

### Section 3: Nuclear Radiation Today

#### Preview

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- Where is Radiation?
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- Risks of Nuclear Radiation
- Nuclear Power

### Key Ideas

- › Where are we exposed to radiation?
- › What are some beneficial uses of nuclear radiation?
- › What factors determine the risks of nuclear radiation?
- › How is the energy produced by nuclear fission used?

### Bellringer

Using what you know about radiation and nuclear reactions, answer the items below.

1. Along with a change in the nuclei involved, what other significant change occurs with radiation and nuclear reactions?
2. Radioactive isotopes are sometimes used for tracer studies, which analyze how and where a person's body takes up a certain element. As the isotope is taken up by the body, the isotope decays, and the radiation it produces can be detected in order to determine where the element is. Based on how deep the different forms of radiation penetrate, do you think that alpha, beta, or gamma radiation is used?

### Bellringer, continued

3. In Rutherford's famous gold-foil experiment, the patterns of deflection of the radiation that he shot at the gold foil led him to believe that the atom must contain a small, positively charged nucleus. **Explain why Rutherford used alpha radiation rather than gamma radiation.**

### Where is Radiation?

- › Where are we exposed to radiation?
- › We are continually exposed to radiation from natural sources, such as the sun, soil, rocks, and plants.
- **background radiation:** the nuclear radiation that arises naturally from cosmic rays and from radioactive isotopes in the soil and air

### Where is Radiation?, *continued*

- Radiation is measured in units of rems.
- **rem:** the quantity of ionizing radiation that does as much damage to human tissue as 1 roentgen of high-voltage X rays does
- Exposure varies from one location to another.
- Some activities add to the amount of nuclear radiation exposure.

### Where is Radiation?, *continued*

Radiation Exposure per Location

Location	Radiation exposure (millirems/year)
Tampa, FL	63.7
Richmond, VA	64.1
Las Vegas, NV	69.5
Los Angeles, CA	73.6
Portland, OR	86.7
Rochester, NY	88.1
Wheeling, WV	111.9
Denver, CO	164.6

Radiation Exposure per Activity

Activity	Radiation exposure (millirems/year)
Smoking 1 1/2 packs of cigarettes per day	8,000
Flying for 720 hours (airline crew)	267
Inhaling radon from the environment	360
Giving or receiving medical X rays	100

### Beneficial Uses of Nuclear Radiation

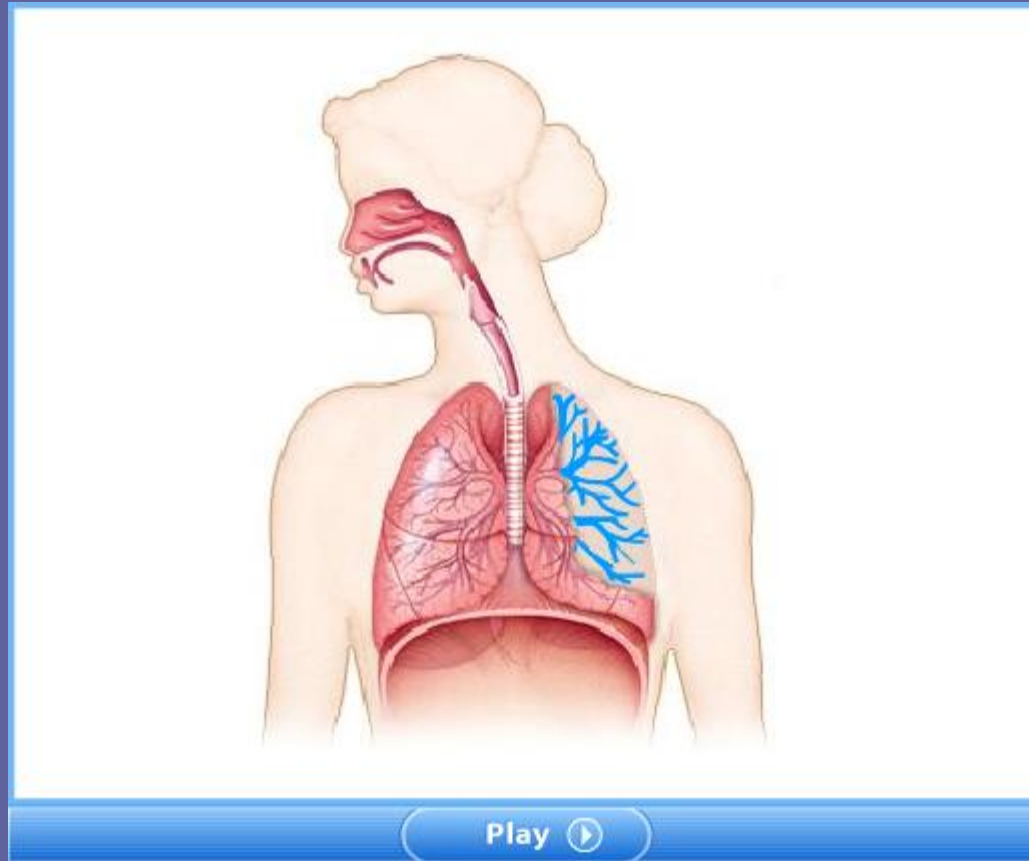
- › What are some beneficial uses of nuclear radiation?
- › Some common applications of nuclear radiation include medical diagnosis and treatment, smoke detectors, manufacturing, and agriculture.
- Smoke detectors help to save lives.
  - Alpha particles produce an electric current.
  - Smoke particles in the air reduce the flow of the current.



### Beneficial Uses of Nuclear Radiation, *continued*

- Nuclear radiation is used to detect diseases.
  - **radioactive tracer:** a radioactive material that is added to a substance so that its distribution can be detected later
- Nuclear radiation therapy is used to treat cancer.
  - **radiotherapy:** treatment that uses controlled doses of nuclear radiation for treating diseases such as cancer
- Agriculture uses radioactive tracers and radio-isotopes.

### Visual Concept: Radioactive Tracer



### Risks of Nuclear Radiation

- › What factors determine the risks of nuclear radiation?
- › The risk of damage from nuclear radiation depends on both the type and the amount of radiation exposure.
- Nuclear radiation can ionize molecules.
  - *ionization*: a change in the number of electrons in an atom or molecule
  - Cancers associated with high-dose exposure include leukemia and breast, lung, and stomach cancers.

### Risks of Nuclear Radiation, *continued*

- High levels of nuclear radiation can cause radiation sickness.
  - *radiation sickness*: an illness that results from excessive exposure to nuclear radiation
  - People working in radioactive areas wear a dosimeter.
    - *dosimeter*: a device that measures the amount of nuclear radiation exposure

### Risks of Nuclear Radiation, *continued*

- High concentrations of radon gas can be hazardous.
  - Radon gas is colorless and odorless.
  - It is produced by the decay of uranium-238 present naturally in soil and rock.
  - Radon gas emits alpha and beta particles and gamma rays.
  - Tests for radon gas are widely available.

### Nuclear Power

- › How is the energy produced by nuclear fission used?
- › Energy produced from fission is used to provide electrical energy to millions of homes and businesses.
- Nuclear fission has both advantages and disadvantages.
  - It does not produce gaseous pollutants.
  - There is much more energy in the known uranium reserves than in the known reserves of coal and oil.

### Nuclear Power, *continued*

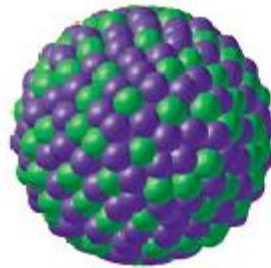
- Radioactive products of fission must be handled carefully.
- A nuclear reactor must be equipped with many safety features.
- Nuclear power plants are expensive to build.
- Nuclear waste must be safely stored.

### Nuclear Power, *continued*

- Nuclear fusion releases large quantities of energy.
  - The hydrogen fusion reaction itself releases very little waste or pollution.
  - These reactions are difficult to produce in the laboratory.
- Nuclear fusion also has advantages and disadvantages.
  - Fuel for fusion is abundant.
  - The expense of operating a fusion power plant would be high.



### Visual Concept: Nuclear Energy



Uranium-235

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