Unit - 5
Radiopharmaceuticals

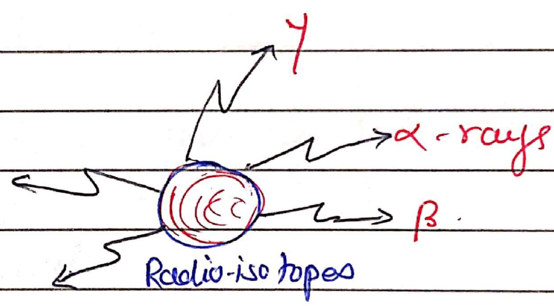
Radiopharmaceuticals ⇒

It is the branch of science that deals with the study of radioactive substances which are used as medicine.

Radioactivity

It is a natural and spontaneous process in which one element emits or radiates excess energy in the form of particals or waves.

→ The emitted particals or waves are called ionizing radiation. (α, β, γ rays)



Radioactive Rays

① Alpha rays (α-rays)

→ These are +vely charged particles.
→ These are heaviest as they are produced when the heaviest element decay.
→ It is not wave but high energy particals which are expelled from unstable nuclei.

→ These are similar to Helium atom, c contain 2 proton and 2 nuetron having a mass of 4 amu.

$^{4}_{2}He$

→ Penetration power is less as these are large particles.

→ They get deflected in electric and magnetic field.

→ They produce fluorescence and phosphorescence in some material such as zinc sulphide

	Fluorescence and	Phosphorescence
Time	immediate, usually on the scale of "Nanosecond"	Long-lived, (millisecond → second)
light emission	Higher energy light	Lower energy light

Both are photoluminescence that occurs when a substance absorb light and then emit light c longer wavelength and lower energy.

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Beta rays (β^-)

→ They are much lighter energy particle and have less ionizing power than α- particle.

→ Beta particles are 8000 times smaller than α- particles.

→ β- particles have negligible masses, and are high speed electron ($_{-1}e^0$ or β. particle)

→ They get deflected in electric and magnetic field.

→ It ionize the gas through which they pass, and can penetrate through matter.

→ It's penetrating power is 100 times more than α - particles.

→ Ionizing strength of β particle is 1/100th of α- particle.

→ They produce fluorosence & phosphorescence in some material i.e. ZnS.

→ Energy range 2 to 3 meV.

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Gamma Rays

- → They are having completely different character.
- → They do not have any charge or mass on them.
- → It travel to the velocity of light.
- → γ-rays are like X-Ray, have shorter wavelength than visible light.
- → Penetration power $\gamma > \alpha, \beta$.
- → No change or loss of atomic mass or number takes place.
- → They produce fluorescence in some material.
- → They produce heat on surface they fall.
- → It can produce nuclear reaction.

Properties of α, β, γ radiation

Property	Type of radiation α	β	γ
(1) Charge	+1	-1	0
(2) Mass	6.64×10^{-24} g	9.11×10^{-28} g	0
(3) Relative penetrating Power	—	100	10,000
4) Nature of Radiation	^4_2He nuclei	Electron	High Energy Proton.

Radio. isotopes

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→ Atoms of an element c have the same atomic number but different mass number. are called as **Isotopes**

→ Isotopes are called as Nuclides.

→ Nuclides have same number of Proton different No. of Neutron.

example

Hydrogen →
- $^{1}_{1}H$ (Proteum)
- $^{2}_{1}H$ (Deuterium)
- $^{3}_{1}H$ (Tritium)

Isotopes
- Stable isotopes
- Radioactive Isotopes

Stable isotopes

→ Stable isotopes

→ Do not emit radiation

→ e.g. ^{13}C, ^{35}Cl, ^{1}H (Protium), ^{2}H (dueterium)

Radioactive Isotopes

→ It have unstable nuclie.

→ Emit α, β, γ rays

→ End product is stable & non-radioactive element.

→ Parent Nucli (unstable) $\xrightarrow{\alpha, \beta, \gamma}$ daughter Nucli (Stable)

Types of Radio-active Isotopes

- **Naturally Occurring**
  - e.g. U^{235} – Uranium
  - Ra^{226} → Radium
  - Rb^{87} → Rubidium
  - K^{40} → Potassium
- **Artificial radio nuclides**
  - They are produced in nuclear reaction.
  - e.g. $^{27}_{13}Al \xrightarrow{^{4}_{2}He \text{ (bombarding)}} {}^{30}_{15}P + {}^{1}_{0}n$

Radioactive decay

→ Radio activity involve release of radiation from the nuclei of radioactive isotopes.

→ Each radionuclide (Natural/artificial) get disintegrated by emission of energy.

Half life

⇒ It is a time required for a radioactive isotopes to decay to one half of it's original value at a given point of time.

→ Each radioactive element has its own characteristic half-life ($t_{1/2}$).

$$t_{1/2} = \frac{0.693}{\lambda}$$

λ = Disintegration constant

→ Half life period for any given radioelement remains unchanged under varying condition of temp., Pressure, and chemical environment.

Example of radioactive pharmaceutical c̄ Half life.

Name	Half life	Application
Ferric citrate (Fe^{59})	45 days	Study of iron metabolism and R.B.C. formation.
Sodium iodide (^{131}I)	8.06 days	Thyroid scanning and Study of thyroid uptake
Sodium phosphate inj. (^{32}P)	14.2 days	Treatment of Polycythemia
Calcium chloride (^{45}Ca)	160 days	Study of calcium metabolism disorder, bone cancer
Ammonium Bromide Inj. (^{82}Br)	36 hrs.	Extracellular water measurement.

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Units of Radioactivity

Curie :

1 gm of radioactive element = 3.7×10^{10} disintegration/sec

Roentgen

1R = 2.58×10^{-4} C/kg (c= collloumb)

RAD (Radiation Absorbed Dose)

1 RAD = 10^{-2} J/kg

Mode of Decay

→ Radionuclide can undergo disintegration by different modes until a stable nucleus does not form.

→ If Daughter nuclie is unstable, it becomes new parent and start decaying until it become stable this series is called radioactive series.

→ Daughter nuclie will have different number of neutrons or atomic number.

Characteristic of an isotope to act as useful radio diagnostic agent.

1) Should release high energy photon
2) Half life 1 hr - 1 year
3) Should decay (out particle emission