



# **SNS COLLEGE OF TECHNOLOGY**

## **(AN AUTONOMOUS INSTITUTION)**

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## **Department of Biomedical Engineering**

**Course Name: 19BME301 – Medical Physics**

**III Year : V Semester**

**Unit III – PRODUCTION OF RADIONUCLIDES**

**Topic : Units of Radioactivity**

# Radiation units

- **Units of Radioactivity**

  - Curie

  - Becquerel

- **Units of Radiation doses**

  - 1) Units of Exposure

    - Roentgen

    - C/kg

  - 2) Units of Absorption

    - Physical dose – Rad/ Gray

    - Biological dose – rem/seivert

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# Units of radioactivity

- **Curie:** corresponds to activity of 1 gram of Radium 226
- Original unit
- 1 Curie =  $3.7 \times 10^{10}$  radioactive decay per second
- SI unit is Becquerel
- 1 Bq = 1 radioactive decay per second  
=  $2.703 \times 10^{-11}$  Ci
- Also as a measure of quantity of radioactive material  
i.e. the no. of atoms that will produce 1 Ci of radiation is

$$N = \frac{3.7 \times 10^{10}}{\lambda}$$

- 1 gram of Cobalt 60 prod 44 TBq of radioactivity  
883 $\mu$ g of  $^{60}\text{Co}$  produces 1 Ci of radiation
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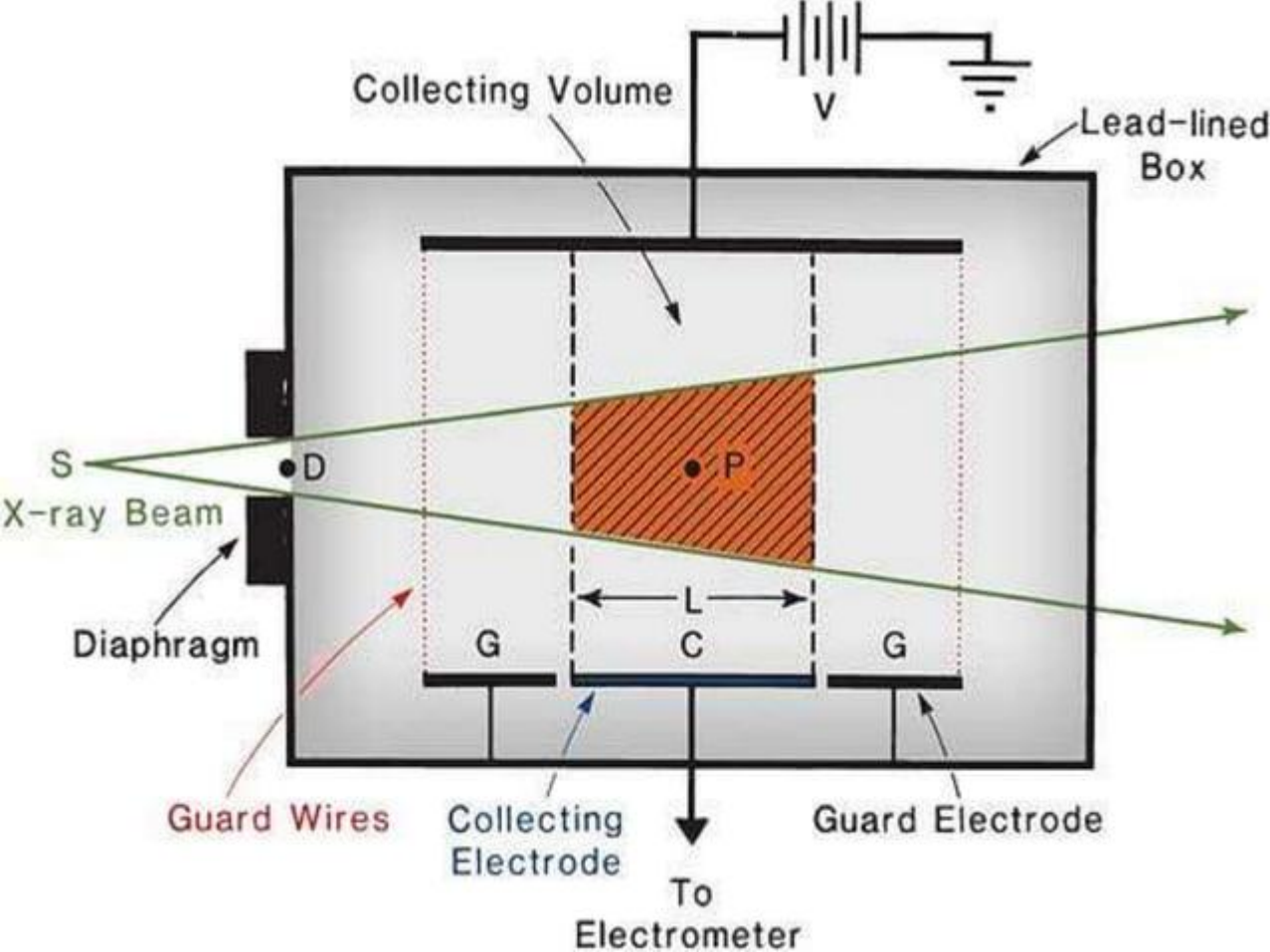
# Unit of Exposure X

- Measure of ionization produced in air by photons
  - Cannot measure photon energies more than 3 MeV
  - The actual amount of energy that reaches the body
  
  - Exposure =  $\frac{\text{Total no. of ions of one sign}}{\text{mass of air}}$
  - SI unit is C/kg
  - Special unit is Roentgen
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- Roentgen is defined as the quantity of radiation which liberates by ionization one esu of electricity per  $\text{cm}^3$  of air under standard temp and pressure.

$$1 \text{ Roentgen} = 2.58 \times 10^{-4} \text{ C/kg}$$

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# Absorption Dose D

- Physical Dose
- Amount of energy deposited in a unit mass of human tissue or medium
- Original unit is rad

$$1 \text{ rad} = 100 \text{ erg/g}$$

- SI unit is Gray

$$1 \text{ Gray} = 1 \text{ J/kg}$$

$$1 \text{ Gray} = 100 \text{ rad}$$

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# How is exposure and absorbed dose related?

- Conversion factor is the F factor
  - It converts the amount of exposure in Roentgen to the amount of absorbed dose in rad
  - F factor depends on the effective Z of the medium and the type of ionizing radiation used
  - F factor for air and soft tissue is nearly 1
  - While for bone it is 4
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# Equivalent Dose H

- Biological dose/effective dose/committed dose
  - Represents stochastic biological effects of ionising radiation
  - It is a weighted average of absorbed dose taking into account both the type of ionising radiation and the type of medium
  - Conversion factor is the Q factor
  - |                       |        |
|-----------------------|--------|
| x rays and gamma rays | 1      |
| alpha rays            | 20     |
| neutrons              | 5 – 20 |
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# Equivalent dose H

$$H = Q \text{ factor} \times D$$

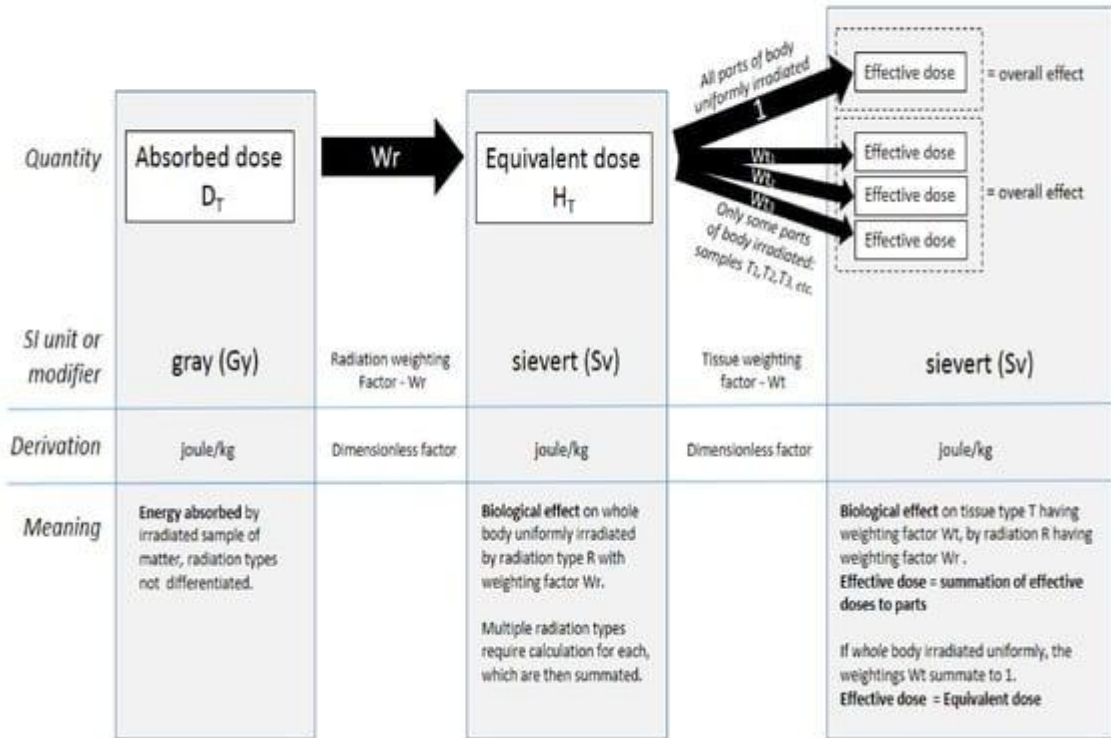
- cgs unit is rem (roentgen equivalent in man)
  - SI unit is sievert
  - 1 sievert = 100 rem
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# Effective Dose Equivalent

- Co relates a dose to a specific tissue to a equivalent risk factor from whole body dose
  - Tissue weighting factor  $W_T$
  - Effective Dose Equivalent = Equivalent dose  $\times W_T$
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ORGAN	$W_T$
GONADS	0.2
COLON	0.12
RED BONE MARROW	0.12
LUNG	0.12
STOMACH	0.12
BLADDER	0.05
CHEST	0.05
LIVER	0.05
THYROID	0.05
ESOPHAGUS	0.05
SKIN	0.01
BONE SURFACE	0.01
OTHERS	0.05

# Ionising radiation - SI "protection" dose unit relationships



# Environmental Radiation limits

- Radiation worker limit 5 rem/yr
  - Pregnancy 0.05 rem/ month
  - Public 1 rem/yr
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# kerma

- Acronym for Kinetic Energy released per unit mass
  - $K$  = sum of kinetic energy all charged particle liberated by ionizing radiation per unit weight of matter
  - $K = \frac{dE}{dm}$
  - Unit is J/kg
  - It is different from absorbed dose as some of the kinetic energy escapes from the absorbing volume
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# FLUENCE

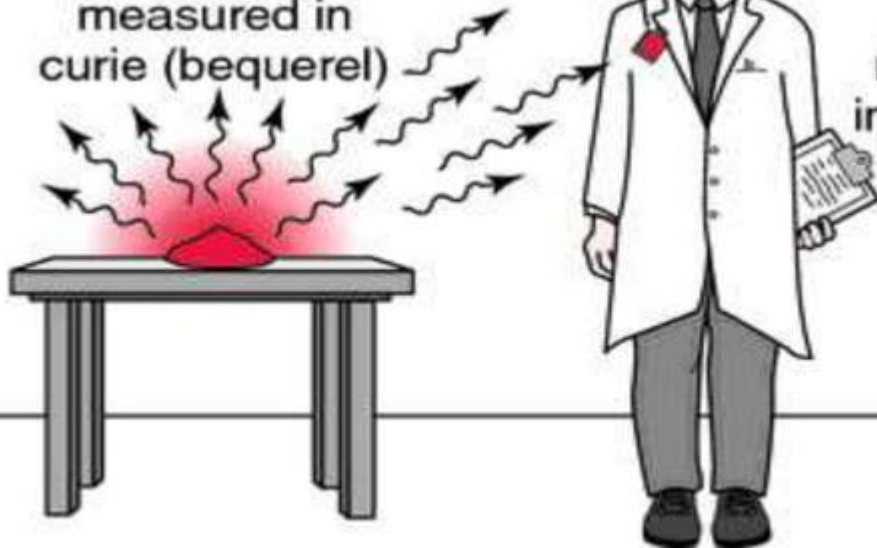
- Fluence is the particle flux or radiative flux integrated over time
  - Fluence = total no. of particles that intersect a unit area in a specified time
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Dose equivalent  
measured in rem (sievert)

Intensity of gamma rays  
measured in roentgen (gray in air)

Radioactive material  
measured in  
curie (bequerel)

Absorbed  
dose  
measured  
in rad (gray)





# Thank You