Medical Technology

ARRT

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Question: 1

Which of the following types of radiation will NOT cause atoms in human tissue to lose electrons?

A. Gamma radiation
B. Ultraviolet light
C. X-rays from computed tomography (CT) scanning
D. Microwave radiation

Answer: D

Explanation:
Ionizing radiation is energetic enough so that when it interacts with matter, electrons become energized and are ejected from their atoms or molecules. After losing electrons, atoms or molecules become positive ions, meaning that they have an excess positive charge. X-rays and gamma rays are high-energy forms of electromagnetic radiation that are ionizing. Ultraviolet (UV) light is electromagnetic radiation that is slightly more energetic than visible light, but slightly less energetic than X-rays. Low UV, which is more energetic than visible light, is non-ionizing, while medium and high UV are ionizing. The rest of the radiation spectrum, including low UV, visible light, infrared, microwave, and radio waves, is non-ionizing.

Question: 2

Which of the following can result in exposure to gamma radiation?

A. Computed tomography (CT) scanning
B. Magnetic resonance imaging (MRI) scanning
C. Being near a patient treated with iodine-131 therapy
D. Sunbathing on the beach

Answer: C

Explanation:
The radionuclide iodine-131 decays through beta emission and gamma emission, and is quite energetic, so that treated patients become a significant source of radiation. Patients with hyperthyroidism or thyroid cancer who are treated with iodine-131 are warned that they could set off radiation sensors at airports. Computed tomography (CT) scanning works with X-rays, not gamma radiation. Magnetic resonance imaging (MRI) uses radio waves and a magnetic field. While the nuclear fusion reactions that take place inside the Sun generate gamma radiation, the energy of this radiation is reduced and is no longer is gamma by the time it reaches the Earth's surface. Furthermore, higher energy radiation is absorbed by the Earth's atmosphere. The ultraviolet (UV) rays that reach the Earth are different from gamma radiation.

Question: 3

An adult patient imaged with full body computed tomography (CT) scanning would receive a radiation exposure of approximately which of the following?

A. 4 microsieverts (SV)
B. 40 microsieverts (Sv)
C. 4 millisieverts (mSv)
D. 40 millisieverts (mSv)

Answer: D

Explanation:
Compared to most other medical imaging modalities, computed tomography (CT) scanning provides relatively high exposure to ionizing radiation, with 40 millisieverts (mSv) falling in the normal range for a full body CT. Four microsieverts (HSV) is in the range of a typical dental X-ray exposure. A typical individual in the United States receives an average annual radiation dose of 3 mSv. People living in higher altitude areas, such as Denver, receive more radiation as compared to those living at sea level.

Question: 4

Which of the following sources of ionizing radiation would be shielded appropriately with Plexiglas?

A. Computed tomography (CT) scanner
B. Technetium-99 used for scintigraphy
C. Positron emission tomography (PET) scanner
D. Iodine-123 used for diagnosis of thyroid conditions

Answer: B

Explanation:
Materials made of polymethyl methacrylate (PMMA), known commonly by the trade names Plexiglas, Lucite, and Perspex, are used to shield beta-emitting radionuclides such as technetium-99. X-rays and gamma rays are effectively blocked by materials made of atoms with large nuclei, such as lead or tungsten. Computed tomography (CT) uses X-rays. Positron emission tomography (PET) uses agents that emit positrons, which produce annihilation radiation in the form of gamma rays. Used diagnostically, iodine-123 emits gamma rays.

Question: 5

Which of the following pairs of radiation dose and source is NOT correct?

A. 3 microsieverts (Sv): typical annual exposure for an individual in the United States Correct
B. 6 millisieverts (mSv): typical annual exposure for an individual in Denver, Colorado

C. 40 millisieverts (mSv) for an adult patient imaged once with full body computed tomography (CT) scanning
D. 10 microsieverts (Sv): a dental X-ray

Answer: A

Explanation:
The average radiation exposure in the United States is 3 millisieverts (mSv). Since higher altitudes receive more space radiation, people living in Denver have more exposure, as much as 6 millisieverts (mSv) annually. Ionizing radiation comes from a variety of natural sources. Galactic cosmic radiation consists of gamma rays, X-rays, neutrons, and heavy particles, and the Sun sends out X-rays and ultraviolet radiation. While Earth's magnetic field and atmosphere prevent most space radiation from reaching the surface, a small amount penetrates. Ground radioactivity from uranium in rocks and radon gas is a natural source of ionizing radiation, as are some foods, notably bananas. Dental X-rays typically are 4 microsieverts (µSv), though a full series of dental radiographs might be more than double this value. Computed tomography (CT) scanning exposes patients to fairly high radiation doses, 40 mSv for the typical full body scan.

Question: 6

Which of the following factors can reduce the dose of radiation to which an individual is exposed?

A. Increasing the distance between the individual and the radiation source
B. Increasing the amount of time that the individual is exposed to the radiation source
C. Increasing the number of coworkers who work with the individual near the radiation source
D. All of the above

Answer: A

Explanation:
Exposure to ionizing radiation can be reduced by increasing the individual's distance from the radiation source, by increasing the amount of shielding between the radiation source and the individual, or by decreasing the amount of time that the individual is exposed to the radiation source. The intensity of the radiation at the source depends on the nature of the source and its energy. Thus, given the same shielding, distance, and exposure time, dosage is higher for an individual working with a high energy source than for an individual working with a weak source. The presence of coworkers would not reduce the radiation exposure in any significant amount.

Question: 7

Implications of the bremsstrahlung effect include which of the following?

A. Tungsten can be used to produce X-rays.
B. Shields consisting of large atoms, such as lead, can be used against beta radiation.
C. The intensity of radiation decreases in proportion to the square of the distance from the radiation source.

D. Positrons emitted by certain radionuclides produce gamma radiation through annihilation.

Answer: A

Explanation:
Tungsten is often the material used inside an X-ray machine. When a beam of electrons strikes material consisting of atoms with a high atomic number, such as lead or tungsten, some of the energy is converted to X-rays through a phenomenon known as the bremsstrahlung effect. The rest of the energy is released as heat. A large atom material like lead is not an effective beta radiation shield, since lead will produce X-rays when bombarded by beta particles. The equation used to measure the decrease in radiation intensity of relative to the distance from the radiation source is known as the inverse square law. A positron emission tomography (PET) scan utilizes gamma radiation that results from positron-emitting radionuclides injected into the body to produce three-dimensional images of targeted tissue.

Question: 8

X-rays might initiate cancer through which of the following effects?

A. Stimulation of DNA repair mechanisms in cells
B. Damage to cell components, leading to cell death
C. Damage to cell components, leading to incorrect repair Correct
D. Inhibition of cell division

Answer: C

Explanation:
X-rays are a type of ionizing radiation that can damage cell structures and DNA. When damaged cells reproduce, they can lose the ability to control cell division, which can result in cancer. When functioning normally, cells can repair themselves if the X-ray dose is modest. However, if a cell receives a high dose, it will die through a process known as apoptosis. Inhibition of cell division is the opposite of cancer, but it can also result from X-ray exposure. Some evidence suggests that exposure to low levels of X-radiation can stimulate the mechanisms that cells use to repair DNA. If so, this would have a preventive effect against cancer.

Question: 9

While working 2 meters from a magnetic resonance imaging (MRI) scanner, a technician is found to receive a monthly exposure to ionizing radiation of approximately 300 microsieverts (Sv). If the technician's distance from the MRI scanner is doubled to 4 meters, his expected monthly exposure would be approximately:

A. 75 µSv
B. 150 µSv
C. 300 µSv
D. 1,200 µSv

Answer: C

Explanation:
Exposure to ionizing radiation of 300 microsieverts (Sv) per month calculates to 3.6 millisieverts (mSv) per year, which is close to the average annual exposure in the United States. Radiation exposure comes from natural sources, such as galactic cosmic radiation, solar particle events, radioactivity from uranium, radium, and other materials in the ground, as well as from medical sources. Magnetic resonance imaging (MRI) is not a source of ionizing radiation, as it uses a magnetic field and radio waves to produce images. Increasing the technician's distance from the MRI machine would have no effect on his radiation dose.

Question: 10

Which of the following types of radiation will NOT penetrate the skin?

A. Alpha particles
B. Beta particles
C. X-rays
D. Gamma rays

Answer: A

Explanation:
An alpha particle is a helium nucleus that consists of two neutrons and two protons. Alpha particles are more massive than beta particles and can be destructive to tissue, but they have great difficulty penetrating through almost any material, including skin. However, this kind of radiation can be harmful if materials that emit alpha particles, such as radon or uranium, are swallowed, inhaled, or absorbed through cuts or wounds on the skin. Windows, surgical scrubs, and even one sheet of paper will stop alpha radiation. Beta particles are emitted by materials such as strontium-90, carbon-14, tritium, and sulfur-35. Beta particles can penetrate to the germinal layer of the skin and may cause tissue damage after long, heavy exposure. X-rays and gamma can easily penetrate the skin and body tissue.

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