

IONIZING RADIATION: BASIC PRINCIPLES

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Ionizing radiation may be thought of in terms of alpha particles, beta particles, gamma rays, and x-rays, each type having its own physical characteristics and relative biological effect (RBE). Alpha particles consist of two protons and two neutrons and are identical to the nucleus of a helium atom. Beta particles are charged particles emitted from an atomic nucleus, with a mass and charge equal to those of the electron. Gamma rays are high-energy electromagnetic radiations of short wavelength that are produced by changes occurring within the nucleus during radioactive decay of many elements. X-rays result from extranuclear transitions of electrons in the atom. The interactions of both x-rays and gamma rays are similar. These rays are similar to light or ultraviolet waves, except that they are more energetic; when they interact with cells in the body they cause atoms to become ionized.

PRODUCTION OF RADIATION

Radiation is released during decay of unstable atoms. Many atoms that occur in nature or that are produced by man are unstable because of an imbalance in the number of neutrons and protons in the nucleus. For example, if a particular atom has too many neutrons, it tends to decay by emitting a negative electron, ie, a negative beta particle, or "negatron." If, on the other hand, the unstable nucleus has too few neutrons, it tends to decay by emitting positrons (ie, positive electrons). Alpha particles are emitted by very heavy atoms such as radium, polonium, and plutonium. Gamma rays are emitted during the process of radioactive decay as the nucleus releases energy. Thus, all ionizing radiations except x-rays result from the process of radioactive decay of unstable atoms.

How are these unstable atoms produced? Some exist in nature; for example, a certain fraction of all potassium on earth is radioactive and about one ten-thousandth of one percent of all the potassium in our bodies is potassium 40. Other types of radioactive materials also occur in nature, such as radium and uranium.

Many more radioactive atoms are produced as a result of processes that man has developed. One of those processes is nuclear fission. If you use neutrons to bombard certain heavy atoms, for example, uranium 235, and add a neutron to the nucleus, it becomes unstable and splits. The resulting lighter atoms are unstable because they have too many neutrons. Therefore, they will undergo radioactive decay. In this manner, radioactive products are produced by the process of nuclear fission.

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