Radiation Biology

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Definitions

- **Radiation** is a process in which energetic particles or energetic waves travel through vacuum or media.

- **Radiobiology** (also known as radiation biology) is the study of the action of ionizing radiation on living things.

History

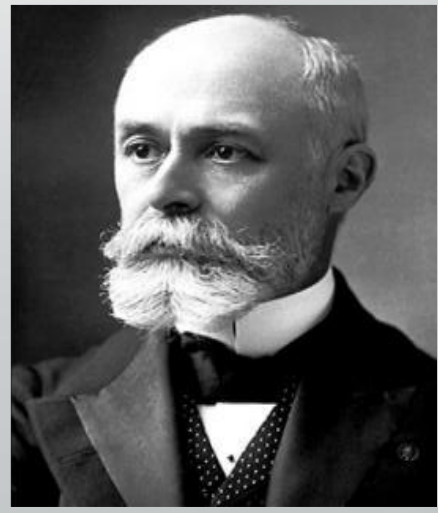
Sir Frederick William **Herschel** (German, 1738-1822) discovered planet Uranus & its major moons (Titania and Oberon). He was the first person who discovers ***infrared radiation***.

Johann Wilhelm **Ritter** (Germany**,** 1776 – 1810) discovered ***Ultraviolet.***

Heinrich **Hertz** (German 1857 – 1894) detected ***Radio waves*** therefore, some prefer to call Hertz the "Father of Radio" and the unit of radio frequency is called the "hertz".

- Wilhelm Conrad **Rontgen** (German, 1845 – 1923) discovered ***X-rays***. In 1901 he was awarded the first Nobel Prize in Physics. He published the first X-ray photograph of his wife's hand, also he subjected his fingers to X-rays and observed the acute effects of radiation (his fingers burned).

- Antoine Henri **Becquerel** (France, 1852- 1908) discovered that uranium salts emitted rays that resembled X-rays in their ability to penetrate solid objects. Henri Becquerel, Pierre Curie, Marie Curie won the Nobel Prize in Physics 1903.



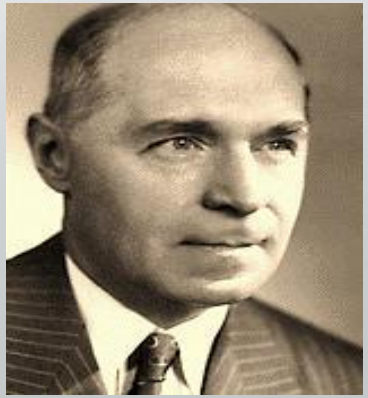
- Pierre **Curie** (1859-1906) & **Marie Curie** (1867-1934) together with Antoine Becquerel won the 1903 Nobel Prize in Physics for their investigations of ***radioactivity***. Marie won a 1911 Nobel Prize in Chemistry for discovering Radium, Polonium. The health dangers of radioactive substances were not well known and Marie died of cancer.

- Ernest **Rutherford** (1871-1937) discovered two distinctive types of radiation emitted by thorium and uranium which he named ***alpha and beta***. Also he named the radiation discovered by Paul **Villard**, a French chemist as ***gamma***. He found out that this radiation had a much greater penetration power than alpha and beta.

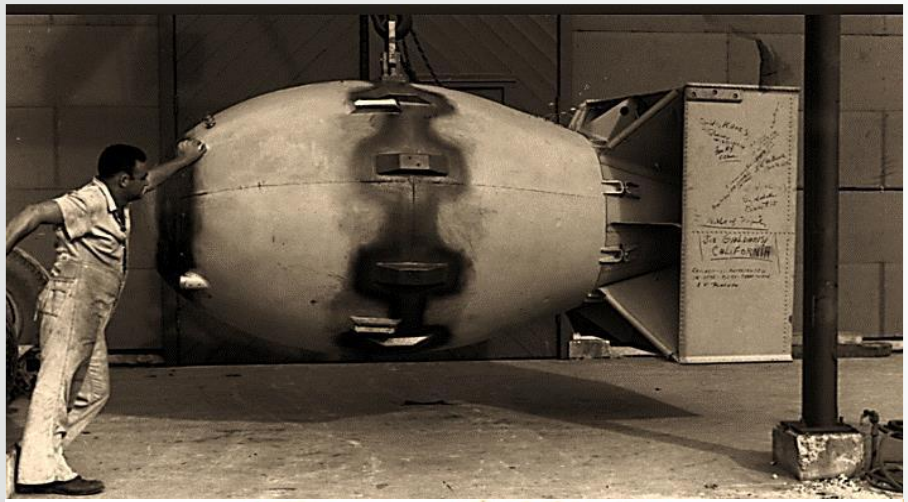
Victor **Hess** discovered ***cosmic rays*** during balloon flights in 1912. He won the 1936 Nobel prize in physics.

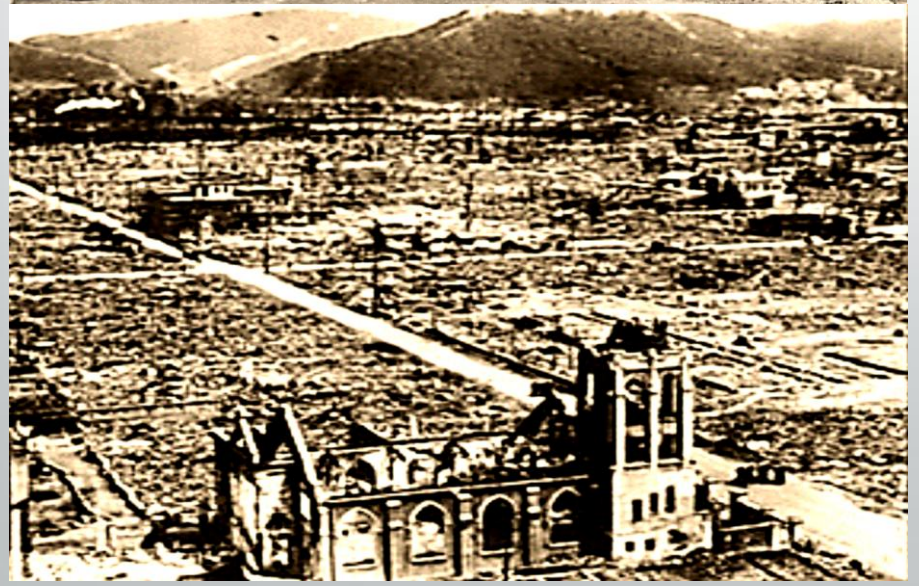
James **Chadwick** (1932) discovered ***neutron radiation*** and ***isotopes***.

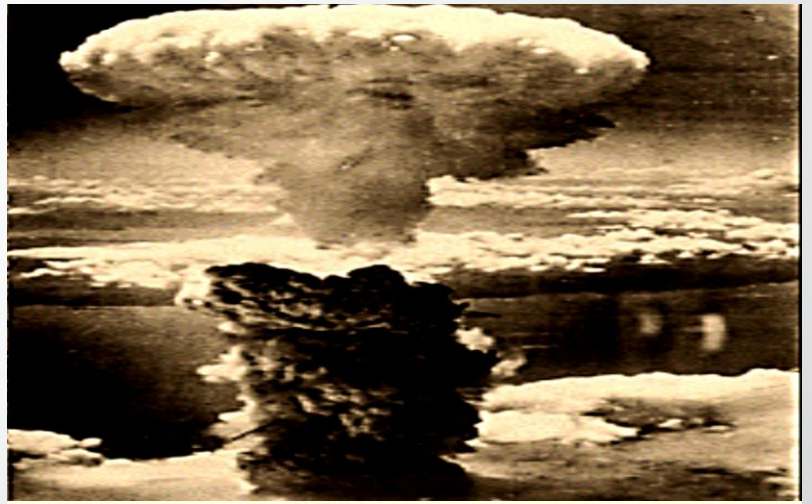
Hermann Joseph **Muller** (1890-1967) recognized the ***genetic effects of radiation*** in 1927 including cancer risk, gene mutations & chromosome changes by X-rays. In 1946, he was awarded the Nobel Prize for his findings.



The atomic bombings of Hiroshima and Nagasaki, 1945 resulted in a large number of incidents of radiation poisoning, allowing for greater insight into its symptoms and dangers.







Uses of Radiation

A. In medicine

1. Detection of broken bones & tumor masses by using X-rays.

2. Diagnosis of thyroid gland diseases by radioactive substance (Iodine isotope).

3. Detection of infectious diseases & hormonal disturbance by radioimmunoassay.

4. Decontamination of medical equipment & products by UV & gamma (γ) rays.

5. Treatment of cancers (radiotherapy) by using gamma (γ) ray.

Uses of Radiation

B. In communication

All modern communication systems use forms of electromagnetic radiation that vary in their intensity according to changes in:

1. **Sounds** (e.g. phone)
2. **Words** (e.g. fax)
3. **Pictures** (e.g. internet)

C. In science

1. Determination the composition & age of materials by using radioactive atoms.
2. Determination the pathways taken by pollutants through the environment.

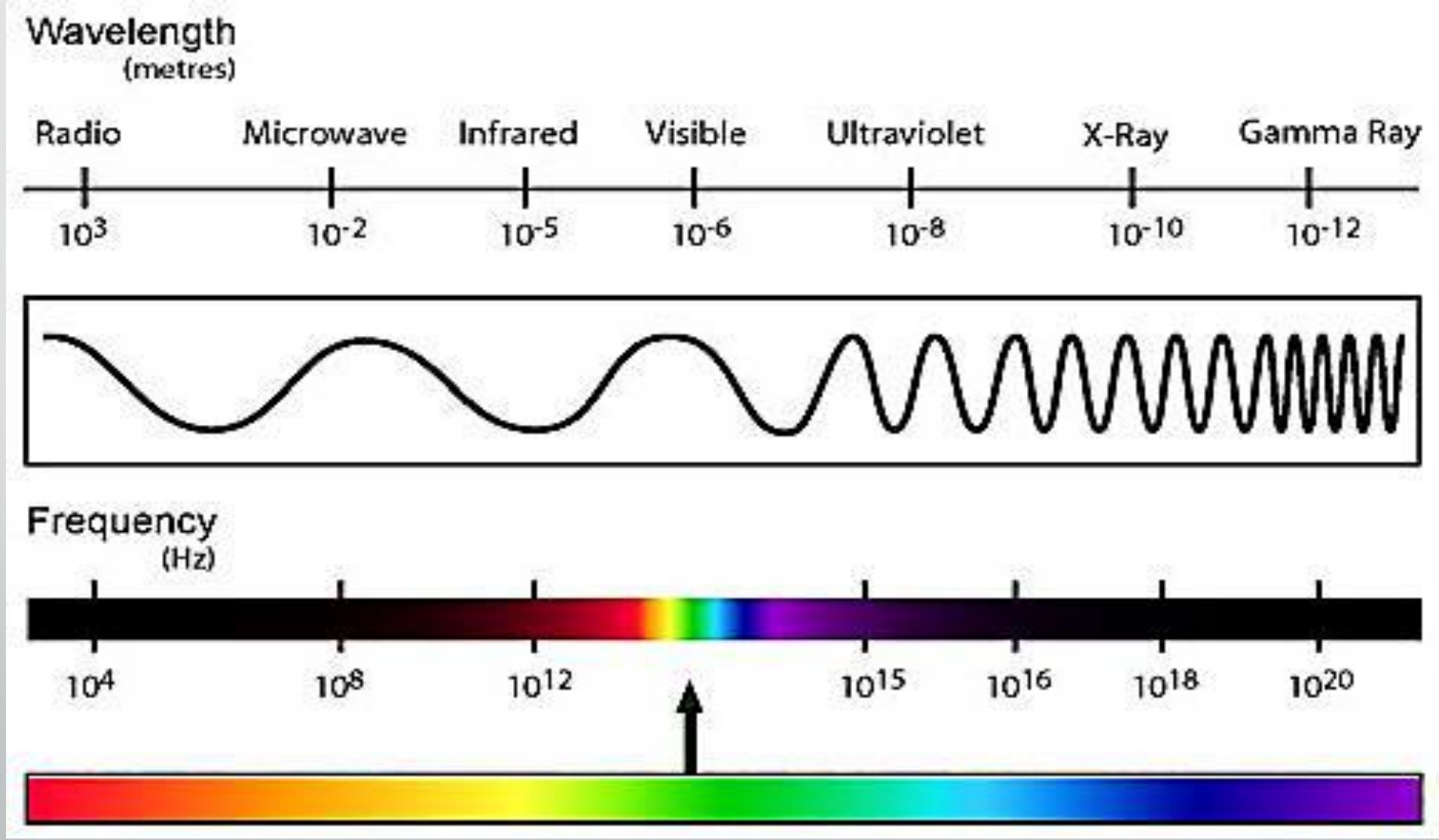
Types of Radiation

Electromagnetic radiations can be classified in several types of radiation according to their ***wave length & frequency***. A smaller wavelength corresponds to a higher energy according to the equation:

$$E = h c / \lambda$$

(**E** = Energy; **h** = Planck's constant; **c** = speed of light; **λ** = wavelength).

Spectrum of Electromagnetic Waves



A. Non-ionizing Radiation

Electromagnetic waves that are not energetic enough to detach electrons from atoms or molecules **(3.1 eV),** thus can't ionizing them.

1. **Visible light (400–700 nm)** from sunlight irradiance (1 kilowatt/square meter, only 445 watt is visible light.
2. **Infrared (IR) (700 nm - 300 micrometers)** From 1 kilowatt of sunlight energy, 527 watts is infrared radiation.
3. **Microwave (**one meter to as short as one millimeter)
4. **Radio waves (**thousands meters)
   - ***naturally*** resulted from **lightning** and **astronomical objects.**
   - ***artificially*** to be used for (mobile, broadcasting, radar, satellite, computer networks).
5. **Ultraviolet radiations (UV) (400 nm -125 nm)**
   - From 1 kilowatt of bright sunlight energy, only 32 watt is UV radiation.
   - UV can cause excitation in biological system and resulting in serious damage.

B. Ionizing radiation

- They have energies larger than **(10 eV)** which is a typical binding energy of an outer electron to an atom or organic molecule.
  - ✓ **High doses** resulting in skin burns, radiation sickness and death
  - ✓ Low doses resulting in cancer, and genetic damage.
- They have short-wavelength **125 nm** or less (higher frequency & higher energy):
  1. **Alpha particles**
  2. **Beta particles**
  3. **X-ray**
  4. **Gamma ray**
  5. **Free neutrons** & **Cosmic ray.**


THANK YOU