Medical Technology

ARRT-Radiography

Radiography Exam

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Question: 1

Which material should be used as the primary shielding around a beta-emitting radionuclide, such as phosphorus-32?

a. Lead, because high-density metals absorb most particle radiation
b. Plexiglas, because beta particles striking it are converted to harmless Bremsstrahlung radiation
c. Lead, because absorbers with larger atomic nuclei block radiation better than absorbers with smaller atomic nuclei
d. Plexiglas, because absorbers with larger atomic nuclei produce more Bremsstrahlung radiation than absorbers with smaller atomic nuclei

Answer: D

Explanation:
Bremsstrahlung radiation consists of x-rays that are produced when high-velocity electrons interact with shielding materials. Electrons emitted from the nuclei of many radioactive isotopes (radionuclides) are known as beta particles. Beta particles are less harmful to biological tissue than other types of ionizing radiation, while Bremsstrahlung radiation is quite harmful. Nevertheless, high-energy beta emitters such as phosphorus-32 do require some type of shielding. Since the magnitude of Bremsstrahlung radiation produced when beta particles strike an absorber is proportional to the absorber's atomic number, the primary shielding around a beta emitter should consist of small atoms. Thus, polymethyl methacrylate (PMMA), known commonly by the trade names Plexiglas, Lucite, and Perspex, is used around beta emitters. Although lead cannot be used as primary shielding, it is appropriate as secondary protection, placed outside of the PMMA shield.

Question: 2

On average, an individual living in the United States receives approximately how much ionizing radiation from the natural environment per year?

A. None
B. 3 microsieverts (Sv)
C. 3 millisieverts (mSv)
D. 30 millisieverts (mSv)

Answer: C

Explanation:
Ionizing radiation comes from a variety of natural sources. Galactic cosmic radiation consists of gamma rays, x-rays, neutrons, and heavy particles resulting from explosions of distant stars. Solar particle events send particles from the Sun toward Earth, while the Sun's regular activity sends out x-rays and

ultraviolet radiation constantly. While Earth's magnetic field and atmosphere prevent most space radiation from reaching the surface, a small amount penetrates. At the same time, ground radioactivity, from uranium in rocks, and especially from radon gas, constitutes a natural, terrestrial source of ionizing radiation, as do many foods, notably bananas. In higher altitudes, the natural radiation dose from space increases. People living in Denver, for instance, receive more radiation as compared with those living at sea level. Overall, a typical individual in the United States receives an annual approximate dose of 3 millisieverts (mSv), which is not harmful.

Question: 3

When x-rays strike a human body, which of the following may occur?

A. Cells may be damaged, leading to cell death, or they may repair themselves
B. Cells may be damaged, then repair themselves incorrectly, leading to disease
C. X-rays may pass through the body, or bounce off it, without affecting cells
D. All of the above

Answer: D

Explanation:
X-rays can have a variety of effects, depending on the intensity and duration of the exposure, the shape and direction of the x-ray beam, the anatomic area that is hit, and, probably, an individual's genetic makeup. While x-rays can damage cell structures and DNA, complex repair mechanisms have evolved. When functioning normally, cells can repair themselves, if the x-ray dose is modest. On the other hand, if a cell receives a very high dose, it may simply die in a process known as apoptosis. In between these two outcomes are numerous scenarios in which a cell may attempt to repair itself, but with errors. Exposure levels separating these outcomes are not known, but probably vary from person to person. Additionally, age is a factor. X-rays also may penetrate tissue with no interactions, while low-intensity, wide-beam x-rays may simply bounce off the skin.

Question: 4

Factors affecting the dose of ionizing radiation that an individual receives as a result of exposure to a radiation source in the work environment include all of the following EXCEPT?

A. The number of coworkers who work with, or in proximity to, the radiation source
B. The shielding around the radiation source
C. The distance between the individual and the radiation source
D. The amount of time that the individual is exposed to the radiation source

Answer: A

Explanation:
Exposure to ionizing radiation may be quantified in terms of the dose that an individual receives during an acute event or in terms of cumulative exposure over a time period. Thus, doubling the time that one spends near a particular radiation source doubles the cumulative radiation dose. Exposure can be

reduced by increasing the amount of shielding between the radiation source and the individual. It also can be reduced by increasing the individual's distance from the radiation source, the intensity of the radiation at a given location being inversely proportional to the square of the distance from the radiation source. The intensity of the radiation at the source, in turn, 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, such as a proton beam, than for an individual working with a weak radionuclide, such as tritium.

Question: 5

A technician receives an exposure to ionizing radiation of approximately 2 µSv per week while sitting 1 meter from a medical x-ray source. If the technician's distance from the x-ray source were moved to 3 meters, the weekly exposure would be:

A. 0.67 µSv
B. 6 µSv
C. 0.5 µSv
D. 0.22 µSv

Answer: D

Explanation:
The intensity of ionizing radiation decreases with the distance from the radiation source according to the inverse square law. Thus, if the distance in this case were doubled, from 1 meter to 2, the radiation dosage received per time would decrease 4 times, which is to say from 2 to 0.5 µSv. Since the distance in this case is tripled, however, the dosage decreases by 3 squared, or 9 times, resulting in a weekly exposure of 0.22 µSv. The first choice, 0.67 µSv is the result of simply dividing the original exposure by 3, without squaring, while 6 µSv would be an exposure increased 3 times.

Question: 6

Which of the following pairings of radiation source and dosage of ionizing radiation received during one event is typical?

A. 1 millisievert (mSv) for an adult patient imaged with flat film chest x-rays
B. 40 millisieverts (mSv) for an adult patient imaged with full body computed tomography (CT) scanning
C. 50 microseiverts (USV) for a patient given dental x-rays
D. 10 microseiverts (Sv) for a passenger flying from New York to San Francisco

Answer: B

Explanation:
Compared with 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. Flat film chest x-ray radiography (lateral and posterior-anterior) imparts ionizing radiation doses typically in the range of 10 to 100 microsieverts (uSv), but the dose should not be as high as 1

mSv. Dental x- rays typically are in the area of 5 µSv, with some variation, but should not provide exposures as high as 50 µSv. For a passenger flying from New York to San Francisco, an exposure of approximately 40 µSv is typical because of increased exposure to cosmic radiation as one ascends to higher altitudes.

Question: 7

Which of the following is NOT true regarding radiation monitoring badges?

A. They protect the wearer against most types of ionizing radiation
B. Radiographers must wear them at all times when working in the vicinity of a radiation source
C. They should be placed on the torso, between the waste and the neck
D. When not being worn, they should be kept away from radiation sources

Answer: A

Explanation:
Radiation monitoring badges contain film that changes when it is exposed to ionizing radiation. Often, such badges are divided into different areas made of different materials to detect separately a worker's exposure to alpha particles, beta particles, and x-ray and gamma rays. After a certain time interval, often 1 month, the badge is sent to be developed in a laboratory to see how much of each type of radiation a worker has received. To present an accurate picture of one's radiation exposure, a badge must be worn at all times when the worker is in a radiation area, but kept away from radiation when not being worn. Since the neck to pelvis regions are the most critical anatomic areas to protect, this is where the badge should be worn. While a radiation badge detects radiation, it offers no protection to the person who wears it.

Question: 8

lodine-125 (1251) is a low-energy gamma-emitting isotope that is used in brachytherapy for certain tumors, such as carcinoma of the prostate. Which of the following is MOST accurate regarding the type of hazard that this isotope presents?

A. It is mainly an external exposure hazard because gamma radiation penetrates biological tissue deeply
B. The dangers from external versus internal exposure are approximately equal
C. It is more of a danger when the exposure is internal because it is taken up easily by the thyroid gland
D. It is a hazard only when exposure is internal because of the low energy of its gamma decay

Answer: C

Explanation:
Because it has particular affinity for the thyroid gland, where it can concentrate and release gamma radiation that can destroy tissue and lead to thyroid malignancy, 1251 is particularly hazardous when taken into the body. Moreover, since the molecular form of iodine (12) is volatile, internal exposure to 1251 can take place through inhalation, while certain 1251 compounds can be absorbed through gloves. For these reasons, concern about gamma radiation from 1251 is somewhat greater with respect to the

possibility of internal, rather than external, exposure. Nevertheless, since a small bottle of 1251 does indeed release a fair amount of gamma radiation, the possibility of external exposure should warrant a moderate level of concern.

Question: 9

X-rays and gamma rays are absorbed effectively by which of the following materials?

A. Lead
B. Barium sulfate
C. Depleted uranium
D. All of the above

Answer: D

Explanation:
X-rays and gamma rays are blocked best by materials made of atoms with large nuclei. For this reason, lead is the shield of choice in clinical settings where the sizes of radiation sources are fairly small and where walls and barriers around such equipment must be reasonably thin. Around large sources such as nuclear reactors, however, cement is used, often mixed with barium sulfate (barite or baryte), which also is radiation- dense, and with a thin layer of lead. Being a liquid, barium sulfate also is used as a contrast material in various radiographic applications that use x-rays to image internal structures. Depleted uranium is uranium whose ratio of 235U:238U has been reduced from that typical of uranium ore. Although it manifests its own radioactivity, depleted uranium actually makes an excellent shield against x and gamma radiation.

Question: 10

The linear no-threshold model (LNT) of radiation biological effects is derived from all of the following ideas EXCEPT:

A. Cells have the capability of repairing radiation-induced damage to DNA
B. Any dose of ionizing radiation, even a tiny dose, increases the chance that a cell will undergo malignant change
C. The risk of undesirable biological effects increases as the cumulative radiation exposure of an individual increases
D. The risk of undesirable biological effects, such as malignancy, is proportional to the amount of ionizing radiation to which an individual is exposed

Answer: A

Explanation:
In contrast to the threshold model, which posits that exposure to ionizing radiation must not be harmful below a certain threshold, the linear no-threshold model (LNT) assumes that any ionizing radiation can be harmful, even the background radiation dose that all people receive naturally from the environment. The LNT model is called "linear," because a line is graphed for low-dose exposures by extrapolating

backwards from a line calculated from high-dose data. These high-dose data come from populations known to have suffered harmful effects from fairly high radiation exposures. If even very small radiation exposures can increase an individual's risk of ill effects, it follows that damage resulting from low-level exposure is cumulative for any given individual. Since it is known that cells actually do repair, not only radiation-induced DNA breakage, but damage to other cell structures, the LNT model has been challenged. If the LNT is wrong, the effects of chronic, low-level radiation exposure should not be cumulative at all. Nevertheless, in health care settings, a policy of "as low as reasonably achievable" (ALARA) is followed.

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