An experiment on the flow of water through a capillary tube as an introduction to decay curves and the study of half life

History of Radioactivity

The history of **radioactivity** really began with the discovery of **X-rays** by **Wilhelm Roentgen** in November **1895**.

In **1896**, **Henri Becquerel** found that Uranium salts could activate a photographic plate in the absence of light, also they could activate air so as to discharge an electroscope. He suggested the term "**Radioactivity**" by referring to the phenomenon of "**Radiation Activity**".

In **1902**, **Marie Curie** succeeded in isolating 0.1g of radium. **Pierre Curie** exposed his arm to the radiation from the radium, and studied the healing of the resulting burn.

In **1934**, **Frederic Joliot** and **Irene Curie** produced radioactive phosphorus by bombarding aluminum with alpha particles, and thus produced the first isotope which does not occur in nature.

Radioactivity

Radioactivity is a number of disintegration per second, its unit for measurement is **Becquerel** (**Bq**).

<u>**There are two main sources of radiation found in the environment: -**</u>

1. **Natural Radioactivity Sources: -**

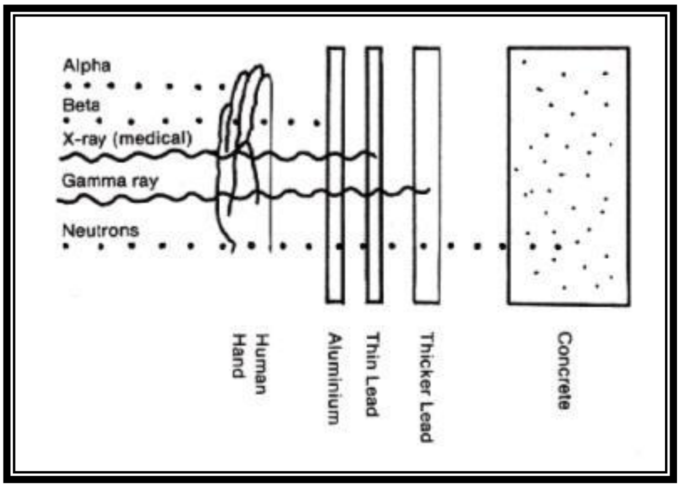
   Which include terrestrial, cosmic rays, and cosmogenic.

2. **Man-Made Radioactivity Sources: -**

   Which include medical, fallout, and nuclear power.

Ionizing Radiation

Ionizing radiation consists principally of **electromagnetic waves** like light (e.g. gamma and X-rays) or **charged particles** (e.g. Alpha and Beta particles) and of **neutrons**.



Radiation Exposure

Exposure is an act or condition of being subjected to irradiation. The types of exposure are: -

- **External Exposure: -**

  Irradiation by sources outside the body.

- **Internal Exposure: -**

  Irradiation by sources inside the body (**by inhalation or ingestion or through the skin**).

The Actions of Ionizing Radiation

The actions of ionizing radiation on cells are **two** types: -

- **Direct Action.**
- **Indirect Action.**

Both actions are involved when a charged particle passes through a cell. Both actions can cause damage to the cell but by different mechanisms.

1. **Direct Actions: -**

   Direct action occurred within milliseconds following irradiation, this type of action causes a number of physical and chemical events are used to describe the death of the cell.

2. **Indirect Actions: -**

   Indirect action occurs when a molecule reacts with a molecule or the product of a molecule that has undergoes direct action.

   Since the human body is an aqueous solution containing approximately 80% water molecules. When ionizing radiation interacts with water molecules, they dissociate into other molecular product, and this action termed the radiolysis of water.

Radiation Injuries From Ionizing Radiation

Radiation injures can be divided into **two** classes: -

- **Somatic Effects: -**

  In which the damage appear in the irradiated person himself (**loss of hair, reddening of the skin, etc**).

- **Genetic (hereditary) Effects: -**

Which arise only in the offspring of the irradiated person as a result of radiation damage to germ cells in the reproductive organs (**the gonads**).

The Radioactive Decay

The basic equation describing radioactive decay is: -

$$A = A_o e^{-\lambda t}$$

Where: -

A = is the activity in disintegration per second.

A_o = is the initial activity.

λ = is the decay constant.

t = is the time.

We can express the previous equation as: -

$$A = \lambda N$$

N = is the number of radioactive atoms.

Half-Life

Some nuclei are **unstable** and decay; others are **stable** and last forever. The most unstable nuclei decay the most rapidly. That is, they have the shortest lifetime.

Two factors determine the length of time the radionuclide is in the organ, or the effective half-life ($T_{1/2\ eff}$): -

- **The Physical Half-Life ($T_{1/2\ phy}$): -**

Is the time that needed for one-half of the nucleus to decay.

- **The Biological Half-Life ($T_{1/2\,bio}$): -**

Is the time needed for one-half of the original atoms present in an organ to be removed from the organ, and it is independent of whether the element is radioactive.

$$T_{1/2eff} = \frac{(T_{1/2bio})(T_{1/2\,phy})}{T_{1/2bio} + T_{1/2\,phy}}$$

<u>The decay constant is related to the half-life by simple equation: -</u>

$$T_{1/2} = \frac{\log_{10} 2}{\lambda}$$

The Medical Applications of Radiation

1. Ionizing radiation is used to **diagnose** numerous medical conditions. The doses in **rems** from diagnostic procedures are usually small.
2. Large doses of ionizing radiation are applied for **therapeutic** purpose, almost exclusively for the treatment of cancer.

The **risk** of exposure versus the **benefit** of the medical procedure is usually carefully considered, as in any medical procedure.