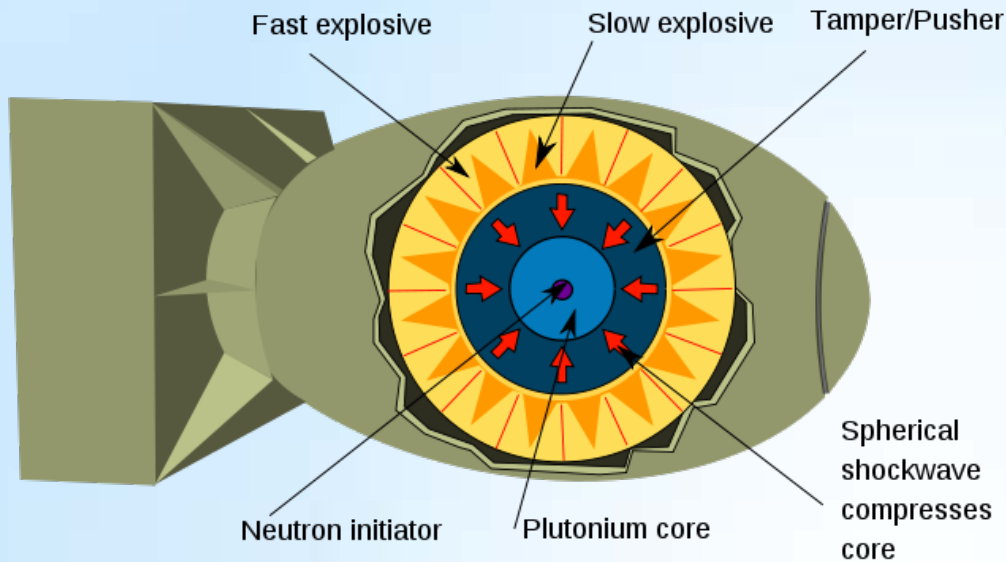


1945 Atomic Bombings: Radiation and the Human Body

Atomic Bombs



Implosion Mechanism

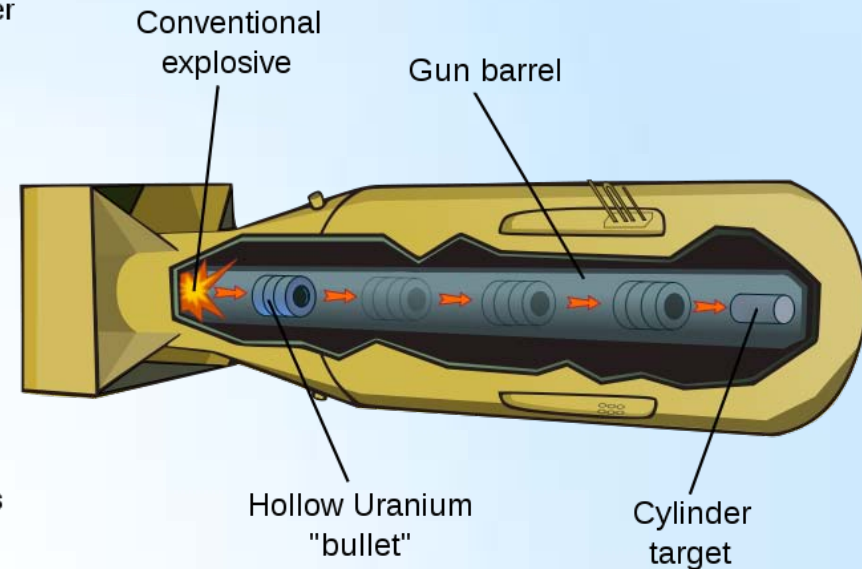
Little Boy

8-6-1945

Uranium-235

Hiroshima

13-16 kilotons TNT



Gun Mechanism

Fat Man

8-9-1945

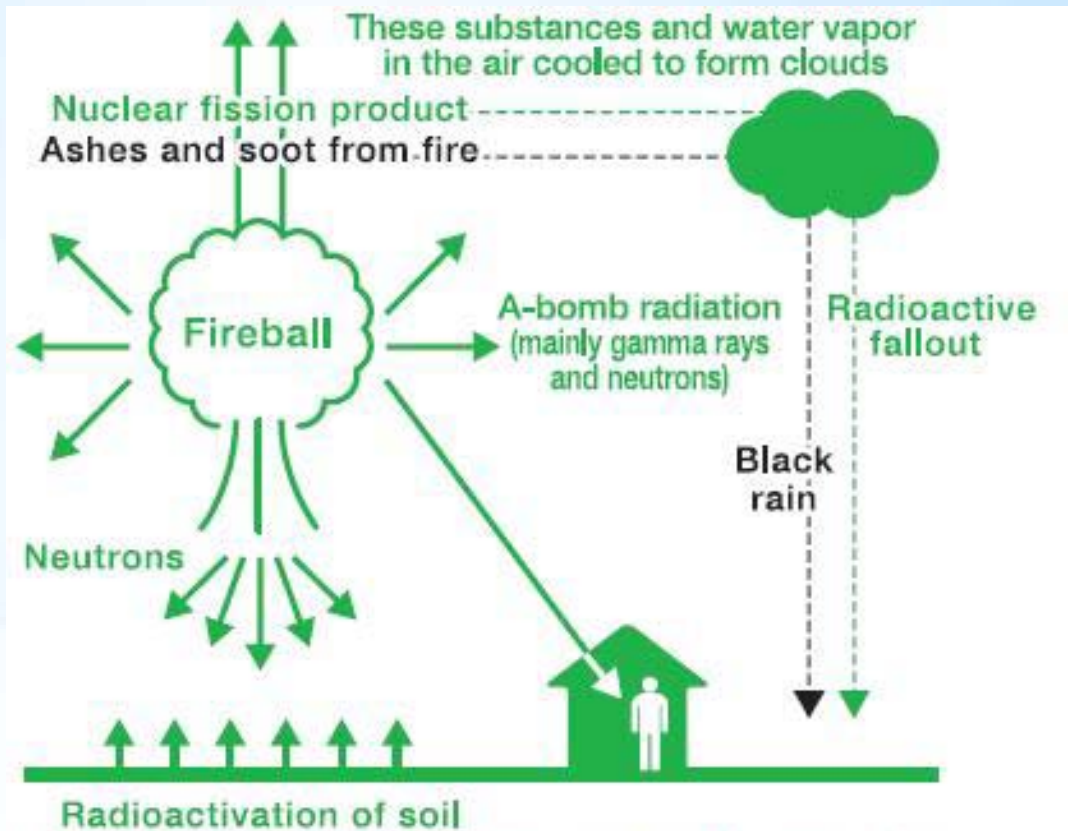
Plutonium 239

Nagasaki

21-23 kilotons TNT

Boom.

- Energy breakdown
 - 35% radiant heat
 - 15% Radiation
 - 50% initial blast



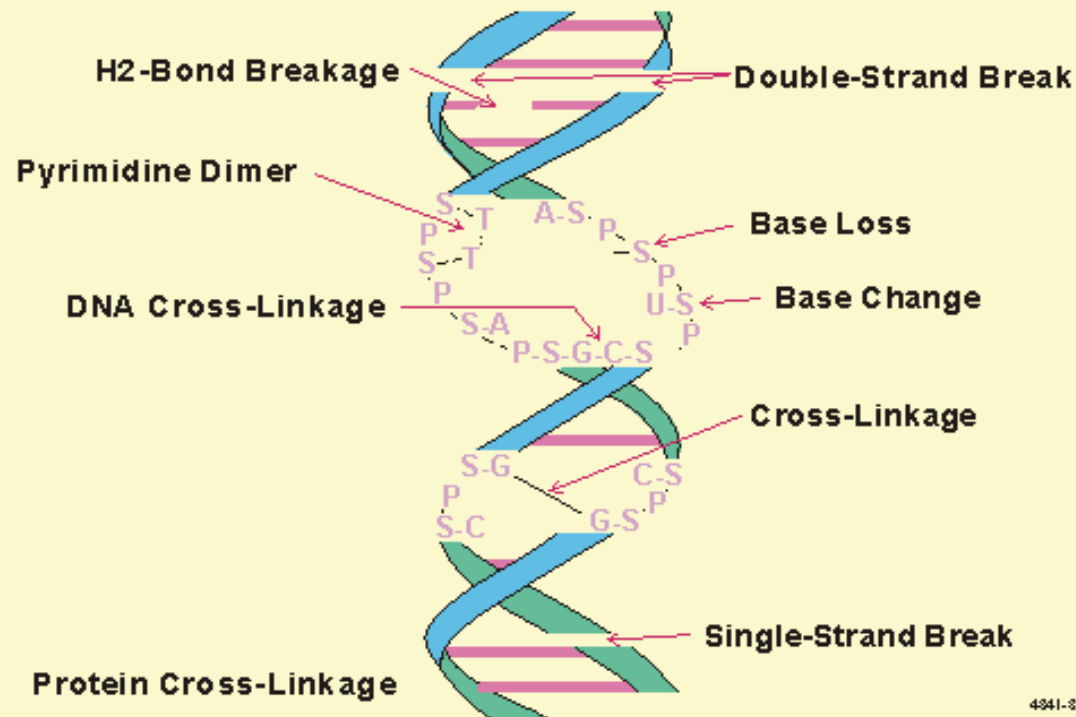
Radiation

Radiation

1. Alpha particles
2. Beta particles
3. Gamma Rays
4. Neutrons

Initial vs. Residual

RADIATION DAMAGE TO DNA



4341-2

Effect on DNA

Prompt Effects

1. Death

- if within 1km of center, dead within two weeks

Hiroshima: 66,000

Nagasaki: 39,000

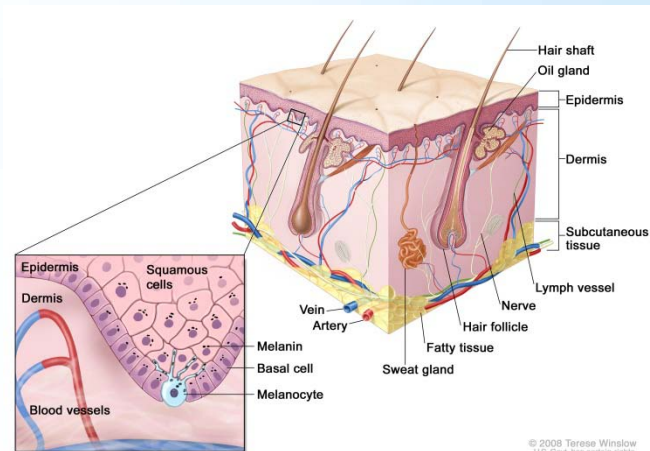
- 90% of casualties happened within the first 3 weeks



Prompt Effects

2. Radiation burns

- Penetrate the basal layer
- Immediate symptoms: hair loss, skin peeling, itching which causes redness and rashes
- Exacerbated by: Heal slowly and little (if any) treatment
- Result: keloids, permanent hair loss, skin darkening, maybe damaged sweat and sebaceous glands



Prompt Effects

3. Radiation sickness

- Prodrome
 - Initial symptoms
 - Minutes to days
- Latent
 - Seemingly healthy
 - Hours to weeks
- Manifest
 - Recurrence of symptoms
 - Days to months
- Recovery or Death



Three types of Radiation Sickness

Syndrome	Dose*	Prodromal Stage	Latent Stage	Manifest Illness Stage	Recovery
Bone Marrow	>0.7 Gy >70 rads	- Anorexia, nausea and vomiting. - Stage lasts for minutes to days.	- Stem cells in bone marrow are dying, although patient may appear and feel well. - Stage lasts 1 to 6 weeks.	- Anorexia, fever, and malaise. - Drop in all blood cell counts occurs for several weeks. - Primary cause of death is infection and hemorrhage. - Most deaths occur within a few months	- in most cases, bone marrow cells will begin to repopulate the marrow. - There should be full recovery for a large percentage of individuals from a few weeks up to two years after exposure.
Gastrointestinal	>10 Gy >1000 rads	- Anorexia, severe nausea, vomiting, cramps, and diarrhea. - Stage lasts about 2 days.	- Stem cells in bone marrow and cells lining GI tract are dying, although patient may appear and feel well. - Stage lasts less than 1 week.	- Malaise, anorexia, severe diarrhea, fever, dehydration, and electrolyte imbalance. - Death is due to infection, dehydration, and electrolyte imbalance. - Death occurs within 2 weeks of exposure.	the LD100 is about 10 Gy (1000 rads)
Cardiovascular / Central Nervous System	>50 Gy >5000 rads	- nervousness and confusion; severe nausea, vomiting, and watery diarrhea; loss of consciousness; and burning sensations of the skin. - Stage lasts for minutes to hours.	- Patient may return to partial functionality. - Stage may last for hours but often is less.	- Return of watery diarrhea, convulsions, and coma. - Onset occurs 5 to 6 hours after exposure. - Death occurs within 3 days of exposure.	No recovery is expected.

Delayed Effects

1: Cataracts



- First showed up in 1948
- Younger, closer affected more
- Severe cases appeared earlier

TABLE 9.6
*Frequency of A-bomb Cataracts among Survivors
Exposed during Infancy in Hiroshima*

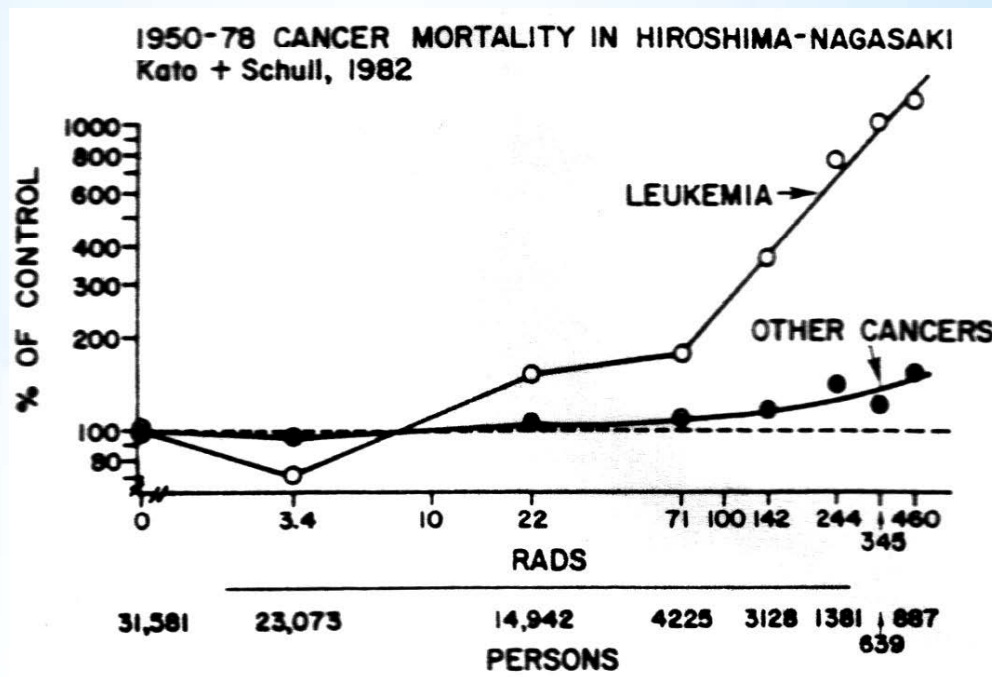
Distance from Hypocenter (km)	Number of Eyes Examined	Number of Eyes with A-bomb Cataracts*	
		Definite	Suspected
0-1.0	18	10 (55.6)	2 (11.1)
1.0-1.2	20	10 (50.0)	0
1.2-1.4	18	4 (22.2)	2 (11.1)
1.4-1.6	50	6 (12.0)	1 (2.0)
1.6-1.8	30	0	0
1.8-2.0	38	1 (2.6)	2 (5.3)
2.0-3.0	56	0	1 (1.8)
Total number	230	31 (13.5)	8 (3.5)

* Figures in parentheses are percentages of eyes examined.

Source: S. Toda, Y. Hosokawa, K. Chōshi, A. Nakano, and M. Takahashi, "Ocular changes in A-bomb survivors exposed during infancy," *Nihon Ganka Kyō* [Folia Ophthalmologica Japonica] 15 (1964): 96.

Delayed effects 2: Cancers

- Cancer formation correlated with distance from epicenter and age
- radiation makes the predestined (solid) cancers happen at a younger age



Leukemia

- excessive overgrowth of young white cells, accompanied by a decrease in red cells and platelets.
- can lead to anemia and a tendency to bleed.
- white cells lose their normal function, compromising the individual's resistance to infection and death.
- No cure.

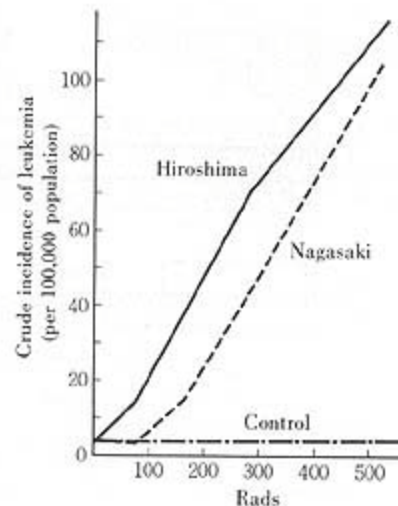


Figure 20. Crude incidence of leukemia among A-bomb survivors and controls in the RERF Cohort Sample by dose and city (October 1950–December 1971). (Ishimaru, Ōtake, and Ichimaru 1977)

Cancers part 2

- Increase: lung, breast, liver, stomach, colon, ovary, salivary gland (10x)
- nonmelanoma skin cancer, but not linked to mortality
- risk of basal cell carcinoma increased substantially when the victim was younger
- w/in 2 km, leukemia
- Increased breast cancer risk in childhood
- no significant increase in squamous cell carcinoma
 - the subbasal layer of skin is more resistant to the effects of radiation

Prenatal Exposure

- At 8-15 weeks the brain is the most susceptible to radiation.
- Miscarriage
- Microcephaly
- Mental retardation



That is all.