**Mid Term, Online Home Examination Submission**

**Radiologic Protection**



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**Question-1:**

Answer:

**Bergonie and Tribondeau law of radio sensitivity affecting by physical factors:**

In 1906 two French scientist Bergonie and Tribondeau present the theory and observed that

* Radio sensitivity was depend on function of the metabolic state of tissue being irradiated
* This phenomenon is called law of Bergonie and Triondeau
* This law has many application in radiology
* The fetus and children is more sensitive as compared to adult
* The stem cells are radio sensitive and mature cells are radio resistant
* Younger tissue and organs are radio sensitive
* Tissue with high metabolic activity are more radio sensitive
* Highly dividing and growing tissue or cells are more radio sensitive

**Physical factors that affect Radiosensitivity:**

**Radiosensitivity:** The tissue that being irradiated and the response of the tissue depend upon the energy deposited per unit mass

* If equal dose passed on equal specimen the response will not the same of the tissue due to different factors interference
* Here are some physical factors that affect the radiation response
1. **Linear Energy Transfer (LET):** The linear Energy Transfer is a measure of the rate at which energy is transferred from ionizing radiation to soft tissue.
* The LET of diagnostic x-ray is approximately 3KeV/um
* Another method to determine radiation quality and the value of tissue weight factors (WT)
* WT accounts for relative radiosensitivity of various tissue
* LET is expressed in units of KeV/um
* LET is directly proportional to biologic response
1. **Relative Biologic Effectiveness (RBE)**
* Increase in LET will also increase biologic damage
* REB = dose of the standard radiation necessary to produce given effect **/** dose of test radiation necessary to produce same effect
* As LET increases RBE also increases but a maximum value is reached followed by a lower RBE because of over kill
* The RBE of diagnostic X-ray is 1
1. **Protraction and fractionation:**
* If a dose of radiation is delivered over long period of time rather than quickly the effect of that dose is less
* Stated differently, if the time if irradiation is lengthened a higher dose is required to produce the same effect
* The length of time determined by two types

**Protraction:** if a dose is delivered continuously but at a lower dose rate, it is said to be protracted.

**E.g.** Six gray (600 rad) delivered in 3 -minutes at a dose of 2 Gyt/min is lethal for a mouse. However, when 6 Gyt is delivered at the rate of 10 mGyt/hr for a total time of 600 hours, the mouse will survive. How ever,

**Fractionation:** If the 6-Gyt dose is delivered at the same dose rate, but in 12 equal fractions of 500 mGyt, all separated by 24 hours, the mouse will survive. The dose is said to be fractionated.

* The dose divided into number of small doses
* Dose fractionation cause smaller effect because of the time b/w doses is enough for recovery and repair of cells

Fractionation and protraction is uses in oncology radiotherapy

**Question-2:**

Answer:

1. **Macromolecule Irradiation:**

In vivo: Natural environment

In vitro: out of natural environment ( very dangerous to body)

When macromolecule irradiated in vitro, three major effects can occur

1. **Main chain secession**
2. **Cross linking**
3. **Disruption of single chemical bond (**point lesion)

All three types of damages are reversible by intracellular repair and recovery

 **Main chain secession:**

* Breaking of long chain backbone of the macromolecules occur
* Smaller chain production occur
* Viscosity decreases

**Cross linking:**

* Increase viscosity
* Chain sticky ends attached with neighbor molecules

**Point lesion:**

* Single chemical bond disrupt
* Not detectable

**Radiation effects on DNA:**

* DNA is composed of nitrogenous basis the unique assembly of the basis is in specific order
* The DNA is highly radiosensitive of all macromolecules and is called target molecule
* The radiation changes the sequence of basis in DNA
* Chromosome aberration can results from DNA damage

The DNA irradiation cause three observable effects

* Cell death
* Malignant diseases
* Genetic damage

**(2) Radiolysis of Water:** (radi = radiation, lysis = breakdown)

The breakdown of water molecules due to radiation is called radiolysis

* The human body is composed of 70-80% of water molecules
* H2O +↑rad →HOH+ + e-
* It can rejoin to form stable water molecule again or the e- (electron) ionize other molecule further
* H2O + e- ⇝ HOH-
* The HOH+ and HOH- are unstable in nature and can be break down further
* HOH+→ H+ + OH\*
* HOH- → H\* + OH-

The final result of water radiolysis is to form two ions H+ and OH- can rejoin to form water molecule normally and pair of **Free Radicals** forms H\* and OH\*

Free Radicals: is an uncharged molecule that contain single unpaired e- in the outer shell

* OH
* highly reactive and unstable
* excess energy
* disrupt bonds and produce point lesion
* form hydrogen peroxide OH\* + OH\* = H2O2

The free radicals directly and indirectly damage DNA.

**(3) Effect of Radiation on Cells:**

The radiation exposure change the structure and function of the cell.

The effect of radiation on cell results from an elemental ionizing extent that changes the target molecule DNA,

* The cell respond through cellular transformation or cell death

**The cellular transformation**: the process is progress slowly and take time

* Mitotic division delayed
* Function disturbed
* Chromosome depletion occur

**Cell death:** The cell death can occur in early deterministic effect

* Immediately occur
* Mostly reproductive system affect
* Death occur in inter phase stage
* Death of chromosome and gene occur
* No lethal gene defect may also be occur

**Repair:** Most of the effect of radiation on cell can results no response due to recovery and repair

**Target theory:**

* Cell become inactivated
* Cell death
* Spontaneous interaction
* Mostly DNA targeted

The cell can be single hit, in case of virus and bacteria, double hit occur in case of human and other complex cells

* The cell cycle can also be affected due to irradiation.
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**Question-3**

Answer:

**Summary of the early effect of Radiation:** When a person expose to a high level of radiation dose, he can experience a response within a few days to a few weeks

This immediate response is known as deterministic effect of radiation exposure, the early effect can be deterministic due to the severity of the response which is dose dependent

Higher the dose of radiation greater will be the severity of response, so the dose threshold and the dose response is non-linear

The acute radiation syndrome is a condition that occur after high dose radiation exposure which resulting into death within days and weeks which include Hematologic syndrome, GIT syndrome and the CNS syndrome, these syndrome are dose dependent.

When the whole body is being irradiated and the 50% subject die with in 60 days this refers to **LD50/60** dose, for human this dose is about 3.5 Gyt  or (350 rad), higher the dose greater will be the death of tissue with less exposure time,As radiation increases, the time b/w exposure and death decreases.

If the only part of the body expose to radiation (irradiated) the local tissue death will occur, and higher dose will be required to produce response

Example: local tissue damage contain the effect of skin, gonads and bone marrow etc.

The skin irradiation injury is manifested by damage to the basal cells, which results into a series of symptoms like erythema, desquamation and hyperemia etc.

The male testes are more sensitive to radiation, when exposes cause reduction of spermatozoa, the temporary infertility is caused by about 200 rad and about 500 rad causes permanent sterility, like male female gonads are also more radiosensitive

The stem cell of ova after irradiation of 200 rad temporary delayed ovulation but about 500 rad can cause permanent sterility, mostly at the age 40 menopause occur due to rad

Hemopoitic system composed of bone marrow blood cells and lymphatic tissue, the radiation on hemopoitic system leads to anemia and fewer RBCs at periphery, the mature circulating cells are decreased because of the radiation on bone marrow to reduce the precursor stem cells in bone marrow.

THE END