# Medical Physics Related to Radiation Oncology

## 1. BASIC CONCEPTS

Units – Rind mental units – Derived Units –Electrical Units – Radiation Units. Atoms – Nucleus – Atomic Number – Mass number – Isotope –Nuclear Structure – energy levels Binding energy – electric magnetic radiation – Quantum nature of Radiation – Radiation energy from an atom.

## 2. NUCLEAR PHYSICS

Radio activity – Units of Activity – Experiential decay – half life – transformation constant – disintegration – Bota mirus decay – Bota plus decay – Electron capture – Internal conversion – Auger electronic Isometric transitions – Fission – Fusion – Nuclear – reactors Activation of Isotopes.

## 3. INTERACTION OF RADIATION WITH MATTER

### (1) Photo interaction.

Absorbtion of energy – Linear attenuation – co – efficient – Half value layer – mass, electronic and atomic attenuation co – efficient – energy transfer and energy absorption – Photo electric absorption Compton scattering – pair production – total attenuation co – efficient – Relative importance of different types of interactions.

### (2) Particele interaction

Electron interaction – Isonizational Iosses – Bremsstrah lung losses – Range of electrons –Electron – Electron spectro – energy specification – stopping power – LET particles for radiotherapy.

## 4. PRODUCTION OF X-RAYS

### X-ray Production

X-ray circuit Diagnostic X – ray tubes X – ray tubes for Radiotherapy X- rays spectron – interactions of electron with the target Angular distribution of X- rays – quality of X – rays – Eilters – HVL.

5. HIGH ENERGY MACHINES

Isotope machines – cobalt 60 unit source housing – beam Commission – ponumbra coasium 137 – Betatran – Linear accelerator (detailed study) – microtron – Recent development.

6. RADIATION DOSIMETERY

Fluence – kerma and absorbed dose – electronic equilibrium – Bragg Gray cavity principle.

Exposure – Rootegen standard air chamber – Thimble chamber – condenser chamber – Farmer – chamber – Secondary standard decimeter – Inverse square – Thermeluminescent Decimeter – Chemical decimeter film as a decimeter.

7. BEAM THERAPY

Phantoms percentage depth dose – Tissue air radio – Back scatter factor – Tissue Phantom rations – Tissur maximum ratios – equivalent squares for rectangular fields – Isotope curves – Paramelions and Ise Dose energy – Champarism of Ise dose curve of cobalt 60 with high energy beams – wedge filters – integral dose – choice of radiation beam.

8. TREATMENT PLANNING

Patient dose calculation – treatment time calculation – SSD and SAD Technique – Body contours – centours – corrections – for tissue in homogeneities –corrections for surface obliquities – tissue compensators.

Dose distribution – opposing pairs of beams – three field techniques – Rotation therapy – Wedge pairs – open and wedge field combinations.

Preparation of mould – shielding blocks – Styrofoam cutting machine – simulator and its application – Role of CT and Ultrasound in treatment planning.

9. BRACHYTHERAPY

Brachytherapy sources Radium 226 – cesium 137 – cobalt 70 – Iridium 192 – Gold 198 – Iodine 125 – Physical characteristics – source production – storage and transport facility.

Implant technique – types of implant – Patterson – parker system – Patterson – parket tables – determination of implant area – radiographic examination of implants – orthogonal imaging method stereo shift method – After leading technique Iridium 192 implant permanent implants – clinical examples of dose calculation.

Intracavitary application – paris technique – Stockholm technique – Manchester system – Dose specification - Point A and Point B – leading arrangement – Applications – Manual after leading systems – Computer Dosimetry – examples of dose calculation. Recent developments in Brachytherapy.

10. RADIATION PROTECTION

Biological effects of radiation – sematic and Genetic effects – immediate and late effects – evaluation of radiation hazards – personnel monitoring – film badge pocket decimeter – TLD – Area monitoring survey meters – survey procedures – quality assurance in radiotherapy.

Maximum permissible dosa – historical review – Radiation protection rules in India – ICRP recommendations – dosa equivalent Limits – quality factor – Sivertz.

Planning of Radiotherapy department – work lead – occupancy factor – use factor – protection from primary radiation protection against leakage adiation and scattered radiation – Design considerations for accelerator facility.

Guidelines for safe work practice – recent development in radiation protection.

## Physics Practicals

1. Plateu of G.M. tube.
2. Mass absorption coefficient of Beta particles.
3. Range of beta particles.
4. Gamma ray spectrum.
5. Determination of the energy of unknown Isotope.
6. Output measurement in a Telecobalt unit.
7. Determination of % depth dose for cobalt beam.
8. Output measurement in a Linear accelerator.

9. Determination of optical and radiation field congruence.
10. Determination of optical and radiation field congruence.
11. Determination of Timer error in a cobalt unit.
12. Rectal Dose measurement.
13. Verification of Inverse square law.
14. Familiarization of computerized treatment planning system.
15. Familiarization of simulator.
16. Radiation survey in a Teletherapy facility.
17. Radiation survey a Branchy therapy facility.
18. Dose simulation in multified with open field and wedge fields.
19. Quality assurance in Radiotherapy.
20. Uptake studies with Gamma camera and scanners.

## Clinical Practices of Radiotherapy and Oncology

### A. PRINCIPLES OF RADIOTHERAPY

1. **Teletherapy**
    a. Radiation factors
    b. Megavoltage therapy
    c. Orthovoltage therapy
    d. Electron therapy
    e. Heavy particle therapy (Neutron, Photon, Pimeson).
2. **Branchy therapy and Radioactive isotopes**
    a. Radium and its substitutes.
    b. Practice of surface, Intracavitary and interstitial, etc. Endoluminal
    c. Clinical application
    d. Rules and techniques

    Never developments after leading – Manual
    - Remote

Low medium and high dose rates.

## B. TECHNIQUES OF RADIOTHERAPY

1. Small field beam directed therapy.
2. Extended and irregular field therapy.
3. Single, double and multiple field therapy.
4. Beam modification therapy (Wedge filter / compensator etc.)
5. Rotation and Arc therapy.
6. Techniques in Branchy therapy.
    a. Intracavitary
    b. Interstitial
    c. Mould application
    d. Modern developments and after leading devices
    e. Systemic

## C. EFFECTS OF IRRADIATION OF THE LUNG

1. Acute clinical effects
2. Ultimate effects
3. Histological substratus of effects
4. Measures to reduce final effects
5. Sequelae

## D. EFFECTS OF IRRADIATION OF NERVOUS TISSUES

1. Effects on the brain
2. Effects on spinal core
3. Effects on peripheral nerves
4. Clinical manifestations
5. Histological substratus

6. Sequelae

## E. EFFECTS OF IRRADIATION OF THE OVERY

1. Clinical manifestations.
2. Histological substratus
3. Reversibility of effects
4. Therapeutic implications

## F. EFFECTS OF IRRADIATION OF THE TESTIS

1. Clinical consequences
2. Histological substratus
3. Reversibility
4. Protective measures

## G. EFFECTS OF IRRADIATION OF THE EYE

1. Clinical consequence
2. Histological substratum
3. Protective measures
4. Time does connotations
5. Sequelae therapy

## H. EFFECTS OF IRRADIATION OF LYMPHEID TISSUE

1. Clinical manifestations.
2. Histological substratum.
3. Reversibility

## I. EFFECTS OF IRRADIATION OF THE BONE MARREW

1. Clinical and laboratory manifestations
2. Chronology of effects

3. Histological substratum
4. Recovery
5. Therapeutic applications

**J. EFFECTS OF IRRADIATION OF THE ORAL, PHARYNGOLARYNGEAL AND ESEPHAGEA MUCUOUS MEMBRANE**

1. Clinical manifestations
2. Histological substratum
3. Repair
4. Sequelae

**K. EFFECTS OF IRRADIATION OF THE SALIVERY GLANDS**

1. Acute manifestations
2. Histological substratum
3. Dental consequences
4. Prophylaxis

# Radiobiology

## I. RADIOBIOLOGY AND LABORATORY RADIOTHERAPY

### 1. Mammalian Cell radio sensitivity

A. Interphase and reproductive death
B. Cell Survival curves in vitro
C. Characterization of Cell survival curves
D. Critical sites and target theory
    1. DNA
    2. Membranes
E. Dose response curves in Vivo

1. Skin clones
2. Surviving Crypts
3. Bone marrow colonies growing in spleen monolayer culture, sperieds speroids.

F. Quantitative normal tissue reaction based on systems.

1. Pig Skin,
2. Redent Skin,
3. Lung,
4. Esophagus,
5. Kidney,
6. CMS and spinal cord

## II. FACTORS THAT MODIFY RADIATION RESPONSE

### A. The Oxygen effect.

1. Effect of Oxygen concentration 2. Time of action of Oxygen.
2. Mechanism of the Oxygen effect 4. Implications for radio therapy.
3. Methods of overcome Problems of hypoxic cells.

### B. The age response function

1. The cell cycle
2. Age response for cells cultures in vitro
3. Age response for tissues in viva
4. Age response for neutrons
5. Oxygen effect through the cell cycle
6. Implications for radiotherapy

### C. Potentially lethal damage

1. Repair in vitro
2. Repair in vivo
3. PLD and high LET radiations

4. Implications in radiotherapy

**D. Sublethal damage**

1. Split dose experiments with cells in vitro
2. Sublethal damage repaire in normal tissues
3. Sublethal damage repaire in tumors
4. Sublethal damage and hypoxia
5. Sublethal damage and high LET radiations
6. Dose a measure of repair

**E. Dose – rate**

1. Dose rate effect in cell in vitro
2. Dose rate effect in normal tissues
3. Dose rate effect in tumors
4. Interstitial therapy
5. Beam therapy at low dose rate

**F. Radio sensitizers**

1. The halegonated pyrimidines
2. Hypoxic cell radio sensitizers
    a. Structure and mode of action
    b. Enhancement ratio
    c. Metronidazole pmidonidazole
    d. Pharmokinetics in the human
    e. Clinical limitations

**G. Radioprotectors**

1. Free radical scavenger

## III. LINEAR ENERGE TRANSFER

a. Definition
b. Track and energy average
c. LET for different types of radiation

d. CEF as a function of LET

## IV. RELATIVE BIOLOGICAL EFFECTIVENESS

a. Definition
b. RBE for difference cells and tissues
c. RBE as a function of dose
d. RBE and fractionation
e. RBE as a function of LET
f. Q. Factor

## V. CELL AND TISSUE KINETICS

a. The cell cycle
b. Autoradiography
c. Constituent parts of the cell cycle
d. Percent labeled mitoses technique
e. Growth kinetics of human tumours

## VI. TISSUE RADIOSENSITIVITY

a. Classification based on radiation pathology
b. Types of cell populations
    1. Self renewal
    2. Conditional renewal
    3. Stom cell
    4. Differentiated

## VII. TIME – DOSE AND FRACTIONATION

a. The 4R’s radiobiology
b. The basis of fractionation

c. The stranquist plot
d. Nominal standard dose
e. Linear quadrate education

## VIII. HYPERTHERMIA

a. Methods of heating
    1. RF microwaves
    2. Ultrasound
    3. Water baths
b. Systemic hyperthermia
c. Localized heating
d. Cellular response to heat
e. Repair of thermal damage
f. Thermo tolerance
g. Hyperthermia combined with irradiation(X-rays)
h. Time sequence of heat and irradiation
i. Hypoxic cells and heat
j. Effect of Ph on the response to hyperthermia
k. Response of spontaneous tumours to heat
l. Response of transplanted tumours to heat
m. Response of normal tissues to heat
n. Heat and the therapeutic gain factor
o. Hyperthermia and chemotherapy

## IX. TOTAL BODY IRRADIATION – ACUTE EFFECTS

a. Prodromal radiation Syndrome
b. Central nervous system / cerebrovascular Syndrome
c. Gastrointestinal Syndrome
d. Homatopoietic Syndrome

e. Mean lethal case(ITD 50)
f. Treatment of radiation accidents

## X. LATE EFFECTS

### a. Non Specific life shortening

1. Definition
2. In animals
3. In man

### b. Carcinogenesis

1. The latent period
2. Dose response curve in animals
3. Leukemia
4. Breast cancer
5. Thyroid cancer
6. Bone cancer
7. Skin cancer
8. Lung cancer
9. Other cancer
10. Malignancies in prenatally exposed children
11. Mechanisms of radiation carcinogenesis

### c. Genetics of irradiation

1. Point mutations
2. Relationship to dose
3. Chromosome aberrations
4. Relationship to dose
5. Doubling dose
6. Genetically significant dose(GSD)

7. Genetic effect in humans
8. Background radiations in relation to the GSD

## XI. RADIATION EFFECTS IN THE DEVELOPING EMBRYS AND FETUS

a. Intrauterine death
b. Congenital abnormalities including neonatal death
c. Growth retardation
d. Dependence of the above effects on dose, dose – rate and stage in gestation
e. Carcinogenesis following in utere exposure
f. Human experience of pregnant woman exposed to therapeutic doses
g. Occupational exposure of potentially pregnant woman
h. Elective booking of " 10 day rule"
i. The " Practical thresheld" for therapeutic abortion

## XII. RADIOPHYSIOLOGY OF HUMAN TISSUES

**a. Effects of irradiation of the skin**

1. Clinical manifestations
2. Histological substratus of effects
3. Repair
4. Degrees of equalac
5. Injuries effects

**b. Effects of irradiation of bone and cartilage**

1. Effects on growing bones and cartilage
2. Effects on adult bones and cartilage
3. Clinical manifestations
4. Histological substratum of effects
5. Functional consequences and sequelae

C. **Effects of irradiation of the kidney.**

1. Clinical manifestations.
2. Histological substratus of effects
3. Acute and chronic functional repercussions
4. Permanent sequelae