Natural and Human-made Sources of Radiations

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Radiation, Energy, and the Distinction Between Ionizing and Non-Ionizing Forms

Radiation is the transmission or emission of energy from a source through the movement of particles or waves. This energy may travel through a material medium or through empty space. Radiation is present everywhere in the environment, and human beings are exposed to it every day from both natural and human-made sources. Although the word radiation often creates fear, not all radiation is harmful. Some forms of radiation are part of ordinary life, while others can be dangerous if exposure is high or uncontrolled. Therefore, it is important to understand the types, sources, and effects of radiation.

Radiation can be divided into two major categories: ionizing radiation and non-ionizing radiation. Ionizing radiation has enough energy to remove electrons from atoms or molecules. This process can damage living cells and may increase the risk of disease if exposure is strong or repeated. Examples of ionizing radiation include X-rays, gamma rays, alpha particles, beta particles, and some forms of cosmic radiation. Non-ionizing radiation has lower energy and does not have enough power to remove electrons from atoms. Examples include visible light, radio waves, microwaves, infrared radiation, and most ultraviolet radiation. Non-ionizing radiation can still cause effects, such as heating, but it is generally less damaging than ionizing radiation at ordinary exposure levels.

Cosmic Radiation and Exposure from Space

Radiation may be generated from a variety of sources, both natural and human-made. (United Nations Scientific Committee on the Effects of Atomic Radiation, 2010; World Health Organization, 2023) Natural radiation has existed since the formation of the earth and is part of the natural environment. Human-made radiation comes from technologies, industries, medical equipment, and consumer products developed by people. Both types of radiation can be useful or harmful depending on the amount, type, and duration of exposure.

One of the most important natural sources of radiation is cosmic radiation. Cosmic radiation comes from outer space and includes high-energy particles that reach the earth’s atmosphere. The sun is one major source of cosmic radiation. Nuclear fusion processes taking place in the sun produce large amounts of energy, some of which travel toward the earth in the form of particles and

electromagnetic waves. Solar radiation reaches the earth through sunlight and solar wind. The earth's atmosphere and magnetic field protect people from much of this radiation, but some particles still reach the surface.

Cosmic radiation also comes from deep space beyond the solar system. This type of radiation is often more energetic than ordinary solar radiation. It may originate from stars, supernovae, galaxies, and other high-energy cosmic events. People living at higher altitudes are exposed to more cosmic radiation because the atmosphere is thinner and provides less shielding. For example, airline pilots, flight attendants, and frequent air travelers receive slightly higher doses of cosmic radiation than people who remain at ground level. Astronauts are exposed to even higher levels because they travel outside much of the earth's protective atmosphere and magnetic field.

Terrestrial Radiation, Soil, and Radon Gas

Another major natural source of radiation is terrestrial radiation, which comes from radioactive materials found in the earth's crust. Rocks, soil, and minerals contain naturally occurring radioactive elements such as uranium, thorium, and potassium-40. These substances have existed since the formation of the earth. As they decay, they emit radiation. The amount of terrestrial radiation varies from place to place depending on local geology. Some areas have higher natural background radiation because their soil and rocks contain more radioactive minerals.

Radiation can also be found in soil. Radioactive particles in soil may come from naturally occurring materials in the earth's crust. In some cases, soil may also contain radioactive substances deposited from the atmosphere. However, most ordinary soil radiation is natural and comes from long-lived radioactive elements. People may be exposed to small amounts of this radiation when they live, work, or grow food in such environments. Normally, these levels are low and not harmful, but areas with high natural radioactivity may require monitoring.

Radon gas is another important natural source of radiation. Radon is produced when uranium in soil and rocks breaks down. It is a colorless and odorless radioactive gas that can enter homes through cracks in floors, walls, and foundations. Radon can accumulate indoors, especially in poorly ventilated buildings. Long-term exposure to high levels of radon can increase the risk of lung cancer. For this reason, radon is considered one of the most important natural radiation concerns in homes and buildings.

Radiation in Water, Natural Gas, and the Human Body

Drinking water can also contain small amounts of natural radiation. Water may absorb radioactive materials from rocks and soil as it moves through the ground. Groundwater is more likely to contain

naturally occurring radioactive elements than surface water because it remains in contact with rocks and minerals for longer periods. The amount of radiation in drinking water depends on the local environment and the source of the water. In most cases, the level is very low, but water supplies may be tested in areas where natural radioactivity is higher.

Natural gas used for cooking or heating may also contain trace amounts of radioactive substances, especially radon. These amounts are usually very small, but they show that radiation can be present in ordinary household materials. Building materials such as granite, bricks, cement, and tiles may also contain small amounts of naturally occurring radioactive elements. These sources usually contribute only a low dose of radiation, but they are part of the natural background exposure that people receive every day.

Radiation is also naturally present in the human body. This is because human beings consume food and water that contain small amounts of naturally occurring radioactive materials. For example, potassium-40 is found naturally in the body because potassium is an essential element for life. Carbon-14 is also present in small amounts. These internal sources of radiation are normal and unavoidable. They do not usually pose a health risk because the doses are very low.

Lightning may also be mentioned as a natural source of radiation because it produces electromagnetic energy, including visible light, radio waves, and other forms of radiation. However, lightning is not a major source of everyday radiation exposure for most people. Its main danger comes from electric shock, heat, and physical injury rather than long-term radiation exposure. Still, it shows that radiation can occur naturally in many different forms.

Medical Radiation and Its Diagnostic and Therapeutic Uses

Human-made radiation sources are also common in modern life. One of the most important human-made sources of ionizing radiation is medical imaging equipment. Medical imaging uses radiation to diagnose diseases, injuries, and internal conditions. X-rays are commonly used to detect bone fractures, chest problems, dental issues, and other medical concerns. Computed tomography, or CT scanning, uses multiple X-ray images to produce detailed cross-sectional pictures of the body. These imaging methods are extremely useful because they help doctors diagnose conditions accurately and quickly.

Medical radiation is beneficial when used properly, but it must be controlled carefully. Patients should receive imaging only when medically necessary, and healthcare professionals must follow safety guidelines. The goal is to use the lowest radiation dose needed to obtain a useful image. This principle helps reduce unnecessary exposure while still allowing patients to benefit from modern medical diagnosis.

Radiation is also used in nuclear medicine and cancer treatment. In nuclear medicine, small amounts of radioactive materials may be introduced into the body to help diagnose or treat disease. These materials can show how organs are functioning. In radiation therapy, controlled doses of ionizing radiation are used to destroy cancer cells. Although this involves high-energy radiation, it is carefully planned and targeted to treat disease while protecting healthy tissue as much as possible. This shows that radiation can be dangerous if uncontrolled, but highly beneficial when used responsibly in medicine.

Industrial sources also contribute to human-made radiation. Radiation is used in some industries for inspection, measurement, sterilization, and quality control. For example, radiography can be used to inspect welds, pipes, and machine parts without destroying them. Radiation can also be used to sterilize medical equipment and food products. These uses are controlled by safety regulations to protect workers and the public.

Nuclear Power and Radiation from Consumer Technology

Nuclear power plants are another human-made source of radiation. These plants use nuclear reactions to produce electricity. Under normal operating conditions, radiation exposure to the public from nuclear power plants is very low because the radioactive materials are contained and monitored. However, accidents can release radioactive substances into the environment, which is why nuclear safety is taken very seriously. Nuclear waste must also be stored and managed carefully because some radioactive materials remain hazardous for long periods.

Consumer products may also contain small sources of radiation. Smoke detectors, for example, may use a tiny amount of radioactive material to detect smoke particles. Some older clocks, watches, and instruments used glow-in-the-dark paints that contained radioactive substances. Modern products are generally safer and regulated, but older items may still contain radioactive materials. These sources usually produce very low exposure if they are intact and handled properly.

Televisions and computer monitors can also be discussed as human-made sources of radiation, but this point requires clarification. Older televisions and computer monitors that used cathode ray tubes could produce very small amounts of X-ray radiation, but they were designed with shielding to keep emissions low. Modern flat-screen televisions, laptops, and computer monitors do not produce significant ionizing radiation. They may emit visible light and small amounts of non-ionizing electromagnetic radiation, but these are not considered major radiation hazards under normal use.

Cell Phones, Microwaves, Cigarettes, and Everyday Exposure

Cell phones are another common source of non-ionizing radiation. They emit radiofrequency waves, which are a form of electromagnetic radiation. These waves are much lower in energy than X-rays and gamma rays. Because radiofrequency radiation is non-ionizing, it does not have enough energy to break chemical bonds or remove electrons from atoms. The main biological effect of strong radiofrequency exposure is heating, but ordinary cell phone use produces relatively low levels of exposure. Wi-Fi routers, Bluetooth devices, and microwave ovens also use non-ionizing radiation.

Microwave ovens use microwave radiation to heat food. The radiation remains inside the oven when the device is properly functioning and the door seal is intact. Microwave radiation does not make food radioactive. It simply causes water molecules in food to vibrate, producing heat. This is another example of non-ionizing radiation used safely in daily life.

Cigarettes are also a source of radiation exposure. Tobacco plants can absorb radioactive materials from soil and fertilizers. As a result, cigarette smoke may contain radioactive substances such as polonium-210 and lead-210. When smokers inhale cigarette smoke, these radioactive particles can enter the lungs. This adds to the harmful effects of smoking, along with toxic chemicals and carcinogens. Therefore, cigarette smoke is not only chemically dangerous but may also contribute to radiation exposure in the lungs.

In conclusion, radiation comes from both natural and human-made sources. Natural sources include cosmic radiation, solar radiation, terrestrial radiation from rocks and soil, radon gas, drinking water, natural gas, building materials, food, and even the human body itself. Human-made sources include medical imaging, radiation therapy, nuclear medicine, industrial radiography, nuclear power, consumer products, older cathode ray tube screens, cell phones, microwave ovens, and cigarettes. (U.S. Environmental Protection Agency, n.d.) Radiation may be ionizing or non-ionizing, and its effects depend on energy, dose, exposure time, and type of radiation. Although radiation can be harmful at high levels, it also has many useful applications in medicine, industry, communication, and technology. Understanding radiation helps people recognize its risks, benefits, and role in everyday life.

References

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