



MANGALORE UNIVERSITY

MSc Medical Physics

MPH 501: Clinical Radiation Biology

Teaching hours: Each Unit – 12 h

Objective:

To acquaint the students with the basic mechanism of radiation induced damages at cellular and tissue levels and familiarizing physical, biological and chemical modification of radiation damage including tumour biology and new modalities of radiotherapy.

Outcome:

- Students will gain the knowledge regarding kinetics of different stages in irradiated cells.
- They will understand the effects of radiation and DNA damages.
- Understand the somatic and genetic effects of radiation, damages to different organs and identify radiation syndromes.
- They will learn about prenatal radiation effects and enhanced risk of childhood cancers.
- They will also learn tumour biology, transplanted tumour system and radiobiological bases for fractionated radiotherapy.
- They will understand the causes of clinical radio-resistance and overcoming it.
- They will also learn about various kinds radiotherapies and will understand the new modalities of treatment to reduce the normal tissue morbidity

Unit I: Interaction of Radiation with Living Cells

Kinetics of different stages in irradiated cells-physical stage, physicochemical stage, chemical stage, biochemical stage, induction of cellular level damage. Mechanism of direct and indirect action of radiation, radiolytic products of water Critical target in the living cells, evidences for DNA to be the primary target, Nature of the DNA damage Induced by Radiation. Cell lethality, mitotic death, interphase death and apoptosis. Models of Cell survival, Target Theory, its modifications multi target- single hit and single target- multi hit hypothesis, survival curve parameters-Dq, D0, n, slope etc and limitations of target theory, Linear Quadratic Model of cell survival and the mechanistic support to LQ model, Modification of Cell Survival by dose, Dose Rate, Dose Fractionation, repair and recovery,

LET, Oxygen, Chemical radioprotectors and sensitizers, Cell Stage, and Hyperthermia. Law of Bergonie and Tribondeau, mammalian cell sensitivity protocol, classification, Repair and Recovery, Basis of Radiosensitivity of Cells, DNA Content and Radiosensitivity. Radiation induced Division delay, biochemical and biophysical changes, Induction of Mutations and Chromosomal Aberrations (CA), Application of CA Analysis in Biodosimetry.

Unit II: Biological Effects of Radiation

Introduction Historical Data Base, Somatic and Genetic Effects, Immediate and Late Effects. Relationship between cellular level damage Deterministic and Stochastic Effects. Deterministic effects- Radiation Syndromes: Radiation Sickness (NVD syndrome), Haemopoietic Syndrome, LD50 (60) Dose for human beings G.I. Syndrome, CNS syndrome. Damage to Individual Organs. Skin, Eye Lens, Reproductive System, Lungs, Endocrine Glands, Threshold Doses for different effects, dose-effect relationship. Late Damage in Skin, Lung, immune system and Other Organs.

Unit III: Radiation Damage

Prenatal Radiation Effects- prenatal death, neonatal death, malformations, mental retardation and enhanced risk of childhood cancers. Factors modifying radiation damage: acute, protracted and chronic exposure, nature of radiation, dose rate, localized exposure, partial body Vs whole body, internal and external exposures, age and sex. Chronic radiation syndrome.

Stochastic Effects: Radiation Carcinogenesis, mechanisms, Human Data base, latent period, organ sensitivity, dose response relationship, Risk Evaluation from A-Bomb Survivor Data. Genetic Effects: Studies using model experimental systems, doubling dose concept, Genetic Risk Evaluation, Adaptive response, bystander effect, genomic instability.

Unit IV: Radiobiological Basis of Radiation Therapy

Tumour Biology, Growth Kinetic Factors, Cell Cycle, Potentially Doubling Time, Volume Doubling Time, Cell Loss Factor, Studies with Transplanted Tumour System. Radiobiological Bases for Fractionated Radiotherapy, Brachytherapy, 4 Rs of Fractionated Radiotherapy, Causes of Clinical Radioresistance and Approaches to Overcome Radioresistance.

Unit V: New Modalities of Radiotherapy

Light Ion Particles, Neutrons, Boron Capture Therapy, Radiolabelled Immunotherapy, Recent Developments, and Bio- Effect Models for Radiotherapy, Strandquist's Cube Root Rule, NSD, TDF, BED Application of LQ Model in Developing Bio-effect Models for Radiotherapy.

Reference Books:

1. Hall Eric J. Radiobiology for the radiologist, Lippincott Williams & Wikins, Philadelphia, 1994.
2. Bushong, Stewart C. Radiological Science for technologists – physics, biology and protection, Mosby, St. Louis, 1997.
3. A LANGE medical book –Basic Radiology| 2nd Edition, The McGrawHill2011
Edward L. Alphen, –Radiation Biophysics| Academic Press, Second Edition.

