

Al-Mustaqbal University Colleg
Medical Physics Department



Medical Imaging

Lecture 2

Radiation

Second Stage

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Radiation:

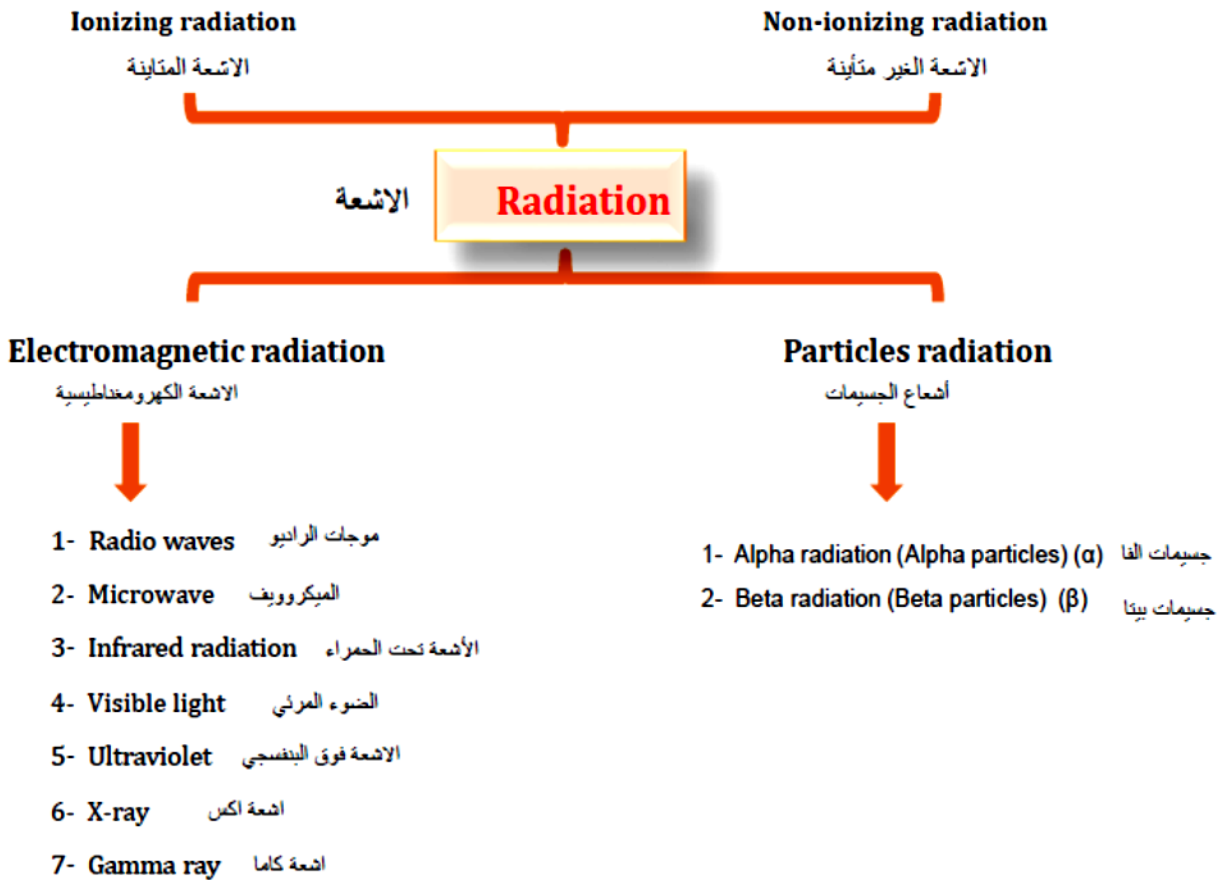
Is the emission of energy which comes from a source and travels through space and may be able to penetrate various materials.

Radiation can be divided into:

1. **Particulate radiation** such as alpha and beta particles.

2. **Electromagnetic radiation** such as x rays or gamma rays etc.

✚ Some types of radiation are **ionizing** radiation and **non-ionizing** radiation.



Ionization process عملية التأين

It is the process of gaining or losing an electron from an atom or a molecule, which will turn into a negative or positive charge.

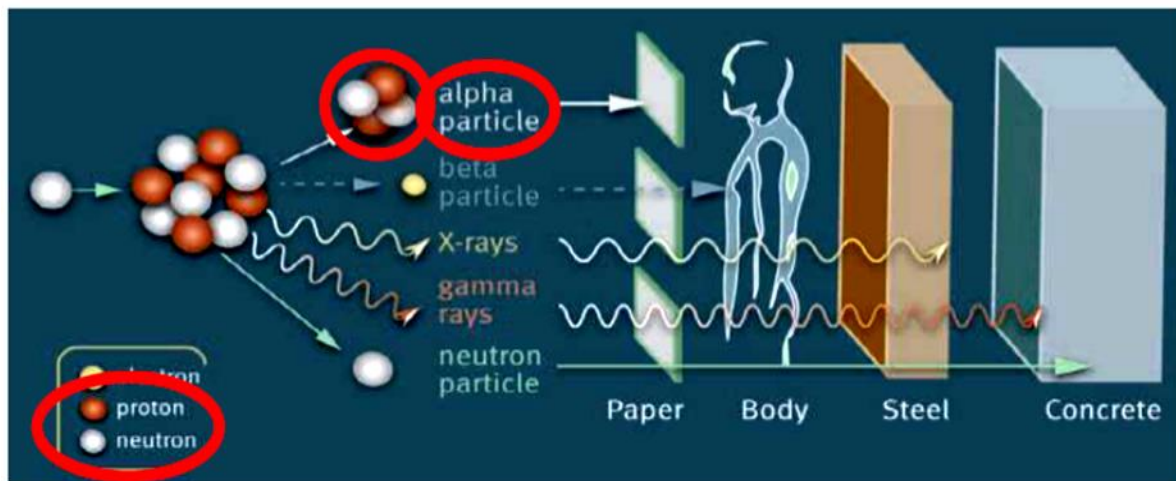
Ionizing radiation: It is the radiation that is carry enough energy to produce ions.

Non ionizing radiation: It is the radiation that is cannot carry enough energy to produce ions.

✚ Ionizing radiation has larger energy than non-ionizing radiation

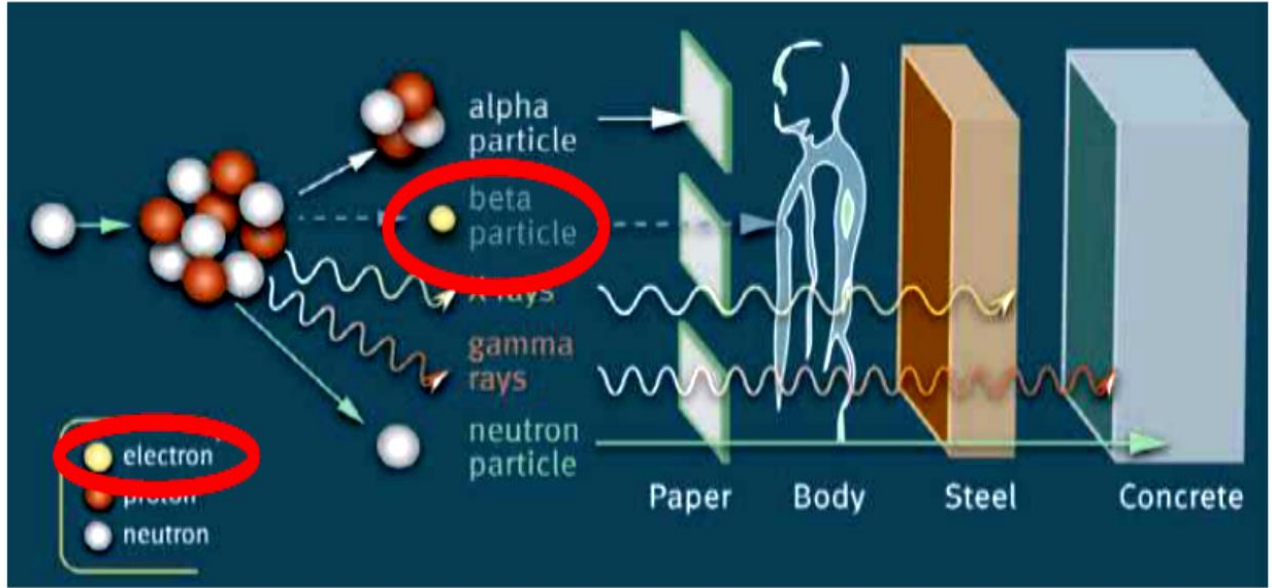
Particles Radiation أشعاع الجسيمات

1- Alpha Particle (Alpha radiation)



- ✓ It is consisting of two protons (2p) and two neutrons (2n).
- ✓ It is carry a double positive charge.
- ✓ It can be stopped by outer dead skin.

2- Beta Particle (Beta radiation) (β) جسيمات بيتا



- ✓ It is charged particles that are ejected from an atom.
- ✓ It has a negative charge.
- ✓ It is can be penetrate the outer dead skin.

Electromagnetic Radiation الاشعاع الكهرومغناطيسي

- ✚ **Electromagnetic radiation:** is the flow of energy at the speed of light in the form of the electric field and magnetic field

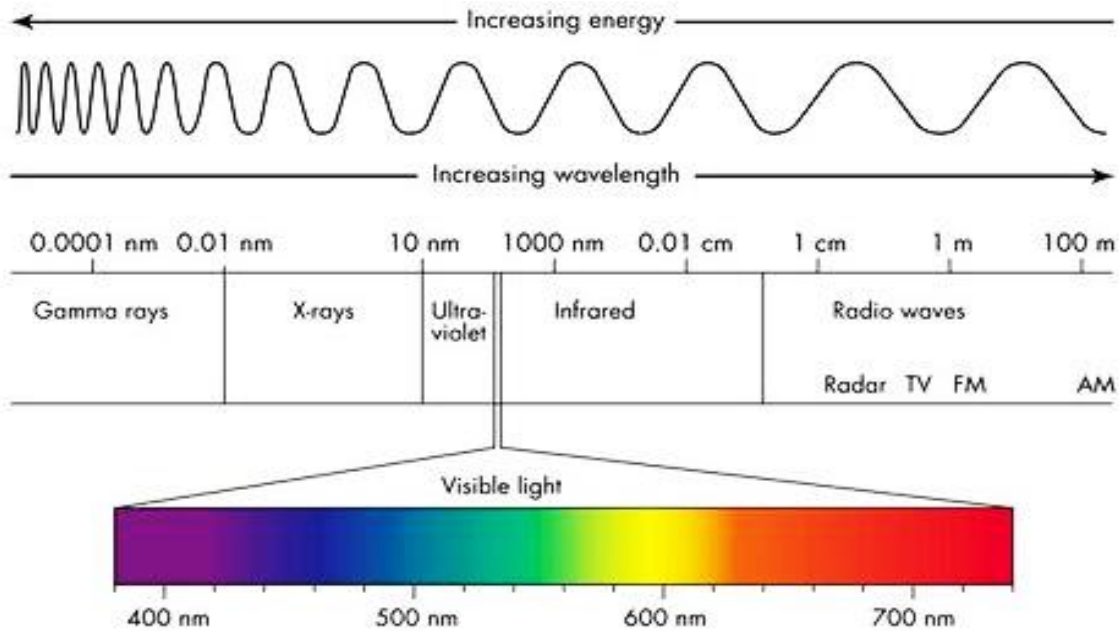
اسم الموجة	Name of Wave	Wavelength (λ)	Frequency (f)
الموجة الراديوية	Radio wave	10^3 m	10^4 Hz
موجات الميكروويف	Microwaves	10^{-2} m	10^8 Hz
الأشعة تحت الحمراء	Infrared radiation	10^{-5} m	10^{12} Hz
موجات الطيف المرئي	Visible light	10^{-6} m	10^{15} Hz
موجات الأشعة فوق البنفسجية	Ultraviolet	10^{-8} m	10^{16} Hz
موجات الأشعة السينية	X-rays	10^{-10} m	10^{18} Hz
موجات أشعة غاما	Gamma rays	10^{-12} m	10^{20} Hz

✚ The energy of electromagnetic radiation is directly proportional to its frequency.

✚ Planck's law:

$$E = h\nu$$

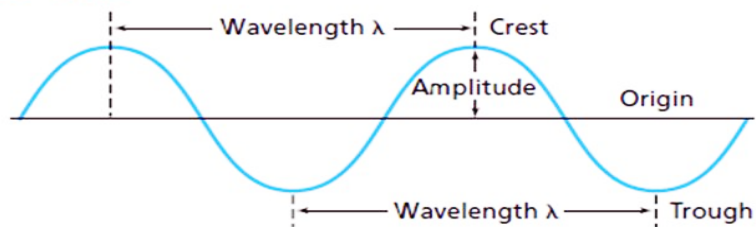
$$E = \frac{hc}{\lambda}$$



Electromagnetic Radiation

- Defined as energy that exhibits wavelike behavior.
- **Waves are characterized by:**
 - **Wavelength (λ):** The distance between successive crest or troughs. Measured in m, cm, nm.
 - **Frequency (ν):** The number of waves that pass a given point per second. Measured in 1/s (s^{-1}) or Hertz (Hz).
 - **Amplitude:** The waves height from the origin to the crest or the trough.
 - **C = speed of light, is a constant** (always known, never changes) = $3.00 \times 10^8 \text{ m/s}$

$$c = \lambda \times \nu$$



What is Electromagnetic Radiation?

(Also referred as ER or EMR)

Definition: A type of radiation that has both magnetic fields and electric fields

Wave-Particle Duality

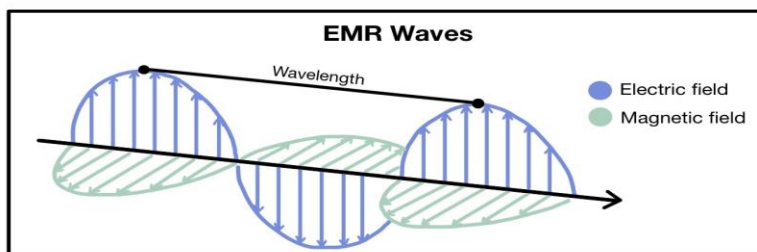
Electromagnetic radiation has characteristics of both a particle and a wave

Types of EMR

Radio, microwaves, infrared, visible light, ultra-violet, x-rays, and gamma rays

EMR Waves Characterized By:

Wavelength and frequency. Stronger EMR waves having higher frequencies and smaller wavelengths



1. Radio waves: are a type of electromagnetic radiation with wavelength of 10^3 m and frequency of 10^4 Hz.

Radio waves are used for transfer signals of sound, radio and television.

2. Microwaves: are a type of electromagnetic radiation with wavelength of 10^{-2} m and frequency of 10^8 Hz.

Microwaves are used in

- (i) radar.
- (ii) communications.
- (iii) cooking in microwave ovens.
- (v) and microwave energy used in medicine for the thermal ablation of tissue.

3. Infrared radiation: is a type of electromagnetic radiation with wavelength of 10^{-5} m and frequency of 10^{12} Hz

Infrared radiation uses in reduce muscle tension.

4. Visible light: is defined as the wavelengths that are visible to most human eyes, and it is a form of electromagnetic radiation with wavelength of 10^{-6} m and frequency of 10^{15} Hz.

- ✚ The sun is a natural source for visible light waves.
- ✚ Light lamp is an industrial source of visible light waves

5. Ultraviolet: is a type of electromagnetic radiation with wavelength of 10^{-8} m and frequency of 10^{16} Hz

Uses of ultraviolet

- ✓ Kill microbes.
- ✓ In hospitals use UV lamps to sterilise surgical equipment.
- ✓ It is suitable dose to produce vitamin D in the body

6. X-ray: is a type of electromagnetic radiation with wavelength of 10^{-10} m and frequency of 10^{18} Hz, which is able to pass through many materials.

Uses of X-ray

- ***Medical imaging***: used in medical imaging
- ***Radiation therapy***: used to kill cancer cells
- ***Airport security***: used in airports to check for dangerous items.

7- Gamma rays are photons or a light wave in the same electromagnetic family as light and x-rays, but much more energetic with wavelength of 10^{-12} m and frequency of 10^{20} Hz.

Uses of Gamma rays; are used to kill cancer cells