lack the energy to penetrate even the outer layer of skin, so exposure to the outside of the body is not a major concern. Inside the body, however, they can be very harmful. If alpha-emitters are inhaled, swallowed, or get into the body through a cut, the alpha particles can damage sensitive living tissue. The way these large, heavy particles cause damage makes them more dangerous than other types of radiation. The ionizations they cause are very close

together — they can release all their energy in a few cells. This results in more severe damage to cells and DNA.

Beta particles are more penetrating than alpha particles but are less damaging to living tissue and DNA because the ionizations they produce are more widely spaced. They travel farther in air than alpha particles, but can be stopped by a layer of clothing or by a thin layer of a substance such as aluminum. Some beta particles are capable of penetrating the skin and causing damage such as skin burns. However, as with alpha-emitters, beta-emitters are most hazardous when they are inhaled or swallowed.

Gamma rays are a radiation hazard for the entire body. They can easily penetrate barriers, such as skin and clothing that can stop alpha and beta particles. Gamma rays have so much penetrating power that several inches of a dense material like lead or even a few feet of concrete may be required to stop them. Gamma rays can pass completely through the human body easily. As they pass through, they can cause ionizations that damage tissue and DNA.

Health Effects of Radiation Exposure

Low frequency sources of non-ionizing radiation are not known to present health risks. High frequency sources of non-ionizing radiation (such as the sun and ultraviolet radiation) can cause burns and tissue damage with overexposure.

Ionizing radiation can damage living tissue by changing cell structure and damaging DNA. The amount of damage depends on the type of radiation, the exposure pathway, the radiation's energy and the total amount of radiation absorbed.

Children are more sensitive to ionizing radiation than adults because children are still in the process of growing. There are more cells dividing and a greater opportunity for radiation to disrupt the growth process. Recent U.S. Environmental Protection Agency (EPA) radiation protection standards take into account the differences in sensitivity due to age and gender.

How Do We Know Ionizing Radiation Causes Cancer?

The greatest risk from exposure to ionizing radiation is cancer. Much of our knowledge about the risks is based on studies of more than 100,000 survivors of the atomic bombs in Hiroshima and Nagasaki, Japan, at the end of World War II. Studies of radiation industry workers and people receiving large doses of medical radiation are also important sources. Scientists learned many things from these studies, including:

- The higher the radiation dose, the greater the chance of developing cancer.
- The chance of developing cancer (not the seriousness or severity of the cancer) increases as the radiation dose increases.
- Cancers caused by radiation do not appear until years after the radiation exposure.
- Some people are more likely to develop cancer from radiation exposure than others.

Additional Resources:

- RadTown USA: www3.epa.gov/radtown
- Radiation Basics: http://www2.epa.gov/radiation/radiation-basics
- Radiation: Facts, Risks and Realities: http://www2.epa.gov/sites/production/files/2015-05/documents/402-k-10-008.pdf