The Genetic health effect of radiation and human rights of the second generation of Atomic Bomb survivors in Hiroshima and Nagasaki

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Studies of genetic effects of radiation

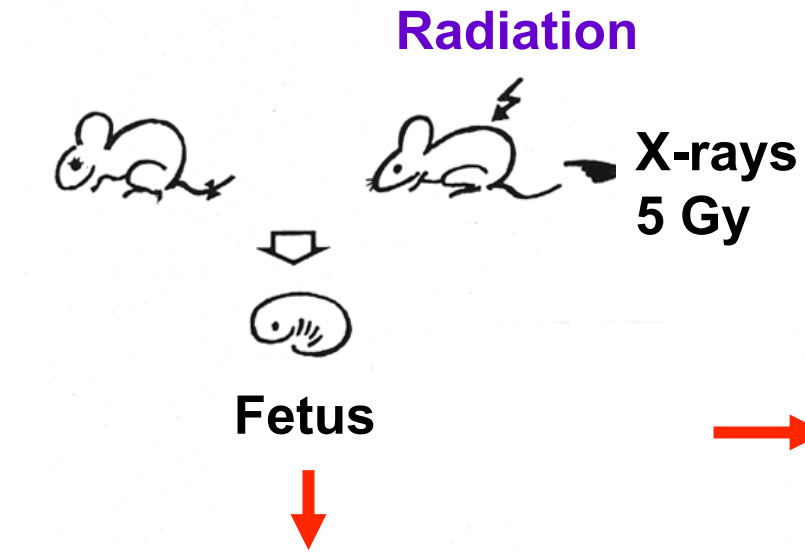
- **Animal experiments:**
  estimation of risk to human being

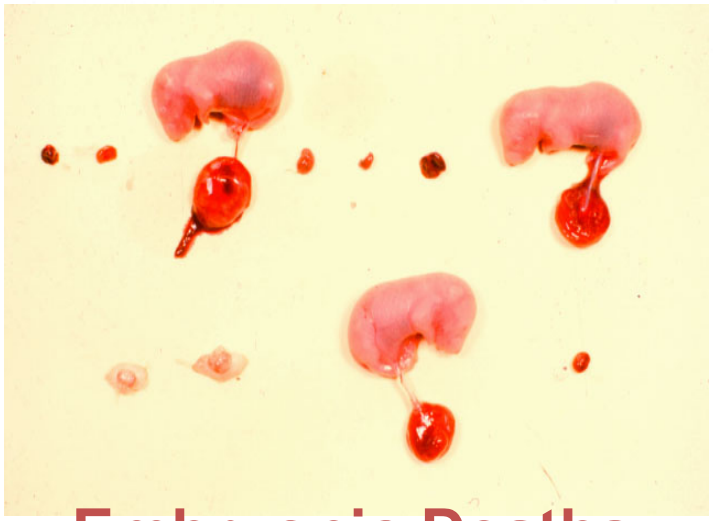
- **Epidemiological study:**
  human health survey on the children of survivors exposed to radiation.

- **Molecular genetics:**
  DNA mutation of germ-line cells,
  RNA expression, and so on.

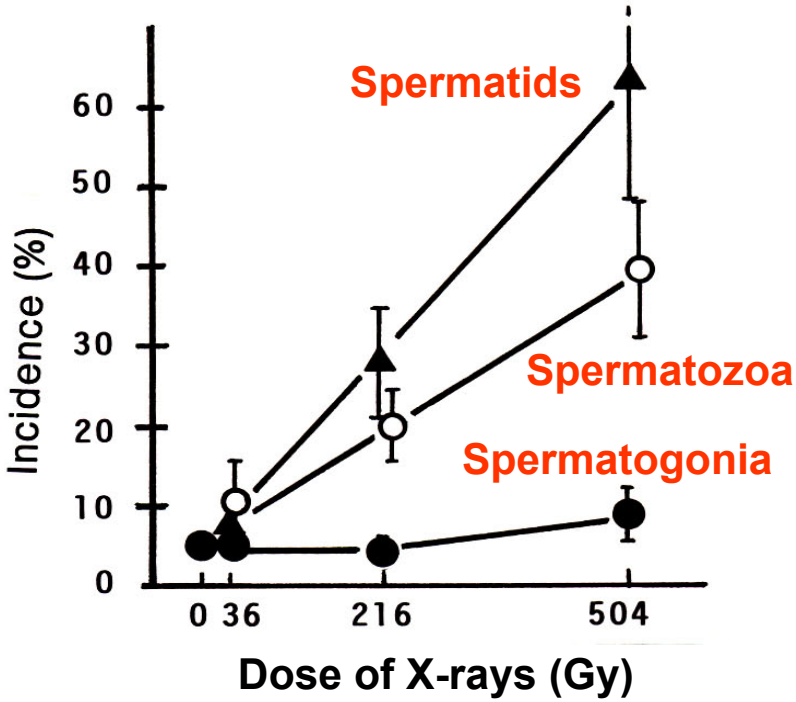
Visible Evidence of Genetic Effects of Radiation

Embryonic Deaths in F_1 Fetuses (Dominant Lethals)





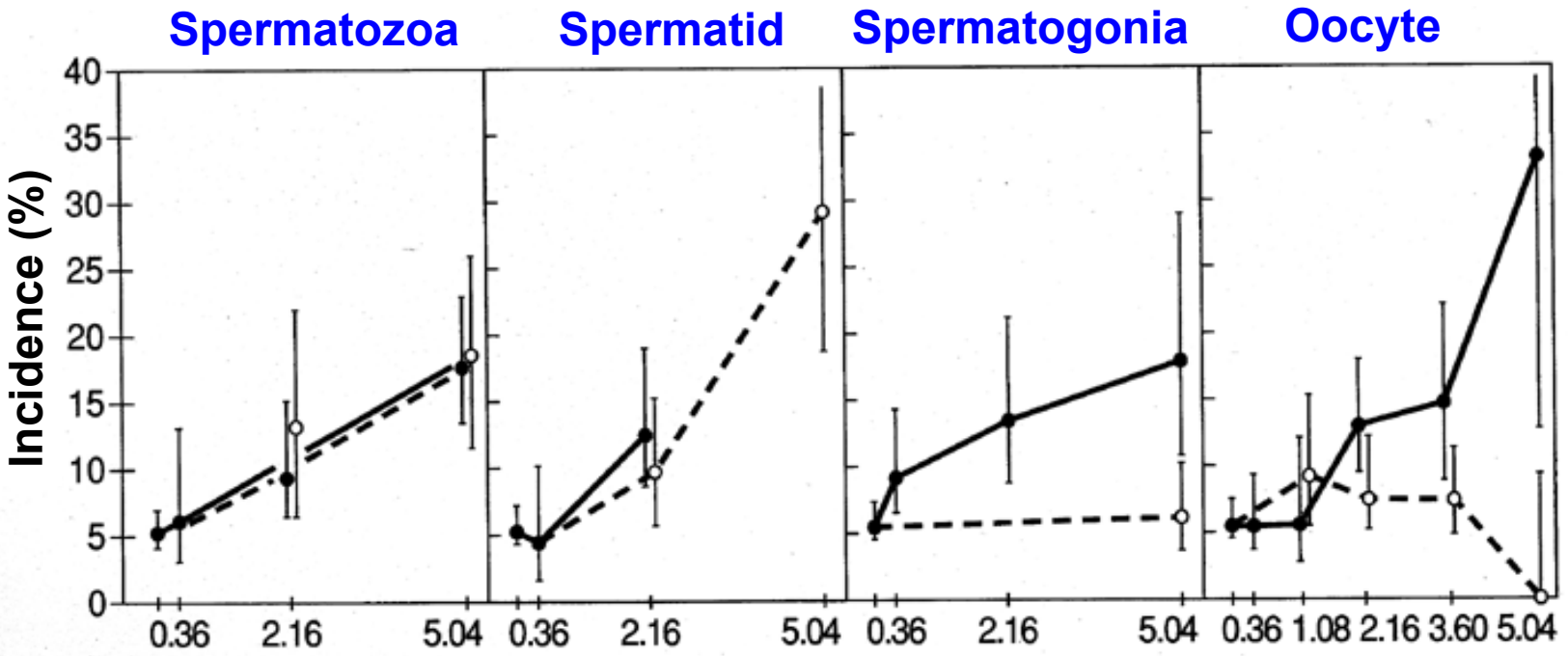
Embryonic Deaths



No significant increase by the exposure of spermatogonia which will be killed during meiosis due to large chromosomal changes

(Nomura, 1975, 78, 82)

Tumor Induction in the Next Generation (F_1) after Parental Exposure to Radiation



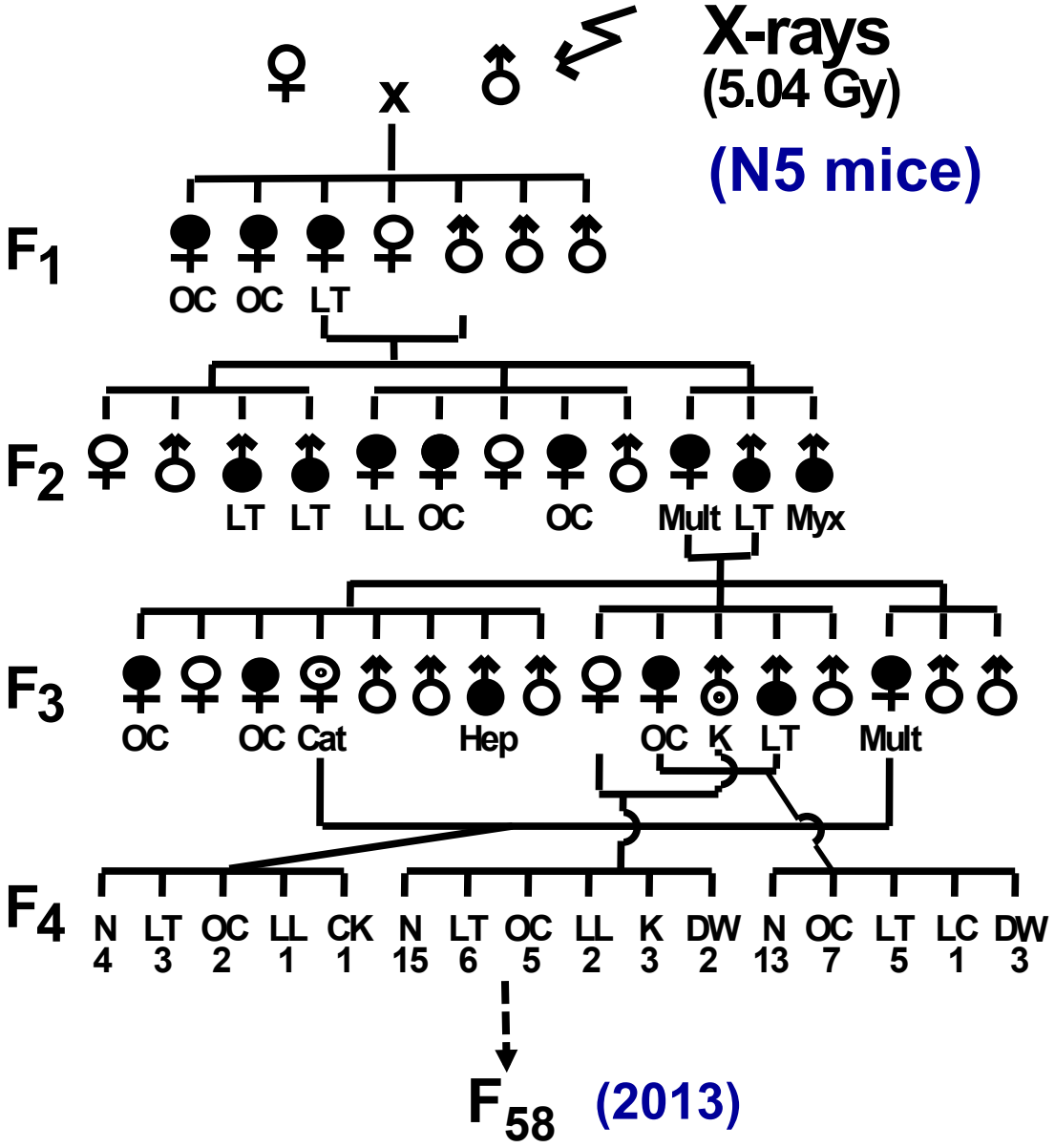
出典：Nomura, T. Parental exposure to X rays and chemicals induces heritable tumours and anomalies in mice. Nature, 296: 575-577, 1982.

Solid line; single and high dose. Broken line; low and fractionated.

1. **Postmeiotic stages are more sensitive than Spermatogonia.**
2. **Protract effects in Spermatogonia and Oocytes; Reduction factor > 10 (1 for postmeiotic stages).**

(Nomura, Tumors of Early Life in Man, 1978; Nature, 1982)

Inheritance; Transmission of Tumour Susceptibility



(Nomura, 1986, 2000)

Retrospective analysis demonstrated that variety of tumors and malformations developed in next generation.

OC: ovarian cancer
LT: lung tumor
LL: lymphatic leukemia
Hep: hepatoma
CK: kidney cancer
LC: lung cancer

Understanding from the animal experiment

- The results of the animal-experiment, especially on mammals, suggest that the similar genetic health effects could be induced in human being.

- The genetic health effect induced by radiation exposure is "non-specific disease" to radiation: congenital disorders, cancers, non-cancer diseases, etc.

- The risk of the genetic health effect of radiation increases in proportion to the exposure dose of the parents. "Stochastic Effect"

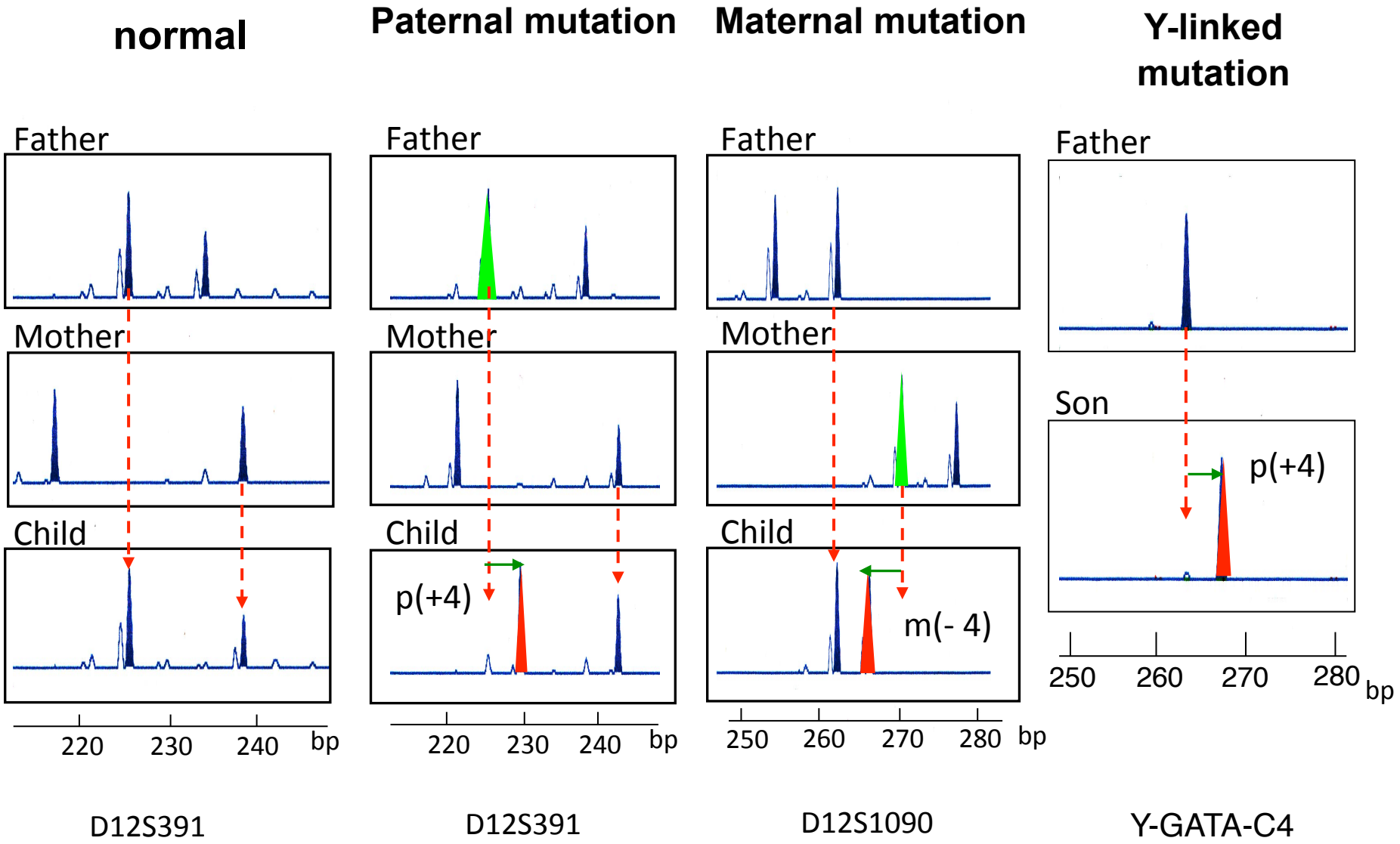
Genetic studies on the children of A-bomb survivors by ABCC/RERF

Birth defects （still birth, malformation, perinatal death, etc.）	1948～1954
Sex ratio	1948～1962
Growth and development（height, weight, mental development）	1965
Chromosome aberrations	1967～1984
Cancer incidence (on going)	1960～
Mortality (on going)	1960～
Protein electrophoresis	1977～1984
DNA studies (ongoing)	1985～
Clinical examination study (on going)	2001～

“There is no clear evidence so far, which indicates the health risks induced by radiation exposure of parents.”

Their study has several scientific problems and limitation.

Detection of mutation in children using makers of microsatellite length



Microsatellite mutation rates in the children of the liquidators, who had been exposed to radiation before conception and those of the un-exposed control

No. of microsatellite loci	control group		preconceptional exposed group	
	total No. of loci	No. of mutations (mutation rate, x10^{-3})	total No. of loci	No. of mutations (mutation rate, x10^{-3})
autosomal (31)	2108	18 (8.5)	1852	11 (5.9) ($p \fallingdotseq 0.3$)
Y-linked (40)	1458	3 (2.1)	1392	4 (2.9) ($p \fallingdotseq 0.95$)
X-linked (1)	68	0 (0.0)	59	0 (0.0)

Furitsu, Ryo, Nomura, et.al, 2005

Mini- and Microsatellite Mutations in the Children of Radiation-exposed Parents

		Exposed	Control	Reference
Atomic Bomb Survivors (Japan)	No change	62 children (1.9 Sv)	60 children (<0.01Gy)	Kodaira, et al (1995, 2004) 〔71,72〕
Chernobyl (Belarus) (Inhabitant)	Increase(x1.8)	127 children	120 UK non-exposed	Dubrova, et al (1996) 〔73〕
Chernobyl (Ukraine) (Liquidator)	No change	183 children	163 children Non-contemn. area	Livshits, et al (2001) 〔74〕
Chernobyl (Ukraine) (Inhabitant)	Increase(x1.6)	240 children	98 matched control	Dubrova, et al (2002) 〔75〕
Chernobyl (Estonia) (Liquidator)	No change	148 children	155 children born before exposure	Kiuru, et al (2003) 〔76〕
Chernobyl (Ukraine) (Liquidator)	No change	51 children	24 children born before exposure	Slebos, et al (2004) 〔77〕
Semipalatinsk (Kazakhstan) (Inhabitant)	Increase(x1.7)	40 families (3 generations)	28 families (3 generat) (matched control)	Dubrova, et al (2002) 〔78〕
Techa River (Mayak) (Russia) (Inhabitant)	Increase(x1.7)	159 children (50 mSv)	110 children (non-contamn. area)	Dubrova, et al (2006) 〔79〕
Chernobyl (Belarus) (Liquidator)	No change	73 children (39mSv)	69 children (non-exposed)	Furitsu, et al (2005) 〔81〕
Atomic Bomb Survivors (Japan)	No change	66 children (1.56 Gy)	63 children (<0.01Gy)	Kodaira, et al (2010) 〔82〕

Recent activities of the association of second generation A-bomb survivors

- **Domestic activities:**
  requesting the Japanese government to take measures to protect their right to health
- **International activities:**
  - raising the issue of the human rights of the second generation to the UN human rights counsel
  - making clear voices for the nuclear free world in succession to the activities of the first generation Hibakusha

What is necessary?

to protect the human rights of the nuclear victims including their second and further generation

- **The social and medical support:**
  to nuclear victims and their next generations based on "precautionary principle"

- **Abolition of nuclear weapons,**
  as well as "peaceful use of nuclear"
  to avoid any further burden to the future generations from the nuclear contamination and radiation exposure.