Radiation protection –Theoretical
Lec6.
Biological Factors Affecting Radio-Sensitivity

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Introduction

- **Biological factors** are the cellular and molecular characteristics that can influence the response of living organisms to ionizing radiation. These factors can affect the ability of cells and tissues to repair DNA damage caused by radiation and can determine the severity of the radiation-induced damage.
- **The biological factors that can influence radio-sensitivity include factors such as**
- 1. Oxygen effect
- 2. Age effect
- 3. Tissue Recovery
- 4. Chemical Agents

1. Oxygen effect

- 1. **Oxygen effect** Tissues are more sensitive to irradiation when in oxygenated or aerobic state, this characteristic of tissue is called oxygen effect.
- **Described as OER (Oxygen Enhancement Ratio) is the ratio of doses under hypoxic to aerobic conditions that produce the same biologic effect.**
- • When tissue is in **the oxygenated** state (aerated) tissue is most sensitive (low LET)
- • **Low oxygen state (hypoxic)** tissue is less sensitive (high LET)
- The oxygen effect has particular importance in external beam radiation therapy where the killing of tumor cells with photon and electron beams in well-oxygenated regions ,can be up to three times greater than in a poorly vascularized portion of the tumor.

2. Age effect

- **2. Age effect In humans ‹the age of a person may also impact on their response to radiation .**
- **Children are much more likely to suffer from malignancies due to radiation exposure. Children also have developing tissues (such as cartilage), which can be permanently damaged by low doses of radiation (10-20 Gy). As a person ages, cell division slows and the body is less sensitive to the effects of ionizing radiation. Once cell division has slowed, the effects of radiation are somewhat less damaging than when cells were rapidly dividing .**
- **In general:**
- **• Humans are most sensitive to radiation before birth and infants.**
- **• Least sensitive to radiation in adulthood.**
- **• Humans are more radiosensitive again in old age.**

3. Tissue recovery

- **3. Tissue recovery is the process by which damaged cells in the body are replaced by new cells, which can help mitigate the effects of radiation exposure.**
- **At low doses of radiation, tissue recovery may be able to fully repair any damage caused by radiation exposure.**
- **At higher doses of radiation, the damage may be too extensive for tissue recovery to fully compensate.**
- **In some cases, radiation exposure can cause long-term or even permanent damage to tissues and organs, which can have serious health consequences.**

- **Tissue recovery can be influenced by other factors such as**

age, overall health, the dose of radiation, the type of radiation, and the rate of cell turnover in the affected tissue and the presence of pre-existing medical conditions. For example, older individuals may have a slower rate of tissue recovery than younger individuals, and individuals with compromised immune systems may have a more difficult time recovering from radiation-induced damage.

4. Chemical agents

- **4. Chemical agents can have a range of effects on ionizing radiation, depending on the specific agent and the circumstances of exposure.**
- **Some chemical agents can act as radio-protectors, which means they help to protect cells and tissues from the damaging effects of ionizing radiation. Radio-protectors are compounds that can reduce the harmful effects of radiation on the body by enhancing the body's natural ability to repair damaged cells and tissues.**
- **Examples of radio-protective agents include antioxidants like vitamin C and vitamin E.**

- **Other chemical agents can act as radio-sensitizers, which means they increase the sensitivity of cells and tissues to radiation damage.**
- **Radio-sensitizers are compounds that can increase the sensitivity of cells and tissues to radiation damage. These agents are often used in radiation therapy to increase the effectiveness of radiation treatments for cancer.**
- **Examples of radio-sensitizers include certain chemotherapy drugs.**

Types of biological effects

1 - Somatic Effect

Somatic damage by radiation is damage to any part of the body except the reproductive organs and it directly affects the individual exposed to the radiation, and does not deal with after-effects in future generations. These effects can be acute (immediate) or chronic (long-term) and can vary depending on the dose and duration of exposure.

- **Examples:**
  - **Skin burns.**
  - **Cataract**
  - **Blood disorder, Irradiated bone marrow can cause anemia (low red blood cell count) and therefore fatigue and muscle weakness. ➢ Nausea**
  - **Organ failure.**
  - **Hair loss and dryness of skin**

- **2 - Genetic Effects Radiation that causes genetic damage directly damages the reproductive organs, and therefore affects any offspring that individual may have after the damage has occurred. Radiation damage is done to genes and chromosomes, which can be passed on to future generations.**
- **Examples**
- **➢ Congenital defects**
- **➢ Premature death**
- **➢ Chromosome abnormalities**
- **➢ Cancer in later life**