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Kinetics of double strand breaks of DNA in tritiated water evaluated using single molecule observation method

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Detailed understanding of mechanisms underlying DNA damages by low energy beta-rays from tritium is important for evaluation of impact of tritium release from fusion devices to the environment. In this study, the rate of double strand breaks (DSBs) of DNA in tritiated water was measured using a single molecule observation method.

Genome size linear double strand DNA molecules of bacteriophage T4 GT7 (57 micrometers, 166 kbp = kilo base pairs) were provided by Nippon Gene Ltd., Japan. The DNA molecules were suspended in sterilized and non-sterilized tritiated water (5.2 MBq/cm3) and irradiated with beta-rays at 10 ℃ for 1, 7 and 14 days. The values of absorption dose were 0.41, 2.9 and 5.7 Gy. After staining with fluorescent dye YoYo-1, DNA molecules were placed on a glass substrate in extended forms. The lengths of DNA molecules were measured using an inverted type fluorescent microscope (Olympus IX73). The number of DSBs were evaluated using a method proposed in [1]. DSBs in non-radioactive sterilized and non-sterilized water were also examined for comparison.

Under sterilized conditions, significant reduction in DNA lengths due to beta-ray irradiation was observed after irradiation for 7 and 14 days corresponding to 2.9 and 5.7 Gy, respectively. The number of DSBs per 100 kbp was evaluated to be 0.2 at 1 day, 1.0 at 7 days and 1.6 at 14 days. Interestingly, DNA lengths in non-sterilized tritiated and non-radioactive water were clearly shorter than those in sterilized tritiated water. It means that the irradiation effects of beta-rays were far weaker than the influence of microorganisms in water though tritium concentration was as high as 5.2 MBq/cm3.

[1] S. F. Shimobayashi et al., J. Chem. Phys. 138, 174907 (2013).

Co-author: Dr HATANO, Yuji (Hydrogen Isotope Research Center University of Toyama)

Presenter: Dr HATANO, Yuji (Hydrogen Isotope Research Center University of Toyama)

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