

other genetic defects. DNA can be mutated directly by interaction with radiation or indirectly by interaction with previously ionized molecules.

Everyone is exposed to environmental background radiation. Average exposure for people living in the United States is estimated to be about 0.1 rem per year. However, actual exposure varies. The maximum permissible dose of radiation exposure for a person in the general population is 0.5 rem per year. Airline crews and people who live at high altitudes have increased exposure levels because of increased cosmic ray levels at high altitudes. Radon-222 trapped inside homes also causes increased exposure. Because it is a gas, radon released from certain rocks can move up through the soil into homes through holes in the foundation. Radon trapped in homes increases the risk of lung cancer, especially among smokers.

Radiation Detection

Film badges, Geiger-Müller counters, and scintillation counters are three devices commonly used to detect and measure nuclear radiation. A film badge and a Geiger-Müller counter are shown in **Figure 12**. As previously mentioned, nuclear radiation exposes film just as visible light does. This property is used in film badges. **Film badges** use exposure of film to measure the approximate radiation exposure of people working with radiation. **Geiger-Müller counters** are instruments that detect radiation by counting electric pulses carried by gas ionized by radiation. Geiger-Müller counters are typically used to detect beta-particles, X rays, and gamma radiation. Radiation can also be detected when it transfers its energy to substances that *scintillate*, or absorb ionizing radiation and emit visible light. **Scintillation counters** are instruments that convert scintillating light to an electric signal for detecting radiation.

FIGURE 12 Film badges (a) and Geiger-Müller counters (b) are both used to detect nuclear radiation.



(a)



(b)