Radiation protection –Theoretical
Lec5. Radio-sensitivity
Physical Factors Affecting Radio-Sensitivity

Asst.Lec.Dumoaa Haider Shakir

Radio-sensitivity

- Radio-sensitivity is an important consideration in radiation therapy, which is often used to treat cancer. **The goal of radiation therapy** is to kill cancer cells while minimizing damage to healthy cells, and understanding the radio-sensitivity of different types of cells can help doctors tailor treatment plans to maximize effectiveness and minimize side effects.
- **Radio-sensitivity is the relative vulnerability of cells, tissues, organs or organisms to the harmful effect of ionizing radiation. As ionizing radiation passes through living cells it destroys the capacity of reproduction in some cells. Different cells and tissues in the body have varying degrees of radio-sensitivity, which means they may react differently to the same amount of radiation exposure**.

- The time between the exposure and the first signs of radiation damage is called the Latent period

- Examples of most sensitive cells are the epidermal stem cells, gastrointestinal stem cells. The very sensitive cells are oocytes and lymphocytes. The least sensitive cells are the muscle fibers and the nerve cells.

Physical factors Affecting Radiosensitivity

- When tissue is irradiated, the response of the tissue is determined principally by the amount of energy deposited per unit of mass: the dose in Rads (Gy).
- Even under controlled conditions, the response to like exposures may be different.

Physical factors Affecting Radiosensitivity

- **Physical property factors**
  - **L**inear **e**nergy **t**ransfer (**LET**)
  - **R**elative **B**iological **E**ffectiveness (**RBE**)
  - Fractionation and Protraction

Linear Energy Transfer

- The rate which energy is transferred from ionization to soft tissue is the **Linear Energy Transfer (LET).**
- It is another method of expressing radiation quality and determining the value of the tissue weight factor used in radiation protection.
- It is expressed in the units of kiloelectron volts of energy transferred per micrometer of track length in soft tissue.

Linear Energy Transfer

- The ability of ionizing radiation to produce a biologic response increases as the LET of the radiation increases.
- The LET of diagnostic x-rays is approximately 3 keV/μm.

Relative Biologic Effectiveness

- As the LET of the radiation increases, the ability to produce biologic damage also increases. This quantification is referred to as the **Relative Biologic Effects (RBE).**
- The RBE of diagnostic x-ray is 1.
- Radiations with a lower LET will have a RBE of less than 1.
- Radiations with a higher LET will have a RBE greater than 1.

❖ $$RBE = \frac{\textit{dose of standard radiation necessary to produce a given effect}}{\textit{dose of test radiation necessary to produce the same effect}}$$

The LET & RBE of Various Radiations

Type of Radiation	LET	RBE
25 MV x-rays	0.2	0.8
^{60}Co rays	0.3	0.9
1MeV electrons	0.3	0.9
Diagnostic X-ray	3.0	1.0
10 MeV protons	4.0	5.0
Fast Neutrons	50.0	10
5 MeV Alpha Particles	100.0	20

Fractionation & Protraction

- If the dose is administered over a long time rather than quickly, the effects of that dose will be less.
- If the time of irradiation is lengthened, a higher dose is required to produce the same effect.
- Dose protraction and fractionation cause less effect allowing time for intracellular repair and tissue recovery.

Fractionated dose refers to delivering same dose rate but in several fractions. It causes less effect because tissue repair and recovery occur between doses .

- If that 600 rads is given at 150 rad per day over 4 days, the effects would be less than 600 rads given over 1 day.
- This is called **fractionation**.

Protracted dose refers to delivering dose continually/continuously but at a lower dose rate. It causes less effect because of lower dose rate

- If we give an exposure of 600 rads at 300 rads/minute, the effects will be less than if the same exposure is given at 600 rads/ minute. This us called **protraction**.