Health Implications of the West Valley Site

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Confederacy Chief Jacob E. "Jake" Thomas holds Great Law Recital in Oshweken (1992)

The three main principles of **The Great Law of Peace**:

Peace - Being of a good mind and able to use our minds to negotiate rather than going to war. In order to have peace, one must have balance within their mind, body, and spirit.

Power - Among the Haudenosaunee, power comes from unity knowing there is strength in numbers. Living a community-based existence with unity at its core. Like the symbol of the five arrows bound together, singularly we are easily broken but together we are unbreakable.

Righteousness - The Haudenosaunee believe that the Creator has for us all a life path and a responsibility. Each individual must have a strong sense of justice, must treat people as equals and must enjoy equal protection under the Great Law.

Fun Fact

Rocky Flats Environmental Technology Site (1995)

Five-year review shows Superfund area remedy effective (2012)

In our daily lives… (NRC)

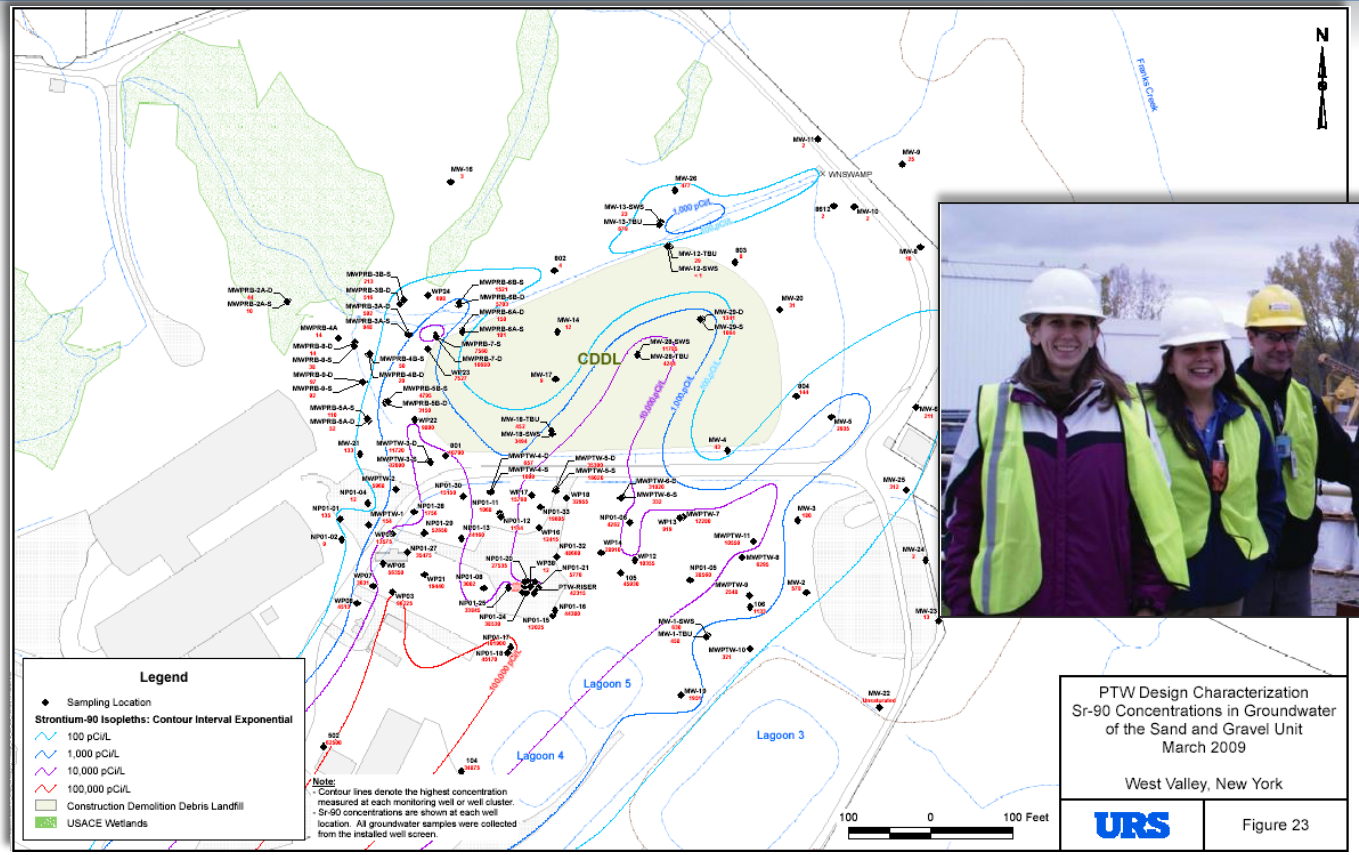
Consumer Products

- ✓ Building and road construction materials
- ✓ Combustible fuels, including gas and coal
- ✓ X-ray security systems
- ✓ Televisions
- ✓ Fluorescent lamp starters
- ✓ Smoke detectors (americium)
- ✓ Luminous watches (tritium)
- ✓ Lantern mantles (thorium)
- ✓ Tobacco (polonium-210)
- ✓ Ophthalmic glass used in eyeglasses
- ✓ Some ceramics

Natural Radioactivity in Food

^{40}K half-life is 1.28x10^{9} years (beta); ^{226}Ra half-life is 1600 years (alpha)		
Food	^{40}K (pCi/kg)	^{226}Ra (pCi/kg)
Bananas	3,520	1
Carrots	3,400	0.6 – 2
White Potatoes	3,400	1 – 2.5
Lima Beans (raw)	4,640	2 – 5
Red Meat	3,000	0.5
Brazil Nuts	5,600	1,000 – 7,000
Beer	390	---
Drinking Water	---	0 – 0.17

2011 Outstanding Groundwater Remediation Project



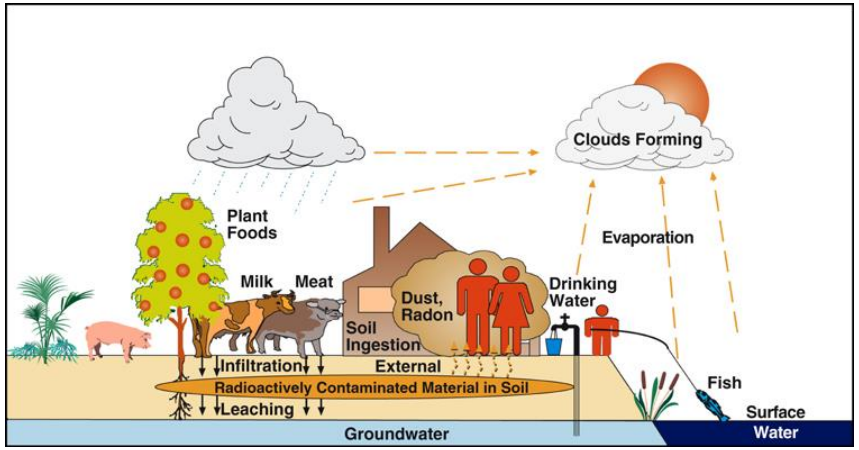
Potential off-site migration of radionuclides

- ✓ Seneca Nation Environmental Protection Department Contaminated Sediment Migration Studies
- ✓ An Aerial Radiological Survey of the Western New York Nuclear Service Center (Survey 2014, Report 2015)
- ✓ Radiological Survey and Dose Assessment Report For the Western New York Nuclear Service Center and Off-Site Areas In Follow Up to Aerial Gamma Radiation Survey Conducted in 2014, Rev. 1 (Survey 2015, Report 2016)

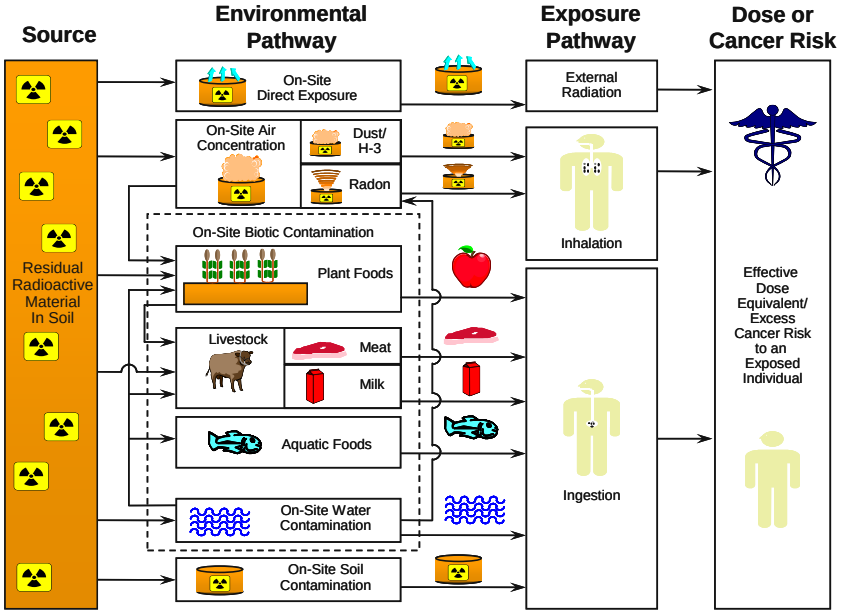
DECEMBER 22, 2015

Man-made Radiation Pathways

A depiction of use in the RESRAD code



Pathway analysis used in RESRAD code

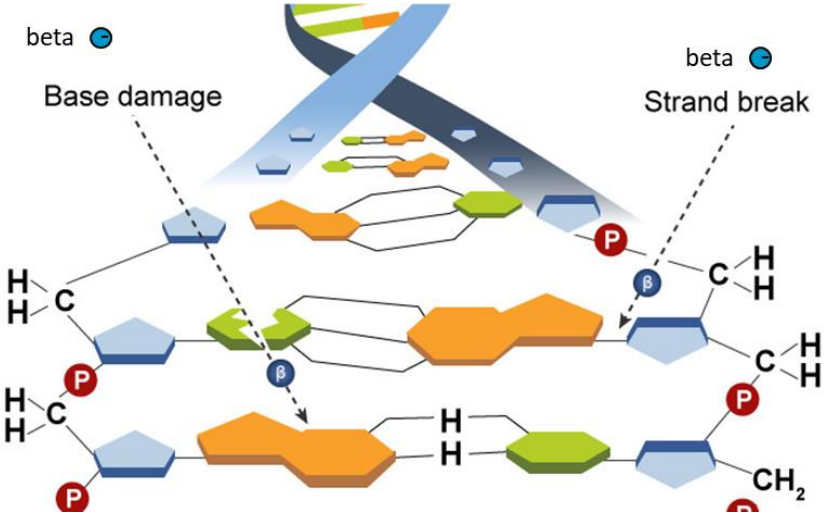


Radiation Damage

Types of damage

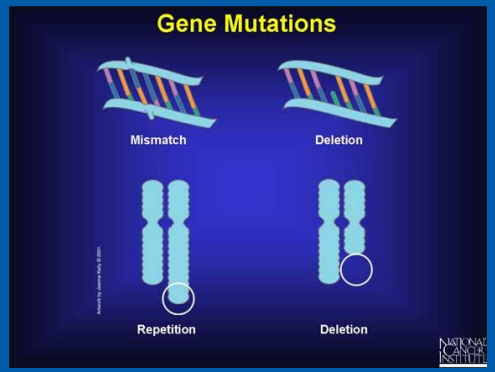
- ✓ **Biological effects on the cell from ionizing radiation result from both primary and secondary actions.**
- ✓ **<u>Direct</u> effects are produced by the initial action of the radiation itself.**
- ✓ **<u>Indirect</u> effects are caused by the later chemical action of free radicals and other radiation products.**
  - **Radiation interacts with cellular water to produce free radicals and other reactants (H, H_3O^+, H_2O^*, etc.)**
  - **These reactants can affect DNA by breaking chemical bonds**

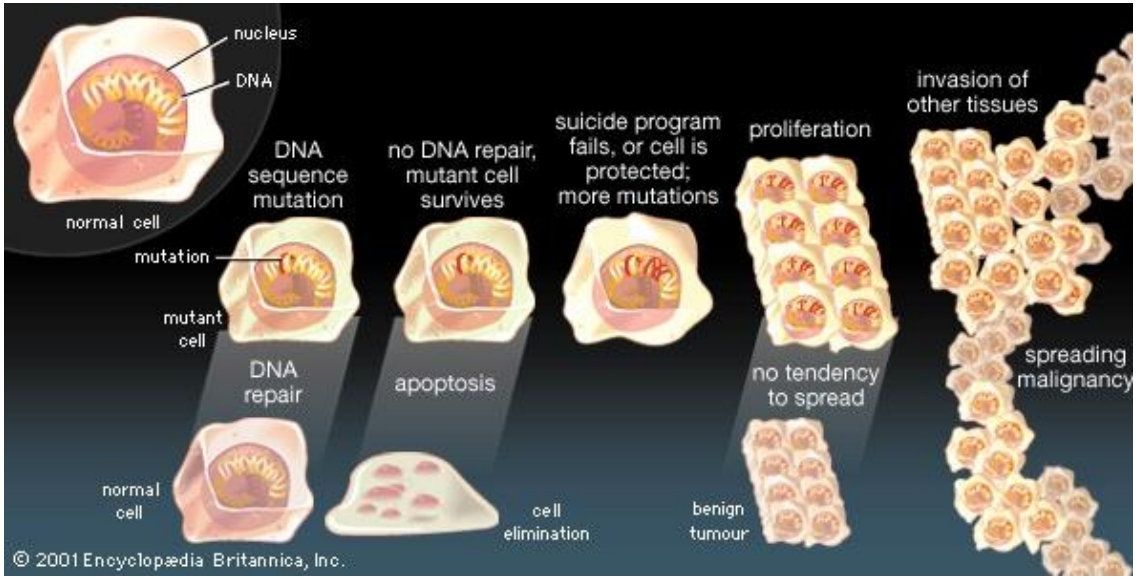
Direct action



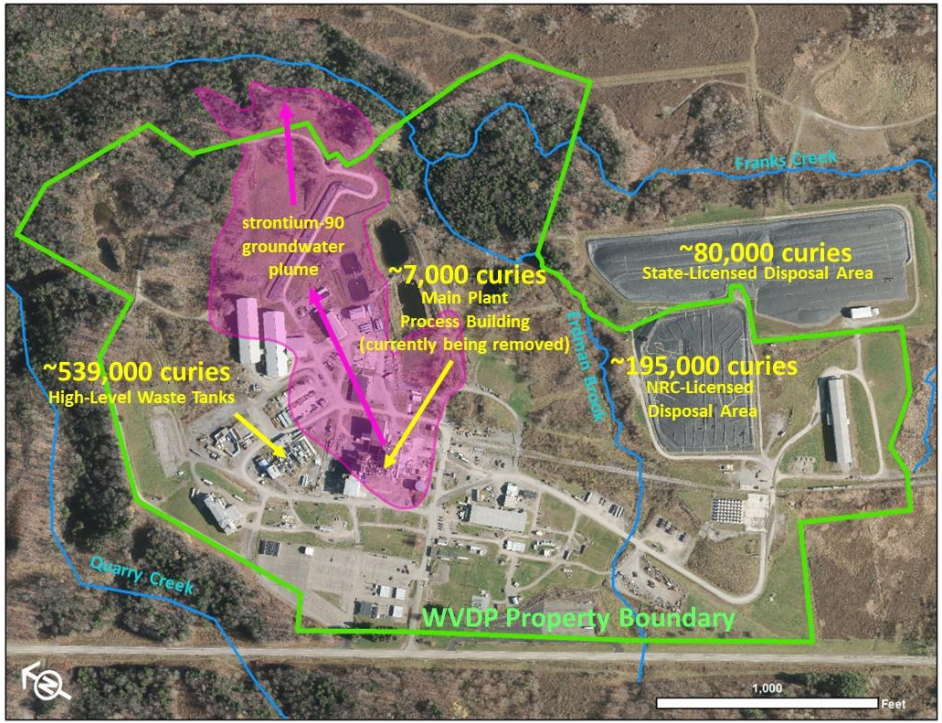
Genetic Mutations

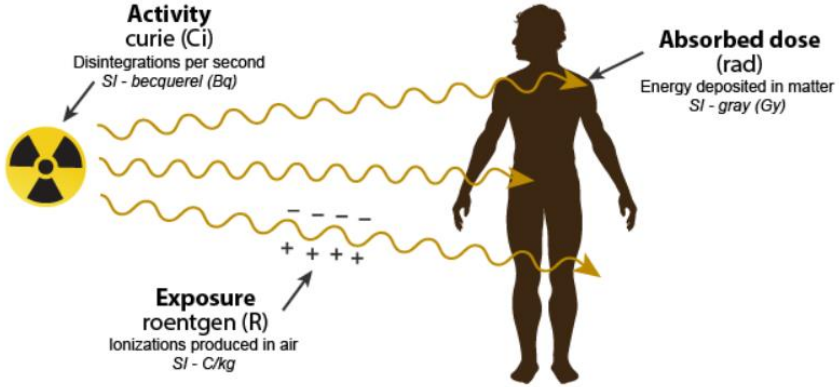
- ✓ Although cells have the ability to repair DNA damage, misrepair can result in mutations
- ✓ Not all DNA mutations are manifested as a disease or defect





Radiation is NOT dose





1 Ci = 3.7×10^{10} Bq

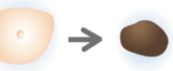
Radiation Absorbed Dose = 0.01 gray

Roentgen Equivalent Man = 0.01 sievert

Ionizing Radiation

Along with its intermediate half-life, a combination of high-energy radioactivity and chemical reactivity makes cesium-137 a particularly dangerous fission product. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

Effects on Human Body — Classification of Radiation Effects

		Incubation period	e.g.	Mechanism of how radiation effects appear
Categories of effects	Physical effects	Within several weeks = Acute effects (early effects)	Acute radiation syndromes*1 Acute skin disease	Deterministic effects (tissue reactions) caused by cell deaths or cell degeneration*2 
		After the lapse of several months = Late effects	Abnormal fetal development (malformation)	
			Opacity of the lens	
			Cancer and leukemia	Stochastic effects due to mutation
	Heritable effects		Hereditary disorders	

*1: Major symptoms are vomiting within several hours after exposure, diarrhea continuing for several days to several weeks, decrease of the number of blood cells, bleeding, hair loss, transient male sterility, etc.
*2: Deterministic effects do not appear unless having been exposed to radiation exceeding a certain dose level.

Low-Dose Radiation Research Act of 2015 calls for an assessment of the current status of US and international low-dose radiation research

Electric Power Research Institute (US, 2009) - From an epidemiological perspective, individual radiation doses of less than 100 mSv in a single exposure are too small to allow detection of any statistically significant excess cancers in the presence of naturally occurring cancers. The doses received by nuclear power plant workers fall into this category because exposure is accumulated over many years, with an average annual dose about 100 times less than 100 mSv

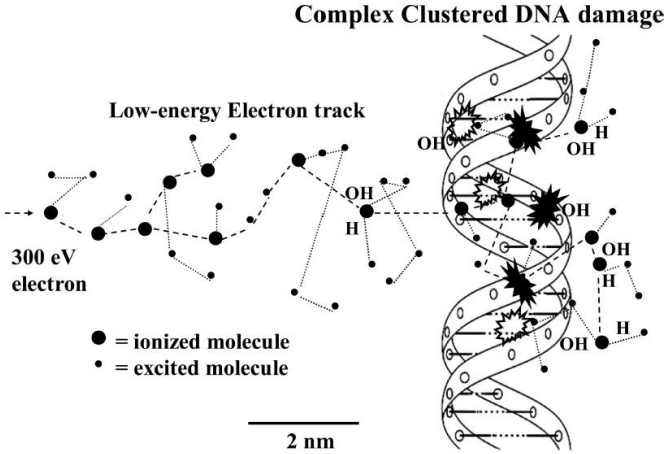
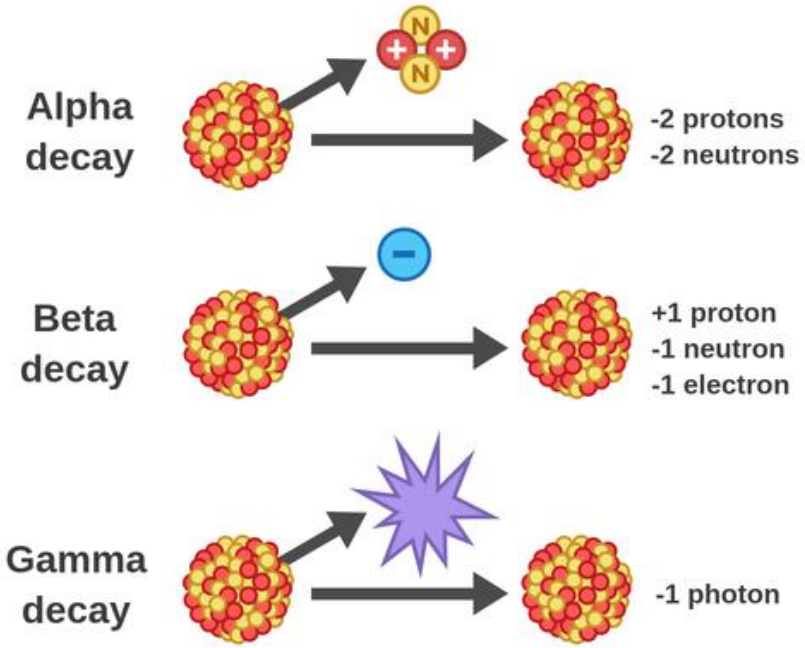
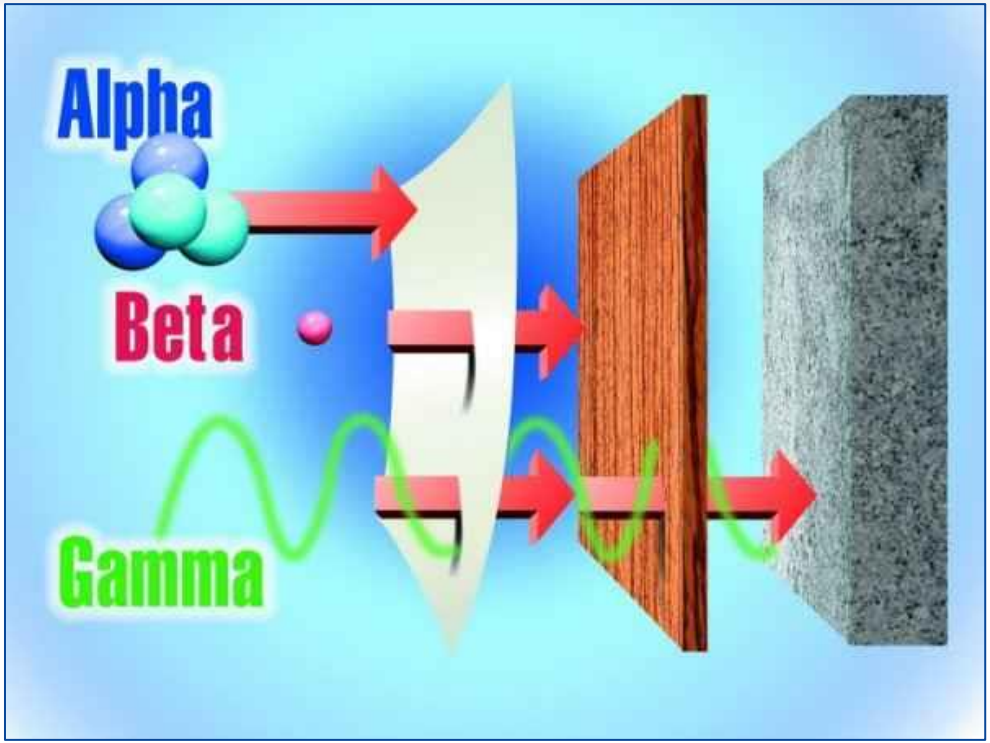


Table 4.4 An Example Showing the Relationship Between Dose in Grays and Dose in Sieverts for Alpha, Beta, and Gamma Radiation

Type of Radiation	Description	Dose in Grays	Relative Biological Effectiveness (RBE)	Equivalent Dose in Sieverts
Alpha	2 protons + 2 neutrons	2	10	20
Beta	1 electron	2	5	10
Gamma	High-energy electromagnetic radiation	2	1	2

Exposure & Shielding





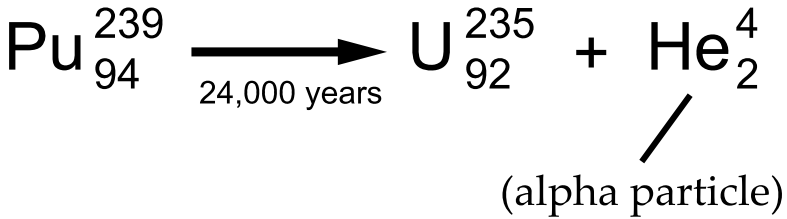
Radionuclides of Interest

Element/Isotope	Source	Half-life (years)	Radiation released	Persistence in the Environment	Bioaccumulation and/or biomagnification
Americium-241	By-product of plutonium-241 production	432 years	Alpha and gamma	Soil or sediment	Bioaccumulation (Thiels, 1983)
Strontium-90	By-product of nuclear reactors and weapons testing.	28.8 years	Beta	Sediment and groundwaters	Bioaccumulation (Burger, 2019)
Technetium-99	By-product of U-238, U-235, Pu-239 fission. By-product of Tc-99m in a medical setting.	214,000 years	Beta	Similar to Sr-90, sediment and ability to penetrate to groundwater (Meena, 2017)	Bioaccumulation in plants and aquatic biota (Meena, 2017)
Cesium-137	Fission product of Uranium and Plutonium. Used in medical equipment.	30.1 years	Beta and gamma	High affinity for soil and concrete, will not penetrate deep into ground.	Bioaccumulation in fish and deer (Whicker, 2007)

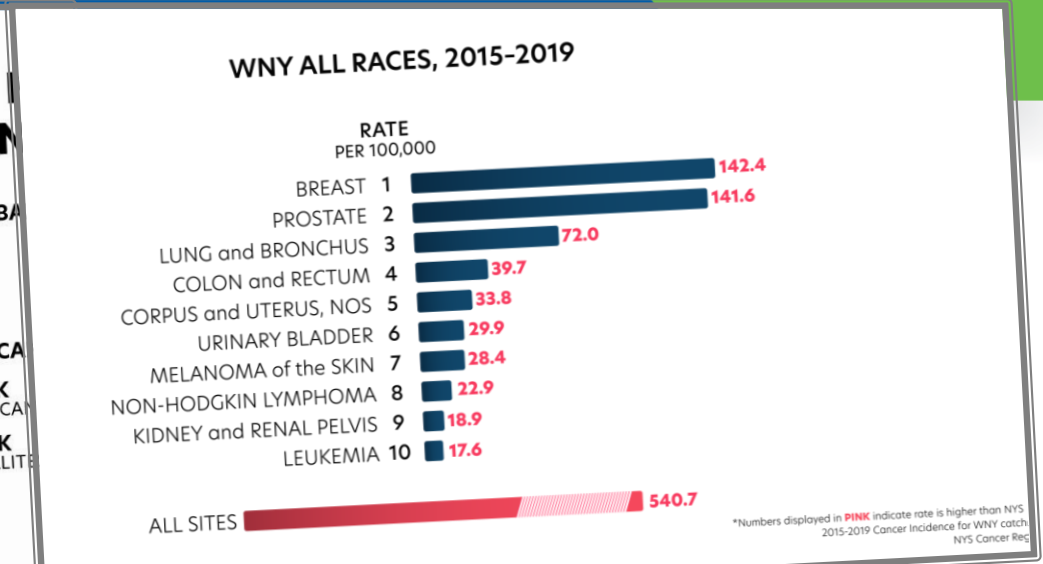
Impact on health

Element/Isotope	Chemical similarity	Exposure route	Deposition in body	Disease or Cancer
Americium-241		Inhalation and ingestion	liver, muscles, and surfaces of bone (ASTDR 2023); skeleton (Neton, 1988)	Bone Cancer (ASTDR 2023) Osteosarcomas and myeloid leukemias (Ellender, 1998)
Strontium-90	Calcium or Magnesium	Ingestion	Bones and teeth (nrc.gov 2023) Affinity for CaSR (Carnevale, 2013) Affinity for DNA phosphate backbone (Busby, 2013)	Increased chance for osteosarcoma, leukemia, blood cancers, anemia and blood clotting deficiencies (nrc.gov 2023)
Technetium-99	Manganese (transition metal), common oxidation states +7, +4	Ingestion	Thyroid and GI tract (nrc.gov 2023)	Any form of radiation exposure to thyroid increases risk of thyroid cancer and hyperthyroidism (Sinnot, 2010) Rapidly dividing cells of GI tract at risk.
Cesium-137	Potassium or Sodium	Ingestion and inhalation	Distributes uniformly similar to potassium in the body (epa.gov 2023); Build up in muscles (cdc.gov 2023); Pancreas, thyroid, adrenal glands found to have high concentrations (Venturi, 2021)	Inhalation: bronchial fibrosis, and chronic airway inflammation due to neutropenia and radiation (Svendson, 2010) Pancreatic cancers (Venturi, 2021)

Plutonium-239/240



- ✓ By-products of nuclear reactors and weapons testing
- ✓ Adsorption to particulate matter, affinity for sediment. Will not penetrate deep in soil like Cs-137 (Yii, 2011)
- ✓ Ingestion and inhalation hazard
- ✓ Liver and bone cancer (world-nuclear.org 2023); Lung cancer (cdc.gov 2023); Lung, liver, bone cancers (ASTDR, 2023); Osteosarcomas and myeloid leukemias (Ellender, 1998)



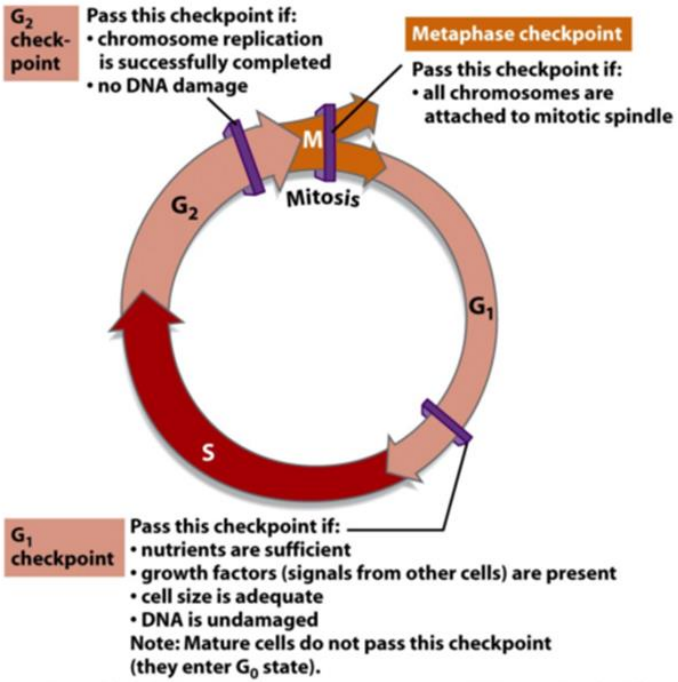
TOP 10 CANCERS IN WNY (INCIDENCE RATE IN THE EIGHT-COUNTY CATCHMENT AREA)

–PINK/RED COLOR INDICATION ON THE CANCER BURDEN REPORT SHOWS INCIDENCE IS HIGHER THAN THE AVERAGE NYS RATES AND/OR THE AVERAGE US RATES

https://www.roswellpark.org/newsroom/202209-roswell-parks-wny-cancer-snapshot-analysis-new-data-reveals-regional-progress

Cell Cycle Checkpoints

Cells are equipped with DNA maintenance checkpoints to arrest cell cycle and facilitate *DNA repair*



What to do?

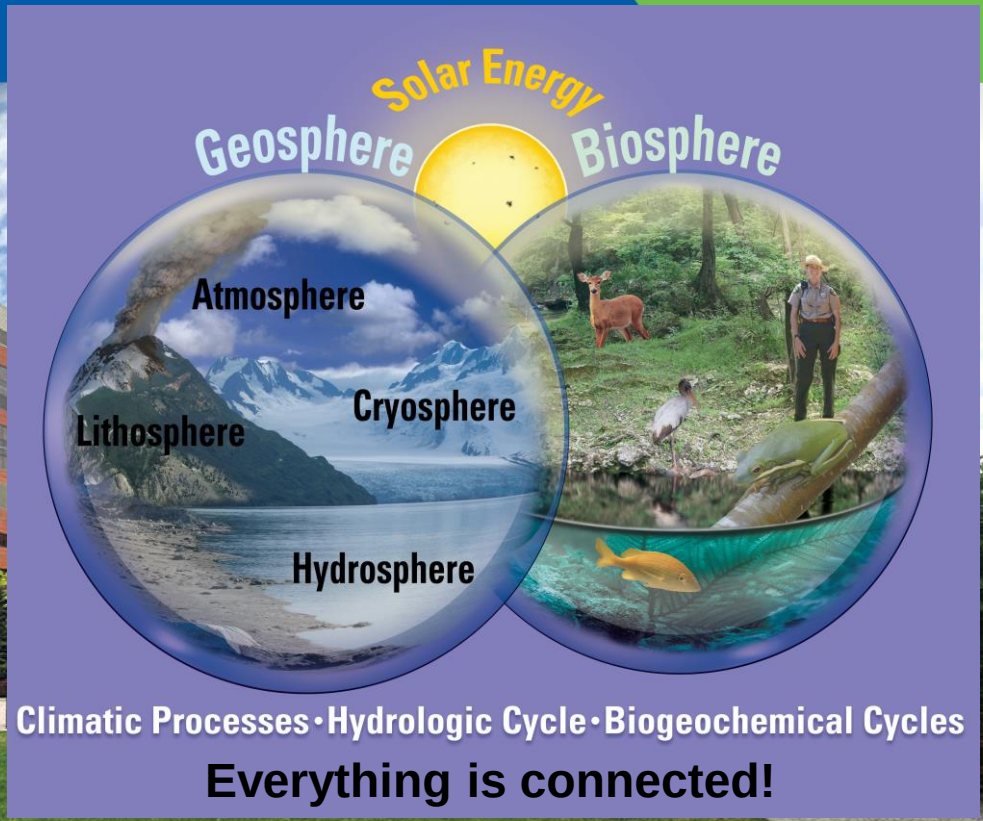
Health trends

- Small population trends can be analyzed
- Population burdens can be determined
- Should we be analyzing health trends to ensure an increase in disparities is not occurring?
- Should we prepare snapshots for the county for the last 50 years on 5-year intervals?

How do we best assist a population stricken with health disparities?

- Identify risks
- Remove the risk
- Targeted prevention measures

WHEN ASSESSING OFF-SITE MIGRATION AND DOSE, WORST CASE SCENARIO MUST BE EVALUATED!


Solar Energy
Geosphere
Biosphere
Atmosphere
Cryosphere
Lithosphere
Hydrosphere
Climatic Processes • Hydrologic Cycle • Biogeochemical Cycles
Everything is connected!