Radiation is not detectable by our senses...but it shows up other ways.

When radiation interacts with matter, it usually knocks electrons out of the electron cloud, creating a positively charged ion = IONIZING RADIATION

Intensity: number of particles or photons emerging /time

Energy: MeV
When radiation interacts with matter, it usually knocks electrons out of the electron cloud, creating a positively charged ion = **IONIZING RADIATION**

Intensity: number of particles or photons emerging / sec or counts/ minute

1. Geiger-Muller counter
2. Proportional counter
   - Uses electricity to measure intensity
   - More particles = more current
3. Scintillation counter
   - Has a phosphor that emits light for each particle that hits it

Curie (Ci): $3.7 \times 10^{10}$ disintegrations/second (dps)
   - Very high intensity
   - From 1 g of Ra
   - Too high for regular medical use

Becquerel (Bq)
   - Is the SI unit
   - 1 disintegration/sec

Intensity of any radiation decreases with the square of the distance from source:

$$\frac{I_1}{I_2} = \left(\frac{d_1}{d_2}\right)^2$$

If the intensity of radiation 1.0 cm from a source is 200 mCi, what is the intensity at 3.0 m?

$$9x = 0.02$$

$$x = 0.002 \text{ mCi}$$
IONIZING RADIATION

Energy: MeV (Megaelectron Volt)

Penetration power depends on energy and mass

most massive
least penetrating

most highly charged
less mass, lower charge

least penetrating
no mass or charge

clothing

skin

bone
tissue

body

Intensity and energy alone or together are not all that important. What is important:

Effects in the body

We measure this in 3 ways:

1. Roentgens (R)
2. Rads (radiation absorbed dose)
3. Rems (roentgen equivalent for man)

Roentgens:

*amount delivered
*measure of exposure
* does not take into account effect of radiation on tissue or that tissues react differently
Rads:
- a ratio of radiation absorbed by tissue: radiation delivered to the tissue
- SI unit = Gray (Gy)
- 1 Gy = 100 rad

1 R
- of high energy photons
- 0.97 rad in water
- 0.96 rad in muscle
- 0.93 rad in bone

For low energy photons (soft X-rays):
- 1 R yields 3 rad in bone, but none in soft tissue

Rems:
- measure of the effect of the radiation when a person absorbs 1 R
- used because tissue damage from 1 rad depends on type of radiation

1 Rad alpha rays >> X-rays or gamma rays

- other units:
  - millirem (mrem)

- sievert (Sv) = 100 rem

If an organ receives radiation from different sources, the total effect is summed up in rem.
Radiation Badge:

- Single dose:
  - 25 rem: affects blood count
  - 100 rem: radiation sickness
  - 400 rem: death in 1 month for 50%
  - 600 rem: lethal

- 50,000 rem: bacteria
- 10^6 rem: virus

Small doses over many years: leukemia

Mutations in egg and sperm if any form of radiation strikes

Background radiation: naturally occurring
NUCLEAR MEDICINE

A. Medical Imaging requires 3 things:

1. a radioactive element to be given in pure form or in a compound so that it becomes concentrated in target organ

2. A way of detecting the radiation to show intensity and location

3. Computerized image

Isotopes of the same element behave chemically and metabolically the same way.

I-131

Thyroid produces thyroxin (hormone)
PET: positron emission tomography
based on the fact that certain isotopes (C-11 and F-18) emit positrons

1 positron + 1 electron → 2 gamma rays

Radiation Therapy: selective destruction of pathological cells and tissues
Ionizing radiation damages cells, esp quickly dividing ones

Co-60: treat inoperable tumors
I-131: kills thyroid cancer cells
I-125: prostate cancer