

Nuclear Radiation

SECTION 3

OBJECTIVES

- Compare the penetrating ability and shielding requirements of alpha particles, beta particles, and gamma rays.
- Define the terms *roentgen* and *rem*, and distinguish between them.
- Describe three devices used in radiation detection.
- Discuss applications of radioactive nuclides.

In Becquerel's experiment, nuclear radiation from the uranium compound penetrated the lightproof covering and exposed the film. Different types of nuclear radiation have different penetrating abilities. Nuclear radiation includes alpha particles, beta particles, and gamma rays.

Alpha particles can travel only a few centimeters in air and have a low penetrating ability due to their large mass and charge. They cannot penetrate skin. However, they can cause damage inside the body if a substance that emits alpha particles is ingested or inhaled. Beta particles, which are emitted electrons, travel at speeds close to the speed of light and have a penetrating ability about 100 times greater than that of alpha particles. Beta particles can travel a few meters in air. Gamma rays have the greatest penetrating ability. The penetrating abilities and shielding requirements of different types of nuclear radiation are shown in **Figure 11**.

Radiation Exposure

Nuclear radiation can transfer the energy from nuclear decay to the electrons of atoms or molecules and cause ionization. *The **roentgen (R)** is a unit used to measure nuclear radiation exposure; it is equal to the amount of gamma and X ray radiation that produces 2×10^9 ion pairs when it passes through 1 cm^3 of dry air.* Ionization can damage living tissue. Radiation damage to human tissue is measured in rems (roentgen equivalent, man). *A **rem** is a unit used to measure the dose of any type of ionizing radiation that factors in the effect that the radiation has on human tissue.* Long-term exposure to radiation can cause DNA mutations that result in cancer and

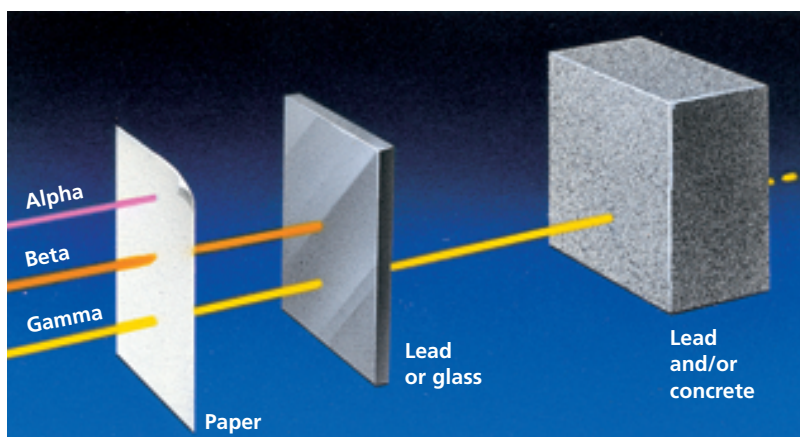


FIGURE 11 The different penetrating abilities of alpha particles, beta particles, and gamma rays require different levels of shielding. Alpha particles can be shielded with just a sheet of paper. Lead or glass is often used to shield beta particles. Gamma rays are the most penetrating and require shielding with thick layers of lead or concrete, or both.