Plutonium Health Effects: Basics

Robert M. Gould, MD, President

SF-Bay Area Chapter

Physicians for Social Responsibility

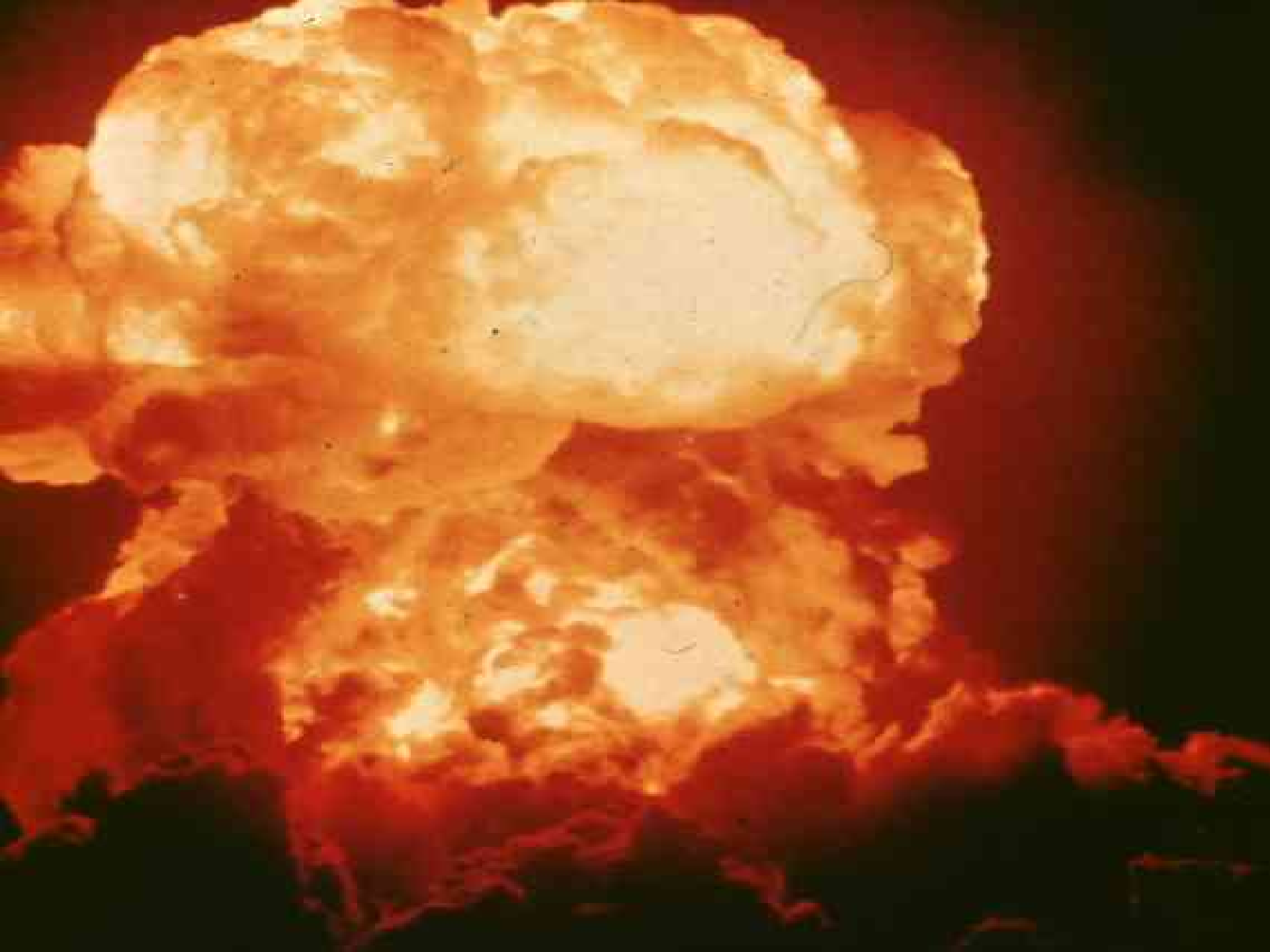
rmgould1@yahoo.com

Plutonium in Livermore:

Ethical Decision Making

Livermore, CA

October 9, 2004

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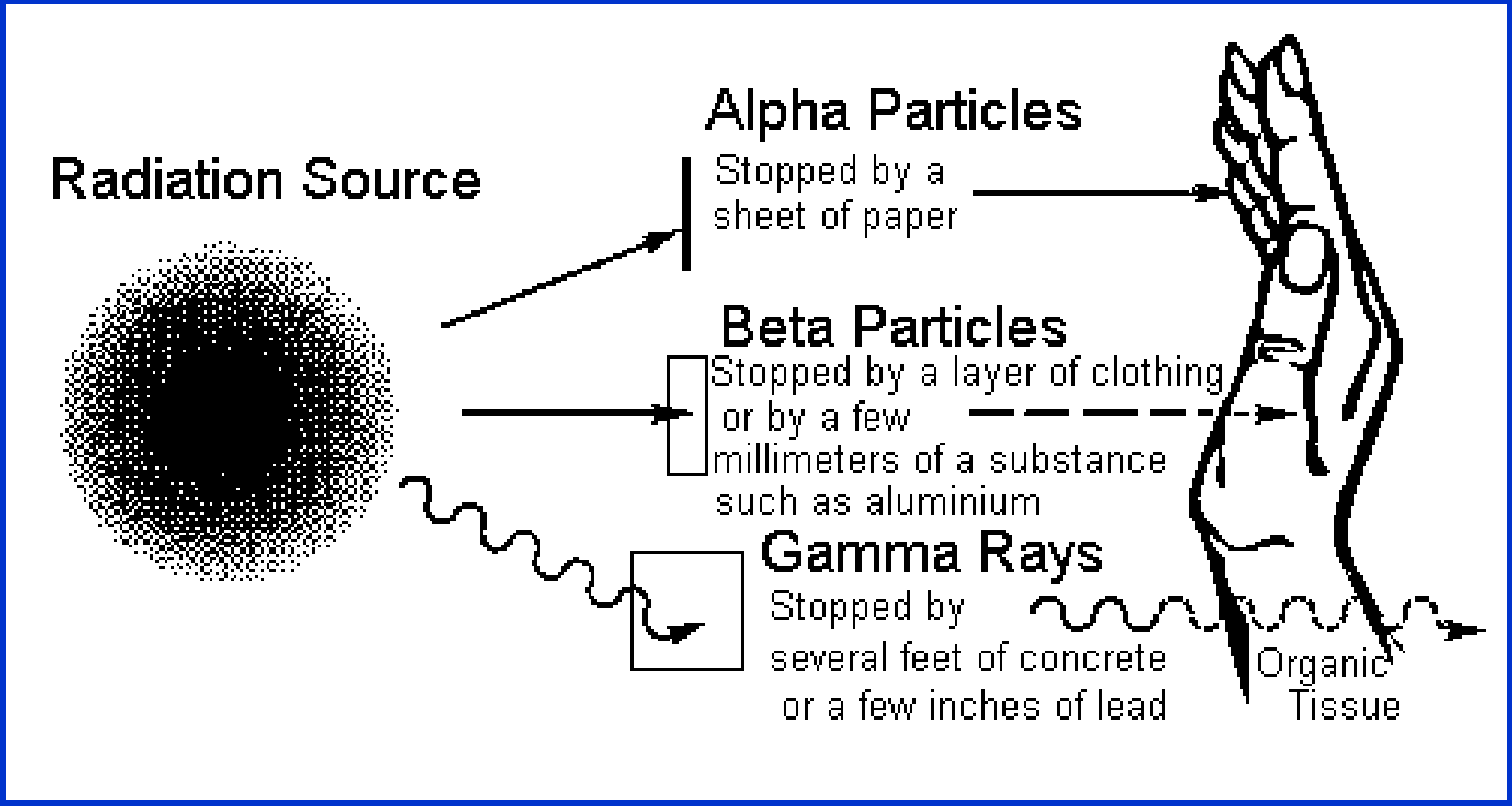
Ionizing Radiation: Health Effects

- **Deterministic (Non-stochastic):** Appear if minimum radiation dose is exceeded, severity increasing with dose. Single radiation doses over about 1 sievert: radiation sickness (nausea, vomiting, diarrhea), radiation burns

- **Random (Stochastic):** Radiation doses less than 1 sievert. Cancer, genetic damage: may appear decades after exposure

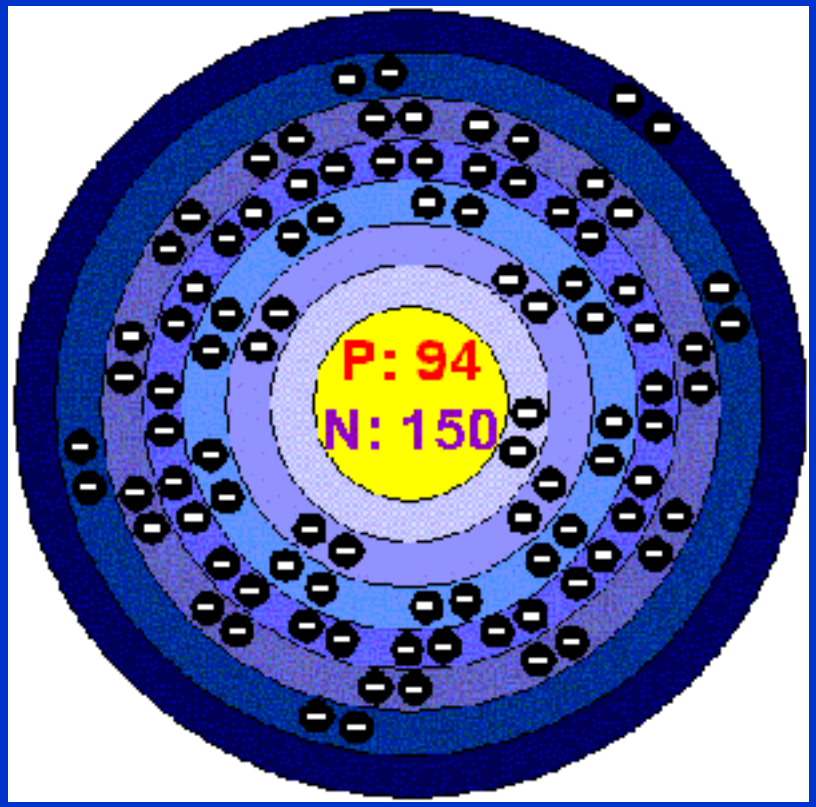
Radiation


Radiation Source
Alpha Particles
Stopped by a sheet of paper
Beta Particles
Stopped by a layer of clothing or by a few millimeters of a substance such as aluminium
Gamma Rays
Stopped by several feet of concrete or a few inches of lead
Organic Tissue

Plutonium

- Solid under normal conditions
- Pu-239 present only in trace amounts in nature
- Over 1,200 metric tons produced since WWII in military and commercial programs
- DOE: 100 million gallons high level waste

Plutonium



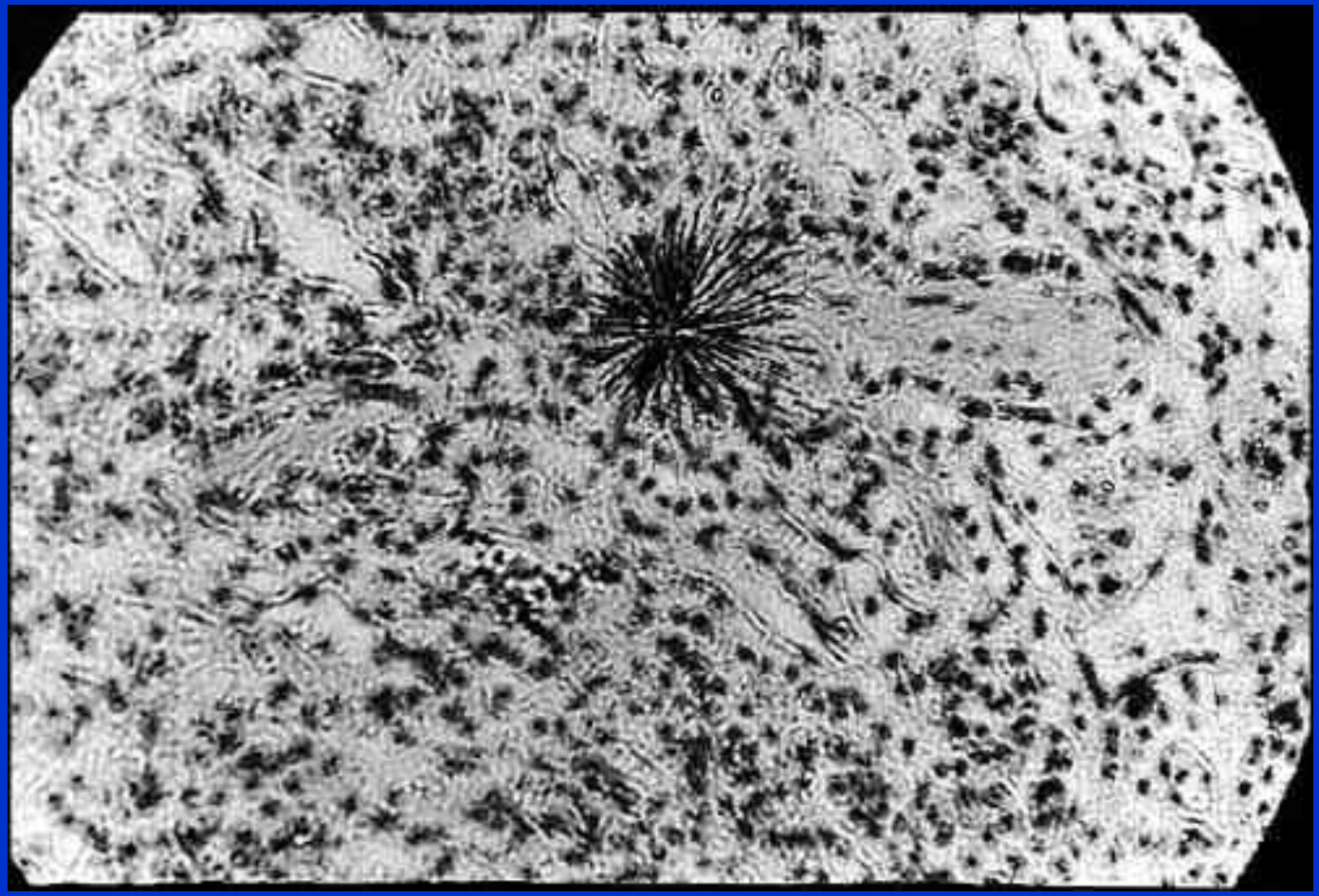
Isotope Half Life

Pu-236
2.87 years
Pu-237
45.2 days
Pu-238
87.7 years
Pu-239
24100.0 years
Pu-240
6560.0 years
Pu-241
14.4 years
Pu-242
375000.0 years
Pu-243
4.95 hours
Pu-244
8.0E7 years
Pu-245
10.5 hours
Pu-246
10.85 days

Plutonium 239: Health Dangers

- Greatest health danger from inhalation, especially in form of insoluble Pu-239 oxide
- Absorption into bloodstream from cuts and abrasions
- Risk from absorption into body via ingestion generally much lower than inhalation
- In general, larger particles produce smaller amount of biological damage and pose smaller risk of disease

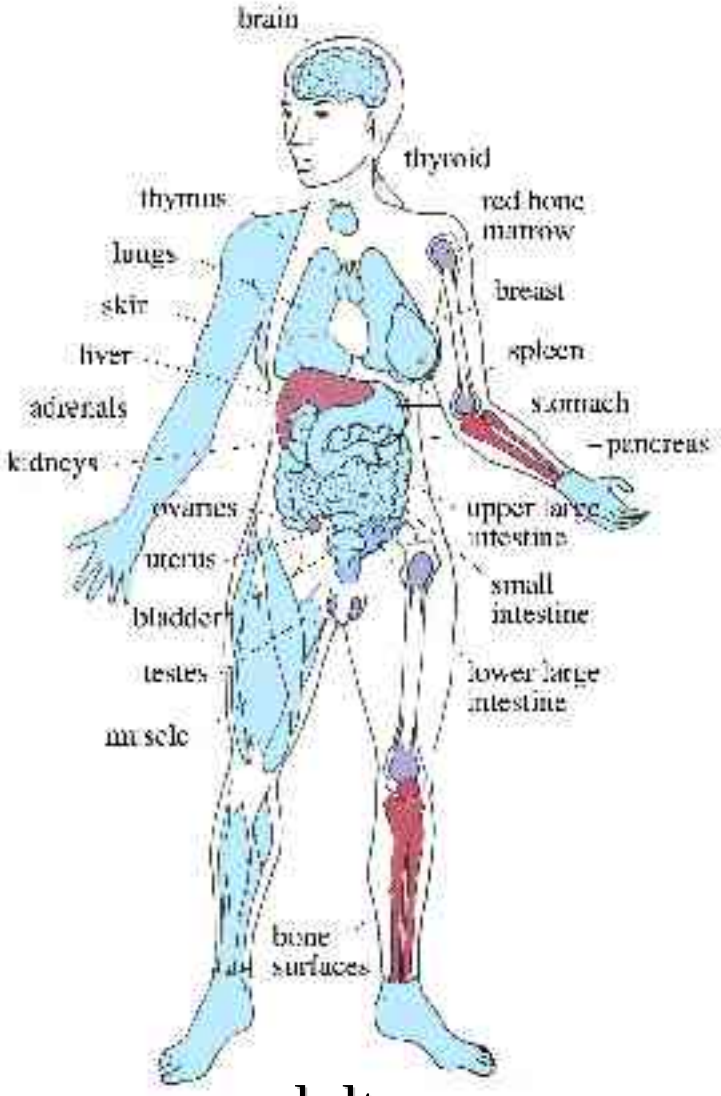
Plutonium: Alpha Tracks



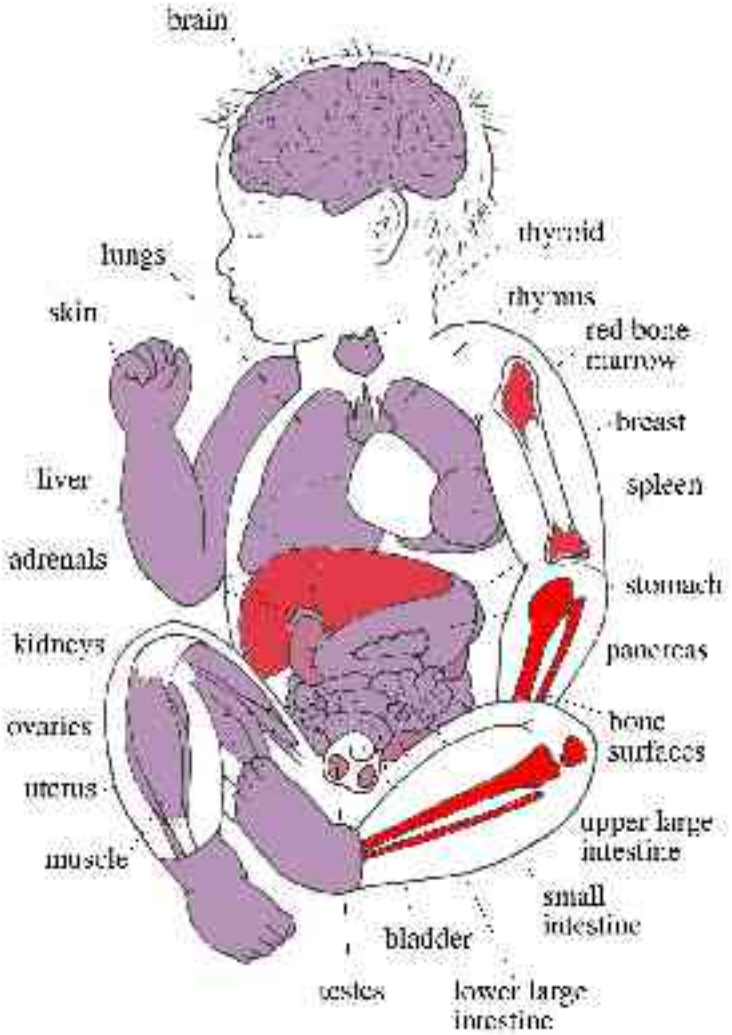
Ionizing Radiation: Cancer

- Genetic damage can occur in any cell, so cancer can occur in many sites
- Effects depend in part on route of exposure: x-Rays or gamma radiation can effect DNA in blood-forming cells or varius organs with delayed effects
- Many pathways: solubility, specific organ accumulation

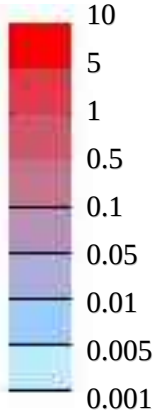
Organ doses of ingested Pu-239



adult



infant

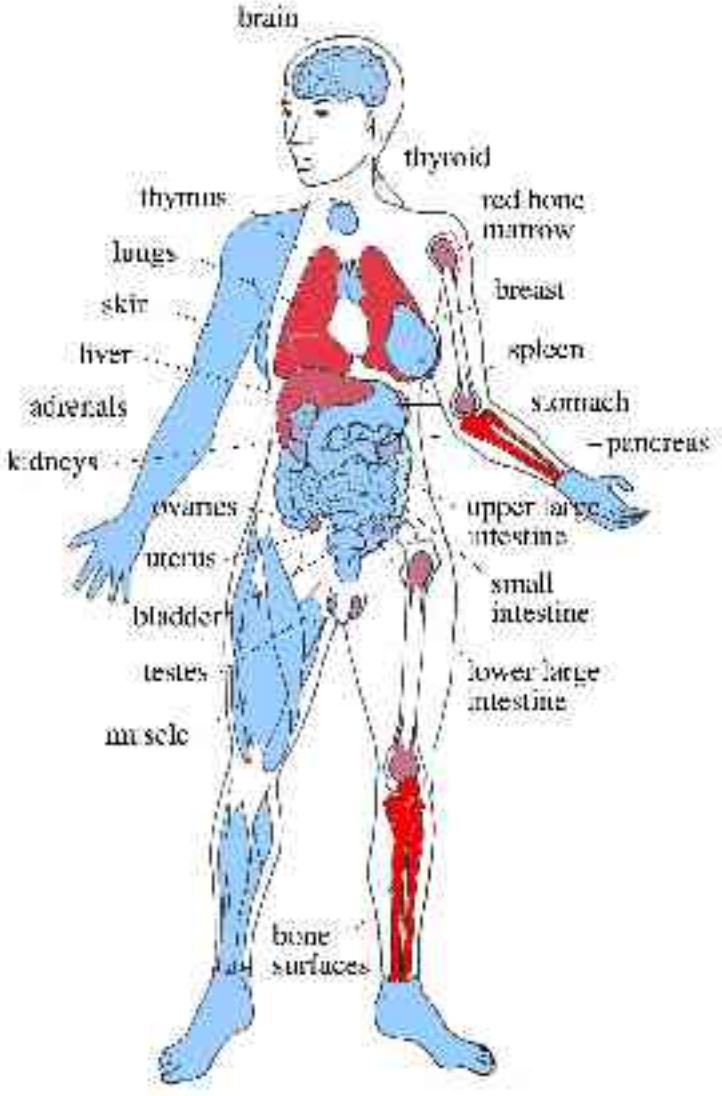


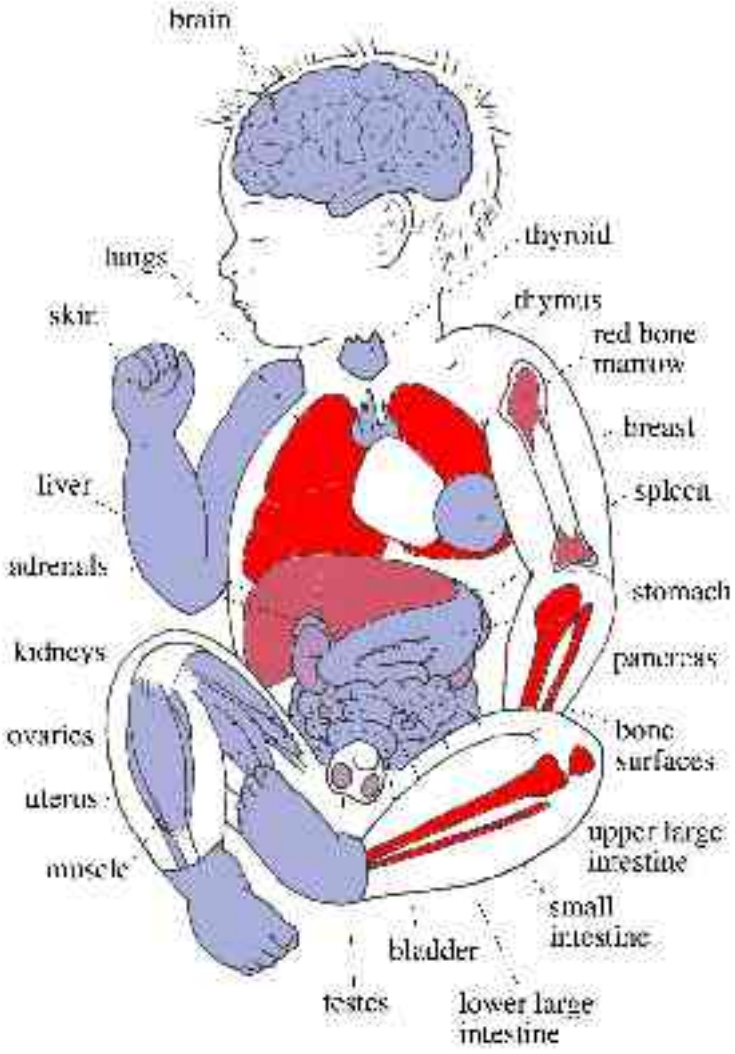
Equivalent dose (mrem/Bq) to age 70 years

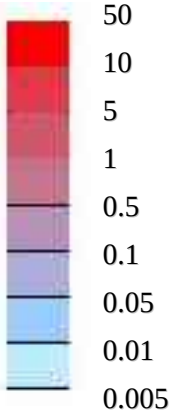
Drawn by Abel Russ, Community-Based Hazard Management Program at Clark University

(values from ICRP publication 67 (1993)).

Organ doses of inhaled Pu-239 Oxides, 1 μm diameter







Equivalent dose
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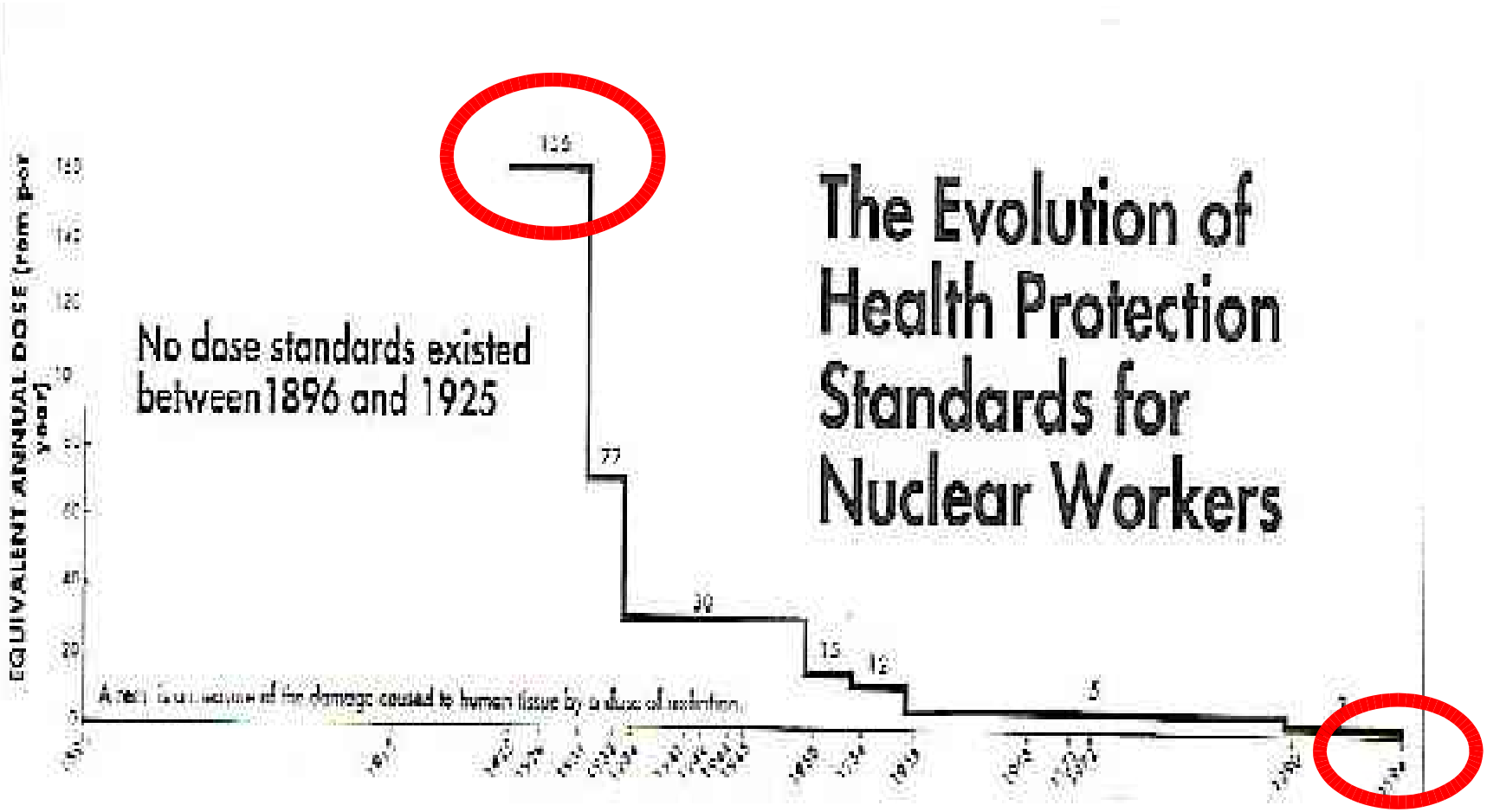
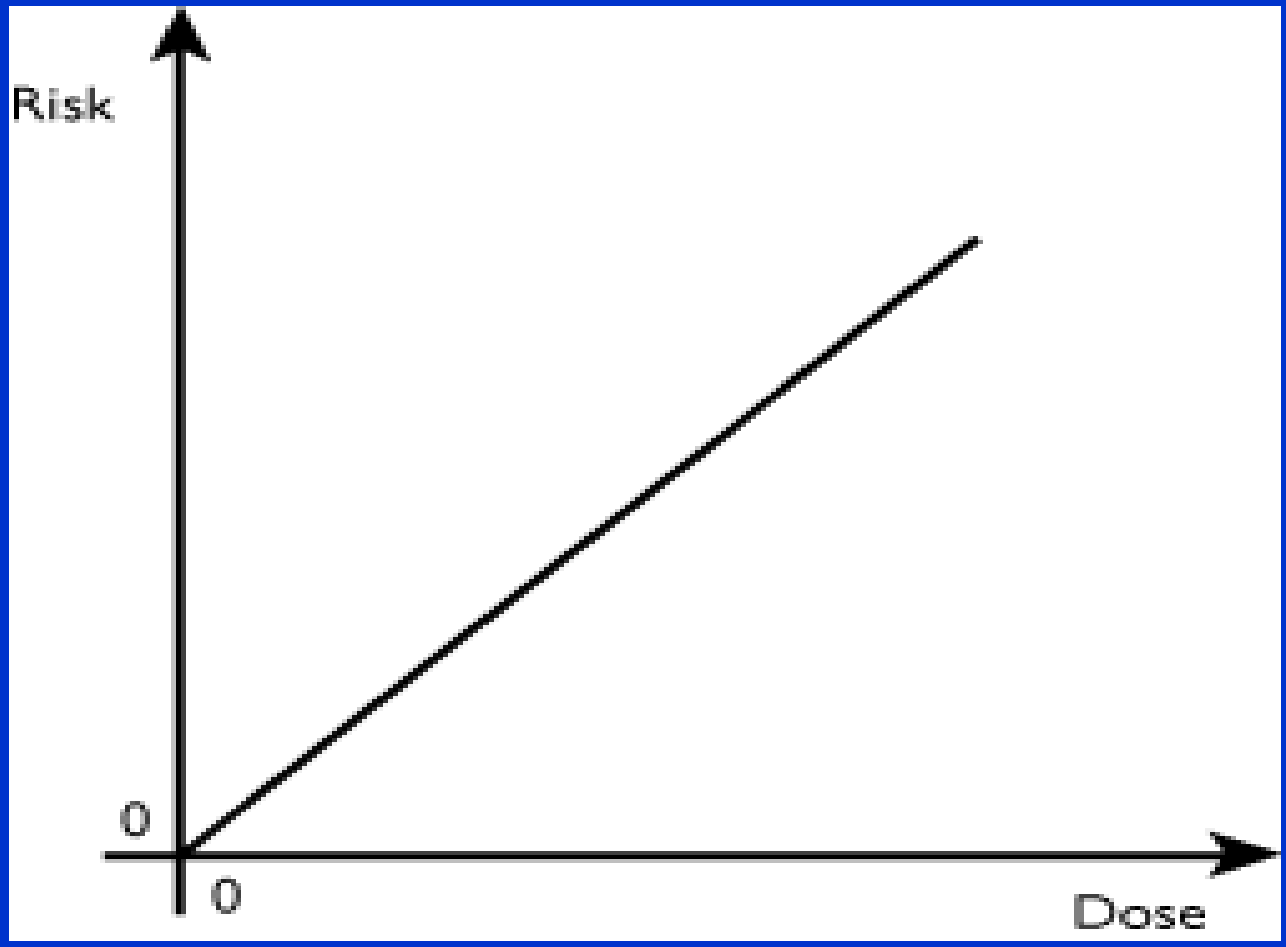
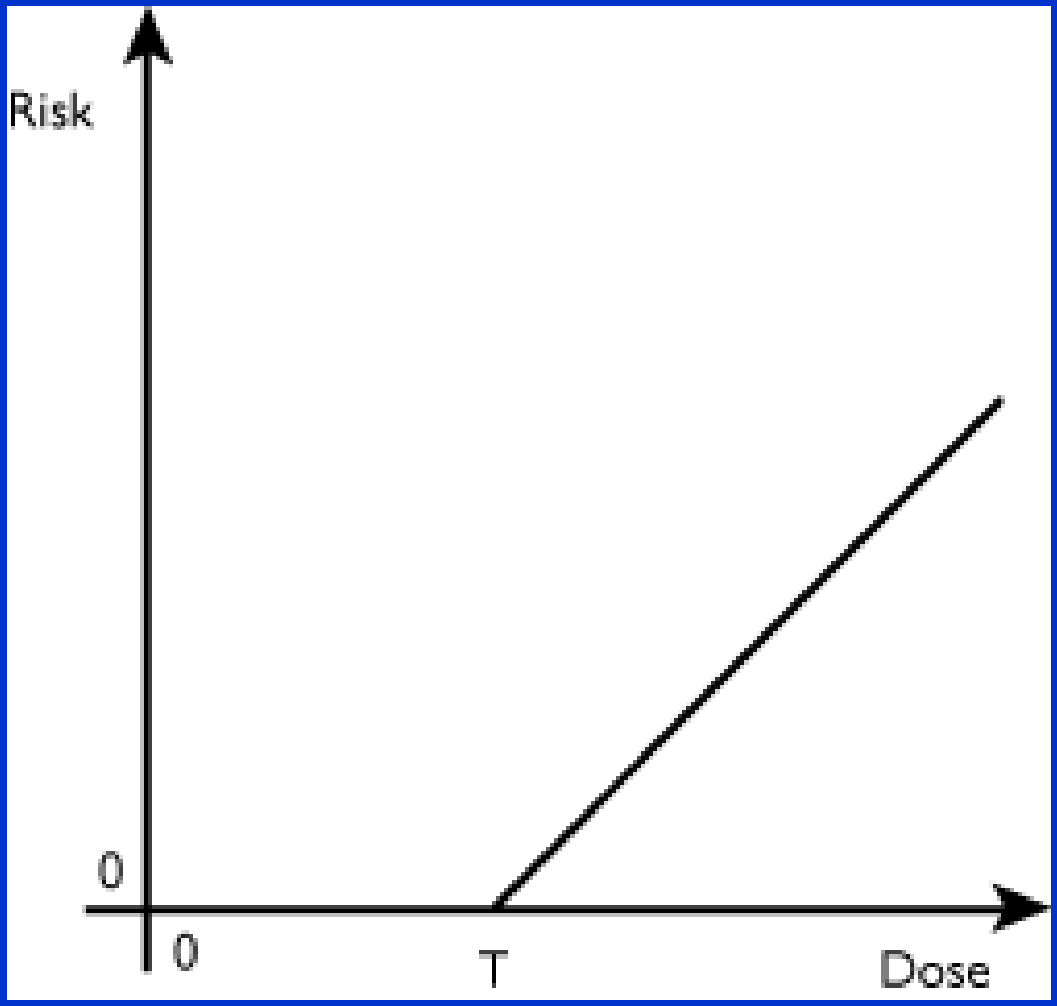
(values from RAC report No. 5-CDPHE-RFP-1998-FINAL(Rev.2) (2000): Assessing Risks of Exposure to Plutonium)


The Evolution of Health Protection Standards for Nuclear Workers
No dose standards existed between 1896 and 1925
EQUIVALENT ANNUAL DOSE (rem per year)
126
77
30
15
12
5

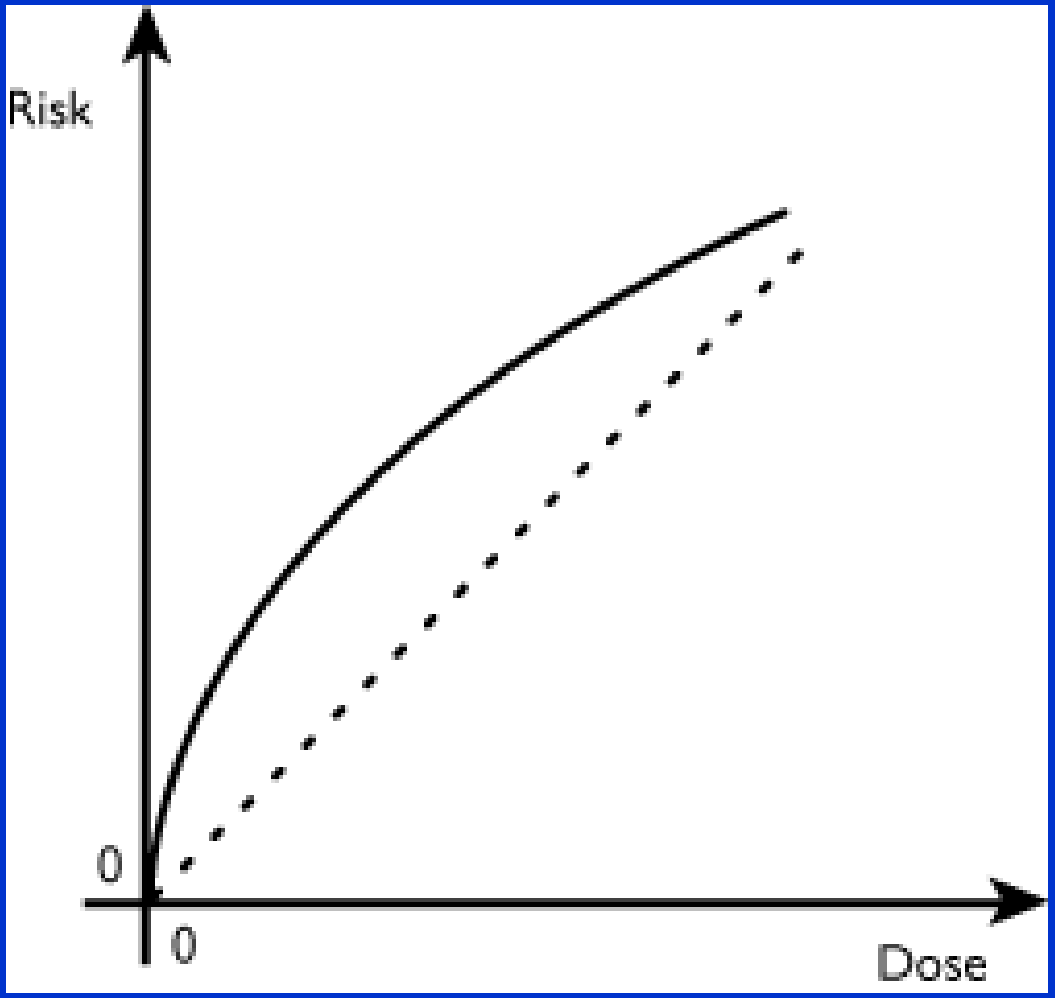
Linear No-Threshold Hypothesis



Threshold Hypothesis



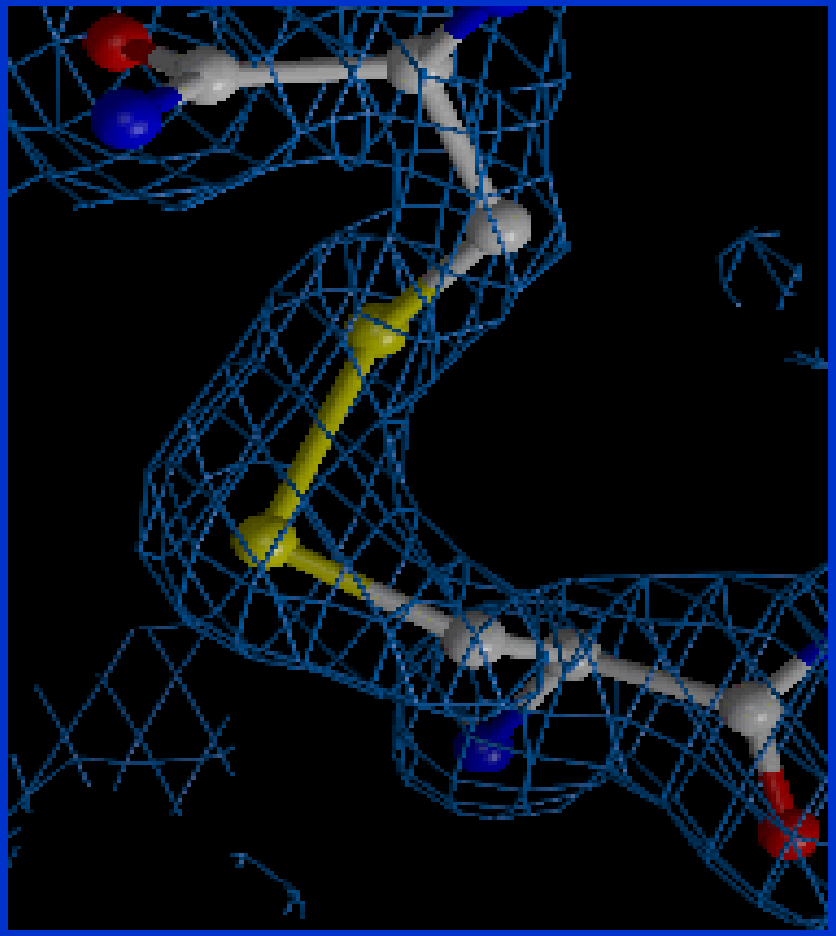
Supralinear Hypothesis



Plutonium in Livermore Parks

- Big Trees Park: Discovered in 1993 when EPA checking background plutonium values in the vicinity of LLNL
- Plutonium found at greater concentration than what would have been expected from global fallout alone
- Issue of elevated levels of plutonium at Sycamore Grove and Sunflower Parks
- Potential Exposure Pathways: Inhalation and Ingestion (children)

Radiation-Genetic Damage



PRECAUTIONARY PRINCIPLE

“ When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically.”

Wingspread Statement