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| **PAPER** | **RADIODIATION PROTECTION** |
| **DISCIPLINE** | **RADIOLOGY 4TH** |

**Q1)** **Explain the law of Bergonie and Tribondeau concerning radio sensitivity and physical factors affecting radio sensitivity?**

**Answer**

**LAW OF BERGONIE AND TROBONDEAU:**

Bergonie and Tribondeau observed that radio-sensitivity was a function of the metabolic state of tissue being irradiated.

Law states that the radio-sensitivity of living tissues varies with maturation and metabolism

It has found some application in radiation oncology diagnostics imaging etc.

**Physical Factors That Affect Radio-Sensitivity**

When one irradiate tissue the response of the tissue is determine principally by the amount of energy per unit mass even under control experimental conditions when equal doses are delivered to equal specimens the response may not be the same because of other modifying factors

**Linear energy transfer:**

Linear energy transfer is a measure of the rate at which energy is transferred from ionizing radiation to soft tissue let is expressed in units of kilo electron volt of energy transferred per micrometer if track length in soft tissue [kev/lim]

The let of diagnostics x-rays is approximately 3 kev/lim the ability of ionizing radiation to produce a biologic response increases as the let of the radiation increase.

**Relative Biologic Effectiveness:**

As the let of radiation increases the ability to produce biologic damage also increases.

The standard radiation by convention is ortho-voltage x-radiation in the range of 200 to 250 kvp. This type of x-ray was used in radiation cycology

Whereas radiation with lower let than diagnostic x-ray have an RBE less than 1 radiation with higher let have a higher RBE.

**Protraction and Fractionation:**

If a dose of radiation is delivered over a long period of time rather than quickly the effect of that does is less if the time if irradiation is lengthened a higher does is required to produce same effect.

Radiation does fractionation reduces effect because cell undergo repair and recovery between does dose fractionation is used routinely in radiation oncology.

**Q2) Write a short note on the following:**

**Answer**

**IRRADIATION OF MACROMOLECULES:**

A solution is a liquid that contain dissolve substances. A mixture of fluid such as water and alcohol is also a solution.

**Main Chain Scission:**

Main Chain Scission is the breakage of the backbone of the long chain macro-molecule.

Main chain scission reduces not only the size of the macromolecule but also the viscosity of the solution. This viscous solution is one that is very thick e.g tap water, on the other hand has low viscosity than honey. Measurement of viscosity determine the degree of main chain scission.

**Cross Linking:**

Some macro-molecules have small spur like side structure that extends off the main chain. These side structure can behave as though. They had a sticky substance on the end and they attaches with the neighboring or another segment of same molecule this process is called cross linking.

Radiation induced molecules cross linking increases the viscosity of a macromolecule.

**Point Lesion:**

Radiation interaction with macromolecules also can results in disruption of a single chemical bond producing point lesion. Point lesions are not detectable but they can cause a minor modification of the molecule which in turn can cause it to malfunction within the cell.

**RADIATION EFFECT ON DNA AND CELL:**

DNA is the most important molecule in the human body because it contains the generic information for each ell. Each cell has a nucleus that contain DNA complexed and contains chromosomes.

Chromosomes control the growth of and development of the cell. If irradiation damage to the DNA is severe enough, visible chromosomes aberration may be detected. One is radiation induced chromosomes aberration or cytogenetic damage without the production of visible chromosomes aberration.

Although such damage is irreversible it can lead to cell death. Damage to the DNA also can result in abnormal metabolic activity.

* Uncontrolled rapid proliferation of cell cause malignant disease.
* If the damage to the DNA occurs within a germ cell. It describe the cause of genetic effect.
* Unobserved damage to the DNA also can produce response at cellular and whole-body levels.
* The gross structural radiation response of DNA damage the structural makeup of DNA.
* In some type of damage the sequence of bases can be change. The triplet code of codons may not remain intact. This represent a genetic mutation at the molecular level.
* The change or loss of a base also destroy the triplet code and may not be reversible.

**Radiolysis of Water:**

As we know human body is an aqueous solution that contain 80% water molecules.

Ionization, can happen first the ion pair can rejoin a stable water molecule. In this case no damage occurs.

If the ions do not rejoin, it is possible for the negative ion to attach to another waster molecule through the following reaction to produce yet.

Third type of ions:

**H2O + e- H+ + OH-**

The HOH+ and HOH- ions are unstable and can dissolve into still smaller molecules.

**HOH+  H+ + OH- + H**+

The final result of the radiolysis of water is the formation of ion pair H+ and OH- and two free radicals H+ and OH- . The ion can recombine therefore no biologic damage can occur free radicals contain excess energy that can be transferred to other molecules to disrupt bonds and produce point lesions at some distance from one initial ionizing event.

The H+ and OH- molecules are not the only free radicals that produce during the radiolysis of water the OH+ free radical can join with a similar molecule i-e from hydrogen peroxide.

**OH- + OH+ H2O2**

Hydrogen peroxide is poisonous to the cell and therefore acts as a toxic agent the H+ free radical can interact with molecules oxygen to form the Hydro-peroxyl radical as following

**H+ + O2  HO2**

The Hydro-peroxyl radical along with hydrogen peroxide is considered to be the principal damaging product after the radiolysis of water hydrogen peroxide also can be formed by the interaction of two Hydro-peroxyl radicals as follows:

**HO2 + HO2+ H2O2 +O2**

**FRACTIONATION AND PROTRACTION:**

A dose is delivered over a long period of time is less effective than that delivered quickly f the time of irradiation is lengthened high dose is required to produce the same effect.

Lengthening of the time is accomplished by the in two ways.

Divide dose in to series of small doses.

**Example:**

If the 12 Gy dose is delivered at the same 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. Each separated by 24 hours, the rat will survive. The dose is said to be The Fractionated.

Dose fractionation causes less effect due to the intracellular repair and recovery between doses.

Routinely used in oncology.

**Protraction:**

Reduced Dose Rate Reduced Dose Rate.

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 Gy is delivered in 3mins (4Gy/min) is lethal for a rat. However, when 12 lethal for a rat. However, when 12 Gy is delivered at a rate of 1 at a rate of 1 Gy/hour for a total of 12 hours the rat survives.

**Q3) Early Effect of Radiations on Human Body.**

**Answer**

**EFFECTS:**

**First early radiation effect is acute radiations lethality.**

The sequence of events that follows high level radiations exposure leading to death within days or weeks is called acute radiation syndrome.

There are three separate syndromes.

* Hematologic Death
* Gastro-Intestinal Death
* CNS Death.

In addition to the three lethal syndromes, the period are associated with acute radiation lethality.

1. Prodromal period.
2. Latent period.

**Prodromal Period:**

it consists of acute clinical symptoms that appears within minutes to hours of the total body exposure to the radiations doses of approximately 100 rad (2 Gy) and may last from a few hours to a couple of days

* Anorexia.
* Nausea.
* Vomiting.
* Diarrhea.
* Easy Fatigability.
* Reduction in WBCs.

Effects depends on:

* Varies in time onset.
* Severity.
* Duration.

**Latent Period:**

After the period of initial radiations, sickness a period of apparent well-being occurs, which is called the latent period.

Extends from the hours or less 5000 rad) to weeks (100 to 500 rad)