



Biological Radiation Hazards

Biological Factors Affecting Radio-sensitivity

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قسم تقنيات الاشعة والسونار

. 3 Stage

المرحلة 3

محاضرة رقم 3

الجانب النظري

Lecture No.3.

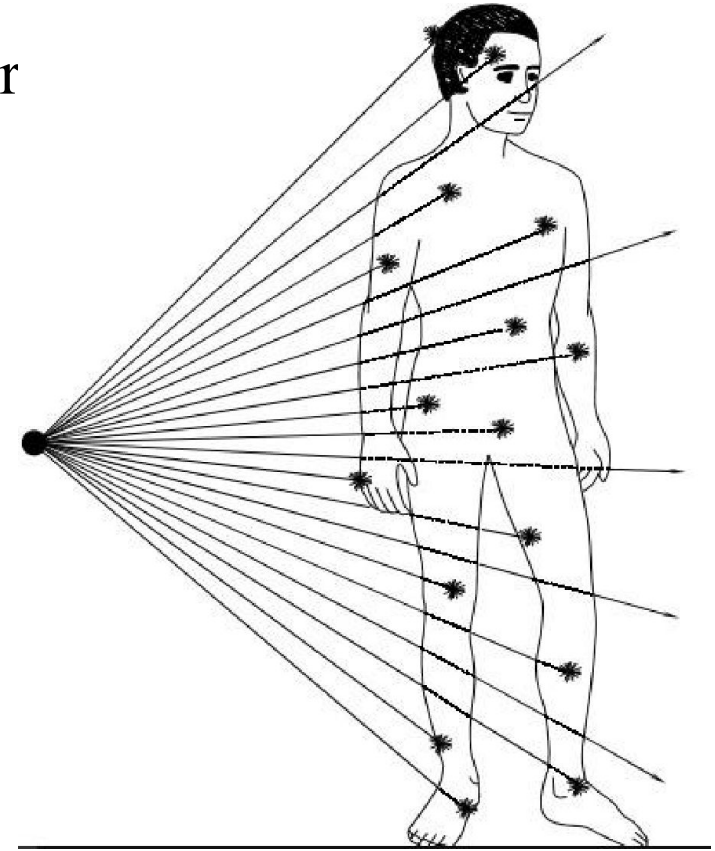
Theoretical

تدريسي المادة : م.م خيرات رحيم لهمود

(INTRODUCTION)

Whether the source of radiation is natural or man-made, whether it is a small dose of radiation or a large dose, there will be some biological effects

- Oxygen Effect
- Age
- Gender
- Recovery
- Chemical Agents
- Hormesis



➤ Oxygen Effect

Tissue is more sensitive when irradiated in oxygenated or aerobic state than in anoxic (without oxygen) or hypoxic (low oxygen) state

This characteristic of biologic tissue described numerically by the oxygen enhancement ratio (OER).

oxygen enhancement ratio (OER) to achieve equivalent biological effect

$$\text{OER} = \frac{D_{\text{hypoxia}}}{D_{\text{in air}}}$$

~ **3** for **low LET** radiation
(as γ rays)

~ **1** for **high LET** radiation
(as α particles)

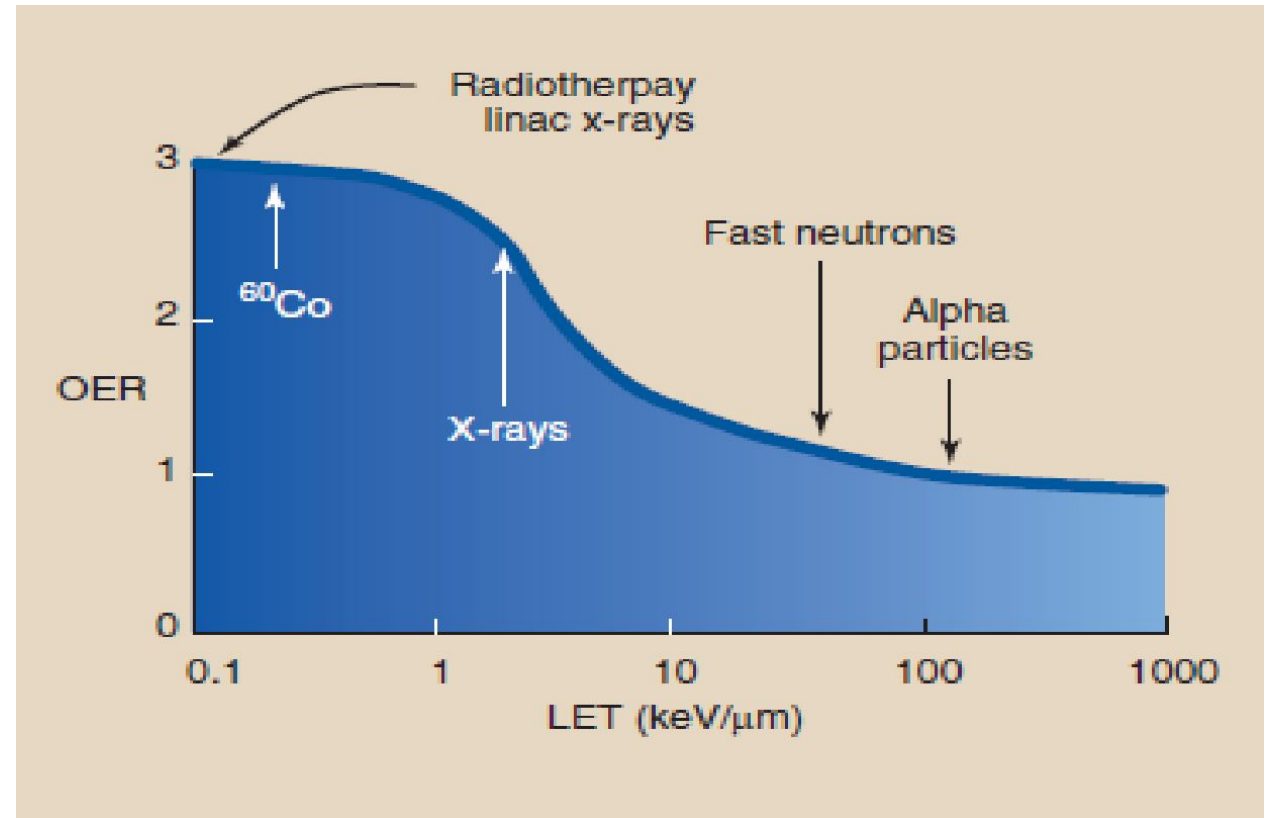
OER is LET dependent

OER is highest for low-LET radiation

It has a maximum value of 3 approx.

It decrease to 1 for high-LET radiation

The oxygen enhancement ratio (**OER**) is high for low linear energy transfer (**LET**) radiation and decreases in value as the LET increases



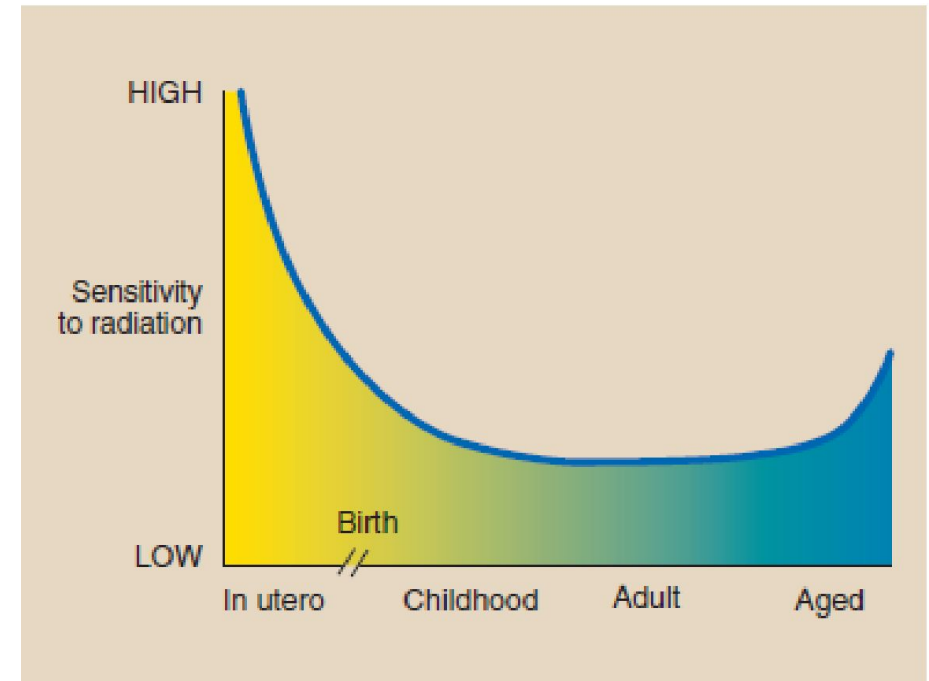
➤ Age

- Age of biological structure affects radio-sensitivity
- Humans are most sensitive at birth
- Sensitivity decreases until maturity
- In old age radio-sensitivity increases

Radiosensitivity varies with age. Experiments with animals have shown that very young and very old individuals are more sensitive to radiation.

➤ Gender

Females are 5-10% less sensitive radiation than males.



➤ Recovery

Cells can recover from radiation injury if dose was not high enough to kill the cells before next cell division.

They can also recover due to biochemical repair mechanism or by use of chemical agents which can modify response of cells.

Radio protectors can be used to prevent cell damage.

$$\text{Recovery} = \text{Intracellular Repair} + \text{Repopulation}$$

Types of Recovery

- ❖ Potentially Lethal Damage Repair (PLDR)
- ❖ Sublethal Damage Repair (SLDR)
- ❖ Long-term recovery (repopulation of damaged tissues)

High irradiation cause cells to shrink This is called Atrophy

➤ Chemical Agents

- Radio-sensitivity of cells, tissues, and organs can be modified by chemical organs
- For the chemical agents to be effective they generally Must be present during irradiation

can be classified into two main categories:

A- Radio-sensitizers: Agent that enhance the effect of radiation are called sensitizing agents.

Examples:

- Halogenated pyrimidines
- Methotrexate
- Actinomycin D
- Hydroxyurea
- Vitamin K

All radiosensitisers have effectiveness ratio of approx 2

As, 90% of the cell culture is killed by 200 rad

But when sensitising agent is present only 100 rad is enough

B- Radio-protectors

The radio-protective compound include molecules a sulfhydryl group (sulfur and hydrogen bound together)

such as

Cysteine and Cysteamine

➤ Hormesis

A separate and small body of radiobiologic evidence suggests that a little bit of radiation is good for you.

Some studies have shown that animals given low radiation doses live longer than controls. The prevailing explanation is that a little radiation stimulates hormonal and immune responses to other toxic environmental agents.

Many nonradiation examples of hormesis can be found. In large quantities, fluoride is deadly. In small quantities, it is a known tooth preservative.

Regardless of radiation hormesis, we continue to practice **ALARA** (“as low as reasonably achievable”) vigorously as a known safe approach to radiation management

Cell Damage Classification:

- 1. Lethal damage.** It is irreversible, irreparable and leads to cell death.
- 2. Sub-lethal damage.** It can be repaired in hours unless additional sub-lethal damage is added that eventually leads to lethal damage.
- 3. Potentially lethal damage.** It can be manipulated by repair when cells are allowed to remain in a non-dividing state.

QUIZ

— Q1/What is the Oxygen Effect in radiobiology, and how is the characteristic of biologic tissue being more sensitive in an oxygenated state described numerically?

Q2/Explain the relationship between the Oxygen Enhancement Ratio (OER) and Linear Energy Transfer (LET). What is the approximate maximum value for OER?

Q3/How does age affect human radio-sensitivity, specifically at birth, maturity, and in old age?

Q4/What is the main difference in radiation sensitivity between females and males according to the lecture?

Q5/What are the two components that make up Recovery from radiation injury, and what are the three types of recovery mentioned?

Q6/Distinguish between Radio-sensitizers and Radio-protectors based on their effect on radio-sensitivity. Give one example of a radio-sensitizer and one example of a radio-protective compound?.

Any questions?

*Thank
You*