BASIC RADIOBIOLOGY CONCEPTS

Radiobiology is the study of how ionizing radiation interacts with living tissue, especially at the cellular and molecular level. Radiation can damage cells by ionizing atoms, which removes electrons and creates unstable molecules called free radicals.

Key Concepts

Ionization = removal of electrons from atoms

Free radicals = highly reactive molecules that damage DNA

DNA damage can lead to:

- Cell repair
- Cell death
- Mutation

Cells that divide rapidly (such as bone marrow, GI tract, and reproductive cells) are the most sensitive to radiation.

- Radiobiology studies the effects of _____ radiation on living tissue.
- Ionization occurs when electrons are _____ from atoms.
- Free radicals are _____ molecules that damage cells.
- The most important target of radiation damage is _____.
- DNA damage can lead to cell repair, mutation, or _____.
- Cells that divide _____ are most radiosensitive.
- Bone marrow is considered _____ sensitive.
- The GI tract is considered _____ sensitive.
- Gonads are important because they affect _____ cells.
- Radiation interaction at the cellular level occurs in the _____ stage.
- The chemical stage produces _____.
- The biological stage determines _____ outcome.
- Oxygen increases radiation _____.
- Radiation damage begins with _____.
- Ionization creates _____ atoms.

RADIOSENSITIVITY (Bergonié and Tribondeau Law)

This law states:

- Cells are more sensitive when they are:
- Rapidly dividing
- Undifferentiated
- Have a long reproductive future

Examples of highly radiosensitive tissues:

- Bone marrow
- Lymphatic tissue
- Gonads

- Stochastic effects have no _____.
- Cancer is a _____ effect.
- Genetic mutations affect _____ cells.
- Deterministic effects have a _____.
- Severity of deterministic effects increases with _____.
- Skin burns are an example of _____ effects.
- Cataracts are a _____ effect.
- Stochastic effects increase in _____, not severity.
- Deterministic effects have a _____ response threshold.
- Radiation effects on the body are called _____ effects.
- Somatic effects affect the _____ individual.
- Genetic effects affect future _____.
- The probability of cancer increases with _____.
- Threshold means a minimum level of _____ is required.
- Deterministic effects are also called _____ effects.

RADIATION EFFECTS

Stochastic Effects

- No threshold dose
- Occur randomly
- Probability increases with dose

Examples:

- Cancer
- Genetic mutations

Deterministic Effects

- Have a threshold
- Severity increases with dose

Examples:

- Skin erythema
- Hair loss
- Cataracts

- ALARA stands for As Low As _____ Achievable.
- The three radiation protection principles are time, distance, and _____.
- Increasing distance _____ radiation exposure.
- Shielding is most commonly made of _____.
- Collimation reduces _____ size.
- Reducing field size decreases _____ radiation.
- Filtration removes _____ energy photons.
- The purpose of filtration is to reduce patient _____.
- The most effective protection tool is _____.
- Exposure time should always be kept _____.
- Lead aprons protect against _____ radiation.
- The inverse square law relates exposure and _____.
- Doubling distance reduces exposure to _____.
- Pocket dosimeters provide _____ readings.
- TLD stands for _____ Dosimeter.
- OSL uses _____ stimulation.
- Film badges are _____ technology.
- Occupational dose is measured in _____.
- The fetal dose limit is approximately _____ mSv.
- The primary goal of radiation protection is to minimize _____.

RADIATION PROTECTION

ALARA Principle
- As Low As Reasonably Achievable

3 Cardinal Principles:
1. Time → minimize exposure time
2. Distance → maximize distance
3. Shielding → use protective barriers

Shielding Materials
Lead is the most common shielding material
Concrete is used in structural barriers

Collimation & Filtration
Collimation reduces field size → reduces scatter
Filtration removes low-energy photons → reduces patient dose

DOSIMETRY & DOSE LIMITS
Dosimeters measure occupational exposure:
- Film badge (older)
- TLD (Thermoluminescent Dosimeter)
- OSL (Optically Stimulated Luminescence)
- Pocket dosimeter (real-time readings)

Dose Limits:
Occupational whole-body: ~50 mSv/year
Fetal dose limit: ~5 mSv total pregnancy limit

BIOLOGICAL DAMAGE
Radiation damage occurs in stages:
- Physical stage (ionization)
- Chemical stage (free radicals form)
- Biological stage (cell response)

Oxygen Effect
Oxygen increases radiation damage by enhancing free radical formation

- Ionization begins the _____ process.
- Free radicals are produced during the _____ stage.
- Oxygen enhances radiation _____.
- DNA is the primary target of radiation _____.
- Cell death is also called _____.
- Tissue repair depends on cell _____.
- Rapidly dividing cells are more _____.
- Radiation damage occurs in _____ stages.
- The biological stage determines cell _____.
- Mutation can lead to _____ formation.

COMMON PROTECTION RULES

- Never hold patients during exposure
- Always use lead shielding when appropriate
- Collimate tightly
- Minimize repeat exposures
- Follow ALARA at all times