

Historical Framework of Major Events Relevant to Radiation Cytogenetics:
Fundamental Nuclear Physics, Chemistry, Biology, Medicine and Radiation Protection

- 1869 Periodic system of the elements (D. I. Mendeléeff).
- 1873 Theory of electromagnetic radiation (J. C. Maxwell).
- 1895 Discovery of X-rays (E. C. Röntgen).
- 1896 Discovery of radioactivity (A. H. Becquerel).
- 1897 Isolation of polonium and radium (M. Curie, P. Curie).
- 1900 Discovery of γ -rays (Villard).
- 1900 Re-discovery of G. J. Mendel's laws (H. de Vries, C.E. Correns, E. von S. Tschermak).
- 1903 "Die Mutationstheorie (Mutation Theory)" (H. de Vries).
- 1903 Chromosomal theory of inheritance (Cytogenetics) (W. S. Sutton).
- 1905 Special theory of relativity ($E=mc^2$) (A. Einstein).
- 1905 Quantum theory of light (photoelectric effect), $E=h\nu$ (A. Einstein).
- 1906 Law of Bergonié-Tribondeau (J. Bergonié and L. Tribondeau).
- 1911 Discovery of atomic nucleus (E. Rutherford).
- 1913 Bohr's theory of hydrogen (H) atom (N. Bohr).
- 1914 Chromosome mutation theory of cancer (Th. Boveri).
- 1915 "The Mechanism of Mendelian Heredity" (T. H. Morgan).
- 1923 Compton effect (A. H. Compton).
- 1925 International Commission on Radiation Units and Measurements (ICRU).
- 1926 Schrödinger's wave mechanism (E. Schrödinger).
- 1927 "The Quantum Theory of the Emission and Absorption of Radiation"
(P. A. M. Dirac)
- 1927 X-ray induced mutagenesis in *Drosophila* (H. J. Muller)
- 1928 X-ray induced mutagenesis in maize (L. J. Stadler).
- 1928 X-ray induced mutagenesis in *Nicotiana* (T. H. Goodspeed, A. R. Olson).
- 1928 International Commission on Radiological Protection (ICRP).
- 1930 Quantum mechanical stopping power (H. A. Bethe).
- 1931 Chromosomal origin of mutation in maize (B. McClintock).
- 1932 Discovery of positron (C. D. Anderson).
- 1932 Discovery of neutron (J. Chadwick).
- 1934 Production of artificial radioisotopes (F. Joliot and I. Joliot-Curie)
- 1935 Prediction of mesons for short range nuclear force (H. Yukawa).
- 1937 Chromosomal origin of mutation in *Drosophila* (B. P. Kaufmann).
- 1938 X-ray induced chromosome aberrations in *Tradescantia* (K. Sax).
- 1938 Discovery of nuclear fission by neutron (O. Hahn and F. Strassmann).
- 1941 Neutron-induced chromosome aberrations (K. Sax).
- 1945 Atomic bombing (nuclear fission) in Hiroshima and Nagasaki.
- 1946 "Action of Radiation on Living Cells" (D. E. Lea).
- 1947 Radiocarbon (^{14}C) dating (W. F. Libby).
- 1947 Atomic Bomb Casualty Commission (ABCC).
- 1949 Photoreactivation (A. Kelner).
- 1952 First thermonuclear fusion test (hydrogen bomb).
- 1952 Stemline theory of cancer (S. Makino).
- 1953 Discovery of DNA double helix (J. D. Watson and F. H. C. Crick).
- 1954 First hydrogen bomb test at Bikini atoll, Marshall Islands,
- 1955 United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR).
- 1955 Exchange theory of chromosome breaks (S. H. Revell).
- 1956 Normal chromosome constitution of man (J. H. Tjio and A. Levan)
- 1957 Molecular chromosome model (Unineme model) (J. H. Taylor).
- 1957 International Atomic Energy Agency (IAEA).

1957 X-ray induced chromosome aberrations in cultured human cells (M. A Bender).
 1957 Split dose recovery in Chlamidomonas (B. S. Jacobson).
 1958 "What is Life: The Physical Aspect of the Living Cell" (E. Schrödinger).
 1958 International Association for Radiation Research (IARR)
 1958 Sister chromatid exchange (SCE) (J. H. Taylor).
 1959 Site theory for chromosome exchanges (S. Wolff).
 1959 Split dose recovery (Sublethal damage) (M. M. Elkind and H. Sutton).
 1959 Birth of human clinical cytogenetics (J. Lejune; C. E. Ford; P. Jacobs).
 1960 Denver Conference on Human Chromosome Standardization.
 1960 Peripheral blood lymphocyte culture technique (P. S. Moorhead et al.).
 1960 X-ray induced chromosome aberrations in man lymphocytes (I. M. Tough).
 1960 Electron spin (paramagnetic) resonance spectroscopy (W. Gordy and
 I. Miyagawa; J. W. Hunt et al.)
 1961 Radioisotope induced chromosome aberrations in human tumor (M. S. Sasaki).
 1961 First manned space flight (Vostok 1).
 1962 "Recuplex" criticality accident, Hanford, USA.
 1964 Unscheduled DNA synthesis (R. E. Rasmussen and R. B. Painter).
 1965 Chromosomal theory of RBE (G. J. Neary).
 1965 Atomic bomb radiation dosimetry system in Hiroshima and Nagasaki, T65D.
 1965 Folded fiber model of chromosome (E. J. DuPraw).
 1966 Okazaki fragment (R. Okazaki).
 1966 Infinite site model for chromosome exchanges (A. Norman and M. S. Sasaki).
 1966 Potentially lethal damage (R. A. Phillips and L. J. Tolmach).
 1966 International Radiation Protection Association (IRPA)
 1968 First human missions landed on the earth (Apollo 11).
 1968 Chromosomal biodosimetry in man (M. S. Sasaki and H. Miyata).
 1968 UV hypersensitivity of xeroderma pigmentosum (J. E. Cleaver).
 1968 Restriction endonuclease (S. Linn and W. Arber).
 1969 "Human Radiation Cytogenetics" (M. A Bender).
 1969 UV hypersensitivity of xeroderma pigmentosum (J. E. Cleaver)
 1970 Micronucleus test (K. Boller and W. Schmid).
 1970 Premature chromosome condensation (PCC) (R. T. Johnson and P. N. Rao)
 1970 Quinacrine fluorescence chromosome banding (Q-band) (T. Caspersson).
 1970 Q-banding (T. Caspersson)
 1971 C-banding (J. J. Yunis), G-banding (A. T. Sumner), R-banding (B. Dutrillaux).
 1971 Chromosome aberrations in atomic bomb survivors (A. A. Awa).
 1971 Nuclear magnetic resonance (NMR) imaging in medicine (R. Damadian).
 1971 Ames mutagen test (B. N. Ames).
 1972 Theory of dual radiation action (A. M. Kellerer and H. H. Rossi).
 1973 Molecular theory of aberration formation (KH. Chadwick and HP. Leenhouts).
 1973 Cross-link hypersensitivity of Fanconi anemia (M. S. Sasaki and A. Tonomura).
 1973 X-ray computer tomography (CT) (G. N. Hounsfield).
 1974 High frequency of SCE in Bloom syndrome (J. German).
 1974 Harlequin staining of sister chromatid (P. Perry and S. Wolff)
 1975 X-ray hypersensitivity of ataxia telangiectasia (A. M. R. Taylor).
 1976 Chromosomal origin of mutation in mice (M. Abrahamson and S. Wolff).
 1979 TMI nuclear power plant accident, USA.
 1982 Photon Factory (PF), High Energy Accelerator Research Organization (KEK),
 Tsukuba, Japan.
 1982 X-ray induced heritable tumor in mice (T. Nomura).
 1982 Threshold energy-repair saturation model (D. T. Goodhead).
 1982 Inverse dose-rate effect (C. K. Hill).
 1984 Radioadaptive response (G. Olivieri, J. Bodycote and S. Wolff).
 1985 Polymerase chain reaction (PCR) (R. K. Saiki).

- 1985 Transcription coupled repair (P. C. Hanawalt).
- 1985 Cytokinesis-block micronucleus method (M. Fenech and A. A. Morly)
- 1986 Fluorescence *in situ* hybridization (FISH) (D. Pinkel).
- 1986 Chernobyl nuclear power plant accident, USSR.
- 1986 Atomic bomb radiation dosimetry system in Hiroshima and Nagasaki, DS86.
- 1987 Cesium-137 accident in Goiânia, Brazil.
- 1989 Single-strand conformation polymorphism (SSCP) (T. Sekiya).
- 1990 Human genome project (HGP).
- 1993 UV photoreactivating enzyme (Cry1, Cry2) (T. Todo)
- 1994 Heavy Ion Medical Accelerator in Chiba (HIMAC), Chiba, Japan.
- 1994 Clustered DNA damage (J. F. Ward; D. T. Goodhead).
- 1997 SPring-8 (Super Photon ring-8 GeV), RIKEN, Harima, Japan.
- 1999 Criticality accident of JCO Tokai-mura, Japan.
- 2002 Atomic bomb radiation dosimetry system for Hiroshima and Nagasaki, DS02.
- 2007 Atlas of Cancer Genome Project.
- 2008 J-PARK (Japan Proton Accelerator Research Complex), Tokai, Japan.
- 2011 TEPCO Fukushima nuclear power plant accident (Japan)

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Relevant Radiation Research in Japan

- 1945 Atomic bombing in Hiroshima (August 6) and Nagasaki (August 9).
- 1945 End of the World War II (August 15).
- 1945 Ad Hoc Committee on the Atomic Bomb Damage (MEXT).
- 1947 Atomic Bomb Casualty Commission (ABCC).
- 1949 Science Council of Japan (SCJ).
- 1951 "Summary Report on the Atomic Bomb Damage" (SCJ).
- 1953 Peaceful Use of Nuclear Energy (President D. D. Eisenhower at the United Nations General Assembly).
- 1954 Hydrogen bomb test at Bikini Atoll: Fallout exposure in 23 fishermen (Fukuryu-maru).
- 1954 Ad Hoc Committee on the Effects of Radiation" (SCJ).
- 1954 Japan proposed at UNESCO General Assembly "Urgent Need for the International Studies on Radiation Effects".
- 1954 First National Budget for the development of nuclear energy.
- 1955 Ground Rule of Nuclear Energy Law (Independency, Democratic, Openness).
- 1956 Atomic Energy Commission (AEC).
- 1956 Ministry of Science Technology (Merged to MEXT in 2001).
- 1957 Japan Atomic Energy Research Institute (JAERI).
- 1957 First research reactor (JRR-1) in criticality.
- 1957 National Institute for Radiological Science (NIRS).
- 1959 Atomic Energy Society of Japan (AESJ).
- 1959 Japan Radiation Research Society (JRRS).
- 1961 Japan Health Physic Society (JHPS).
- 1965 Japanese Society of Radiation Chemistry (JSRC).
- 1965 Atomic bomb radiation dosimetry system in Hiroshima and Nagasaki, T65D.
- 1971 Iridium (¹⁹²Ir) accident in Chiba (September 18).
- 1975 ABCC reformed to US-Japan binational organization (Radiation Effects Research Foundation, RERF).
- 1976 Japan Association for Radiation Research (JARR).
- 1976 Radiation Biology Center (Inter-university Research Center), Kyoto University.
- 1978 Nuclear Safety Commission (NSC).
- 1979 6th International Congress of Radiation Research, May 13-19, Tokyo.
- 1986 Chernobyl nuclear power plant accident.
- 1986 Atomic bomb radiation dosimetry system in Hiroshima and Nagasaki, DS86.
- 1988 Japan Society for Therapeutic Radiology and Oncology (JASTRO).
- 1999 Criticality accident in JCO Tokai-mura (September 30).
- 2000 10th International Congress of Radiation Protection Association, May 14-19, Hiroshima.

- 2002 Atomic bomb radiation dosimetry system for Hiroshima and Nagasaki, DS02.
- 2005 Asian Association for Radiation Research (AARR).
- 2011 Fukushima nuclear power plant accident (March 11)
- 2015 15th International Congress of Radiation Research, May 25-29, Kyoto

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