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Radiation protection
QUESTION 1:
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Radiosensitivty of living tissues varies with maturation & metabolism; maturation & metabolism;
1. Stem cells are radiosensitive. More mature cells are Stem cells are radiosensitive.
2. Younger tissues are more radiosensitive
3. Tissues with high metabolic activity are highly
radiosensitive.
4. High proliferation and growth rate,high
radiosensitivty.
Radiosensitivity
• Response of tissue determined by amount of rmined by amount of energy deposited per unit mass (dose in energy deposited per unit mass (dose in Gy)
• Two identical doses may not produce identical
responses due to other modifying factors
Physical Factors
– Linear energy transfer
– Relative biological effectiveness
– Fractionation & protraction
Biological Factors
– Oxygen Effect
– Age
– Recovery
– Chemical Agents
– Hormesis
– Age
– Recovery
– Chemical Agents
– Hormesis
Linear Energy Transfer
• Measure of the rate at which energy is Measure of the rate at which energy is transferred from ionizing radiation to transferred from ionizing radiation to
tissue. tissue.
• Another way of expressing radiation Another way of expressing radiation quality & determining the value of the quality & determining the value of the
tissue weighting factor (WT)
• WT accounts for relative radiosensitivty accounts for relative radiosensitivty of various tissues
• Expressed in units of Expressed in units of keV of energy of energy transferred per micron of transferred per micron of tracklength in
soft tissue (soft tissue (keV/μm)

• Ability of radiation to produce biological Ability of radiation to produce biological response increases as LET of radiation response increases as LET of radiation increase
• LET of diagnostic X-rays ~3keV/μm

Relative Biological Effectiveness

• Higher LET, higher ability to produce Higher LET, higher ability to produce damage
• Quantitatively described by Quantitatively described by relative relative biological effectiveness (RBE)
• Standard radiation, by convention, is X-radiation radiation in the 200- to 250-kVp range
• For diagnostic X-rays, RBE = 1

Fractionation & Protraction

• A dose is delivered over a long period of er a long period of time is less effective than that delivered time is less effective than that delivered quickly.
• If the time of irradiation is lengthened, If the time of irradiation is lengthened, higher dose is required to produce the higher dose is required to produce the same effect.
• Lengthening of time accomplished in two
ways;

Fractionation

• Divide dose into series of small doses
• Example: Example:
If the 12 If the 12 Gy dose is delivered at the same dose dose is delivered at the same dose rate (4Gy/min), but in 12 equal fractions of 1 rate (4Gy/min), but in 12 equal fractions of 1 Gy each separated by 24 hours, the rat will survive.
The dose is said to be The dose is said to be fractionated
• Dose fractionation causes Dose fractionation causes less effect due to less effect due to intracellular repair & recovery between doses.
• Routinely used in oncology

Protraction

•Reduced Dose Rate
•If the dose is delivered continuously but at a If the dose is delivered continuously but at a lower dose rate, it is said to be protracted. lower dose rate, it is said to be protracted.
•**Example**:
A total of 12 A total of 12 Gy is delivered in 3mins (4Gy/min) is is delivered in 3mins (4Gy/min) is lethal for a rat. However, when 12 lethal for a rat. However, when 12 Gy is delivered is delivered at a rate of 1 at a rate of 1 Gy/hour for a total of 12 hours the /hour for a total of 12 hours the rat survives. rat survives.

Question 2:

Effect of irradiation of macromolecules:

When macromolecues are irradiated in solution three major effects occur

Main chain scission

- Breakage of the backbone of long chain macromolecule
- Reduces viscosity of solution
- Also size of macromolecules

cross linkage

- spurlike side structures that extend off the main chain
- Also produce as consequences of irradiation
- Sticky substance on the end attached to the neighbor macromolecule this process is called cross linkage

Point lesion

- Disruption of single chemical bonds producing point lesions
- Not detectable but cause minor modification of molecule
- Which in turn cause malfunction in cell

2- Radiolysis of water :

- Human body consist of 80% of water
- When water is irradiated it dissociate into molecules products this action is called radiolysis of water
- When atom of water is irradiated it is ionized and dissociate in to two ions
- In ionization the ion pair may rejoin d stable water molecule
- In this case no damge occur
- The radiolysis of water is the formulation of an ion pair H+ and OH- and two free radical

3-Effect of radiation on cell:

- If radiation damage the DNA sever enough, visible chromosome aberration may detected
- Damage to the DNA also can result in abnormal metabolic activity
- Uncontrolled rapid proliferation of cell
- Causes genetic effect which has all the characteristics of a stochastic effect
- Molecular lesion

4- Fractionation and protection :

(Present in above question)

QUESTION 3:

Effect of radiation on the human body:

EARLY EFFECTS OF RADIATION ONTHE HUMAN BODY :

- **Acute radiation syndrome**
- **Local tissue damage**
- **Hematological depression**
- **Cytogenetic damage**

ACUTE RADIATION SYNDROME :

- **hematological syndrome** ..

Hematologic diseases are disorders which primarily affects the blood and blood forming organs .

Hematologic diseases inlude rare genetic disorder, anemia , HIV

- **GASTROINTESTINAL SYNDROME** :

GASTROINTESTINAL disorders include such conditions as constipation , hemorrhoids, anal fistulas

- **CENTRAL NERVOUS SYSTEM SYNDROME** :

Central nervous system diseases, also known as central nervous system disorders, are a group of neurological disorders that affect the structure or function of the brain or spinal cord, which collectively form the central nervous system (CNS).

LOCAL TISSUE DAMAGE :

- **Skin**
- **Gonads**
- **Extremities**

GONADS :

- Gonads are the male and female primary reproductive organs. Male gonads are testes , female gonads are ovaries .

EXTREMITIES :

- The end part of the limb , as a hand or foot

SKIN:

- Early mini fest damage basal cells
- Skin damage was seen aa erythema, sun burn

HEMATOLOGICAL DEPRESSION:

- Bone marrow tumor replacement may predispose patients to marrow depression from radiostrontium, such patients should be treated with caution
- Principal response of hemopoietic system to radiation exposure is decrease in the number of cell types of blood in the circulatory blood.

CYTOGENETIC DAMAGE :

- Cytogenetic damage in cells exposed to ionizing radiation under conditions of changing dose rate.