

What's the Issue?

Radiation that is harmful to living things is called *ionizing radiation*. When this radiation interacts with matter, including living tissue, it ionizes atoms. When an atom is ionized, it loses electrons, which often breaks chemical bonds. New bonds may then form, creating different compounds. When this happens in living tissue, molecules, cells, tissues, and even entire organs can no longer perform their normal functions. Alpha, beta, and gamma decay can all ionize atoms.

Alpha particles have about 8000 times the mass and twice the charge of beta particles. Their large size and charge cause alpha particles to deposit all their energy on the surface of the matter with which they collide. If that matter is the skin of living tissue, the energy is often deposited on dead cells, so it does no harm. However, if radioactive isotopes that emit alpha particles are ingested or inhaled, they can damage tissue significantly.

Beta particles can penetrate the surface of matter. If skin is exposed to beta radiation, it penetrates into living tissue and causes serious burns. However, it does not go beyond the skin into other organs unless it is inhaled or ingested.

Gamma radiation has no mass or charge, so it can pass through very dense matter, including lead and concrete, without interacting with it. This means it can ionize atoms and molecules anywhere in the body. When a gamma ray photon does interact with matter, it deposits all of its energy in one interaction, so it is much more dangerous than alpha or beta radiation.



Dig Deeper

Collaborate with your classmates to explore one or more of these questions—or generate your own questions to explore.

1. How do people who work in facilities where they are exposed to ionizing radiation protect themselves?
2. Radiopharmaceuticals are medicines used to treat cancer and other diseases. They contain radioactive isotopes. Radioactive isotopes emit ionizing radiation. How can these harmful isotopes be used to heal the body?

CAUTION



SPECIAL INSTRUCTIONS

CONTACT RADIOLOGICAL CONTROL BEFORE WORKING IN THIS AREA

Terrestrial Ecosystems and Radiation Exposure

Terrestrial ecosystems are much more likely to be harmed by radiation exposure than aquatic ones. This is because radioactive materials accumulate in soil, while they tend to flush through aquatic ecosystems more quickly. Radioactive materials can build up in terrestrial ecosystems due to accidents at nuclear power plants. Although such accidents are infrequent, their effects can be devastating to ecosystems. Improperly stored nuclear wastes can also contaminate terrestrial ecosystems. This issue is explored on the next page.



In March 2011, radioactive materials were released into the environment after the Fukushima Daiichi nuclear plant in Japan was struck by a tsunami. Harmful effects of the radiation were seen within two months of the accident. Scientists found mutations in eye and wing structures of butterflies near the accident site. The butterflies had been overwintering as larvae when the accident occurred. Butterflies studied six months after the accident had even more mutations. This showed that mutations in the butterflies' reproductive cells were being passed to their offspring.

In 1986, a nuclear reactor at the Chernobyl nuclear plant ruptured when it overheated. The accident released part of the radioactive reactor core into the surrounding area.

Radioactive materials were still being released 10 days later. Plants and animals within 20–30 km of the reactor were the most affected by radiation from the nuclear decay of the materials. In the nearby Red Forest, all the trees were killed. Over 30 years later, the effects of radiation poisoning are still felt in the area. Trees do not grow as quickly. Birds have smaller brain sizes. Perhaps most important is the loss of fungi, microorganisms, and insects involved in biological decay. This decay frees nutrients in dead matter, so they can be taken up by living things. In the Red Forest, many trees did not decay even 15 to 20 years after they were killed.



Before you leave this page . . .

1. Explain how climate change is affecting at least one aquatic organism.
2. Why are radioactive materials so harmful to terrestrial ecosystems?

AT ISSUE

Storing Nuclear Waste Safely

What's the Issue?

Nuclear wastes contain radioactive isotopes that release harmful radiation through nuclear decay over time. Eventually they become less radioactive. However, some nuclear waste takes a very long time to reach this state. Because there are no nuclear power plants in British Columbia, the issue of safe storage of nuclear wastes may seem very far from home. However, improper storage of these wastes can harm ecosystems around the world.

Nuclear energy provides about 15% of Canada's electrical energy. The safe management and storage of nuclear wastes is overseen by government organizations and regulatory bodies. Nuclear wastes are classified based on how much containment and isolation they require to be stored safely.

- **Low-level and Intermediate-level Waste** These are stored at the sites where they are produced. Once their radioactivity decays to acceptable levels, they are disposed of by conventional means, such as in landfills.
- **High-level Waste** These include used nuclear fuel and other waste from producing nuclear power. It can take a long time to undergo nuclear decay. The waste also gives off a lot of thermal energy, so it must be handled in two phases. First, used fuel bundles are stored under water in secure, leak-proof pools for 6 to 10 years until they cool. Then the bundles are transferred to concrete containers where they decay further.



Dig Deeper

Collaborate with your classmates to explore one or more of these questions—or generate your own questions to explore.

1. Compare nuclear waste with another harmful form of pollution. Which do you think is a greater threat to ecosystem health? Explain.
2. Use resources available to you, including those provided by your teacher, to find out more about nuclear waste contamination at the Hanford Nuclear Reservation in Washington. What mistakes were made at the site in terms of safe waste storage? Describe any harmful effects to the environment that resulted from these mistakes.