
Long-terms Effects of Ionizing Radiation

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Introduction

The fact that X-rays can induce mutation was established first in 1927. In the years following the mutagenic effects of β - and γ -rays, α -rays and neutrons were described. When DNA was identified as the universal genetic material, it soon became obvious, and was confirmed by genetic evidence that the genetic material of all living beings is susceptible to radiation induced damage. When DNA is damaged by radiation enzymes within the cell nucleus attempt to repair that damage. If repair does not succeed or not correctly, the cell may die or may suffer changes in genetic information. It is thought that killing of cells is the basis for deterministic effects and that subtle changes in information are important in the development of radiation-induced cancer, or of genetic effects if these changes are induced in germ cells.

Biological effects of ionizing radiation

Deterministic radiation effects

A radiation effect is called deterministic when it is directly perceptible in the irradiated individual within a short time after exposure and when it is sure to occur if the dose is large enough. At high doses (more than 0.5 Sv) cells might be killed to impair the function of an irradiated tissue or organ. In extreme cases, the human organism itself may die, if the dose received is higher than 2 to 4 Sv. The probability of causing a deterministic effect like erythema or depression of the blood forming system will be zero at low doses, but increases steeply to 100% above a given threshold.

If a pregnant woman is irradiated, deterministic effects might be most expressed at the time when the relevant tissue is being formed in utero. The killing of a few, but essential cells may result in malformations. An important effect of exposure in utero is a dose-related increase in mental retardation. This is explained by the impaired proliferation, differentiation, migration and connection of neural cells when the relevant brain cortex is being structured 8 to 15 weeks after conception.

The mentioned deterministic radiation effects, with the probable exemption of the in utero exposure of the conceptus at the one cell stadium, occur only after a threshold dose of more than 0.2 Gy is exceeded. Therefore, deterministic effects are of less concern after low dose exposure. In the low dose range (below 0.2 Gy), only stochastic effects are important.