

## Principal Research Results

# Reduction of the Background Mutation by a Low Dose X-irradiation of *Drosophila* Immature Sperms at a Low Dose-rate

### Background

The dose-response relationship between ionizing radiation and induced mutation frequency was reported as early as 1930 using sex-linked recessive lethal assay in mature sperms of fruit fly *Drosophila melanogaster*. It was shown that between 2.7Gy and 43.5Gy, X-ray dosage and mutation frequency had a linear relationship without any threshold (Fig.1). Since then, the so-called linear non-threshold (LNT) model has been widely accepted as a basis for estimation of radiation risks to humans. However, mature sperms never proliferate nor turn into cancers. We have previously reported that in the somatic mutation assay in *Drosophila* there is a threshold and that a mutation in the DNA repair function decreases the threshold value. It is possible that even in germ line mutation assays, a threshold can be detected when repair proficient immature sperms are used.

### Objectives

To examine possible threshold in germ line mutation assay using repair proficient immature sperms, irradiating them with low dose, low dose-rate X-rays. Also, using a mutation, to indicate the involvement of DNA repair function in threshold formation.

### Principal Results

#### 1. Dose-response relationship in a DNA repair proficient strain

Wild type third instar larvae were irradiated with various doses at various dose-rates (Fig.2).

- (1) Background mutation frequency in the non-irradiated group was around 0.3%, which is consistent with the control frequency in the previous reports.
- (2) Irradiation with 10Gy caused a significant increase of mutation in both dose-rates.
- (3) Irradiation with 0.2Gy caused a reduction in mutation frequency, especially in the low dose-rate group.

These results indicate that the dose-response relationship is not linear but U-shaped. It is inferred that there is a threshold below which no increase of mutation is observed, between 0.2 and 10Gy.

#### 2. Dose-response relationship in a DNA repair deficient strain

When a DNA-repair deficient strain was used instead of wild type, a low dose, low dose-rate irradiation did not cause the reduction in mutation frequency (Fig.3). This indicates the involvement of DNA repair function in the threshold formation in wild type, and thus, suggests that LNT model holds only in repair deficient cells.

### Future Developments

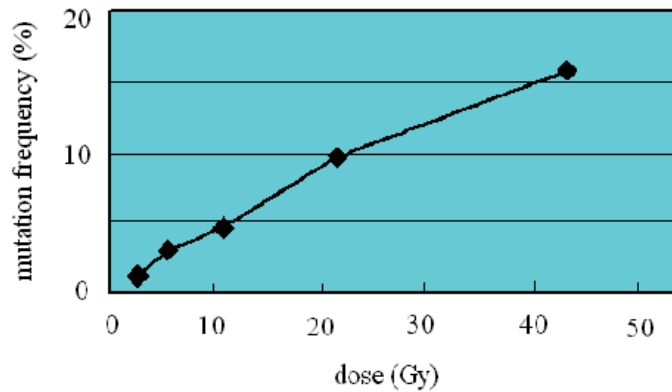
The existence of a threshold was indicated, but the exact threshold value is still to be determined.

**Main Researcher:** Takao Koana, Ph. D.,

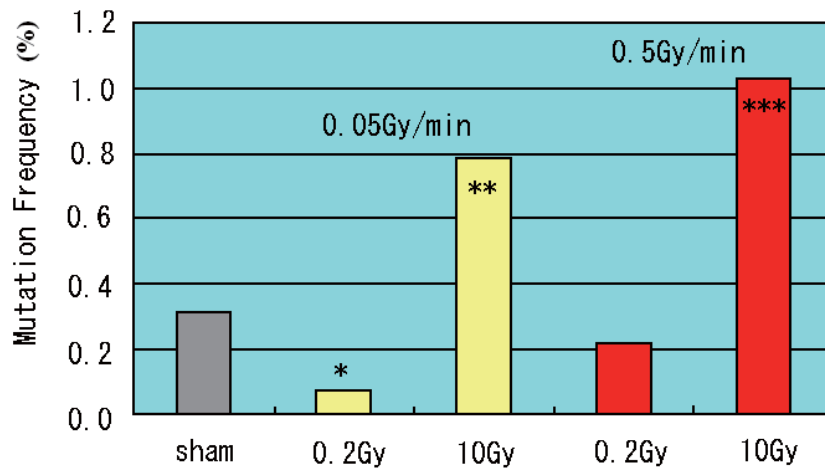
Senior Visiting Researcher, Low Dose Radiation Research Center, Nuclear Technology Research Laboratory

### Reference

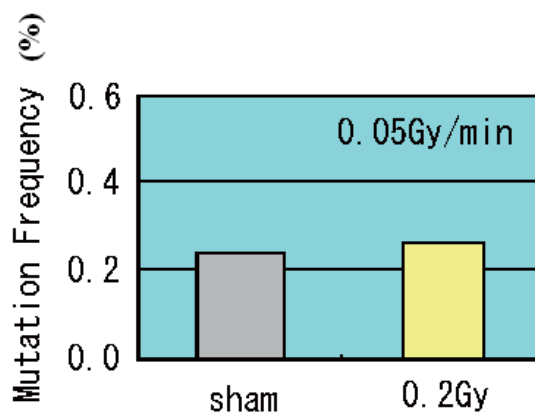
T. Koana et al., 2007, "Reduction of the background mutation by a low dose X-irradiation of *Drosophila* spermatocytes at a low dose-rate.", Radiat. Res., in print



**Fig.1** Dose-response relationship in mature sperms irradiated with high dose X-rays at a high dose-rate (modified from C. P. Oliver, *Science* (1930) 121, 44-46)



**Fig.2** Sex linked recessive mutation frequency in the wild type flies. Irradiation of the immature sperms with a 0.2Gy X-ray at 0.05Gy/min. significantly reduced mutation, whereas irradiation with 10Gy made it significantly higher. Irradiation with 0.2Gy at 0.5Gy/min. did not make a significant change in the mutation frequency



**Fig.3** Sex linked recessive mutation frequency in the excision repair defective *mei-9<sup>a</sup>* flies. A low dose, low dose rate irradiation did not cause a reduction of mutation