

Effects and Uses of Radiation

What do we mean by radiation?

- Includes α , β , γ , X-rays, protons, neutrons, and other particles
- Can also include ultra violet light

Types of Radiation

- Ionizing
 - Radiation with enough energy so that during an interaction with an atom, it can remove tightly bound electrons from the orbit of an atom, causing the atom to become charged or ionized
- Non-ionizing
 - Does not have enough energy to ionize atoms

Alpha and Beta Particles

- Considered directly ionizing because they carry a charge and can, therefore, interact directly with atomic electrons through coulombic forces

Gamma Rays

- Electromagnetic, indirectly ionizing radiation
- Electrically neutral (as are all electromagnetic radiations) and do not interact with atomic electrons through coulombic forces.

Health Effects of Ionizing Radiation

- Any living tissue in the human body can be damaged by ionizing radiation in a unique manner
- The body attempts to repair the damage, but sometimes the damage is of a nature that cannot be repaired or it is too severe or widespread to be repaired
- Also mistakes made in the natural repair process can lead to cancerous cells.

Short Term Effects

- Radiation burns
- Radiation sickness (radiation poisoning)
 - premature aging or even death
 - The symptoms of radiation sickness include: nausea, weakness, hair loss, skin burns or diminished organ function.

Long Term Effects

- Cancer
- DNA mutation

Benefits of Radiation

- Radiation therapy
 - Diagnosing diseases
 - Tracers
 - Positron Emission Tomography (PET)
 - Nuclear Magnetic Resonance (NMR)
 - Treatment of diseases
 - cancers

Dosimetry

- “The dose makes the poison”
- This is true for radiation as well
- Dose is a measurement of the amount of radiation absorbed by the body

- rad
 - The amount of radiation which deposits energy at a rate of $1.00 \times 10^{-2} \text{ Jkg}^{-1}$ in any absorbing material
- gray (Gy)
 - $1 \text{ Gy} = 100 \text{ rad}$

Effective Dose

- Some types of radiation can do more damage than others
- The effective dose multiplies the dose by a quality factor (QF) to account for this difference
- Measured in **rem** (rad equivalent man) or **Sv** (Sievert)

$$\text{rem} = \text{rad} \times \text{QF} \quad \text{Sv} = \text{Gy} \times \text{QF}$$

$$1 \text{ rem} = 100 \text{ Sv}$$

Background Radiation

- Radioactive material is found everywhere
 - rocks, soil, air, living things, water
- The level of this background radiation is around 2 mSv per year
- Regulations place an upper limit of 1 mSv above background per year for civilians up to 50 mSv per year for radiation workers (people working directly with radiation)

Exposure (rem)	Health Effect	Time to Onset (without treatment)
5-10	changes in blood chemistry	
50	nausea	hours
55	fatigue	
70	vomiting	
75	hair loss	2-3 weeks
90	diarrhea	
100	hemorrhage	
400	possible death	within 2 months
1,000	destruction of intestinal lining internal bleeding and death	1-2 weeks
2,000	damage to central nervous system loss of consciousness; and death	minutes hours to days
