

# Radioisotopes Studies in Biological system

presented by :Zahra Anwar  
M.Phil Scholar MMG



# Learning Objectives

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- Introduction
- Isotopes & Radioactivity
- Radioisotopes in biology
- Radiation Hazards

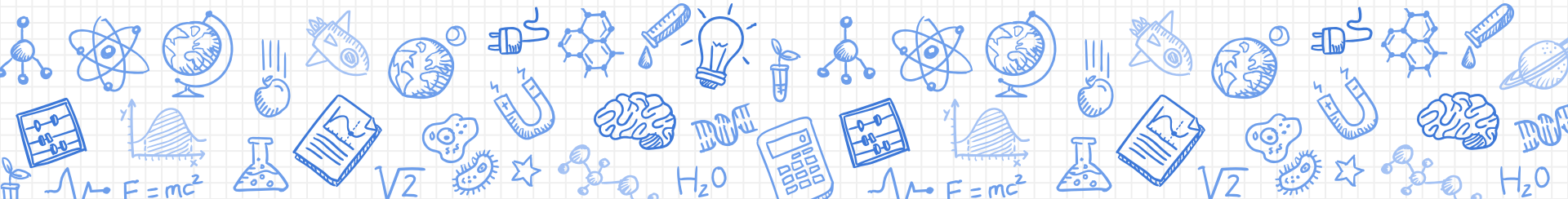



# Introduction

- An Atom is composed of a positively charged nucleus that is surrounded by a cloud of negatively charged electrons.
- The number of electrons is equal to the number of proton present in the nucleus known as atomic number( $Z$ ).
- The sum of protons & neutrons in a given nucleus is the mass number.

# DEFINITION

- Isotopes are nuclides with the same atomic number but different in mass number.
- The spontaneous degradation of nucleus & transmission of one element to another with consequent emission of rays ( or ) particles is known as radioactivity.





- Some isotopes are stable but others can emit, or kick out, subatomic particles to reach a more stable, lower-energy configuration such isotopes are called Radioisotopes.

- The process in which they release particles and energy is known as decay.



# TYPES OF RADIOACTIVE DECAY

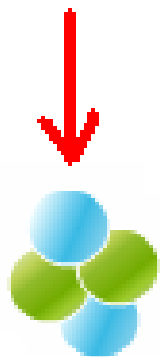
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- Decay by negatron emission
- Decay by positron emission
- Decay by  $\alpha$  particle emission
- Decay by gamma rays emission
- Decay by X rays emission.



# Radiation

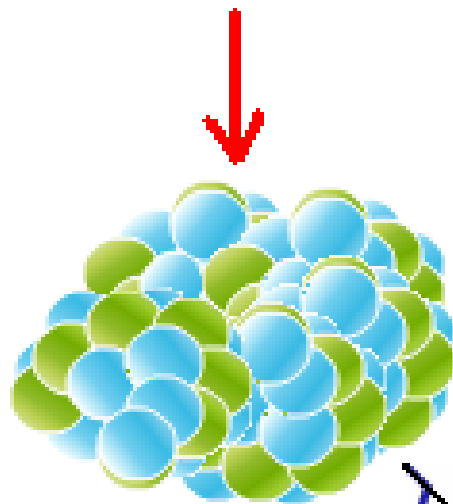
Two Protons and  
Two Neutrons.



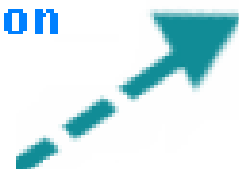
Alpha  
Radiation



Nucleus of  
an Atom

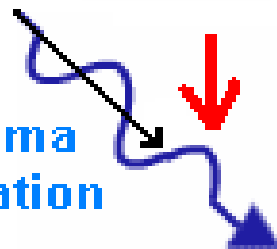


High Energy  
Electron



Beta  
Radiation

High Energy  
Electromagnetic  
Photon



Gamma  
Radiation

The are Three Types of  
Radioactive Decay

# Cont.....

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## ■ Negatron Emission

- $^{32}\text{P}$ , a powerful tool in molecular biology & used as a nucleic acid label.
- $\beta$  emitting isotopes are most suitable for autoradiography, particularly for cell & tissue localization and experiment.

## ■ Positron Emission

- Positron Emission Tomography is used to identify active or inactive areas of brain.
- It is very much useful to study body internal structures.





# Cont.....

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## **$\alpha$ particle Emission**

- $\alpha$  particles have high ionizing power, less penetrance & are extremely toxic.

- Isotopes that decay by  $\alpha$  particle emission are not encountered in biological work.

## **Gamma Emission**

- Emission of  $\gamma$  radiation leads to no change in atomic number or mass number.

- $\gamma$  radiation has low ionizing power but high penetration .



# HALF LIFE OF RADIOISOTOPES

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Half life of radio isotope is the time period required for radionuclide to decay to one half the amount originally present.



# Units of Radioactivity...

- The amount of radioactive material is given in **becquerel** (Bq), a measure which enables us to compare the typical radioactivity of some natural and other materials.
- A becquerel is one atomic decay per second.

# DETECTION AND MEASUREMENT OF RADIOACTIVITY

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Autoradiography

Gas ionization  
detectors

Flourescent  
scintillation



# APPLICATION OF RADIOISOTOPES IN BIOLOGICAL SCIENCES

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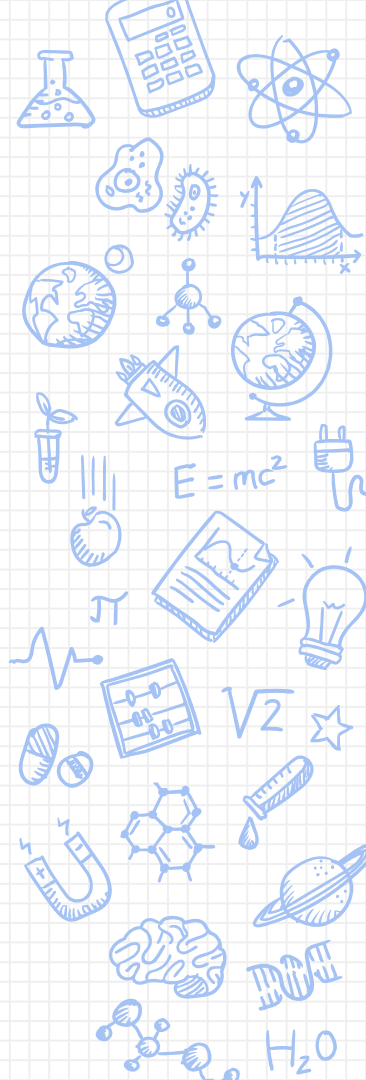
- Radioisotopes are frequently used for tracing metabolic path ways .
- Mixing radiolabeled substrates & samples of the experimental material & collecting samples at various times , extract & separate the products by chromatography.
- Radioactivity detectors can be attached to gas liquid cromatography or HPLC columns to monitor radioactivity coming off the column during separation.



# Cont.....

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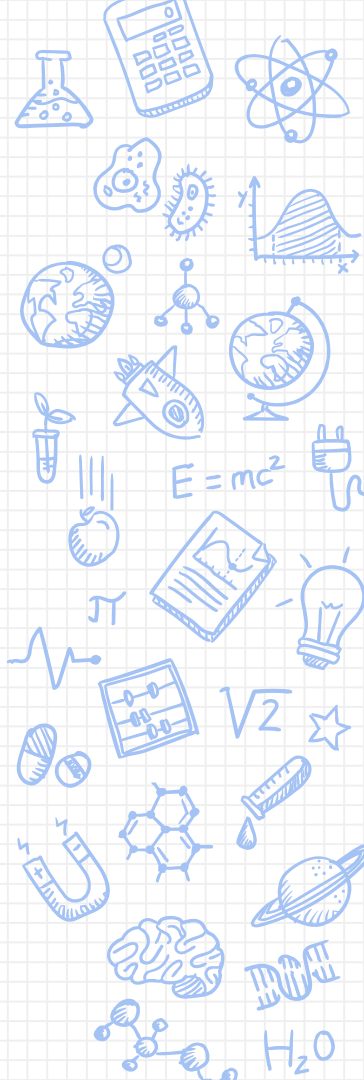
- Radioisotopes are widely used in study of the mechanism & rate of absorption , accumulation & translocation of inorganic & organic compounds in the animal .
- Radiolabeled drugs are useful in pharmokinetic studies (site of accumulation , rate of accumulation , rate of metabolism & metabolic products ).



# ANALYTICAL APPLICATIONS OF RADIOISOTOPES

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- Virtually any enzyme reaction can be assayed using radioactive tracer methods.
- Radioisotopes have been used in study of
  - The mechanism of enzyme action
  - In studies of ligand binding to membrane receptors.



# Cont...

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- By isotope dilution analysis plasma volume , total body water , E.C.F volume , RBC cell volume , total exchangeable sodium can be measured .
- $^{131}\text{I}$  labeled human serum albumin useful in diagnosing protein losing enteropathy .
- $^{51}\text{Cr}$  labeled RBC are given intra venously if there is any GI blood loss radioactivity can be measured.





# Cont...

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- Radio immuno assays are useful in analysis of hormones , growth factors , tumour markers , cytokines , bacterial antigens , vitamin D & various biological molecules.



# RADIOISOTOPES USED IN DIAGNOSTIC PURPOSES

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- Radio active iodine uptake & imaging reveals the functional status of thyroid tissue , including nodules , the whole thyroid gland & metastatic foci .
- $^{131}\text{I}$  is used for thyroid cancer imaging & management .
- $^{123}\text{I}$  I is used for thyroid scan .



## THERAPEUTIC USES OF RADIOISOTOPES

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- Radioisotopes have role in management of malignancies
- Tumour tissues are attacked by beam of radiation .
- $^{131}\text{I}$  is used for treatment of thyroid cancer .
- Teletherapy :  $^{60}\text{Co}$  is the source of radiation , radiation occurs from a distant source .
- Radioactive material is impregnated into body in form of beads either as surface applicants .



# RADIATION HAZARDS

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- Immediate effects :
  - Bone marrow syndrome,
  - Gastrointestinal track syndrome
  - Central nervous system syndrome
  
- Bone marrow syndrome : severe damage to hematopoietic system , leads to pancytopenia occurs with exposure of 200-1000 rads.



## Cont...

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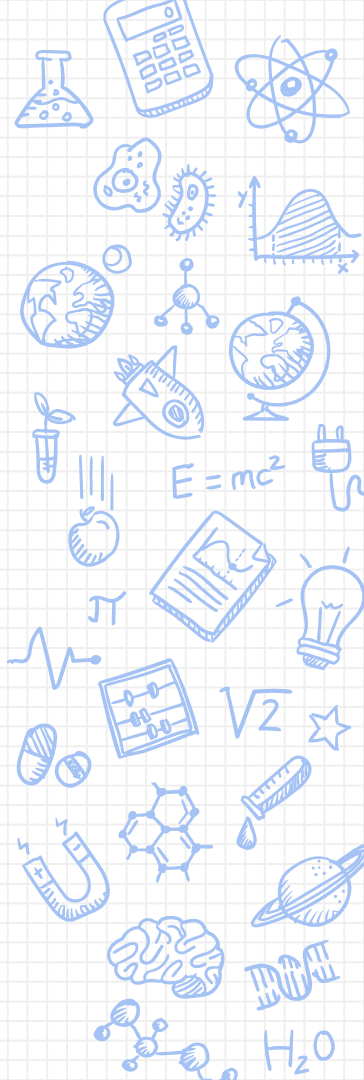
- Gastro intestinal syndrome : Severe damage to mucosal epithelium . Exposure of 1000 – 5000 rads is the cause .
- Central nervous system syndrome : Blood brain barrier is lost . Exposure of 5000 – 10000 rads is the cause .
- Delayed effects : carcinogenesis by damaging DNA.



# RADIATION SAFETY AND PROTECTION

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- The most popular triad of radiation protection is time ,distance & shield (TDS).
- Minimum possible time should spent near the radiation zone .
- Handling of radioactive material should be done from maximum possible distance .
- Person should be shielded by lead .



# TOWARDS A BETTER WORLD

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■ we should look towards a better world with the use of radioisotopes. Not a world where nuclear bombs are used for causing destruction and death but towards a world where radioisotopes are used as a life saver through x-rays and power supplier as nuclear power. It is our mother Earth, let's make the best place to live in peace and harmony. It depends on you and me that in which world we want to live in.



**THANK YOU**