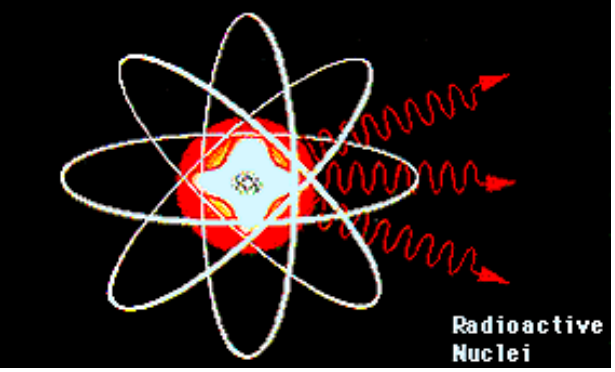
RADIOPHARMACEUTICALS



- **Radiopharmacy** –branch of pharmacy that deals with radiopharmaceuticals.
- **Radiopharmaceutical-** a radioactive pharmaceutical agent that is used for diagnostic or therapeutic procedures
- A radiopharmaceutical consists of a drug/ chemical component(carrier) and a radioactive component (radionuclide)
- Some carriers such as peptides and monoclonal antibodies are more specific and are used to target tumor sites-
  - a desired localization property useful in radio-immunotherapy

Production of Radiopharmaceuticals

- Currently over 100 radiopharmaceuticals available worldwide
  - radio-nuclides mostly produced from nuclear reactors and cyclotrons
- Radiopharmaceutical production involves handling of large quantities of radioactive substances and chemical processing
- Radiopharmaceutical production
  - relatively small scale
  - requires well qualified personnel
  - uses controlled materials and procedures
- procedures are technically demanding to ensure both radiological and pharmaceutical safety.

Production of Radiopharmaceuticals

The radioactivity in radiopharmaceutical allows non-invasive external monitoring or targeted therapeutic irradiation with very little effect on the biologic processes in the body

Imaging techniques e.g gamma camera are then used to monitor activity

Generally , radiopharmaceuticals have an excellent safety record and their incidences of adverse effects is extremely low.

What are the applications of Radiopharmacy?

1. **Diagnostic**
   - The radiopharmaceutical accumulated in an organ of interest emit gamma radiation which are used for imaging of the organs with the help of an external imaging device called gamma camera.
2. **Treatment**
   - They are radiolabeled molecules designed to deliver therapeutic doses of ionizing radiation to specific diseased sites.
3. **Research**

RADIOPHARMACEUTICALS

- **Radiopharmaceuticals are medicinal products that are radioactive.**
- **They are used for both diagnosis and therapy, principally in the branch of medicine known as Nuclear Medicine.**
- **Radiopharmaceuticals vary from inorganic salts to large organic molecules and complexes, and are prepared in a variety of preparations, which include intravenous injections, gases, aerosols, oral solutions and capsules.**

- **Radiopharmaceuticals, which contain radionuclides with long half-lives, are obtained from commercial suppliers.**

- **As the majority of radiopharmaceuticals in clinical use contain radionuclides with short half-lives, commercial supply is often impractical and such products are prepared in hospital radiopharmacies and represent the largest area of radiopharmaceutical work.**

FUNDAMENTALS OF RADIOISOTOPES

Particles and Waves

A.Elementary Particles

Electrons, protons, and neutrons constitute the basic building blocks of atoms, both stable and radioactive.

The electron is the smallest of these three particles. Its mass, m_e, is 9.1091 x10^{-28} g.

The mass of the electron, m_e, is used as a unit of mass.

The neutrino is a very unusual particle.

It has zero charge and zero mass. Yet, this particle plays a very important role in beta decay.

Common Particles and waves of Nature

Particle	Symbol	Charge	Mass (in electron masses)
Negatron (-v *Beta)*	e^{-} (β^{-})	-1	1
Positron (+v Beta)	e^{+} (β^{+})	+1	1
Proton	p	+1	1836
Neutron	n	0	1837
Alpha	α	+2	7346
Neutrino	v	0	0
Gamma rays (photon)	γ	0	0

Although gamma rays are electromagnetic radiation, they possess particulate properties.

B. Radiation from Radioactive Nuclei

There are three types of radiation most frequently emitted from radioactive nuclei.

They consist of two protons and two neutrons. Identical with the helium nucleus.

The range of α particles in air is about 5 cm, and less than 100μ in tissue.

2. Beta particles:

Are either negative charged (negatron) or positive (positron).

Beta particles may have a range of 3 m air and up to about 1 cm in tissue.

Are electromagnetic waves, whereas alpha and beta radiations are particulate.

Gamma rays are the most penetrating of all types of radiation and can easily pass through more than a foot of tissue or several inches of lead.

Atoms and Nuclei

A- Atomic Structure

A neutral atom consists of a positively charged nucleus (composed of protons and neutrons) associated with orbital electrons.

The atomic number (Z) is the number of protons in the nucleus

The neutron number (N) is the number of neutrons in the nucleus.

The mass number (A) is the sum of the protons and neutrons.

$$A = Z+N$$

A nucleon is a heavy nuclear particle of any type (proton or neutron)

B- Nuclides and isotopes

A nuclide is a nuclear species characterized by the magnitudes of its atomic and mass numbers.

Nuclides may be stable or unstable and unstable nuclides are radioactive (radionuclides).

The representation of nuclide is:

$$^{A}_{Z}\text{Chemical symbol}, \quad \text{e.g.} \quad ^{32}_{15}\text{P}$$

^{1}H, ^{2}H, ^{12}C, ^{23}Na are stable nuclides

^{3}H, ^{14}C, ^{22}Na are radionuclides.

An isotope is one of a series of nuclides with the same atomic number,

e.g. ^{1}H, ^{2}H, ^{3}H are isotopes of hydrogen of which only H (tritium) is radioactive.

^{10}C, ^{11}C, ^{12}C, ^{13}C, ^{14}C are isotopes of carbon of which ^{10}C, ^{11}C, and ^{14}C are radioactive.

Types of radioisotopes

1)Isotopes:

Are species of nuclides which possess the same number of protons but a different, number of neutrons,

e.g.

1H1, 2H1, 3H1 are isotopes

2)Isobars:

Are those nuclides which have the same mass number,

e. g.

3H1 , 3He2 are isobars

3)Isotones:

Are the nuclides which possess the same number of neutrons

e.g.

3H1, 4He2 are isotones

The electronvolt (eV) is the unit of energy used for radiations,

One eV is the energy (work done) acquired by an electron when accelerated through a potential difference of 1 V.

This amount of energy is very small, so the energies of particles are usually given in terms of MeV megaelectronvolt or KeV (Kiloelectronvolt):

$$1\text{MeV} = 10^3\ \text{KeV} = 10^6\ \text{eV} = 1.60 \times 10^{-6}\ \text{erg.}$$