Guidelines

for

Competency Based Training Programme

in

DNB- Radio Therapy

NATIONAL BOARD OF EXAMINATIONS

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CONTENTS

PROGRAMME GOAL

The students after successful completion of their training should be able to provide

- Comprehensive cancer care and empowered for the future development of the specialty.
- The main goal of the radiation oncology residency programme is to produce radiation oncologists with the necessary knowledge, skills and attitude to prevent diagnose and manage various cancers. As a result of training in radiation oncology, the resident should become competent in the use of the various radiation equipments, techniques, treatment planning, radiation dose prescription, treatment verification, treatment delivery; chemotherapy,immunotherapy administration and management of related complications.
- In order to be considered a competent radiation oncologist, a resident must possess humanistic qualities, attitude and behavior necessary for the development of appropriate patient-doctor relationship.
- Has acquired skills in effectively communicating with the patient, family and the community.

PROGRAMME OBJECTIVES

Postgraduate students should be well conversant and trained in:

1. Specialized oncology care pertaining to the needs of cancer patients.
2. The management of cancers prevalent in Indian subcontinent.
3. Knowledge and application of genetic and Molecular Oncology and Cell biology.
4. Knowledge of Clinical Radio biology and Radiation pathology.
5. Basic knowledge ‘research methodology’ enabling him/her to develop, conducts and interprets clinical trial and investigations.

6. Delivery of radiation and in-depth technical knows how of equipment as well as physics and sequelae related to radiotherapy and oncology.
7. Exposure to epidemiology including relevant statistical methods used in analysis of clinical data, Descriptive and Analytical Epidemiology.
8. Technical skill in the use of cytotoxic agents for treatment of cancer.
9. Familiarity with role of surgery in management of oncological cases.
10. Planning and setting up specialty department of radiotherapy and oncology and interaction with government machinery.
11. Information Technology in Oncology
12. Pediatric Oncology
13. Geriatric Oncology
14. Palliative Oncology and care of Terminally ill cancer patients.
15. Knowledge of medical education technology for training of undergraduate and paramedical staff.

Communication Skills:

- Demonstrate communication skills of a high order in explaining management and prognosis, providing counseling and giving health education messages to patients, families and communities
- Develop communication skills not only to word reports and professional opinions but also to interact with patients, relatives, peers and paramedical staff.
- Patient –Doctor relationship

16. National Programmes- Knowledge of National and International programmes like WHO ,UICC,AJCC etc

At the end of 3 years of post graduate training, a resident must acquire knowledge and skill as a result of training under the resident education program syllabus which includes the following:

1. Basic sciences related to Oncology

Anatomy

Physiology

Biochemistry

Pathology and Radiation Pathology

Radiation Physics

Clinical Radiobiology

Statistical basis for planning and interpretation of clinical trials

2. Principles of Oncology

Etiology and pathogenesis of
cancer Epidemiology of Cancer

Cancer screening and prevention

Cancer Registries and National Cancer Control Programme

Cancer Chemotherapy

Cancer Biotherapeutics

Imaging in oncology

Pharmacogenomics

3 Clinical Radiotherapy

4 Chemotherapy and targeted Therapy in Management of Malignancies

5 Other Disciplines allied to Radiotherapy and Oncology

6 Palliative Care

7 Research, Training and Administration

ELIGIBILITY CRITERIA FOR ADMISSIONS TO THE PROGRAMME

(A) DNB Radiotherapy Course:

1. Any medical graduate with ***MBBS*** qualification , who has qualified the ***Entrance Examination*** conducted by NBE and fulfill the eligibility criteriafor admission to DNB ***Broad Specialty*** courses at various NBE accredited Medical Colleges/ institutions/Hospitals in India is eligible to participate in the Centralized counseling for allocation of DNB **Radiotherapy** seats purely on merit cum choice basis.

2. Admission to 3 years post MBBS DNB **Radiotherapy** course is only through ***Entrance Examination*** conducted by NBE and Centralized Merit Based Counseling conducted by National Board of Examination as per prescribed guidelines.

(B) DNB (Post diploma) Radiotherapy Course:

1. Any medical graduate with MBBS qualification who has successfully completed DMRT (and fulfill the eligibility criteria for admission to DNB (Post Diploma) Broad Specialty courses at various NBE accredited Medical Colleges/ institutions/Hospitals in India is eligible to participate in the Centralized counseling for allocation of DNB (Post Diploma) **Radiotherapy** seats purely on merit cum choicebasis.

Admission to 2 years post diploma DNB **Radiotherapy** course is only through PDCET Centralized Merit Based Counseling conducted by National Board of Examination as per prescribed guidelines.

Duration of Course :

For Primary candidates : 3 years
For Secondary Candidates : 2 years

Every candidate admitted to the training programme shall pursue a regular course of study (on whole time basis) in the concerned recognized institution under the guidance of recognized post graduate teacher for assigned period of the course.

TEACHING AND TRAINING ACTIVITIES

The fundamental components of the teaching programme should include:

1. Case presentations & discussion- once a week
2. Seminar – Once a week
3. Journal club- Once a week
4. Grand round presentation (by rotation departments and subspecialties)- once a week
5. Faculty lecture teaching- once a month
6. Clinical Audit-Once a Month
7. A poster and have one oral presentation at least once during their training period in a recognized conference.

The rounds should include bedside sessions, file rounds & documentation of case history and examination, progress notes, round discussions, investigations and management plan) interesting and difficult case unit discussions.

The training program would focus on knowledge, skills and attitudes (behavior), all essential components of education. It is being divided into theoretical, clinical and practical in all aspects of the delivery of the rehabilitative care, including methodology of research and teaching.

Theoretical: The theoretical knowledge would be imparted to the candidates throughdiscussions, journal clubs, symposia and seminars. The students are exposed to recent advances through discussions in journal clubs. These are considered necessary in view of an inadequate exposure to the subject in the undergraduate curriculum.

Symposia: Trainees would be required to present a minimum of 20 topics based on thecurriculum in a period of three years to the combined class of teachers and students. A free discussion would be encouraged in these symposia. The topics of the symposia would be given to the trainees with the dates for presentation.

Clinical: The trainee would be attached to a faculty member to be able to pick upmethods of history taking, examination, prescription writing and management in rehabilitation practice.

Bedside: The trainee would work up cases, learn management of cases by discussionwith faculty of the department.

Journal Clubs: This would be a weekly academic exercise. A list of suggested Journalsis given towards the end of this document. The candidate would summarize and discuss the scientific article critically. A faculty member will suggest the article and moderate the discussion, with participation by other faculty members and resident doctors. The contributions made by the article in furtherance of the scientific knowledge and limitations, if any, will be highlighted.

Research: The student would carry out the research project and write a thesis/dissertation in accordance with NBE guidelines. He/ she would also be given exposure to partake in the research projects going on in the departments to learn their planning, methodology and execution so as to learn various aspects of research.

SYLLABUS

Structure:

1) Basic Sciences

a. anatomy and Physiology as related to Radiation
oncology b) Cancer Pathology

c. Radiation Physics

d. Radiobiology

e. Statistical basis for planning & interpretation of clinical trials.

2) Clinical Radiotherapy

3) Clinical Cancer Chemotherapy

4) Other disciplines allied to Radiotherapy and Oncology

5) Preventive and community oncology

6) Palliative care

7) Training

8) Administration

BASIC SCIENCES

ANATOMY

- Knowledge of surface anatomy pertaining to Oncology
- Detailed knowledge of the all organs
- Detailed knowledge of the lymphatic system of all organs-regions
- Practical familiarity with the radiographic appearance of important regions (living anatomy)
- Cross sectional anatomy

CELL BIOLOGY

- The cell: structure and function
- Relative radio sensitivity of nucleus and cytoplasm
- Mitosis, cell cycle
- Principles of DNA, RNA and protein synthesis
- Radiation effects on DNA, strand breakage and repair

- Common molecular biology techniques.

TUMOR PHYSIOLOGY

- Angiogenesis
- Microenvironment
- Hypoxia and Re oxygenation
- Cell proliferation in tumor that is cell cycle and cell cycle control
- Proliferation and cell death
- Tumor heterogeneity metastasis

PATHOLOGY

- Definitions of & distinction between different types of growth disorders (i.e; distinction between hyperplasia, hypertrophy, regeneration, malformations and neoplasia.
- Malignant transformation:
    - Initiation and promotion stages of carcinogenesis.
    - Mode of origin–monoclonal, polyclonal, unifocal, multifocal structural and
    - Functional changes in cellular components.
- Etiology of cancer including genetic predisposition & congenital syndromes chromosomal abnormalities & hereditary tumors, Protooncogenes, oncogenes, tumor suppressor genes & viruses in the causation of malignancy.
- Multifactorial causation including Nutritional aspects in cancer causation and prevention

- **Environmental causes of cancer**:

Biological – protozoal, bacterial, viral

Chemical – classes of carcinogenic chemicals, smoking

Physical – trauma, irradiation (UV rays, other electromagnetic radiation including, X-rays and gamma rays and particulate radiation)

Common occupational cancers & experimental tumors in animals relationship to human mutagenicity.

- Etiology, mechanisms of carcinogenesis, known types of carcinogens & their effects upon the cell.
- The relative importance of different factors in the causation and spread of human cancer including :
    1. Rate of tumor growth
    2. Methods of measurement
    3. Factors affecting growth rate
    4. Mechanisms of spread
    5. Local effects of tumors
    6. Local & systemic reactions to tumors
    7. Effects of therapy on tumors & normal tissues

- Criteria for tumor diagnosis macroscopic, histological & cytological uses & value of biopsy material.
- Apoptosis and cell signaling pathways
- Mechanisms of spread
- Local effects of tumors
- Local & systemic reactions to tumors
- Effects of therapy on tumors & normal tissues
- Tumor Markers
- Tumor Immunology
- Cytogenetics, Molecular Pathology and Immunohistochemistry
- Classification of tumors – histogenic, histological, behavioral & immunological nomenclature – solid tumors, lymphoproliferative disorders
- Structure & organization of tumors- vascular supply, stroma etc.
- Systems of grading Endocrine aspects of malignancy:
- Production of hormones by tumors, effect of hormones on tumors,
- Paracrine effects of tumors Paraneoplastic syndromes.
- Tumor Immunology including organization & development of the immune system and the role response in disease,
- cellular basis of immunity & measurement of immune function,

- Graft versus host reaction, tumor immunity,
- Tolerance, enhancement, Immune surveillance hypothesis
- Immunological markers in diagnosis & monitoring, the I ILA systems & molecular biology for diagnostic and therapeutic purposes.

PRINCIPLE OF ONCOLOGY

- Genetic pre disposition
- Congenital syndrome
- Chromosomal abnormalities
- Hereditary tumors
- Protooncogenes ,Oncogenes And Tumor Suppressor genes
- Multifactorial causation
- Nutritional aspects in cancer causation and prevention.
- Environmental causes of cancer
- Biological - protozoal, bacterial, viral
- Chemical - Classes of carcinogenic chemicals, smoking
- Physical - trauma, irradiation (UV rays, other electromagnetic radiation including X rays and Gamma rays and particulate radiations)
- Occupational cancers.

RADIATION PHYSICS/RADIATION ONCOLOGY PHYSICS

- The aim of this subject is to provide the Oncologist with the knowledge of physics required in clinical practice.
- An understanding of the principles of planning & carrying out treatment is a necessary prerequisite & will be enhanced by the study of this subject.
- A familiarity with the physics of electromagnetic radiation and atomic structure will be required.

- With respect to their implications for accurate dose delivery in clinical radiation therapy, applicability, limitations, advantages & disadvantages of the various devices & techniques should receive particular attention.
- Candidates should be encouraged to observe & gain practical experience with the equipment & techniques used in radiotherapy in clinical oncology departments.
- **Structure of Matter:**

1. Constituents of atoms,
2. Atomic and mass numbers,
3. Atomic and mass energy units,
4. Electron shells,
5. Atomic energy levels,
6. Nuclear forces,
7. Nuclear energy levels,
8. Electromagnetic radiation,
9. Electromagnetic spectrum,
10. Energy quantization,
11. Relationship between Wavelength,
12. Frequency
13. Energy Nuclear Transformations: Natural and artificial radioactivity, Decay constant, Activity, Physical, Biological and Effective half-lives, Mean life, Decay processes, Radioactive series,

- Radioactive equilibrium Production of X-rays :
    1. The X-ray tube,
    2. Physics of X-ray production,
    3. Continuous spectrum,
    4. Characteristic spectrum,
    5. Efficiency of X-ray production,
    6. Distribution of X-rays in space,
    7. Specifications of beam quality,
    8. Measurement of beam quality,

- Filters and filtration Interaction of radiation with matter:
    1. Attenuation, Scattering,
    2. Absorption,
    3. Transmission,
    4. Attenuation coefficient,
    5. Half Value Layer (HVL),
    6. Energy transfer,
    7. Absorption and their coefficients.
    8. Photoelectric effect,
    9. Compton Effect, Pair production Relative importance of different attenuation processes at various photon energies Electron interactions with matter

- Energy loss mechanisms –

1. Collisional losses,
2. Radioactive losses,
3. Ionization,
4. Excitation,
5. Heat production,
6. Delta rays,
7. Polarization effects,
8. Scattering,
9. Stopping power
10. Absorbed dose,
11. Secondary electrons.

- Interactions of charged particles:

1. Ionization vs. Energy,
2. Stopping Power,
3. Linear Energy Transfer (LET),
4. Bragg curve,
5. Definition of particle range.
6. Measurement of radiation: Radiation Detectors: Gas, Solid – state, Scintillation, Thermo luminescence, Visual Imaging (Film, Fluorescent screens), and their

examples. Exposure, Dose, Kerma: Definitions, Units (Old, New), Inter-relationships between units, Variation with energy and material.

- Measurements of exposure (Free air chamber, Thimble chamber),
- Calibration of therapy beams:
    1. Concepts,
    2. Phantoms,
    3. Protocols (TG 21, IAEA TRS- 398, TG 51)
    4. Dose determinants in practice (brief outline only, details not required)

- Radiotherapy Equipment:
    1. Grenz rays,
    2. Contact,
    3. Superficial, Orthovoltage or Deep therapy,
    4. Super voltage,
    5. Megavoltage therapy.

- Therapy and diagnostic X-ray units – comparison. Filters, factors affecting output. Co-60 units :
    1. Comprehensive description of the unit,
    2. Safety mechanisms,

Source capsule Linear accelerators,

- Source capsule Linear accelerators :
    1. History,
    2. Development,
    3. Detailed description of modern Dual mode linear accelerator,
    4. Linac head and its constituents ,
    5. Safety mechanisms,
    6. Computer controlled linacs,
    7. Record and Verify systems.
- Relative merits and demerits of Co-60 and linac units.
- Simulators:
    1. Need for them,
    2. Detailed description of a typical unit,

3. Simulator CT. Dose distributions,
4. Beam modifications and shaping in Teletherapy beams.

- Characteristics of photon beams:
    1. Quality of beams,
    2. Difference between MV and MeV,
    3. Primary and scattered radiation.
- Percentage depth dose, Tissue-Air Ratio, Scatter Air Ratio, Tissue-Phantom Ratio, Tissue Maximum Ratio, Scatter Maximum Ratio, Back Scatter Factor, Peak Scatter Factor, Off-Axis Ratio, Variation of these parameters with depth, filed size, source-skin distance, beam quality or energy, beam flattening filter, target material. Central axis depth dose profiles for various energies

- Equivalent square concept, Surface dose (entrance and exit), Skin sparing effect, Output factors.
- Practical applications:
    1. Co-60 calculations (SSD, and SAD technique),
    2. Accelerator calculations (SSD, and SAD technique)
    3. Beam profiles Isodose curves,
    4. Charts,
    5. Flatness,
    6. Symmetry,
    7. Penumbra (Geometric, Transmission, and Physical),
- Field size definition Body inhomogenities
    1. Effects of patient contour,
    2. Bone, Lung cavities,
    3. Prosthesis on dose distribution
    4. Dose within bone / lung cavities,
    5. Interface effects, Electronic disequilibrium

- Wedge filters and their use, Wedge angle, Wedge Factors, Wedge systems (External, In built Universal, Dynamic / Virtual), Wedge Isodose curves
- Other beams modifying and shaping devices:

1. Methods of compensation for patient contour variation and / or tissue inhomogeniety– Bolus,

2. Buildup material,
3. Compensators,
4. Merits, and Demerits of beam modifying devices

- Shielding of dose limiting tissue :
    1. Non-divergent and divergent beam block,
    2. Independent jaws,
    3. Multileaf collimators,
    4. Merits and Demerits

Principles of Treatment Planning

- Treatment planning for photon beams: ICRU 50 an NCAP terminologies. Determination of body contour and localization: Plain film, Fluoroscopy, CT, MRI , Ultrasonography, PET CT
- Simulator based. Methods of correction for beam's oblique incidence, and body Inhomogeneties
- SSD technique and isocentric (SAD) technique: Descriptions and advantages of SAD technique
- Combination of fields:
    1. Methods of field addition,
    2. Parallel opposed fields,
    3. Patient thickness vs. Dose uniformity for different energies in a parallel opposed setup,
    4. Multiple fields (3 fields, 4 field box and other techniques).
    5. Examples of above arrangements of fields are SSD and SAD techniques, Integral Dose. Wedge field technique, Rotation Therapy (Arc, and Skip), Tangential fields. Beam balancing by weighting. Total and hemi-body irradiation. Field junctions. Limitations of manual planning.

- Description of a treatment planning system (TPS):
    1. 2D and 3D TPS
    2. Beam data input,

3. Patient data input (simple contour, CT, MR data, Advantages of transfer through media)
4. Input devices Digitizer, floppies, DAT devices, Magneto-optical disks, direct link with CT, MR)

- Beam selection and placement, Beam selection and placement, Beam's Eye View (BEV),
- Dose calculation and display (Point dose, Isodose curves, Isodose surfaces, Color wash).
- Plan optimization
- Plan evaluation tools:

1. Dose volume Histograms (Cumulative and Differential),
2. Hard copy output,
3. Storage and retrieval of plans.

- Alignment and Immobilization:

1. External and internal reference marks,
2. Importance of Immobilization methods (Plaster of Paris casts, Perspex casts, bite block, shells, head rests, neck roll, Alpha-Cradles. Thermoplastic materials, polyurethane foams
3. Methods of beam marks, and front / back pointers

Treatment execution: Light field, Cross hair, ODIs, Scales in treatment machines.
Treatment verification : Port films,

- Electronic portal imaging devices,Invivo patient dosimetry (TLD, diode detectors, MOSFET, Film, etc) Changes in patient position, target volume , and critical volume during course of treatment. Electron Beam
- Therapy Production of electron beams:

1. Production using accelerators
2. Characteristics of electrons
3. Surface dose,
4. percentage depth dose,
5. beam profiles,
6. Isodose curves and charts,
7. Flatness and Symmetry.
8. Beam collimation,

9. variation of percentage depth dose and output with filed size, and SSD, photon contamination

- Energy spectrum, Energy specifications, variation of mean energy with depth.
- Suitability of measuring instruments for electron beam dosimetry Treatment planning:

1. Energy and field size choice,
2. air gaps, and obliquity,

- Tissue in- homogeneity : lung, bone, air filled cavitites. Field junctions (with either electron or photon beam). External and internal shielding. Arc therapy, Use of bolus in electron beam.

- Total Skin Electron Irradiation, Intraoperative Radiation therapy.
- Physical Principles of Brachytherapy:

1. Properties of an ideal brachytherapy source,
2. Sources used in brachytherapy: Ra-226, Cs-137, Ir-192, Au-198, Co-60, I-125,I-131 ,P-32,Sr-90, Yt-90, Ru-106, Ta-182 and other new radionuclides.
3. Therapy with Unsealed sources
4. Complete physical properties of all the sealed and unsealed sources.
5. Radiation hazards
6. Source construction including filtration, comparative advantages of these radionuclides

- Historical background.
- Radiation and Dose units:

1. Activity used, Exposure, Absorbed dose, mg-hr, curie, milli-curie destroyed, milligram Radium equivalent, Roentgen, Rad, Gray.
2. Source strength specification, Brachytherapy Dose calibrator
3. Technique: Preloaded, after loading (manual and remote),
4. Merits and Demerits.
5. Surface, Interstitial, Intracavitary, Intraluminal, Intravascular , Systemic brachytherapy , Low, Medium, High and Pulsed Dose Rates.

- Remote after loading machines.
- Dosage Systems: Manchester System, Paris System Treatment Planning: Patient selection, Volume specification, Geometry of implant, Number, Strength

and Distribution of radioactive sources, Source localization, Dose calculation, Dose rate specification, Record keeping ICRU 38.

- Radiation Safety: Planning of brachytherapy facility, Rooms and equipment, Storage and `Movement control, Source inventory, Disposal, Regulatory requirements Beta-ray brachytherapy including methods of use, inspection, storage and transport of sources, dose distribution
- Unsealed Radionuclides: Concepts of uptake, distribution and elimination, Activities used in clinical practice, Estimation of dose to target tissues, and critical organs, Procedures for administering radionuclide to patients
- Quality Assurance in radiotherapy.(QART) Overview of QART:

1. Need for quality system in Radiotherapy,
2. Quality system: Definition and practical advantages, Construction, Development and implementation of a Quality system
3. Quality Assurance of simulator/CT simulator Co-60, Linear Accelerator Acceptance testing of Simulator, TPS, Co-60, Linear Accelerator

- Radiation Protection and Regulatory Aspects: Statutory Framework

1. Principles underlying International Commission on Radiation Protection (ICRP) recommendations, ICRP and National radiation protection
    a. i.e; Atomic Energy Regulatory Board (AERB) standards. Effective dose limits (ICRP and AERB)
2. Protection mechanisms: Time, Distance and Shielding.
3. Permissible doses for Radiation workers and Public including Pregnant Women.

- Concept of “As low as Reasonably Achievable” (ALARA) Personnel and Area

  Monitoring; Need for personnel monitoring, Principles of film badge, TLD badge used for personnel monitoring. Pocket dosimeter
- Need for area monitoring, Gamma Zone monitors, Survey meters Regulatory aspects and Calliberation.
- Procedural steps for installation and commissioning of a new radiotherapy facility (Teletherapy and Brachytherapy). Approval of Standing Committee on Radiotherapy Development Program.
- Type approval of unit. Site plan, Layout of installation / Associated facility: Primary, Secondary barriers, leakage and scattered radiation. Regulatory requirement in procurement of teletherapy / brachytherapy source(s).

- Construction of building, qualified staff, Procurement of instruments, and accessories, installation of unit and performance tests. Calibration of unit, AERB/DRP approval for clinical commissioning of the unit.
- Other regulatory requirements: Regulatory consent, NOCs, Periodical reports to AERB and Radiological Physics and Advisory Division (RP & AD) , Bhaba Atomic Research Centre (BARC)
- Conformal radiotherapy (CRT): Principles, Advantages over conventional methods, Essential requirements for conformal radiotherapy.
- Various methods of CRT:

1. With customized field shaping using conventional coplanar beams.
2. Multiple non-coplanar MLC beams conforming to target shape.
3. Stereo tactic radiotherapy

- Principle of inverse planning and Intensity Modulated Radiation Therapy (IMRT)

1. Using 3D compensator
2. Static IMRT (Step and Shoot technique)
3. Dynamic IMRT (sliding window technique)
4. Dynamic arc IMRT
5. Micro –MLC
6. Tomotherapy methods
7. Time gated (4D) radiotherapy
8. Merits and demerits of IMRT

Stereo tactic irradiation methods:

- Physics Principles,
- Techniques,
- Description of units
- 1.Gamma Knife
- Linac based
- 3.Cyber Knife
- 4.Tomotherapy
- Stereo tactic Radio surgery (SRS) and Stereo tactic Radiotherapy (SRT), Stereo -tactic body Radio therapy (SBRT).
- Merits and demerits

- Networking in radiotherapy: Networking of planning and treatment units in radiotherapy department including Picture Archival Communication System (PACS), Advantages.

- Patient Data Management, Oncology information systems(OIS)

High LET Radiation

Comparison and contrast with low LET radiation.

Neutron source (including 252 Cf) and Boron Capture Neutron Therapy (outline only). Advantages and disadvantages of neutrons, RBE values, hazards of low dose and low energy neutrons, RBE values, hazards of low dose and low energy neutron, use in radiotherapy, combination with low LET, current clinical results.

Other high LET particles: protons, high energy heavy nuclei, application to radiotherapy, current clinical results.

RADIOBIOLOGY AND APPLIED RADIOBIOLOGY

- Introduction to Radiation Biology
- Radiation interaction with matter
- Types of radiation, excitation and ionization.
- Radiation chemistry: direct and indirect effects, free radicals, oxygen effect and free radical scavengers, LET and RBE theory, dual action theory, intracellular repair, general knowledge of repair models.
- Introduction to factors influencing radiation response.
- Physical factors: dose, dose quality, dose rate, temperature Chemical factors: Oxygen, radio sensitizers, radio protectors
- Biological factors: type of organism, cell type and stage, cell density and configuration, age, sex.
- Host factors: Partial or whole body exposure.
- Relevance of radiation biology to radiotherapy
- Interaction of ionizing radiation on mammalian cells.
- The cell: structure and function; relative radio sensitivity of nucleus and cytoplasm, mitosis, cell cycle, principles of DNA, RNA and protein synthesis,

radiation effects on DNA, strand breakage and repair, common molecular biology techniques.

- Cell injury by radiation: damage to cell organelle like chromatids, chromosomes; interphase death, apoptosis, mitotic death, micronucleus induction, SLD, PLD
- Oxygen effect: mechanism, hypoxia, OER, reoxygenation in tumors, significance in radiotherapy.
- Dose rate
- Brachytherapy sources including sealed and unsealed sources.
- Radiobiology of low, high dose rate & pulsed brachytherapy, hyper fractionation, significance in radiotherapy.
- Effects of low LET and high LET radiation on cell.
- Cell survival curves.
- Effect of sensitizing and protective agent.
- Dose modifying factors and their determination. Variation of response with growth and the progression of cell through the phases of cell cycle. Physical factors influencing cell survival
- Relative biological effectiveness (RBE); its definition and determination, dependence upon linear energy transfer, dose, dose rate and fractionation.
- Hyperthermic and photodynamic injury
- Biological hazards of Radiation; Stochastic and Non Stochastic effects or radiation. Radiation effects on the embryo and the foetus
- Life shortening.
- Leukemogenesis and carcinogenesis, genetic and somatic hazards for exposed individuals and population.
- Biological basis of radiological protection.
- Organ radiosensitivity and radioresponsiveness, Concept of therapeutic index.
- Acute effects of Radiation, Concept of mean lethal dose, Radiation Syndromes: Bone Marrow, Gastrointestinal system, Central Nervous System, Cutaneous Suppression of immune System: mechanism, Consequences.
- Total Body irradiation Biological dosimetry: Blood counts, BM mitotic index. Chromosome aberrations in peripheral blood lymphocytes
- Radiation accidents: typical examples
  Radiation effects on major organs/tissues

- Acute & late effects on all normal organs & tissues including connective tissue, bone marrow, bones, gonads, eye, skin, lung, heart, central nervous system tissues, peripheral nerves, oesophagus, intestine, kidney, liver & thyroid with special reference to treatment –induced sequelae after doses employed in radiotherapy.
- Normal tissue tolerances
- Late effects of radiation (somatic)
- Sterility, cataracts and cancer
- Carcinogenesis: mechanism in vitro and in vivo, oncogenes and antioncogenes Radiation induced cancer of occupational, medical or military origin.
- Recent controversial results for low-level exposure, risk estimates
- Late effects of Radiation (Genetic)
- Mutations: definition, types, potential hazards.
- Low level radiation: sources, potential hazards, stochastic and deterministic nonstochastic effects, high background areas and cancer.
- Effects of Radiation on Human Embryo & Fetus
- Lethality, congenital abnormalities and late effects (Leukemia and childhood caner), severe mental retardation. Doses involved.
- Biology and Radiation Responses of Tumors
- Tumors growth: Kinetics of tumor response. Growth fraction, cell loss factor.
- Volume doubling times, potential volume doubling times, repopulation, and accelerated repopulation.
- Radio curability: definition, factors involved, tumor control probability curves
- Factors determining tumor regression rates. Causes of failure to control tumors by radiation: tumor related, host related technical/mechanical errors.
- Relationship between clonogen numbers and tumor control probability. Local tumor control and impact on survival.
- Applied Radiobiology
- Fractionation : rationate, factors involved (4 R’s)
- Time, Dose and fractionation relationship isoeffect curves, isoeffect relationships, e.g.; NSD, CRE formalisms and their limitations, partial tolerance, means of summating partial tolerance, steepness of dose response curves. Multi-target, two component and linear quadratic model. Alfa/ beta ratios for acute and late

effects and means for deriving these values. Isoeffective formulae. Clinical applications of the L-Q model.

- Hyperfractionation, accelerated fractionation, hypofractionation, CHART, split dose treatments.
- Brachytherapy –low dose rate, high dose rate and pulsed treatments.
- Introduction to new techniques to optimize radio-curability; combination therapy (adjuvant surgery or chemotherapy), hyperthermia, hypoxic cell radio-sensitizers, high LET radiation. Photodynamic therapy.
- The volume effect, general principles and current hypotheses.
- Shrinking Field technique.
- Combination Radiation-surgery
- Pre, post and intra operative radiation.
- Rationale, radiobiological factors, current clinical results.
- Irradiation of sub-clinical disease, debulking surgery, importance of clonogen numbers.
- Combination Radiation-Chemotherapy
- Definitions of radiosensitiser and Radiation protectors, synergism, potentiation, antagonism, Radiosensitisers/Radiation protectors- types, and mechanism.
- Hyperthermia
- Sources, rationale (historical examples), advantages and disadvantages, thermotolerance.
- Cellular damage: comparison and contrast with radiation, thermal and non-thermal effects of ultrasound, microwaves, radiofrequency, etc. general host responses (immunology, metastases)
- Use along with radiotherapy and chemotherapy: optimum sequencing of combined modalities.
- Current limitations to the clinical use of hyperthermia.
- High LET Radiation
- Comparison and contrast with low LET radiation
- Neutrons: Source (including 252 Cf) and boron neutron capture (outline only). Advantages and disadvantages of neutrons, RBE values, hazards of low dose and low energy neutron, use in radiotherapy, combination with low LET, current clinical results.

- Other high LET particles: protons, mesons, high-energy heavy nuclei, application to radiotherapy, current clinical results.

CLINICAL RADIOTHERAPY

- Cancer Epidemiology & Etiology
- Cancer Statistics- world-wide & India
- Cancer Registries , National cancer registry project of ICMR& National Cancer Control Programme
- Analysis of data in cancer registries
- Regional Cancer Centers
- Cancer Screening & Prevention
- Patient Care
- Assessment & referral systems for radiotherapy
- Diagnosis & workup
- Staging
- Care & evaluation during & after treatment
- Emergencies in Oncology
- Radiotherapeutic Management of different malignancies
- Radiotherapy for non malignant conditions
- Treatment Response & Result
- Guidelines for treatment response assessment.
- Complete Response, Partial Response, No response, Stable disease.
- End points of treatment results. Loco-regional control recurrence, metastasis, survival quality of life.
- Treatment related morbidity assessment
- Radiation morbidity (early & late)
- Morbidities of combined treatment
- Grading of morbidity
- Follow up methodologies of treated patients.

CANCER CHEMOTHERAPY

- Basic Principles of chemotherapy
- Chemotherapy drugs

- Newer chemotherapeutic agents
- Basic for designing different chemotherapy schedules. Standard chemotherapy schedules.
- Chemotherapy practice in various malignancies
- Chemotherapy practice & results/toxicities in sequential & concomitant chemoradiotherapy.
- Supportive care for chemotherapy.
- The basic principles underlying the use of chemotherapeutic agents.
- Classification and mode of action of cytotoxic drugs. The principles of cell kill by chemotherapeutic agents, drug resistance, phase specific and cycle specific action.
- Drug administration.
- The general principles of pharmacokinetics; factors affecting drug concentration 'in vivo' including route and timing of administration, drug activation, plasma concentration, metabolism and clearance.
- Principles of combinations of therapy, dose response curves, adjuvant and neo-adjuvant chemotherapy, sanctuary sites, high dose chemotherapy, and regional chemotherapy.
- Toxicity of drugs. Early, intermediate and late genetic and somatic effects of common classes of anticancer drugs.
- Precautions in the safe handling of cytotoxic drugs.
- Endocrine manipulation and biological response modifiers. An understanding of the mode of action and side effects of common hormonal preparations used in cancer therapy (including corticosteroids).
- Use of the major biological response modifiers such as interferons, interleukins and growth factors and knowledge of their side effects.
- Assessment of New Agents. Principles of phase I, II, and III studies.
- Gene Therapy
- Pharmacokinetics and Pharmacodynamics
- Standard chemotherapy schedules
- Drug administration and Precautions in the safe handling of cytotoxic drugs
- Resistance to Chemotherapy
- Basic concepts of Chemotherapy and Irradiation Interaction

Molecular and Genetic Oncology.

1. Cell cycle- DNA repair; apoptosis.
2. Invasion and metastasis, angiogenesis and lymph angiogenesis.
3. Cell signaling and interactive networks.
4. Immune response.
5. Gene Therapy
6. Somatic correction of gene defect
7. Genetic pro-drug activation
8. Genetic immunomodulation

Immunotherapy/Targeted Therapy

1 Monoclonal antibody therapy
2 Radio immunotherapy
3 Advances in immunotherapy
4 Nano-Particle therapy

Combination Radiation-Surgery

- Pre, post and intra-operative radiation.
- Rationale, radiobiological factors, current clinical results.
- Irradiation of sub-clinical disease
- Debulking surgery
- Importance of clonogen numbers/Circulating tumor cells(CTC's)

Combination Radiation –Chemotherapy

- Definitions of radio sensitizers, synergism, potentiation, antagonism. Radiosenistzers/Radio protectors: type , mechanism of action.

Radio-active isotopes used for diagnosis and therapy

Benign diseases- Radiotherapy in non-malignant diseases

Imaging in oncology

Organ radio sensitivity and radio responsiveness, concept of therapeutic index

Acute effects of Radiation

- Concept of mean lethal dose
- Radiation syndromes : BM , GI, CNS, cutaneous
- Suppression of immune System: mechanism, consequences
- Total Body irradiation
- Biological dosimetry: Blood counts, BM mitotic index. Chromosome aberrations in peripheral blood lymphocytes
- Radiation accidents: typical examples

Radiation Effects on Major Organs/tissues

Acute & late effects on all normal organs & tissue including connective tissue, bone marrow, bones, gonads, eye , skin, lung, heart , central nervous system tissues, peripheral nerves, esophagus, intestine, kidney, liver & thyroid with special reference to treatment induced sequelae after doses employed in radiotherapy.
Normal tissue tolerances.

Late effects of radiation (somatic)

- Sterility, cataracts and cancer
- Carcinogenesis: mechanisms in vitro and in vivo, oncogenes and antioncogenes.
- Radiation induces cancer of occupational, medical or military origin.
- Recent controversial results for low level exposure, risk estimates

Late Effects of Radiation (Genetic)

- Mutations: definition, types, potential hazards.
- Low level radiations: sources, potential hazards, stochastic and deterministic (nonstochastic) effects, high background areas and cancer.
- Effects of Radiation on Human Embryo & Fetus

- Lethality, congenital abnormalities and late effects (Leukemia and childhood cancer) severe mental retardation. Doses involved.

Palliative & supportive care:

- Symptoms /Signs of advanced cancer
- Palliation of compression and obstruction due to malignancy
- Palliation of brain & spiral cord metastasis
- Palliation of bleeding catastrophes
- Palliation of bone metastasis
- Palliation of visceral recurrences and metastases
- Pain management: Pain control, WHO guidelines for adults & children
- Patient's and relatives' counseling on end stage management
- Guidelines for palliative care
- Management of terminally ill patients.
- Different pharmacologic & non-pharmacology methods
- Palliative radiotherapy
- Palliative chemotherapy
- Home care
- Hospice care
- Physical, social, spiritual & other aspects
- Others

OTHER DISCIPLINES ALLIED TO RADIOTHERAPY AND ONCOLOGY

Surgical Oncology

- Basic principles of surgical oncology, biopsy, conservation surgery, radical surgery, palliative surgery.
- Basics of surgical techniques – head & neck, breast, thorax, abdomen, gynecological, genitourinary, musculoskeletal, CNS.
- Combined treatments: with radiotherapy, chemotherapy, and hormone therapy.

Diagnostic Radiology and Nuclear Medicine

- Radiographic diagnosis of malignant and non malignant conditions
- Radiological Procedures with reference to Radiotherapy practices
- Study of Ultrasound, CT Scans, MRI Scans, PET scans, as applicable for management of cancer.
- Other nuclear imaging and therapeutic modalities as applicable to management of cancer.

PREVENTIVE &COMMUNITY ONCOLOGY

- Cancer Epidemiology & Etiology
- Cancer Statistics- world wide & India
- Cancer Registries & National Cancer Control Programme
- Analysis of data in cancer registries
- Regional Cancer Centers
- Cancer Screening & Prevention

ADMINISTRATION

- Oncologists role as an administrator.
- How to set up a Radiotherapy and Oncology department, planning of infrastructure, & equipments.
- Role in National Cancer Control Programme (NCCP).
- Responsibilities towards safety & quality assurance.

Cancer Screening and Prevention

Cancer Biotherapeutics

a) Hormonal Therapy

b) Differentiation Agents

c) Monoclonal Antibodies

d) Interferons

e) Interleukins

f) Antiangiogenesis Agents

g) Molecular Targeted Therapy

h) Vaccines

i) Gene Therapy

CLINICAL RADIOTHERAPY, CHEMOTHERAPY AND TARGETED THERAPY IN MANAGEMENT OF SITE SPECIFIC MALIGNANCIES including

- Metastasis of Unknown Origin
- AIDS related Malignancies
- Oncologic Emergencies
- Paraneoplastic syndromes
- Benign Diseases

Rehabilitation

Complementary alternative medicine

Quality Assurance in radiotherapy (QART)

- Overview of ESTRO QART: Need for a quality system in Radiotherapy, Quality System:
- Definition and practical advantages, Construction, Development and Implementation of a Quality System
- Quality Assurance of Simulator, TPS, Co-60, linear accelerator
- Acceptance testing of Simulator, TPS, Co-60, linear accelerator
- Quality assurance and acceptance test of newer equipments.

New Radiation Modalities

A Protons

- Production
- Process of absorption
- Depth dose patterns
- Advantages compared with x-rays
- Facilities available

B. Neutrons

- Production
- Process of absorption
- Depth dose patterns
- Advantages compared with x-rays
- Facilities available

C. Pions

- Production
- Process of absorption
- Depth dose patterns
- Advantages compared with x-rays
- Facilities available

D High energy heavy ions (Carbon and others)

- Production
- Process of absorption
- Depth dose patterns
- Advantages compared with x-rays
- Facilities available

<u>Hyperthermia</u>

1. Sources, rationale (historical example), advantages and disadvantages, thermo tolerance.
2. Cellular damage: comparison and contrast with radiation, thermal and non-thermal effects of ultrasound, microwaves, radiofrequency, etc General host responses (immunology, metastases).
3. Use along with radiotherapy and chemotherapy: optimum sequencing of combined modalities. Current limitations to the clinical use of hyperthermia.

4. Methods of heating

- RF Microwaves
- Ultrasound

- Water baths

5. Systematic hyperthermia
6. Localized heating
7. Cellular response to heat
8. Repair of thermal damage
9. Thermotolerance
10. Hyperthermia combined with ionizing radiations
11. Time sequence of heat and irradiation
12. Hypoxic cells and heat
13. Effect of PH on the response to hyperthermia
14. Response of transplanted tumours to heat
15. Response of normal tissues to heat
16. Response of spontaneous tumours to heat

Modern Trends /Recent Advances

Advancements in Radiation Oncology:

Virtual Simulation: Principle, CT Simulation, TPS based virtual simulation, Differences, Merits and Demerits, Practical considerations

Others:

i. Anti angio-genic factors , Angiogenesis & carcinogenesis

ii. Monoclonal Antibodies - MABs & NIBs

iii. Essentials of Genomics:

- Genomes,
- Signal translation
- Immunology
- Cytogenetic, cell cycle
- Apoptosis
- Invasion and metastasis

Iv. Gene Therapy

v. Molecular therapy,

vi. Cancer
vaccines. Vii others

STASTISTICAL BASIS FOR PLANNING AND INTERPRETATION OF

CLINICAL TRIALS

- Advantages & disadvantages
- Retrospective & Prospective studies
- Controlled & uncontrolled trials
- Single blind & double blind studies
- Phase I,II & III trials
- Ethics (Helsinki declaration/Good clinical practice)

PLANNING A TRIAL

- Establishing objectives – short term and long term
- Determining the appropriate criteria
- Establishing grounds for inclusion and exclusion of patients
- Determining how many treatment schedules are to be completed
- Determining the treatment schedules and any appropriate modifications
- Determining the method of allocation of treatment; the allocation ratio and the method and timing of randomization
- Determining what measures are to be taken, how they will be taken, who will take them, at what times (s) and where they will be recorded.
- Designing, the appropriate forms of documentation
- Determining the proposed duration of the trial, either in terms of a fixed closing date, or the entry of a predetermined number of patients.
- Establishing conditions under which the trial may be terminated earlier than planned & procedures for detecting these conditions.
- Re-assessing the proposed trial in terms of ethics, appropriateness to the short & long terms objectives, feasibility & the availability of resources.
- Writing the protocol
- Running a pilot study

TEACHING SCHEDULE

1 Basic clinical training should rest on day to day working in care of both in & out patients, day care chemotherapy, radiotherapy treatment planning (both manual & TPS) and execution, training in Quality assurance of therapeutic and allied equipments. The common tumors should be discussed at length in the teaching ward rounds. Each individual should present and discuss the respective case problems.

2 There should be intra and inter departmental meeting for discussion the Uncommon / interesting cancer cases.

3 In addition to above the following are suggested as some of the activities to impart clinical training & skills:-

- Didactic teaching- once a week
- Subject seminars - once a week
- Case presentation - once a week
- Journal club - once a week
- Interdepartmental conferences- once a week
- In depth clinical presentation by individual – minimum desirable of at least 15 session per year.

4 Attending various accredited scientific meeting -CME/Symposia/conference- 30 hours.

5. Training in patients' record keeping, hospital based and city tumor registry system, cancer notification and WHO recommendations on improving follow up.

Research Training

Collection of information related to advances in medicine from various sources (use of library, multimedia, internet etc.) their interpolation and application.

Teaching

1. Undergraduate clinical demonstration of minimum 3 sessions

2. Demonstration and teaching for nursing students.

3. Patient /Public education talks and preparation of multi-media presentation, material, articles, lectures, pamphlets & books.

POSTGRADUATE TRAINING

- **Standard Requisite**
- **Teaching**
- **Administration**

Standard Requisite

I. Basic Sciences

II. Clinical Sciences

III. Research

I. Basic Sciences: Minimum undergraduate level training in anatomy, physiology,biochemistry microbiology, pathology & pharmacology relevant in clinical practice, in addition to specific emphasis on basic genetic and molecular biology related to tumor and clinical oncology.

II. Clinical Sciences:

(Radiotherapy, Chemotherapy and related discipline):

Theoretical background including recent advances is prerequisite for clinical training of PG's –

2. Become competent in taking patient's history of illness and able to identify Possible etiological/predisposing factors.
3. Should develop skills to interpret and elicit various physical signs and to arrive at a probable diagnosis and to decide on cost effective diagnostic procedures.
4. Carryout usual clinical interventions in the management of oncology patients like FNAC, pleural aspiration, abdominal paracentesis, bone marrow aspiration, Central venous lines and biopsy etc.
5. Acquainted with basic methodological & interpretation of various diagnostic tests and procedures.

6. Seminars, symposia, reviews, ward round & post graduate interactive group discussion should constitute methodology of their training.
7. Able to provide palliative and terminal care for cancer patients.

III Research: A post graduate student pursuing the specialty of radiotherapy-

- Should have knowledge of the basic scientific methodology, statistical basis and cancer epidemiology
- Should be able to devise, prepare and carry out research project 'individually'.
- Should be able to decide the relevance of any study/analysis on the subject
- Should develop a skill to present data in the form of research paper at conference / symposia/CME etc.
- Should know the basic concepts of Indexing and international classification of disease, tumor registry systems, department tumor registry. The student should also know about the UICC, IACR system for Methodology of follow up and patient retrieval system that forms the foundation of clinical research follow up based expertise.

Teaching

a. Should be well versed with method of teaching using audio-visual aids

b. Should be able to conduct demonstration and teaching for under graduate students

c. Should be able to collect, compile and present the material and data for scientific and public lectures pertaining to radiotherapy and oncology.

Administration

A post graduate student should be involved in managing the day to day affairs related to patient treatment, care, academics, and research. He/she must have knowledge of planning and setting up an oncology department, interaction with government machinery and other agencies , experience of National Cancer Control Programme.cts of training, academic, patient care &research.

SCOPE OF TRAINING

- **Clinical training**
- **Clinical procedures**
- **Research training**
- **Teaching**

Clinical Training

Posting

1. Major tenure of posting should include care of inpatients, out patients, day care, isolation, special clinics, terminally ill patients and maintenance of case records for both in & out patients
2. Linear Accelerator
3. Simulator
4. CT simulator
5. Brachytherapy LDR/MDR/HDR/PDR
6. Computerized TPS
7. Mould room
8. Medical physics lab
9. Others

III Following support department posting is also desirable: -

1. Pathology
2. Radio diagnosis
3. Nuclear Machine
4. Gynecology, GI surgery, Otorhinolaryngology, Neurosurgery and Pulmonary Medicine.
5. Molecular Oncology and genetics

CLINICAL POSTINGS

Rotations Postings

1st Year

- Clinical Oncology (In-patient ward and special clinics)
- Radiation Physics
- Pathology and Radiation Pathology, Cell biology and Radiobiology
- Diagnostic Radiology
- Cancer Epidemiology and Statistics
- Cancer Research and Laboratory methods

2nd Year

- Clinical Oncology & Critical Care (In–patient ward & special clinics)
- Radiation Physics
- Palliative Care
- Medical Oncology including Haemato-oncology
- Targeted /Biological Therapies
- (In-patient ward and special clinics)
- Mould room and Immobilization devices
- Simulator and Teletherapy machine posting
- Brachytherapy

3rd Year

- Radiation Oncology (Inpatient ward and special clinics)
- Clinico pathological meetings / morbidity and mortality and medical audits
- Recent Advances
- Peer reviewed /Indexed journal based studies

BIOSTATISTICS AND RESEARCH METHODOLOGY

1. Sampling –Random sampling, purposive sampling, advantages of sampling, various methods of sampling (Simple random, systemic, stratified, cluster, multistage and multiphase), sampling error, on-sampling error.

2. Descriptive statistics-Arithmetic mean, Median, Mode and standard error, coefficient of variation.

3. Graphics presentation of date-Bar diagram, histogram frequency curve, line graph, pie chart

4. Normal distribution-Definition and properties /Confidence interval, Basic concept of testing of hypothesis, p-value, power of the test.

5. Test of significance-t test, test of proportion, chi-square test, concept of analysis of variance

6. Study design-Descriptive studies, analytical studies. Observational studies, experimental studies, prospective studies, retrospective studies, odds ration, relative risk, attributable risk percent, population attributable risk percent.

7. Correlation and regression-Simple correlation, linear regression, concept of multiple regression.

8. Survival analysis-Life table, survival analysis , K-M Methos, Cox regression ,log ran K test

9. Sample size determination-Basic concept , sample size determination of estimating proportion and mean

10. Clinical trials in cancer research –Basic concept

- **Biostatistics, Research Methodology and Clinical Epidemiology**
- **Ethics**
- **Medico legal aspects relevant to the discipline**
- **Health Policy issues as may be applicable to the discipline**

THESIS PROTOCOL & THESIS

The candidates are required to submit a thesis at the end of three years of training as per the rules and regulations of NBE.

Guidelines for Submission of Thesis Protocol & Thesis by candidates

Research shall form an integral part of the education programme of all candidates registered for DNB degrees of NBE. The Basic aim of requiring the candidates to write a thesi protocol & thesis/dissertation is to familiarize him/her with research methodology. The members of the faculty guiding the thesis/dissertation work for the candidate shall ensure that the subject matter selected for the thesis/dissertation is **feasible, economical** and **original**.

Guidelines for Thesis Protocol

The protocol for a research proposal (including thesis) is a study plan, designed to describe the background, research question, aim and objectives, and detailed methodology of the study. In other words, the protocol is the 'operating manual' to refer to while conducting a particular study.

The candidate should refer to the NBE Guidelines for preparation and submission of Thesis Protocol before the writing phase commences. The minimum writing requirements are that the language should be clear, concise, precise and consistent without excessive adjectives or adverbs and long sentences. There should not be any redundancy in the presentation.

The development or preparation of the Thesis Protocol by the candidate will help her/him in understanding the ongoing activities in the proposed area of research. Further it helps in creating practical exposure to research and hence it bridges the connectivity between clinical practice and biomedical research. Such research exposure will be helpful in improving problem solving capacity, getting updated with ongoing research and implementing these findings in clinical practice.

Research Ethics: Ethical conduct during the conduct and publication of research is an essential requirement for all candidates and guides, with the primary responsibility of ensuring such conduct being on the thesis guide. Issues like Plagiarism, not maintaining the confidentiality of data, or any other distortion of the research process will be viewed seriously. The readers may refer to standard documents for the purpose.

The NBE reserves the right to check the submitted protocol for plagiarism, and will reject those having substantial duplication with published literature.

PROTOCOL REQUIREMENTS

1. All of the following will have to be entered in the online template. The thesis protocol should be restricted to the following word limits.

- Title : 120 characters (with spacing) page
- Synopsis [structured] : 250-300
- Introduction : 300-500
- Review of literature : 800-1000
- Aim and Objectives : Up to 200
- Material and Methods : 1200-1600
- 10-25 References [ICMJE style]

2. It is mandatory to have ethics committee approval before initiation of the research work. The researcher should submit an appropriate application to the ethics committee in the prescribed format of the ethics committee concerned.

Guidelines for Thesis

1. The proposed study must be approved by the institutional ethics committee and the protocol of thesis should have been approved by NBE.

2. The thesis should be restricted to the size of 80 pages (maximum). This includes the text, figures, references, annexures, and certificates etc. It should be printed on both sides of the paper; and every page has to be numbered. Do not leave any page blank. To achieve this, following points may be kept in view:

    a. The thesis should be typed in 1.5 space using Times New Roman/Arial/ Garamond size 12 font, 1” margins should be left on all four sides. Major sections viz., Introduction, Review of Literature, Aim & Objectives, Material and Methods, Results, Discussion, References, and Appendices should start from a new page. Study proforma (Case record form), informed consent form, and patient information sheet may be printed in single space.
    b. Only contemporary and relevant literature may be reviewed. Restrict the introduction to 2 pages, Review of literature to 10-12 pages, and Discussion to 8-10 pages.
    c. The techniques may not be described in detail unless any modification/innovations of the standard techniques are used and reference(s) may be given.
    d. Illustrative material may be restricted. It should be printed on paper only. There is no need to paste photographs separately.

3. Since most of the difficulties faced by the residents relate to the work in clinical subject or clinically-oriented laboratory subjects, the following steps are suggested:
    a. The number of cases should be such that adequate material, judged from the hospital attendance/records, will be available and the candidate will be able to collect case material within the period of data collection, i.e., around 6-12 months so that he/she is in a position to complete the work within the stipulated time.
    b. The aim and objectives of the study should be well defined.
    c. As far as possible, only clinical/laboratory data of investigations of patients or such other material easily accessible in the existing facilities should be used for the study.
    d. Technical assistance, wherever necessary, may be provided by the department concerned. The resident of one specialty taking up some problem related to some other specialty should have some basic knowledge about the subject and he/she should be able to perform the investigations independently, wherever some specialized laboratory investigations are required a co-guide may be co-opted from the concerned investigative department, the quantum of laboratory work to be carried out by the candidate should be decided by the guide & co-guide by mutual consultation.

4. The clinical residents are not ordinarily expected to undertake experimental work or clinical work involving new techniques, not hitherto perfected OR the use of chemicals or radioisotopes not readily available. They should; however, be free to enlarge the scope of their studies or undertake experimental work on their own initiative but all such studies should be feasible within the existing facilities.

5. The DNB residents should be able to freely use the surgical pathology/autopsy data if it is restricted to diagnosis only, if however, detailed historic data are required the resident will have to study the cases himself with the help of the guide/co-guide. The same will apply in case of clinical data.

6. Statistical methods used for analysis should be described specifically for each objective, and name of the statistical program used mentioned.

General Layout of a DNB Thesis:

- **Title-** A good title should be brief, clear, and focus on the central theme ofthe topic; it should avoid abbreviations. The Title should effectively summarize the proposed research and should contain the PICO elements.

- **Introduction-** It should be focused on the research question and shouldbe directly relevant to the objectives of your study.

- **Review of Literature -** The Review should include a description of themost relevant and recent studies published on the subject.

- Aim and Objectives - The 'Aim' refers to what would be broadly achieved by this study or how this study would address a bigger question / issue.

  The 'Objectives' of the research stem from the research question formulated and should at least include participants, intervention, evaluation, design.

- **Material and Methods-** This section should include the following 10elements: Study setting (area), Study duration; Study design (descriptive, case-control, cohort, diagnostic accuracy, experimental (randomized/non-randomized)); Study sample (inclusion/exclusion criteria, method of selection), Intervention, if any, Data collection, Outcome measures (primary and secondary), Sample size, Data management and Statistical analysis, and Ethical issues (Ethical clearance, Informed consent, trial registration).

- **Results-** Results should be organized in readily identifiable sectionshaving correct analysis of data and presented in appropriate charts, tables, graphs and diagram etc.

- **Discussion–**It should start by summarizing the results for primary andsecondary objectives in text form (without giving data). This should be followed by a comparison of your results on the outcome variables (both primary and secondary) with those of earlier research studies.

- **Summary and Conclusion-** This should be a précis of the findings of thethesis, arranged in four paragraphs: (a) background and objectives; (b) methods; (c) results; and (d) conclusions. The conclusions should strictly pertain to the findings of the thesis and not outside its domain.

- **References-** Relevant References should be cited in the text of theprotocol (in superscripts).

- **Appendices -**The tools used for data collection such as questionnaire,interview schedules, observation checklists, informed consent form (ICF), and participant information sheet (PIS) should be attached as appendices. Do not attach the master chart.

Thesis Protocol Submission to NBE

1. DNB candidates are required to submit their thesis protocol within 90 days of their joining DNB training.

2. Enclosures to be submitted along with protocol submission form:
    a) Form for Thesis Protocol Submission properly filled.
    b) Thesis Protocol duly signed.
    c) Approval letter of institutional Ethical committee. *(Mandatory, nonreceivable of any one is liable for rejection)*

Thesis Submission to NBE

1. As per NBE norms, writing a thesis is essential for all DNB candidates towards partial fulfillment of eligibility for award of DNB degree.
2. DNB candidates are required to submit the thesis before the cut-off date which shall be 30th June of the same year for candidates appearing for their scheduled December final theory examination. Similarly, candidates who are appearing in their scheduled June DNB final examination shall be required to submit their thesis by 31st December of preceding year.
3. Candidates who fail to submit their thesis by the prescribed cutoff date shall NOT be allowed to appear in DNB final examination.
4. Fee to be submitted for assessment (In INR): 3500/-
5. Fee can be deposited ONLY through pay-in-slip/challan at any of the Indian bank branch across India. The challan can be downloaded from NBE website www.natboard.edu.in
6. Thesis should be bound and the front cover page should be printed in the standard format. A bound thesis should be accompanied with:
    a. A Synopsis of thesis.
    b. Form for submission of thesis, duly completed
    c. NBE copy of challan (in original) towards payment of fee as may be applicable.
    d. Soft copy of thesis in a CD duly labeled.
    e. Copy of letter of registration with NBE.

7. A declaration of thesis work being bonafide in nature and done by the candidate himself/herself at the institute of DNB training need to be submitted bound with thesis. It must be signed by the candidate himself/herself, the thesis guide and head of the institution, failing which thesis shall not be considered.

The detailed guidelines and forms for submission of Thesis Protocol & Thesis are available at www.natboard.edu.in.thesis.php.

LOG BOOK

A candidate shall maintain a log book of operations (assisted / performed) during the training period, certified by the concerned post graduate teacher / Head of the department / senior consultant.

This log book shall be made available to the board of examiners for their perusal at the time of the final examination.

The log book should show evidence that the before mentioned subjects were covered (with dates and the name of teacher(s) The candidate will maintain the record of all academic activities undertaken by him/her in log book .

1. Personal profile of the candidate
2. Educational qualification/Professional data
3. Record of case histories
4. Procedures learnt
5. Record of case Demonstration/Presentations
6. Every candidate, at the time of practical examination, will be required to produce performance record (log book) containing details of the work done by him/her during the entire period of training as per requirements of the log book. It should be duly certified by the supervisor as work done by the candidate and countersigned by the administrative Head of the Institution.
7. In the absence of production of log book, the result will not be declared.

Leave Rules

1. DNB Trainees are entitled to leave during the course of DNB training as per the Leave Rules prescribed by NBE.
2. A DNB candidate can avail a maximum of 20 days of leave in a year excluding regular duty off/ Gazetted holidays as per hospital/institute calendar/policy.
3. MATERNITYLEAVE:
    a. Afemale candidate is permitted a maternity leave of 90 days once during the entire duration of DNB course.
    b. The expected date of delivery (EDD) should fall within the duration of maternity leave.
    c. Extension of maternity leave is permissible only for genuine medical reasons and after prior approval of NBE. The supporting medical documents have to be certified by the Head of the Institute/hospital where the candidate is undergoing DNB training. NBE reserves its rights to take a final decision in such matters.
    d. The training of the candidate shall be extended accordingly in case of any extension of maternity leave being granted to the candidate.
    e. Candidate shall be paid stipend during the period of maternity leave. No stipend shall be paid for the period of extension of leave.
4. Male DNB candidates are entitled for paternity leave of maximum of one week during the entire period of DNB training.
5. No kind of study leave is permissible to DNB candidates. However, candidates may be allowed an academic leave as under across the entire duration of training program to attend the conferences/CMEs/Academic programs/Examination purposes.

DNB COURSE	NO. OF ACADEMIC LEAVE
DNB 3 years Course (Broad & Super Specialty)	14 Days
DNB 2 years Course (Post Diploma)	10 Days
DNB Direct 6 years Course	28 days

6. Under normal circumstances leave of one year should not be carried forward to the next year. However, in exceptional cases such as prolonged illness the leave across the DNB training program may be clubbed together with prior approval of NBE.
7. Any other leave which is beyond the above stated leave is not permissible and shall lead to extension/cancellation of DNB course.
8. Any extension of DNB training for more than 2 months beyond the scheduled completion date of training is permissible only under extra-ordinary circumstances with prior approval of NBE. Such extension is neither automatic nor shall be granted as a matter of routine. NBE shall consider such requests on merit provided the seat is not carried over and compromise with training of existing trainees in the Department.
9. Unauthorized absence from DNB training for more than 7 days may lead to cancellation of registration and discontinuation of the DNB training and rejoining shall not be permitted.
10. Medical Leave
    a. Leave on medical grounds is permissible only for genuine medical reasons and NBE should be informed by the concerned institute/hospital about the same immediately after the candidate proceeds on leave on medical grounds.
    b. The supporting medical documents have to be certified by the Head of the Institute/hospital where the candidate is undergoing DNB training and have to be sent to NBE.
    c. The medical treatment should be taken from the institute/ hospital where the candidate is undergoing DNB training. Any deviation from this shall be supported with valid grounds and documentation.
    d. In case of medical treatment being sought from some other institute/hospital, the medical documents have to be certified by the Head of the institute/hospital where the candidate is undergoing DNB training.

e. NBE reserves its rights to verify the authenticity of the documents furnished by the candidate and the institute/hospital regarding Medical illness of the candidate and to take a final decision in such matters.

11.

a. Total leave period which can be availed by DNB candidates is 120+28 = 148 days for 6 years course, 60+14=74 days for 3 years course and 40+10 = 50 days for 2 years course. This includes all kinds of eligible leave including academic leave. Maternity / Paternity leave can be availed separately by eligible candidates. Any kind of leave including medical leave exceeding the aforementioned limit shall lead to extension of DNB training. It is clarified that prior approval of NBE is necessary for availing any such leave.

b. The eligibility for DNB Final Examination shall be determined strictly in accordance with the criteria prescribed in the respective information bulletin.

EXAMINATION

FORMATIVE ASSESSMENT

Formative assessment includes various formal and informal assessment procedures by which evaluation of student's learning, comprehension, and academic progress is done by the teachers/ faculty to improve student attainment. Formative assessment test (FAT) is called as "Formative "as it informs the in process teaching and learning modifications. FAT is an integral part of the effective teaching .The goal of the FAT is to collect information which can be used to improve the student learning process.

Formative assessment is essentially positive in intent, directed towards promoting learning; it is therefore part of teaching. Validity and usefulness are paramount in formative assessment and should take precedence over concerns for reliability. The assessment scheme consists of Three Parts which has to be essentially completed by the candidates.

The scheme includes:-

Part I:- Conduction of theory examination
Part-II :- Feedback session on the theory performance
Part-III :- Work place based clinical assessment

Scheme of Formative assessment

PART – I	**CONDUCT OF THEORY EXAMINATION**	Candidate has to appear for Theory Exam and it will be held for One day.
PART – II	**FEEDBACK SESSION ON THE THEORY PERFORMANCE**	Candidate has to appear for his/her Theory Exam Assessment Workshop.
PART – III	**WORK PLACE BASED CLINICAL ASSESSMENT**	After Theory Examination, Candidate has to appear for Clinical Assessment.

The performance of the resident during the training period should be monitored throughout the course and duly recorded in the log books as evidence of the ability and daily work of the student

1. Personal attributes:

- **Behavior and Emotional Stability:** Dependable, disciplined, dedicated,stable in emergency situations, shows positive approach.
- **Motivation and Initiative:** Takes on responsibility, innovative,enterprising, does not shirk duties or leave any work pending.

- **Honesty and Integrity:** Truthful, admits mistakes, does not cook upinformation, has ethical conduct, exhibits good moral values, loyal to the institution.
- **Interpersonal Skills and Leadership Quality:** Has compassionateattitude towards patients and attendants, gets on well with colleagues and paramedical staff, is respectful to seniors, has good communication skills.

2. Clinical Work:

- **Availability:** Punctual, available continuously on duty, responds promptlyon calls and takes proper permission for leave.
- **Diligence:** Dedicated, hardworking, does not shirk duties, leaves no workpending, does not sit idle, competent in clinical case work up and management.
- **Academic ability:** Intelligent, shows sound knowledge and skills,participates adequately in academic activities, and performs well in oral presentation and departmental tests.
- **Clinical Performance:** Proficient in clinical presentations and casediscussion during rounds and OPD work up. Preparing Documents of the case history/examination and progress notes in the file (daily notes, round discussion, investigations and management) Skill of performing bed side procedures and handling emergencies.

3. Academic Activity: Performance during presentation at Journal club/Seminar/ Case discussion/Stat meeting and other academic sessions. Proficiency in skills as mentioned in job responsibilities.

FINAL EXAMINATION

The summative assessment of competence will be done in the form of DNB Final Examination leading to the award of the degree of Diplomate of National Board in Radiotherapy. The DNB final is a two-stage examination comprising the theory and practical part. An eligible candidate who has qualified the theory exam is permitted to appear in the practical examination.

Theory Examination

1. The theory examination comprises of ***Three/ Four*** papers, maximum marks 100 each.
2. There are 10 short notes of 10 marks each, in each of the papers. The number of short notes and their respective marks weightage may vary in some subjects/some papers.
3. Maximum time permitted is 3 hours.
4. Candidate must score at least 50% in the aggregate of ***Three/ Four*** papers to qualify the theory examination.

5. Candidates who have qualified the theory examination are permitted to take up the practical examination.
6. The paper wise distribution of the Theory Examination shall be as follows:

Paper I:

- Basic Sciences related to the specialty(Anatomy , Physiology , General and Systemic pathology, Clinical Oncology)
- Research Methodology
- Evidence Based Medicine ,Tumor Registry System and Follow up Methodologies
- Quality Assurance in Radiotherapy (QART)
- Medical physics and medical dosimetery as applied to clinical Radiotherapy.

Paper II:

Radiotherapy with combined and multi modality approach in relation to :

Urinary system, Genital tract, Breast, Respiratory system, Childhood

tumors, Head & Neck, Mediastinum, Hematepoietic system, Geriatric

Oncology.

Paper III:

- Radiotherapy with combined and multi modality approach in relation to : Skeletal system, Soft Tissue systems, Reticulo-endothelial system, Central nervous system, Skin, Gastro Intestinal system, Non malignant conditions.
- Details of practice of Cancer chemotherapy as applied to human malignancies, Management of Comorbid condition and Consequences(sequellae/side effects) of chemo radiation.
- Molecular and Genetic Oncology

Paper IV:

- Radiotherapy including radiobiology and radioactive isotopes
- Investigations

a) Practical Examination:

1. Maximum Marks: 300.
2. Comprises of Clinical Examination and Viva.
3. Candidate must obtain a minimum of 50% marks in the Clinical Examination (including Viva) to qualify for the Practical Examination.
4. There are a maximum of three attempts that can be availed by a candidate for Practical Examination.
5. First attempt is the practical examination following immediately after the declaration of theory results.
6. Second and Third attempt in practical examination shall be permitted out of the next three sessions of practical examinations placed alongwith the next three successive theory examination sessions; after payment of full examination fees as may be prescribed by NBE.
7. Absentation from Practical Examination is counted as an attempt.
8. Appearance in first practical examination is compulsory;
9. Requests for Change in center of examination are not entertained, as the same is not permissible.
10. Candidates are required not to canvass with NBE for above.

Declaration of DNB Final Results

1. DNB final is a qualifying examination.
2. Results of DNB final examinations (theory & practical) are declared as PASS/FAIL.
3. DNB degree is awarded to a DNB trainee in the convocation of NBE.

RECOMMENDED TEXT BOOKS AND JOURNALS

BOOKS

1. Liebelm and Philips text book of radiation oncology Richard T

Hoppe MD, FACR, FASTRO, Theodore Locke Philips MD, FACR, FASTRO, Mack Roach III MD, FACR.

2. Perez and Brady's Principles and Practice of Radiation Oncology Edward

C Halperin MD, MA, FACR, Carlos A Perez MD, Luther W Brady .

3. Cancer – Principles and Practice of Oncology Vincent T De Vita, Jr.
Theodore S, Lawarence, Steven A Rosenbergo, Stevven A.

4. Clinical Radiation Oncology Leonard L Gunderson, Joel E Tepper.

5. Bethesda Handbook of Clinical Oncology by Carmen J Allegra MD (Editor), Jame Abraham MD (Editor), James L Gulley MD (Editor).

6. Handbook of evidence based radiation Oncology ,Dr. Eric K

Hansen, Dr, Mack Roach III.

7. Moss's Radiation Oncology: Rational, Technique, Results (1994) William Thomas Moss, and James Daniel Cox.

8. Text Book of Radiotherapy, Gilbert H Fletcher.

9. Treatment planning in Radiation Oncology Faiz M Khan.

10. Oxford Handbook of Oncology, Jim Cassidy, Donald Bissett, Roy A J Spence Obe.

11. The Physics of Radiation Therapy: Mechanisms, Diagnosis and Management by Faiz M Khan.

12. The Physics of Radiology , Haold Elford Johns, John Robert

Cunningham.

13. Radiobiology for the Radiologist 6th Edition, Eric J Hall.

14. The Chemotherapy source Book 4th Edition, Michel C Perry.

15. Text Book of Medical Oncology 4th edition, Franco Cavalli, Stan B Kaye, Heine H Hansen, James O Armitage, Martine J.

16. Surgical Oncology: Contemporary principles and Practice, K. I. Bland, John M Daly, Constantine P Karakousis.

17. Basic Clinical Radiobiology, Edited by G Gordon Steel

18. Principles And Management of Cancer, Tejinder Kataria, Hemant Singhal,Dinesh Chand Doval

19. Cancer Biology, Roger J.B.King,Mike W .Robins

20. Textbook of Radio Therapy by Dr Rath and Dr Mohanthy

JOURNALS

1. International Journal of Radiation Oncology, Biology, Physics.
2. Annals of Oncology
3. British Journal for Cancer
4. CA-A Cancer Journal for clinicians
5. Cancer
6. Cancer of clinical Oncology
7. Journal of Clinical Oncology
8. Journal of Cancer Research and therapeutics
9. Medscape Oncology
10. Seminars in Oncology
11. Seminars in Radiation Oncology
12. The Lancet
13. The new England Journal of Medicine
14. Radiotherapy and Oncology, Elsevier
15. Lancet Oncology-Elsevier
16. Acta Oncologica
17. Nature reviews Clinical Oncology
18. Natures Clinical Practice oncology

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