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Biological effects of long-term low-dose-rate irradiation and biodefense mechanism

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Cells or animals respond to stress through a variety of mechanisms depending on their anti-oxidative capacity, DNA repair capability, apoptosis and immunity. Each mechanism works to defend against disease and cancer formation (carcinogenesis). The IES conducts studies on the biological effects of long-term gamma rays exposure at medium-dose-rate (MDR) and low-dose-rate (LDR) (less than the dose rate of 0.1 mGy/min; 132 mGy/day) in mice using unique facilities designed to irradiate continuously for over 400 days under specific pathogen free (SPF) conditions.

Adaptive response (AR), a mechanism that has been shown to decrease radiation damage, can be induced with MDR and LDR irradiation under limited conditions (priming dose of 10˜50 mGy followed by a second [challenge] dose after 4-12 hours).

AR may be sustained from a few hours to several months in mice. Increased levels of reactive oxygen species (ROS) or nitric oxide (NO) have been observed in adaptive cells and both factors may play an important role in the induction of AR.

The lowest dose rate, approximately 0.28 mGy/min (corresponds to MDR of 200 to 400 mGy/day at IES), at which AR is observed coincides with the minimum dose rate region of the inverse dose rate effects, wherein the frequency of extrinsic radiation-induced DNA dsb is equal to the frequency of endogenous DNA dsb repair. It should be noted however that this dose range is far too high when compared to the doses at which humans or animals are exposed to in real life.

AR and DNA dsb repair observed in MDR radiation exposures could be evidence representing evolutionary remnants. Further study on biological effects such as AR and DNA repair systems at much lower LDR region deserves merit.

Keywords: Radiation, Biodefense, adaptive response, low dose rate, DNA repair