Overture

Cytogenetics: Chromosomes are basic building blocks of DNA and present linkage groups of genes. Cytogenetics was first coined by merging cytology and genetics from studies of W. S. Sutton in 1903 on the mitotic and meiotic behavior of chromosomes in grasshopper as the science of chromosomes. Combined with the observations of Th. Boveri (1902) in fertilization in sea urchin eggs, the principle of chromosome behavior is now often called *Sutton-Boveri Chromosomal Theory of Inheritance*.

Radiation cytogenetics: What is mutation? The central problem of mutation was opened up by the epochal discovery of H. J. Muller (1927) that X-rays dramatically increased mutations in Drosophila, in which dominant lethal mutations, incomplete recessive mutations and gross chromosomal rearrangements were suggested. Similarly, B. McCrintock (1931) studied X-ray-induced mutation in plants, maize and *Nicotiana* and concluded that "*None of the recessive phenotypes in the examined plants arose from gene mutation. Each reflected loss of a segment of chromosome that carried the wild-type allele, and x-rays were responsible for inducing these deficiencies*" (McClintock 1984). It is currently accepted that the expression of recessive mutation by radiation is mostly a consequence of a loss of allele by chromosomal mechanisms, deletion or mitotic recombination (Sankaranarayanan 1991a, 1991b). The direct cytological evaluation of radiation-induced chromosome aberrations was first made by K. Sax and his colleagues (Sax 1938, 1939, 1940, 1941) in the mitotic and meiotic chromosomes of *Tradescantia* microspores. The action of X-rays on chromosomes revealed in these early days has continued to provide a fundamental concept of modern radiation cytogenetics.

Human radiation cytogenetics: Advances in the methods of tissue culture (Hsu and Pomerat 1953) and chromosome preparation (Makino and Nishimura 1952), opened the daybreak of modern human cytogenetics. The normal set of chromosomes of man was determined by Tjio and Levan (1956). Aided by the development of culture method of peripheral blood lymphocyte by Moorhead et al. (1969), there became burst of "*clinical cytogenetics*", dealing with inborn errors of chromosome, such as Down syndrome (Lejeune et al. 1959), Turner syndrome (Ford et al. 1959) and Klinefelter syndrome (Jacobs and Strong 1959). When the chromosome methods became available for human material, it soon became clear that chromosome aberrations were produced in the cells of radiation treated humans (Tough et al. 1960, Sasaki 1961, Buckton et al. 1962). The "*human radiation cytogenetics*" evolved as a part of human cytogenetics that concerns the effects of radiation in humans (*e.g.*, Bender 1969).

Radiation dose assessment by chromosome aberration analysis: As to the radiation-induced chromosome aberrations, we have large amount of legacies from over 30 years' studies in plant materials, including the effects of dose and dose-rate, quality of radiation, and cell-cycle position at irradiation. Evidence has been accumulated to show that human chromosomes respond similarly to that of plants. The extensive review was first made on this issue by the United Nations Scientific Committee of the Effects of Atomic Radiation (UNSCEAR) in 1969, in which the use of chromosome aberration analysis was suggested to be a practical application in the biological dose assessment in the human radiation exposure. Currently, chromosome aberration analysis is considered to provide most reliable means for dose assessment in the radiation exposed persons. The standardization of the method may be seen in the reports of the International Atomic Energy Agency (IAEA).

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