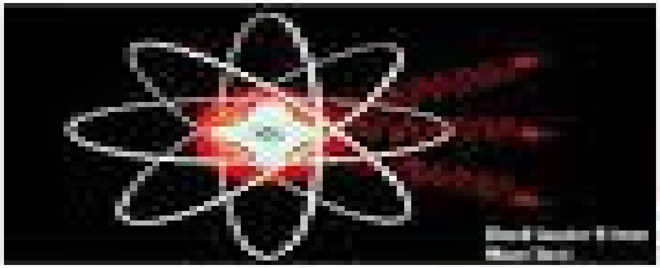

RADIOPHARMACEUTICALS

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RADIO PHARMACEUTICALS

Radiopharmaceuticals are group of pharmaceutical drugs containin radioactive isotopes.

It is can be used as diagnostic and therapeutic agents.

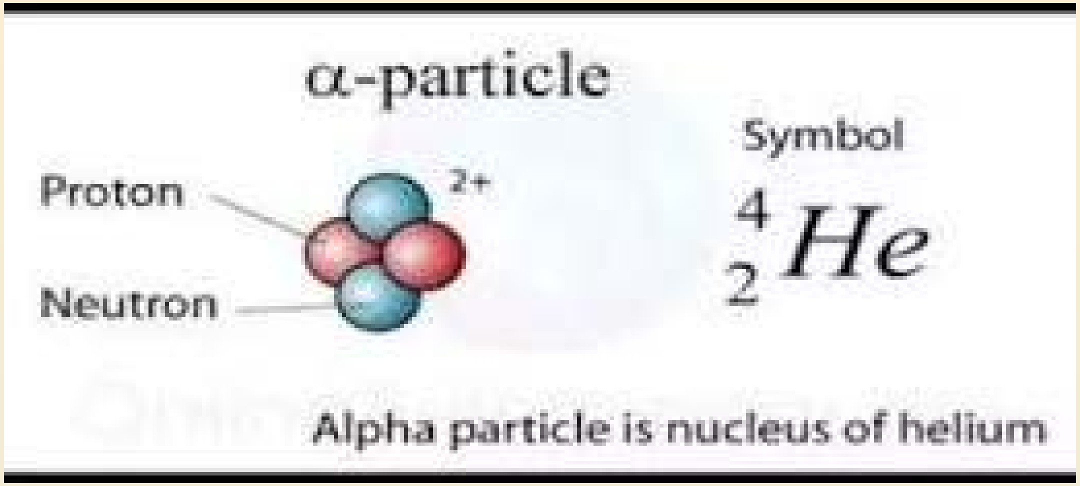
It emit radiation themselves, which is different contrast media which absorb or alter external electromagnetism or ultrasound.

RADIOACTIVITY

- **Radioactivity also known as radioactive disintegration and nuclear disintegration.**
- **It is a process by which an unstable atomic nucleus loses energy by radiation.**
- **A material containing unstable nuclei is considered as radioactive.**

❖Three of the most common type radioactive material are alpha, beta and gamma.

Alpha particles:



These are positively charged particles.

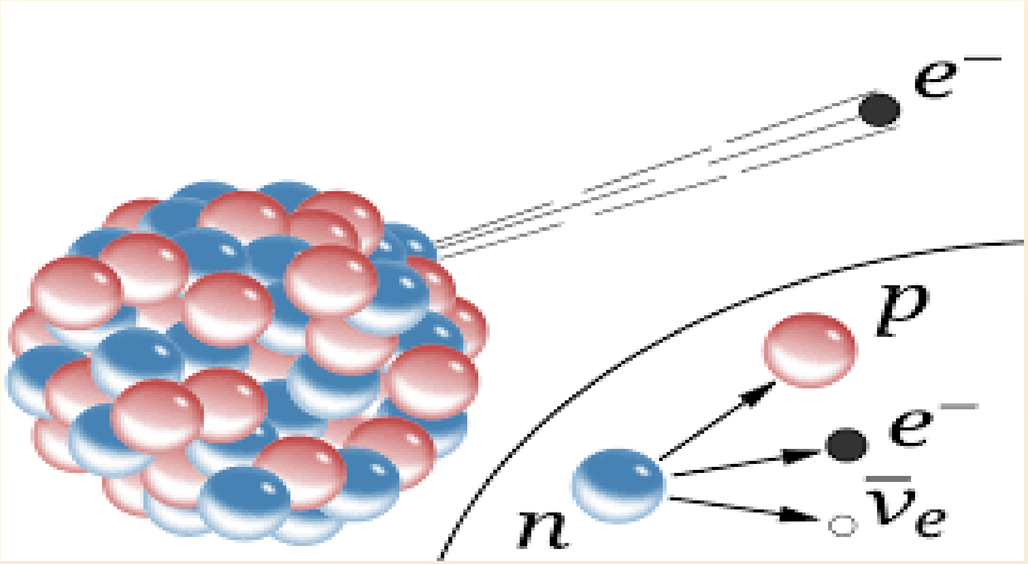
A highly energetic helium nucleus which contains two protons and two neutrons Is called alpha particles.

They can not penetrate the skin but this does not mean that they are not dangerous.

They have great ionization power so if they get into body they can cause serious damage.

Due to this reason radioactive substance alpha particles needs to be handled with rubber gloves.

Beta Particles:



These particles are highly energetic electrons which are released from inside of a nucleus.

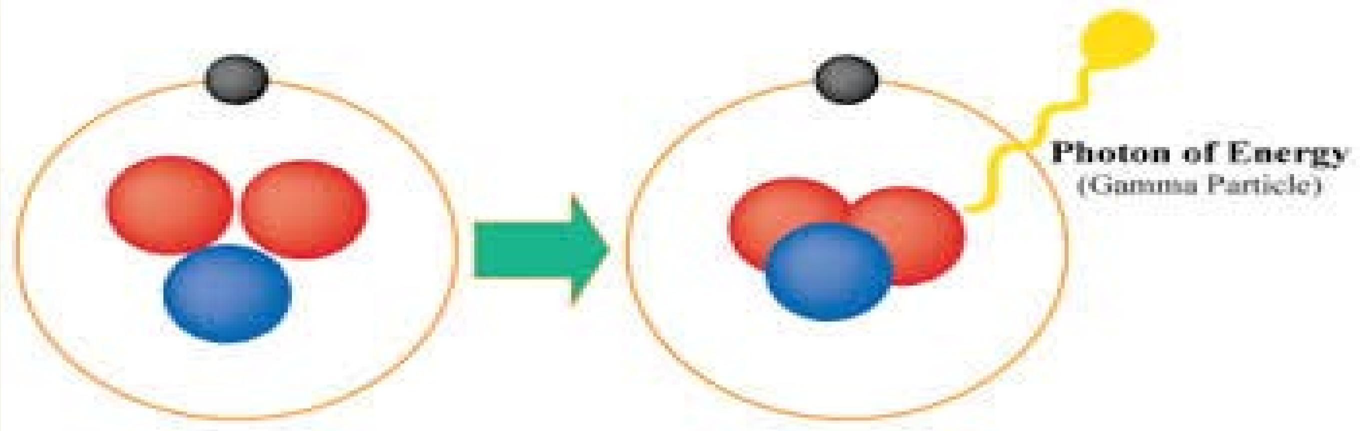
They are negatively charged and have a negligible mass.(+ and – both charge)

On the emission of beta particles , a neutron in the nucleus divides into a proton and an electron.

Beta electrons have a greater penetration power than the alpha particles and can easily travel through skin.

It have less ionization power than the alpha particles but still they are dangerous.

Gamma Particles:



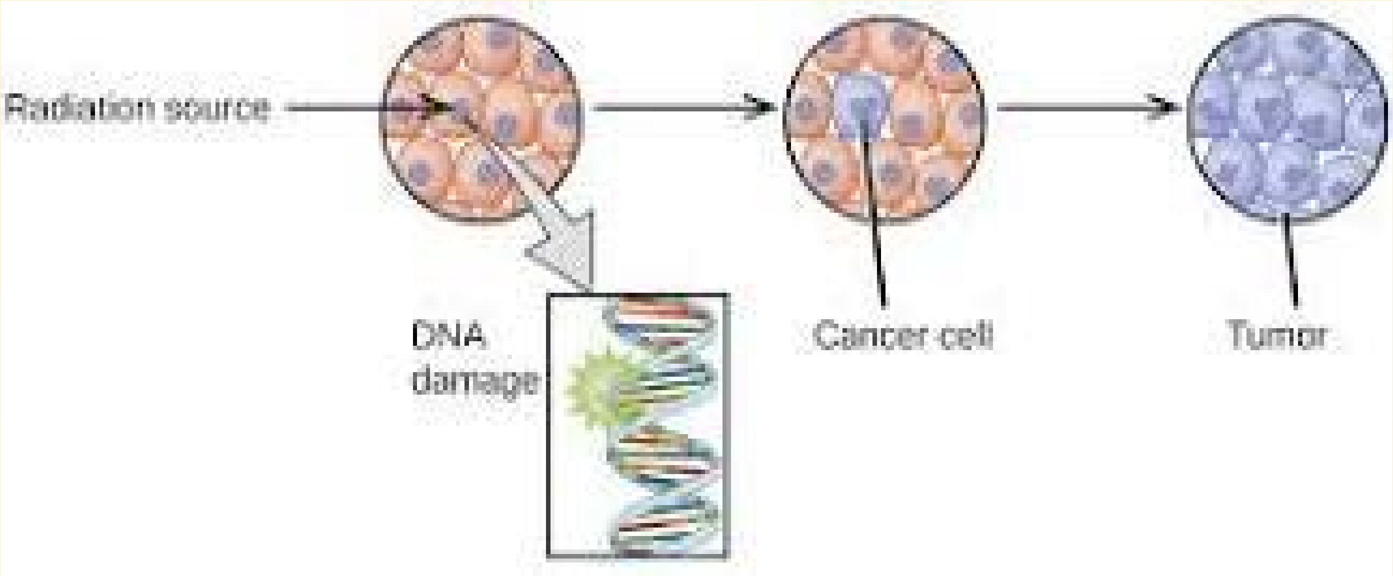
The waves from the high frequency end of the electromagnetic spectrum which do not have any mass are called the gamma rays.

They have greatest power of penetration.

They are least ionizing but most penetrating and it is extremely difficult to stop them from entering the body.

These rays carry huge amount of energy and can travel through thin lead and thick concrete.

BIOLOGICAL EFFECT OF RADIATION:



Radiation can harm either the whole body (somatic damage) or genetic damage.

Alpha particle sources are usually not dangerous if outside the body, but are quite hazardous if ingested or inhaled.

Direct ionization of DNA molecule which may result in genetic damage,

radiation ionizes water which causes free radicals to form. Free radicals attack targets such as DNA.

Four things can happen when radiation enters

cell:

1. The radiation may pass through without any damage occurring.

2. The radiation may damage the cell, but the cell repairs the damage.

3. The radiation may damage the cell the damage is not repaired and the cell replicates itself in the damaged form.

4. The cell dies.

Measurement of radioactivity:

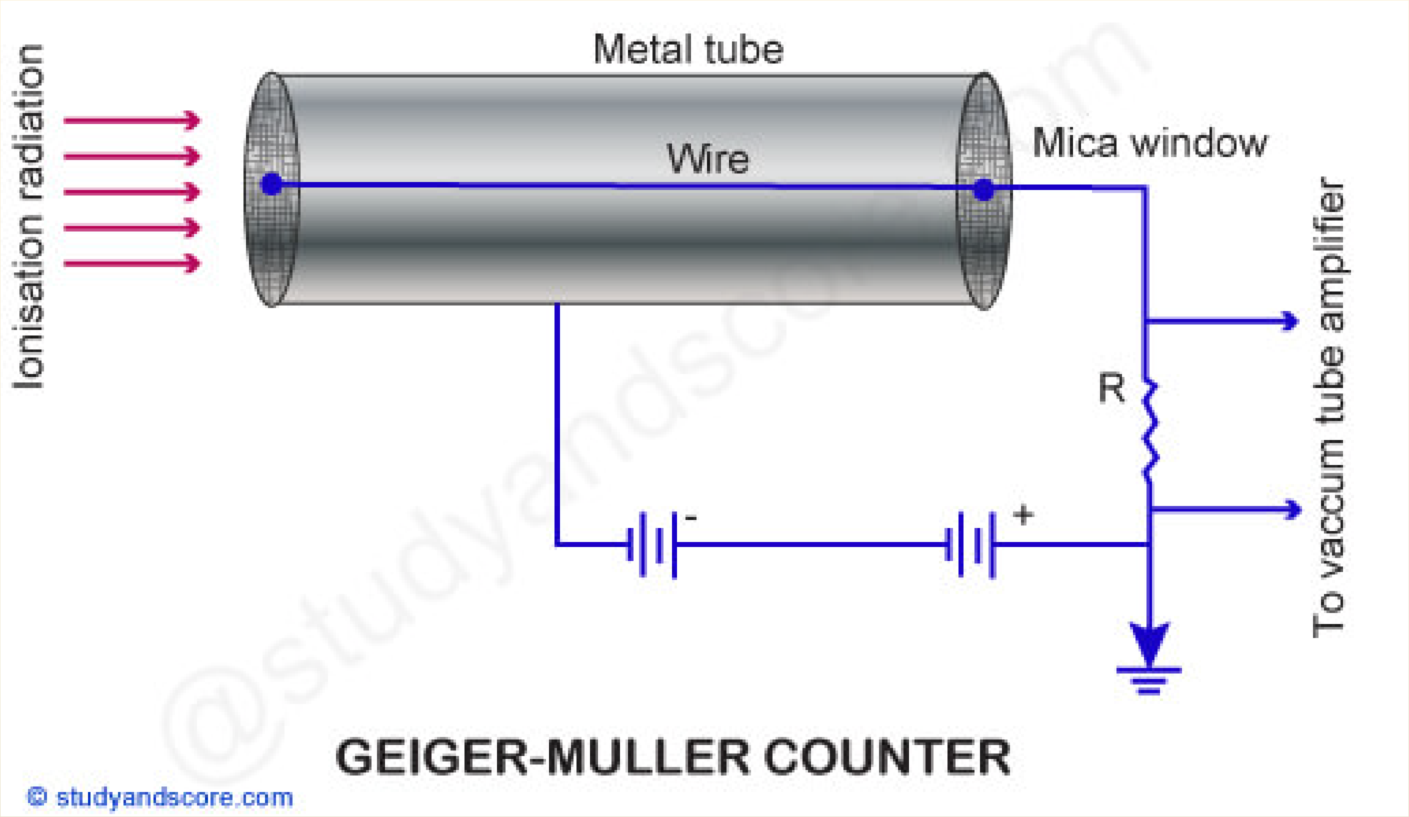
The units of **measure** for **radioactivity** are the curie (Ci).

A Geiger counter is an instrument used for detecting and **measuring** ionizing radiation.

Also known as a Geiger–Muller counter .

it is widely used in radiological protection, experimental physics, and the nuclear industry.

Geiger–Muller counter (G.M):



A **Geiger counter** is an instrument used for detecting and measuring ionizing radiation.

It detects ionizing radiation such as alpha particles, beta particles, and gamma rays using the ionization effect produced in a Geiger–Müller tube, which gives its name to the instrument.

Construction of G.M Counter:

It consists of a hollow metal case enclosed in a thin glass tube. This hollow metal case acts as a cathode.

A fine tungsten wire is stretched along the axis of the tube and this fine tungsten wire acts as anode.

The tube is evacuated and then partially filled with a mixture of 90% argon at 10 cm pressure and 10% ethyl alcohol vapors at 1cm pressure.

The fine tungsten wire is connected to positive terminal of a high tension battery through a resistance R and the negative terminal is connected to the metal tube.

The direct current voltage is kept slightly less than that which will cause a discharge between the electrodes.

At one end of the tube is arranged to allow the entry of radiation into the tube.

Principle of Geiger-Muller counter:

When an ionizing particle passes through the gas in an ionizing chamber, it produces a few ions.

If the applied potential difference is strong enough, these ions will produce a secondary ion whose total effect will be proportional to the energy associated with the primary ionizing event.

A high energy particle entering through the mica window will cause one or more of the argon atoms to ionize.

The electrons and ions of argon thus produced cause other argon atoms to ionize in a cascade effect.

The result of this one event is sudden, massive electrical discharge that causes a current pulse.

The current through R produces a voltage pulse of the order of 10μV.

An electron pulse amplifier accepts the small pulse voltage and amplifies them to about 5 to 50 V.

The amplified output is then applied to a counter. As each incoming particle produces a pulse, the number of incoming particles can be counted.

Working of Geiger-Muller counter:

The tube is filled with Argon gas, and around voltage of +400 Volts is applied to the thin wire in the middle.

When a particle arrives into the tube, it takes an electron from Argon atom.

The electron is attracted to the central wire and as it rushes towards the wire, the electron will knock other electrons from Argon atoms, causing an "avalanche".

RADIOISOTOPES:

Radioisotopes are radioactive isotopes of an element. They can also be defined as atoms that contain an unstable combination of neutrons and protons, or excess energy in their nucleus.

ISOTOPE:

Isotopes are elements with the same atomic number but different mass numbers.

Radioisotope use:

In medicine, for example, cobalt-60 is extensively employed as a radiation source to arrest the development of cancer.

Iodine 131used to locate the brain tumors, liver and thyroid activity.

Sodium 24 is used to study blood circulation.

Thallium 201 is used to determine damage heart tissue & detection of tumour.

Carbon 11 is used to tagged onto to glucose to monitor organs during Positron emission tomography.

Carbon 14 is used to study metabolism changes for the patients with diabetes, gout and anemia.

Phosphorous 32 is used in research involving biology and genetics.

Hyrogen 3 or tritium used to study life science and drug metabolism.

STORAGE OF RADIOISOTOPES:

Store open source **radioisotopes** in the refrigerator marked with a radiation sign.

The refrigerator will be kept locked.

On a routine basis the refrigerators should be defrosted, cleaned and wipe tested.

Food or beverages must not be **stored** in the same refrigerator with **radioisotopes**.

To protect from gamma rays lead shielding has to be used.

Thick glass Perspex containers provide sufficient shielding.

If radioactive liquid is to be handled , it must be carried in trays with absorbent tissue paper, so that any spillage will get absorbed by the paper.

Precautions:

One should not touch the radioactive emitter with hand but it should be handled by means of forceps.

Smoking , drinking and eating activities should not be handled in laboratory where radioactive material is handled.

Sufficient protective clothing have to used while handling of materials.

Radioactive material have to be stored in suitable labeled containers.

Disposal of radioactive materials should be carried out with great care.

Radio opaque contrast media:

Radio opaque contrast agents are substances used to enhance the visibility of internal structures in X-ray-based imaging techniques such as computed tomography (contrast CT).

These are used as diagnostic aid in radiology .

Radio opaque contrast media are chemical compounds of elements of high atomic number.

The most radio opaque contain barium and iodine and are used for X- ray examination of the kidney.

Barium sulphate:

Formula: BaSo4

Occurrence:

It occurs naturally as the mineral barite, which is widely found and used as the major source of barium and other barium compounds.

Preparation:

Barium sulfate is obtained in commercial amounts from the mineral barite, after mining and processing.

The processing of the impure barite involves heating it with carbon to form the water-soluble barium sulfide (BaS), which is then separated from the impurities and reacted with sulfuric acid to give the pure barium sulfate product:

$$BaSO_4 + 4\ C \rightarrow BaS + 4\ CO$$

$$BaS + H_2SO_4 \rightarrow BaSO_4 + H_2S$$

Physical properties:

Pure barium sulfate is found as white, odorless powder or small crystals with a density of 4.49 g/mL.

It has melting point of 1580 °C and boiling point of 1600 °C.

Chemical properties:

Barium sulfate is known for its poor solubility in water. It is also insoluble in alcohols, and soluble in concentrated acids.

It reacts aggressively with aluminum powder.

Barium sulfate has several medical and radio imaging uses due to its water insolubility and radio-opaque properties.

Uses:

Barium sulfate is widely used as a radio-opaque agent or X-ray contrast agent to diagnose gastrointestinal medical conditions.

It also has applications in root canal fillings, pigments, paints, adhesives, paper coatings, fillers in plastics, textiles, rubber

Reference:

1.Bianca Gutfilen and Gianluca Valentini, "Radiopharmaceuticals in Nuclear Medicine: Recent Developments for SPECT and PET Studies":2014.

2. Radiopharmaceutical for therapy: Ashutosh Dash.
3.Medicinal Chemistry Radiopharmaceuticals:


Thank you