19.11: Units of Radiation Dose

A variety of units have been designed to measure how much radiation has been absorbed by a given sample of human or animal tissue. The simplest to understand is the **radiation-absorbed dose**, abbreviated **rad**. This corresponds to absorption of 10^{-5} J of energy per gram of tissue. A more useful unit is the **rem** (**roentgen-equivalent man**), which is the same as the rad except that it is corrected for the relative harmfulness of each type of radiation. For example, an α particle having a kinetic energy of 1.6×10^{-22} J can produce about 10 times as many ions as a γ ray of equal energy. Consequently 1 rad of α radiation would be corrected to 10 rem, while 1 rad of γ radiation would correspond to 1 rem. Once radiation detectors were developed, it was discovered that there is nowhere that one can be entirely free of radiation. That is, there is a natural **background radiation** impinging on all of us every day of our lives. This comes from natural radioactive isotopes in our surroundings and from cosmic radiation which enters the earth's atmosphere from outer space. The average United States citizen receives just over 0.1 rem per year from natural background, although this varies from place to place. In Colorado, for example, background radiation is much higher because of the altitude (less atmosphere to block cosmic rays) and because of naturally occurring deposits of uranium.

Current estimates indicate that the actual radiation dose received by the average person is about 80 percent higher than natural background. The major portion of this increase is due to medical uses—a chest x-ray, for example, contributes about 0.2 rem. Other contributions are made by radioactive fallout from nuclear bombs (about 4 percent of background), and miscellaneous sources such as TV sets (about 2 percent).

There is evidence that the effects of small doses of radiation are cumulative, at least to some degree, and that there is no lower limit to the dose which can cause some damage. Thus even background radiation may be harmful to some extent, but it is hard to determine just how harmful because we have no way of turning it off to see how much difference it makes. In the absence of more accurate information it would seem prudent for each individual and for a society as a whole to minimize unnecessary radiation exposures.

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