F. Radiation

A. Ionizing radiation
   1. Electromagnetic radiation
      i. Gamma Rays (Ý)
      ii. X-Rays
   2. Particulate Radiations
      i. Alpha (α-particles)
      ii. Beta (β-particles)
      iii. Electrons, protons, neutrons, Negative Pi-mesons, Heavy charged ions and other atomic particles varying in mass and charge.

B. Non ionizing Radiation
   1. LASER (Light Amplification by Stimulated Emission of Radiation)
   2. Ultraviolet Radiation
   3. Visible light
   4. Infrared
   5. Microwaves and Radiofrequency
   6. Ultrasound
   7. Radio waves
   8. Video Display Terminals (VDT)

Radiation (def)

Radiation is the emission and propagation of energy=the emitted energy itself

1. Electromagnetic Radiation

Are listed in order of increasing wavelength and decreasing frequency.

A. Gamma Rays
B. X-Rays or Roentgen (roentgen discover X-Rays in 11895)

Which process an mass or charge and which are characterized by extremely short wave length and high frequency.

When x-ray (photon) has more than 15 ev (electron volts) of energy, it is able to ionize an atom and is thus referred to ionizing radiation.

The energy of photon is inversely proportional to the wave length.

Photon =smallest quantity of electromagnetic radiations, an x-ray, Gamma ray r other.

2. particulate radiations.
   A. Alpha (α-particles).
   B. Beta (β-particles).

Particles from radio-active decay.

C. Electrons, protons, neutrons, negative pi-mesons, heavy charged ions and other atomic particles varying in mass and charge.

(Mesons= subatomic, short-lived particles of mass less than that of a proton but more but more than of an electronic, carrying either a positive or negative charge called also mesotron).

Both types of ionization radiation differ from other forms of radiant energy in being able to disrupt the atoms and molecules on which they impinge, othereby producing ions, free radicals, and, in turn biochemical lesions.

An ionizing radiation penetrates matter, it gives up its energy by colliding with atoms and molecules in its path. Such collisions are clustered so closely together along the path of an alpha particle that the particle typically has only enough energy to transverse a few cells, whereas the collisions are separated so far apart along the path of an x-ray that the radiation can transverse the entire body.

The average rate at which energy is deposited per unit length of path, i.e., the linear energy transfer (LET) of the radiation, is customarily expressed in kilo electron volts per micrometer (Kev ⁄ µm).

In general, the chigger the LET of the radiation, the more likely it is to deposit enough in a critical site within the cell, e.g., a deoxyribonucleic acid (DNA) molecule or a chromosome, to cause an irreparable molecular lesion. Alpha particles and other high-LET radiations are typically more potent, therefore, than low-LET radiations such as X-rays.

- The electromagnetic Radiation is the most familiar energy and they behave as "waves" e.g., radio frequency waves.
- The electromagnetic Radiation are also classified according to its biological effects on matter.

  a. Ionizing Radiation.
  b. Non-Ionizing Radiation.

  - The electromagnetic Radiation used in radiology are also classified in form of its origin:

    a. Natural radiation.
    b. Artificial radiation.

    The sources of Radiation in the U.K:

    a. Natural Background (85%).
       - Cosmic Rays 10%.

- From food and drinks 11.5%.
- Gamma Rays from the ground and buildings 14%.
- Radon-gas from ground 50%.

(Radon : colorless odorless naturally occurring radioactive gas)

b. Artificial (Man-made) Radiation 15%
Radiotherapy 14% medical (radio-diagnosis, nuclear medicine)

Nuclear discharge and products, fallout and occupational 1%.

Radiological units.

The international system (SI) of units has come into increasingly wide use in place of the centimeter-gram-second (cgs) system. The SI unit for expressing the dose of radiation that is absorbed in tissue is the gray (Gy) :1GY =1 joule per kilogram of tissue.

Different units are used define exposure, absorption, dose equivalence and radioactivity.

1. Roentgen ®.

The unit of measurement of X-ray and Gamma rays radiation exposure, which required librating 2.5×10◌̄ coulombs of charge per Kg of air

2. Gray (GY).

the unit of radiation absorbed does in matter.

1 GY=1Joule \ Kg of material.

1 GY=100 Rad (Roetgen absorbed dose).

1 C\ centigray (CGY)=1 Rad.

3. Sievert (St).

The units of absorbed does, which takes into account the relative biological effect of the varying types of ionizing radiation.

1 Sv =100 rem (Rem Equivalent Man)

4. curie (CI), Beequarel (Bq)

The unit of radioactivity. It is a unit of the quantity of radioactive material and not the radiation emitted by the material. One Curie is the quantity of material in watch 3.7 10 atoms disintegrade every second.

Some uses of Electromagnetic Radiation as a whole.

Ionizing Radiation.

- Medical diagnosis and treatment.
- Nuclear power.
- Industrial radiography and fluoroscopy.
- Sterilization of medical equipments.
- Agriculture research, security and others.

Non-ionizing Radiation

- ❖ Optical soutces
  - Lighting
  - Heating
  - Measurement
  - Sterilization

- ❖ Electromagnetic fields
  - TV and radio broadcasting
  - Personal telecommunication

X-Rays and their properties

X-Rays are invisible electromagnetic waves similar in natural to e.g. Radio, heat, and light waves but with the characteristic of having very

Short wavelengths (10^{-10} m to 10^{-8} m wavelength) and very high frequency and because of their short wavelength, they have the ability to penetrate matter.

Their properties are:

1. they are rapidly fluctuating electric and magnetic fields.
2. they are generated by bombarding a metal target with high energy electrons.
3. they travel in free space in straight lines with the speed of light ($3x10^{10}$/sec.)=300.000km/sec.
4. in free space they obey the "inverse square law" as their intensity decreases proportionally to square distances.
5. as they pass through matter, their intensity reduced as follows:

Attention= Absorption +Scattering

The denser the mater, the greater the amount of absorption.

6. X-Rays absorbed by matter are proportional :

Atomic Number/Density and thickness of matter through which they pass.

7. Scattering : As X-Rays pass through matter some of the rays become deflected altering their direction producing new softer radiation within the substances, these called Scatter Radiation and they have damaging effects radiologically.
8. X-Rays can penetrate matter and this is a useful and important property which applied in diagnostic Radiology.
9. X-Rays produce photographic effects as that produced by visible light.
10. X-Rays cause ionization of substances through which they pass and therefore the X-Rays are parts of the ionization radiation.
11. Fluorescence : certain substance e.g. calcium tungstate and zinc sulfide can transform the visible X-Rays energy into visible light, which is used on fluoroscopy and intensifying screens.
12. The X-Rays radiation is of sufficiently high energy and short wavelength that the radiation behaves more as particles rather than waves, each particle called photon and carries energy.
13. Biological effects : This is the damaging effects due to ionization's property of the X-Rays and it is useful in the radiotherapy treating malignant tumors but these effects should be limited to a minimum in radio-diagnosis by appropriate measures.