HONG KONG COLLEGE OF RADIOLOGISTS

SPECIALTY TRAINING : CLINICAL ONCOLOGY

OBJECTIVES OF TRAINING

(A) *Basic Specialist Training*

1.0 To acquire a broad background knowledge relating to the management of patients with cancer.
2.0 To have a detailed knowledge of the basic sciences on which Clinical Oncology is based, and a sound understanding of the pathogenesis of neoplastic disorders.
3.0 To develop the power of logical thinking and analysis of scientific and clinical data.
4.0 To acquire a detailed knowledge on the principles and practice of radiotherapy, chemotherapy, hormonal therapy and biologic therapy of neoplastic disorders and other morbid conditions.
5.0 To be conversant with the updated practice and current literature on relevant subjects.

(B) *Higher Specialist Training*

1.0 To be confident as an individual practitioner in Clinical Oncology and be able to give sound and practical advice upon consultation.
2.0 To be an effective member of a team of specialists in the multidisciplinary approach on the management of neoplastic diseases, and to carry out research, teaching, audit and management activities.
3.0 To practice evidence-based medicine with emphasis on total patient care.
4.0 To develop special skills in various fields and subspecialties of Clinical Oncology.
5.0 To be motivated towards continuous professional development.

TRAINING REQUIREMENTS

(A) *Entry Requirements & Duration of Training*

1.0 The trainee needs to be fully registrable with the Hong Kong Medical Council.
2.0 The duration of training shall last for a minimum of 6 years, with 4 years of basic specialist training including a minimum of 3 years of full time training in a recognized Clinical Oncology centre, and 2 years of higher specialist training.
3.0 Trainees in Clinical Oncology should have a regular on-call commitment for their specialty.
4.0 Absence from training and full-time research work may affect the training period requirement.

(B) *Basic Specialist Training: Part I & II*

1.0 Clinical experience outside Clinical Oncology is required. This may involve previous training in other specialty or elective training to other specialty, with the accepted specialty and duration at the discretion of the College.

2.0 Part I.

2.1 A thorough knowledge on the basic sciences on which Clinical Oncology is based is required including radiation physics, radiation protection and related legislation, medical statistics, radiobiology, tumour biology, principles of chemotherapy, biological and hormonal therapy.
2.2 The Part I Fellowship Examination may be attempted after completing the respective basic science courses organized or recognized by the College. Satisfactory attendance on these training courses will be required before trainees are allowed to attempt the Examination.

3.0 Part II.

3.1 This will lead up to the Part II Fellowship Examination of the College.
3.2 The trainee should receive a comprehensive grounding in all subjects related to Clinical Oncology, including care of the terminally ill. This may require rotation to other Clinical Oncology Units/Departments to ensure wide exposure to various diseases.
3.3 A comprehensive knowledge on the aetiology, pathology, epidemiology, natural history, prevention and management of cancer would be acquired. The ability to deal with general acute and chronic problems relating to either the diseases or treatment complications, including palliative care and symptom control of the advanced and terminal cancer patients, would be expected.
3.4 A detailed knowledge on the more practical aspects of radiotherapy is expected, including the whole process of simulation, treatment plan creation and selection, setting up procedures and verification, radiation dosage and scheduling, and toxicities of treatment.
3.5 A detailed knowledge on the use of chemotherapeutic, biological and hormonal agents on the treatment of neoplastic diseases is also required. This would include detailed knowledge of various regimes and dosages of commonly used agents. Knowledge on combined modalities in various diseases is also required.
3.6 The concept of total patient care would be reinforced, emphasizing on the physical, psychosocial and spiritual aspects of care for cancer patients.
3.7 The trainee will be expected to be familiar with up-to-date literature and current trends, and be able to discuss intelligently various treatment options and modalities in a wide variety of clinical settings.
3.8 During the whole period of clinical training, emphasis would be put on the cultivation of a high level of professional conduct and ethics. Communication skills should be developed to ensure good doctor-patient relationship and understanding among colleagues.
3.9 After completing the required minimum of 4 years in basic specialist training in a recognized training centre, and with prior success at the Part I Fellowship Examination, trainees are allowed to attempt the Part II Fellowship Examination.

(C) *Higher Specialist Training*

1.0 In this stage of training, which comprises the final two years of the whole training period after passing the Final Fellowship Examination, more emphases will be made on providing the trainee with opportunities for independent practice.
2.0 Confidence and maturity would be cultivated, resulting in better clinical judgement and more effective problem solving and decision making. Special skills on sub-specialty or site-specialist training would be developed.
3.0 Team work would be emphasized, including organizing and running of combined clinics towards the multidisciplinary approach to cancer management.
4.0 Emphasis would be put on evidence-based practice. Sound knowledge on literature including cost-effectiveness of various treatment modalities and options would be required.
5.0 Theoretic and practical knowledge on clinical research would be acquired. Opportunities would be provided for the trainee to experience the whole process of running clinical trials, performing statistical analyses and writing up treatment protocols.
6.0 Involvement in teaching and training of junior colleagues would be required in the form of formal lectures, tutorials, organization of seminars, clinical pathological conferences and bedside teaching.
7.0 Active participation in academic activities would be enforced. Participation in local or overseas conferences, seminars, or scientific meeting is required. At least one research project lead by the trainee is to be presented at College Annual Scientific Meeting or regional/international radiology/oncology conference, published/accepted for publication in the Journal of the College or other professional journals.
8.0 Management training would be initiated, with participation in departmental meetings, clinical audit and quality assurance programmes, risk management, handling of complaints and conflicts, resource allocation and planning in the delivery of professional service. Attendance of management courses would also be encouraged.

EXAMINATION FORMAT

1.0 The College examination for basic specialist training will be in 2 parts.

2.0 *Format of Part I Examination* :

2.1 The examination consists of written papers of structured questions and multiple choice questions in the following 5 subjects:
- Cancer Biology
- Clinical Pharmacology
- Medical Statistics
- Medical Physics
- Radiobiology

2.2 The examination will be held twice a year in spring and autumn, usually in March and September. Candidates may enter the examination at any four consecutive sittings.

2.3 Candidates may enter any number of subjects at a single sitting. For each subject, there are two written papers - one of multiple choice questions and one of structured questions. Any candidate who does not attempt all components of the subject will be deemed to have failed that subject overall.

2.4 The total number of attempts is restricted to 4 in consecutive sittings.

2.5 There is no requirement to resit a subject once a pass in that subject has been achieved.

3.0 *Format of Part II Examination:*

3.1 The examination has a written part consisting of a case-oriented question paper and a multiple choice question paper.

3.2 There is a clinical examination and a structured oral examination examined by pairs of examiners, with one local and one overseas oncologist.

3.3 Any candidate who does not attempt all components of an examination will be deemed to have failed the examination overall.

3.4 Unsuccessful candidates will be required to resit the whole of the Final Examination for the Fellowship. There is no restriction to the number of attempts for the Final Examination.

4.0 *Review of Performance at Examinations*

4.1 Part I Examination:

4.1.1 After 2 unsuccessful attempts at any subject of the Part I Examination, candidates are invited to meet the Chairman of the Education Committee and the respective supervisor to advise on the required improvement area and remedial actions.

4.2 Part II Examination:

4.2.1 Candidates who fail the examination will be informed of their performance at each paper/session. It is expected that counselling will be provided by the designated training officer at each training centre.

4.2.2 After 3 unsuccessful attempts at the Part II Examination, a candidate's performance will be reviewed by the Chairman of the Education Committee, one examiner of the examination together with the trainee and the respective supervisor, to advise on the required improvement areas and remedial actions. Candidate who performs badly in the Final Examination as a whole may be referred for twelve months.

4.2.3 The Review Committee of the College will consider queries and appeals.

EXIT ASSESSMENT FOR COLLEGE FELLOWSHIP

1.0 After completion of the required period of Higher Specialist Training, a trainee can apply for consideration of the Fellowship of the College.

2.0 Exit Assessment exercises are conducted by the College twice a year, normally in January and July.

3.0 A panel of assessors comprising the following members would carry out a formal assessment of the trainee's completion of training:

(i) The Chairman of the Education Committee of the College.

(ii) Two other distinguished Clinical Oncologists, who should NOT be the trainee's supervisors, appointed by the Education Committee and approved by the Council.

4.0 The procedure of assessment would include:

(i) Scrutiny of the training records of the trainee for completeness of training.

(ii) Appreciation of the regular continuous appraisal reports of the respective supervisor.

(iii) Further supportive documents may need to be furnished by the trainee or the respective training centre on request.

(iv) A 30-minute oral assessment of the trainee by the panel of assessors will be held to evaluate the trainee's professional attitude, ability in communication skill, solving clinical or management issues and appreciation of oncology literature.

5.0 A trainee unsuccessful at an Exit Assessment, and the Head of the respective training department, will be informed of the Panel's comments on the weaknesses of the trainee and the advice on appropriate remedial actions.

SYLLABUS

1.0 PART I EXAMINATION:

1.1 *PHYSICS*

General Remarks

- The course aims at getting the trainees to acquire a broad knowledge of physics relevant to the clinical practice of radiotherapy, including the application of physical principles and methods in clinical radiotherapy, physical basis of the therapeutic uses of radioactive isotopes, radiation hazards and protection.
- A basic knowledge of physics is assumed. A mathematical approach to the syllabus is inappropriate. The emphasis would be placed on a clear understanding of the physical basis of radiological practice in a qualitative sense.
- The whole of the syllabus should be covered by formal teaching, tutorials and demonstrations sessions. During the course, therapeutic and related equipment and procedures will be demonstrated to illustrate the importance of the subject to daily practice.

Scope of the Syllabus

1.1.1 Basic physics relevant to radiotherapy

- Atomic structure, atomic and mass numbers
- Electron shells and energy levels
- Electromagnetic radiation
- Electromagnetic spectrum
- Energy quantitisation
- Relationship between wavelength, frequency and energy
- Description of an x- or g-ray beam (quality, energy, intensity, size)
- Basics of production of x- or g-rays
- Continuous and discrete spectra
- Attenuation, absorption, scattering of x-rays
- Attenuation coefficients, half value layer

1.1.2 Electromagnetic Radiation and its interaction with Matter

For each of the following understand the nature of the effect and its dependence on the properties of the irradiated material (e.g. density, atomic number), its variation with energy and the relative importance in therapy and imaging.

- Elastic scattering
- Compton effect
- Photoelectric effect
- Pair production
- Photonuclear interactions
- Auger effect
- Scattered radiation
- Secondary electrons
- Range versus energy
- Linear energy transfer

1.1.3 Interaction of sub atomic particles with matter

- Ionisation and excitation due to charged particles
- Electrons
    - collision loss
    - radiative loss
    - stopping power due to each and total stopping power
    - particle range
    - Bragg peak
- Bremsstrahlung

- Neutrons: elastic and inelastic collisions
- Protons, ionisation profile
- Elementary knowledge of pions and heavy ions

1.1.4 Radiation Dosimetry

- Concept of absorbed dose
- Definitions and units
- Variation of absorbed dose in different tissues and materials
- Concept of exposure and KERMA
- Simple introduction to the relationship between exposure, KERMA and absorbed dose
- Ionisation in gases
- The physical principles underlying radiation dose measurement
- Concepts and practice of dose measurement
- Relationship between measurement of ionisation and derived measurement of dose
- Measurement of exposure
- Free air ionisation chamber
- Methods of measurement
- Elemental knowledge of the construction, advantages and disadvantages of the following:
  - ionisation methods (ionisation chamber, Geiger counter, diodes)
  - chemical methods, primarily films
  - thermoluminescence (TLD)
  - scintillation counters
  - calorimetry
- Calibration methods
  - intercomparisons
  - standards (local and national)
  - corrections (temperature, pressure, beam direction etc)
  - constancy checks
- Practical dose measurements
  - introduction to the derivation of isodose curves
  - central axis depth dose profiles

1.1.5 Teletherapy beams physics (x-rays)

- X-rays beams used in clinical practice
- Energy ranges
- Build up and skin sparing for x-rays
- Isodose curves for x-rays
- Fixed FSD and isocentric approaches
- Principles of wedges
- Wedge angle
- Trays
- Output factors
- Beam geometry
  - magnification and penumbra
  - field size definition

1.1.6 Electron Beam Physics

- Electron beams used in clinical practice
- Energy ranges
- Percentage depth dose
- Factors affecting depth dose
- Build up and skin sparing for electrons
- Isodose curves for electrons
- Effects of surface obliquity and inhomogeneities on dose distributions
- Internal shielding

1.1.7 Radiotherapy treatment planning

- Data required for treatment planning
- Immobilisation (techniques and accuracy)
- Effects and minimisation of patient and organ movement
- Tumour localisation: direct visual, simulator, CT, MRI, ultrasound
- Separation and contour information (uniplanar, multiplanar)
- Transposition of patient data: magnification, target volumes, sensitive structures, dose modifying structures
- Structure and use of a simulator
- Use of a CT scanner in radiotherapy planning
- CT simulator
- Fixed FSD vs. isocentric planning
- Coplanar planning in a uniform medium
- Isodose distributions in each of the following situations, their uses and critical assessment:
  - single field
  - isodose summation
  - multifield planning
  - weighting
- Principles of conformal therapy including IMRT
- Principles of arc and rotational therapy
- Principles of non-coplanar planning
- Principles of stereotactic localisation
- Tissue compensators
- Surface obliquity
- Inhomogeneous media
- Volume definition (various methods including ICRU 50, 62)
- Dose prescription (various methods including ICRU 50, 62)
- Basics of dose calculations in the presence of extensive shielding (e.g. sector or Clarkson integration)
- Field matching
- TBI
- Principles of CT treatment planning
  - acquisition of data and data transfer
  - image manipulation and image fusion
  - defining the volume, growing tools
  - beam placement using beam's eye view
  - plan verification and evaluation using isodose display, dose volume histograms (DVH cumulative and frequency) and digitally reconstructed radiographs (DRR)
  - elements of inverse planning
  - elements of intensity modulated radiotherapy

1.1.8 Beam Therapy Equipment

- Principles of superficial and orthovoltage x-ray production
- Principles of the linear accelerator
- Basics of the following:
  - microwave production
  - wave guide construction
  - electron beam production
  - x-ray production, beam control and stability
- Basics of the linear accelerator head construction
- Basic construction of a cobalt machine
- Output
- Concept and definition of the isocentre
  - source size
  - defining the beam geometry: collimators, applicators, multileaf collimators, cast blocks, penumbra, factors influencing penumbra
  - defining the beam quality

- wedges and applicators: types, construction, action, use and effect on depth dose
- shielding: techniques, materials, transmission, scatter, doses under shields

- Irradiating the target
  - the treatment couch
  - positioning the patient
  - lasers
  - pointers
  - light fields
  - monitoring radiation output
  - control of the accelerator
- Multileaf collimators: edge definition, leaf leakage, influence of leaf size
- Stereotactic equipment

1.1.9 Quality Assurance in Radiotherapy

- Definition of quality assurance and quality control
- Writing and implementing the radiotherapy prescription
- The role of computer verification
- Manual checking
- Monitoring accuracy of treated volume: verification films and mega-voltage imaging
- Monitoring accuracy of positioning (laser, light-fields, mechanical pointers, tolerances)
- Monitoring accuracy of radiation output: symmetry and field flatness (tolerances)
- Legal requirements

1.1.10 Radioactive sources

- Basics of radioactivity, including
  - Types of radiation and radioactive decay
  - Isotopes
  - concepts, definitions and units of activity and half-life.
  - characteristics of radiation
  - parent and daughter decay series
  - radioactive equilibrium
  - sealed and unsealed sources
- Types of sources and their construction (wires, hairpins, seeds, tubes, needles, ovoids, etc)
- Requirement for clinical sealed sources
- Specific forms of sources (198Au, 192Ir, 137Cs, 125I, 90Sr)
- Inverse square law
- Specifications of source strength, air KERMA rate
- Calculation of absorbed dose from a source
- Dose distributions around standard sources
- Hazards with sealed sources
- Control and testing of sealed sources
- Measurement of activity
- Storage and movement control
- Source handling, issue
- Leak testing, inspection
- Safety devices

1.1.11 Brachytherapy

- Principles of clinical use
- Distribution rules and dose calculation basis for Paris system
- Gynaecological intracavitary brachytherapy systems, source and dose distributions
- Dose specification
- Principles of afterloading
- Types of afterloading (manual, remote, low, intermediate and high dose rate)

1.1.12 Unsealed sources

- § Isotopes
- § Stability, shelf life
- § Physical v biological half life
- § Radiopharmaceuticals
- § Use in imaging and therapy
- § Clinical applications and dose calculations

1.1.13 Radiation Protection

- § Radiation risks
- § Stochastic and non-stochastic processes
- § Quality factors and dose equivalent
- § Statutory framework
- § Background radiation
- § Low level exposure effects
- § Radiation limits
- § Classification of staff, designated areas
- § IRR 1999
- § Guidance Notes
- § IR(ME)R 2000
- § Local Rules
- § Dose limits
- § Controlled areas and screening
- § Protection mechanisms: time, distance, shielding
- § Design of treatment rooms
- § Primary/secondary barriers
- § Transmission through barriers, elementary calculations
- § Mazes, doors and interlocks
- § Leakage and scattered radiation
- § Design of sealed sources
- § Monitoring of personnel: construction and operating of film badge, TLD badge, direct reading dosemeter
- § Dose reporting mechanisms and dose levels

1.2 *MEDICAL STATISTICS*

General Remarks

- The course aims at providing the trainees with sufficient knowledge to enable them to study critically the statistical validity of published investigations with emphasis on the requirements needed to design, monitor and assess clinical trials and epidemiological studies.

Scope of the Syllabus

1.2.1 Types of data

- § Categorical data (nominal, ordinal) & numerical data (discrete, continuous).
- § Presenting and summarizing individual variables
- § Qualitative data: proportions, bar charts and histograms, contingency tables and relative risk
- § Quantitative data: measurements of location and dispersion histograms, transformations, scatter diagram, biological variation and the Normal distribution, measures of central tendency and spread

1.2.2 Sampling

- § Concept of a source population
- § Sampling: random, non-random
- § Estimation of population statistics
- § Standard error of sample mean and of a proportion, and their differences
- § Level of confidence, confidence intervals
- § References ranges

1.2.3 Principles of statistical inference

- Hypothesis testing and estimation
- Type I and II errors
- Interpretation of p-values and confidence intervals
- One or two tailed tests
- Statistical and clinical significance
- Statistical power and statistical insignificance

1.2.4 Comparing 2 or more groups

- T-tests, paired and two-sample t-tests, non-parametric analogues of t-test
- Chi-square test, Yates correction, Fisher's exact test, 2 x 2 contingency table, extension to analysis of variance and larger tables

1.2.5 Measures and tests of association between variables

- Correlation and regression
- Scatter plots
- Screening tests
- Trend test
- Sensitivity and specificity
- Positive and negative predictive value

1.2.6 Survival Analysis

- Types of time-to-event data (survival data, recurrence data)
- Summarising, measurement and presentation of survival data: life table (actuarial) method, prediction model, crude and age-adjusted survival rates, failure time, censoring, survival curve, life table (actuarial) and Kaplan-Meier (product limit) estimates
- Comparing groups, comparison of two curves, logrank (Mantel-Haenszel) test for 2 or more groups, including ordered groups
- Use of Cox's proportional hazards regression model, hazard ratios and their interpretation
- Concept of a cured group and recurrence-free rates.

1.2.7 Clinical trials

- Phases I – IV of clinical trials
- Randomization: needs, problems with non-randomized studies and historical controls, methods (simple, block, stratified minimisation), biases, number of patients required, blinding/masking
- Sequential trials, multi-centre studies, single and double blind studies
- Designs: parallel group, cross-over, factorial and Latin Square
- Protocol: aims of study, inclusion and exclusion criteria, sample size calculation, informed consent, ethical considerations, methods of allocating treatment options, interim analyses, intent-to-treat analysis, prognostic factors, outcomes, violations and when to stop.
- Measures of response, tumour regression, local and regional recurrence, distant metastases, death
- Quality of life, morbidity
- Role and basic principles of meta-analysis.
- Critical appraisal

1.2.8 Epidemiology

- Design and interpretation of retrospective (case control) and prospective (cohort) studies
- Odds ratios and relative risks
- Crude and age specific mortality rates, standardised mortality rate and standardised mortality ratio (SMR), incidence and prevalence rates, age-standardised incidence rates
- Cancer registration and follow-up
- Cancer incidence and mortality rates for major anatomical sites, trends in cancer incidence and mortality, aetiological studies, screening and diagnostic tests.

1.3 *CANCER BIOLOGY*

General Remarks

- Trainees will be required to have understanding on carcinogenesis, cellular and molecular features of malignancy, including biochemical control, signalling and cell death. Knowledge on tumour development, growth kinetics, micro-environmental changes, metastasis and immune response. Common laboratory techniques to demonstrate these features.

Scope of the Syllabus

1.3.1 Biology
- § Cell structure and function
- § Definitions of and distinctions between different types of growth disorder, dysplasia and carcinoma-in-situ
- § Mechanisms of spread, local invasion/migration, metastasis
- § Effects of tumours: local (e.g. pressure), distant (metastatic and non-metastatic)

1.3.2 Techniques in molecular biology
- § Principles and use of technique only, not details of execution
- § Nucleic acid analyses including electrophoresis, hybridisation, blotting, PCR, sequencing, transfection
- § Micro-array techniques
- § Transgenic models

1.3.3 The genetics of normal and malignant cells
- § Normal chromosomal structure and function, normal gene transcription and its control
- § Normal DNA repair mechanisms
- § Polymorphisms, mini and microsatellites
- § Chromatin structure and function
- § Methylation, hypomethylation and methylation reversal
- § Chromosomal and genetic changes in malignancy, point mutations, translocations, deletions, gene amplification and over-expression
- § Oncogenes, proto-oncogenes, tumour suppressor genes (a knowledge of well established examples in each class is expected)
- § Protein-protein interactions

1.3.4 Growth of normal and malignant cells
- § Growth kinetics: cell cycles, growth fraction recruitment, cell loss, and their study through MI, LI, autoradiography, and flow cytometry
- § Tissue classification and cell replacement, apoptosis, cell lineages, stem cells, and proliferative units
- § Signal transduction (MAP kinase)
- § The role of cyclin kinases
- § Gene promoters and their activity in normal and malignant cells

1.3.5 The physiology of haemopoiesis
- § Marrow structure and organisation
- § The haemopoietic microenvironment
- § Cell lineages and hierarchies
- § Control mechanisms in normal haemopoiesis

1.3.6 Cancer genetics
- § Inherited syndromes associated with cancer: ataxia telangiectasia, xeroderma pigmentosa, Nijmegin break syndrome, Li-Fraumeni, Lynch, MEN, Cockayne's, familial polyposis coli, inherited breast cancer syndromes
- § Genes conferring susceptibility to cancer
- § Mechanisms whereby such genes can be associated with neoplasia
- § Linkage analysis
- § Principles of genetic counselling

1.3.7 Causation of human cancers
- § Environmental factors and influences
- § Carcinogenesis in-vitro and in-vivo
- § Viral carcinogenesis: viruses firmly associated with cancer (HPV, EBV etc)

- § Radiation carcinogenesis:- ionising and non-ionising radiation associated with carcinogenesis, DNA damage and repair (differing effects with various radiation types), nucleotide excision repair, genes and products associated with repair

1.3.8 Normal and aberrant mechanisms of cell growth control
- § Control of normal cell growth and behaviour
- § Autocrine, paracrine and endocrine growth factors
- § Altered expression, function and control of these mechanisms in malignancy

1.3.9 The immune system
- § Cellular involvement in the immune system
- § Antigen recognition and processing
- § Dendritic cells
- § Clonal expansion of lymphoid cells in response to stimulation
- § Immunological surveillance
- § Tumour immunology

1.3.10 Molecular biology of drug resistance

1.3.11 Tumour vasculature and angiogenesis

1.4 *RADIOBIOLOGY*

General Remarks

- Trainees are required to have knowledge of the cellular and molecular basis for the response of cells, tissues and tumours to ionizing radiation. To understand the chemical interactions between radiation and cells and the principles underlying the application of radiotherapy to treat diseases. This involves an understanding of the main biological principles and developments underpinning the therapeutic applications of radiation. A knowledge of current models of radiation response is expected.

Scope of the Syllabus

1.4.1 General
- § Cellular systems (hierarchical, flexible) and their response to radiation
- § Parallel and linear systems
- § Radiation biology models (monolayer, spheroids, animal –normal and transgenic), regrowth curves, clonogenic assay, MTT
- § The cell cycle, basic cell kinetics, including parameters associated with cell cycle times
- § LET and its relevance to cellular damage
- § Radiation damage at the cellular level (membrane, cytoplasmic, nuclear)

1.4.2 Molecular biology of radiation damage and repair
- § The basics of experimental molecular radiobiology
- § Molecular processes involved in radiation damage and repair
- § The relevance of molecular radiation biology to radiation sensitivity
- § Time course of repair

1.4.3 Population radiobiology
- § Normal tissue damage (early and late)
- § Production of the cell survival curve
- § Descriptive models, e.g. linear quadratic model
- § The concept of damage (lethal, sublethal, potentially lethal) and repair (early and late)
- § 5Rs of radiobiology
- § Effect of cell cycle on radiation sensitivity
- § The cell survival curve as a basis for fractionation
- § Terms describing cellular sensitivity (SF2, α , β , mean inactivation dose)
- § α/β ratio and its relevance to acute and late responding tissues
- § Isoeffect curves
- § Fractionation and its influence on outcome with varying α/β ratio
- § Altered fractionation:- Hyperfractionation, Hypofractionation, Accelerated fractionation;

methods for estimating the effect of altered fractionation schemes, e.g. BED formula
- § Repopulation, influence of gaps in radiotherapy and their management
- § Time effect, influence of time on radiation response including dose rate effects
- § Relative biological effect (RBE), linear energy transfer (LET), and their relationship
- § Oxygen effect: influence of oxygen on radiosensitivity, oxygen enhancement ratio (OER), relationship between OER & LET, reoxygenation, methods of identifying hypoxia experimentally
- § Hypoxic cell sensitiser and cytotoxins
- § Radiation protectors
- § Use of high LET radiation
- § Dose rate effect, low dose rate, high dose rate and pulse dose rate radiotherapy

1.4.4 Normal tissue radiobiology
- § The concept of normal tissue tolerance, factors influencing tolerance
- § The biological hazards of irradiation, effects of radiation on different tissues and organs
- § Dose protraction and LET
- § Tolerance levels for different tissues and organs
- § Organ tolerance to retreatment with radiation
- § Schemes for reporting normal tissue damage
- § Systemic irradiation and toxicities, whole body syndromes
- § Biological basis of radiological protection. Effects on the embryo and the foetus; life shortening, leukaemogenesis and carcinogenesis, genetic and somatic hazards for exposed individuals and populations.

1.4.5 Interaction between radiation and other agents
- § Chemotherapy (before, during and after radiation)
- § Basic principles of hyperthermia

1.5 *CLINICAL PHARMACOLOGY*

General Remarks

- The emphasis is on clinical use of cytotoxic drugs, hormones and biological therapies, their structure, mode of action, toxicities and side effects.
- Also include basic principles of pharmacokinetics and pharmacodynamics, evaluation of drugs used in the cancer treatment, and the basic pharmacology of drugs used in the supportive care of cancer patients.

Scope of the Syllabus

1.5.1 Mode of action of cytotoxic drugs
- § Classification of cytotoxic drugs
- § Mechanisms of action
- § Phase specific and cycle specific drugs
- § Mechanisms of cell death
- § Drug resistance: mechanism and methods to overcome, drug resistance modifiers

1.5.2 Drug design and development
- § Novel therapeutic targets
- § New drug discovery and development
- § Preclinical assessment of candidate compounds
- § Clinical studies (Phase I, II, III, IV)

1.5.3 Pharmacokinetics and pharmacodynamics
- § General principles of pharmacokinetics
- § Factors affecting drug concentration in-vivo: route and timing of administration, drug activation, plasma concentration, metabolism and clearance
- § Plasma concentration and its relationship to drug actions
- § AUC
- § Protein and tissue binding

- § Drug concentration at target site

1.5.4 Principles of clinical use
- § Dose response curve
- § Dose intensity
- § Single agent and combination therapy
- § Adjuvant and neo-adjuvant therapy
- § High dose chemotherapy
- § Regional therapy
- § Targeting of drugs
- § The clinical pharmacology and technology of continuous infusion
- § Sanctuary sites and the clinical pharmacology of intrathecal treatment
- § Modification of drug resistance

1.5.5 Toxicity of chemotherapy
- § Mechanisms of toxicity
- § Dose limiting and common toxicities
- § Dose-related and idiosyncratic toxicity
- § Early, intermediate and late genetic and somatic effects of common classes of anti-cancer drugs
- § Chemical and other factors modifying drug toxicity
- § Safe handling of cytotoxic drugs

1.5.6 The clinical pharmacology of analgesics
- § Morphine and derivatives
- § Drug combinations
- § Different formulations, e.g. slow release and patch formulations

1.5.7 The clinical pharmacology of steroids and anti-emetics

1.5.8 Drug interactions in cancer treatment
- § potentiation, antagonism
- § common or important interactions between drugs used in cancer therapy and other commonly used agents, e.g. increased toxicity in patients receiving methotrexate who are taking NSAIDs

1.5.9 Endocrine therapy
- § Mechanisms of action
- § Mechanisms of resistance
- § Common side effects
- § Combination with other therapies

1.5.10 Biological and novel therapies
- § Biological therapies, their mechanism of action, combination with standard therapy
- § The mode of action of interferons, interleukins, growth factors, antibody therapy, gene therapy, immunotherapy
- § Novel targets for anti-cancer drugs, including vasculature, cell signal control and oncogene products. DNA repair pathways. Protein kinase signalling pathways. ErbB2 and EGFR pathways. Signal transduction inhibitors
- § Bioreductive drugs
- § Cancer vaccines

1.5.11 The basic principles of high dose therapy
- § The clinical pharmacology and rationale of high-dose therapy
- § Methods for protection / rescue of stem cells
- § Unusual toxicities, e.g. veno-occlusive disease etc

2.0 PART II EXAMINATION

Candidates are expected to have a wide knowledge of malignant disease and the management of patients with cancer of all organ systems. The main emphasis is on radiotherapy and drug therapy, but a good knowledge of general medicine, surgery and gynaecology is expected.

Scope of the Syllabus

2.1 *KNOWLEDGE*

Candidates for the Part II Examination need to have a broad knowledge relating to all aspects of the investigation and management of patients with cancer.

2.1.1 Prevention

- A broad knowledge of the environmental causes of cancer and possible strategies for prevention

2.1.2 Screening

- Details of screening programmes for cervical, breast and colorectal cancers

2.1.3 Genetics

- The familial aspect of some cancers is required (colorectal, breast, ovary, retinoblastoma, multiple cancer syndromes) and the management of high risk families and genetic counselling.

2.1.4 Anatomical Sites and Types of Tumours

- Head and Neck
  - *Lip*
  - *Oral cavity*
  - *Oropharynx*
  - *Hypopharynx*
  - *Nasopharynx*
  - *Supraglottis*
  - *Vocal cord*
  - *Sub-glottis*
  - *Middle ear*
  - *Nose and nasal sinuses*
  - *Orbit and optic nerve*
  - *Lachrymal gland*
  - *Salivary gland*
  - *Glomus jugulare tumours*
  - *Carotid body tumours*
- Gastro-Intestinal Tract
  - *Oesophagus*
  - *Stomach*
  - *Liver*
  - *Pancreas and biliary tract*
  - *Small bowel*
  - *Colon and rectum*
  - *Anal canal and peri-anal region*
- Chest
  - *Pleura*
  - *Trachea*
  - *Lung*

Mediastinum and thymus

§ Genito-Urinary Tract
- *Kidney*
- *Ureter*
- *Bladder*
- *Urethra*
- *Prostate*
- *Penis*
- *Testis*

§ Female Genital Tract
- *Uterine cervix*
- *Uterine body*
- *Vagina*
- *Vulva*
- *Ovary*
- *Fallopian tube*

§ Central Nervous System
- *Brain*
- *Spinal cord*
- *Craniopharyngioma*
- *Chordoma*
- *Acoustic neuroma*
- *Meninges*

§ Soft Tissue Sarcomata and Bone Tumours
- *Adult soft tissue sarcoma*
- *Childhood/adolescent sarcoma*
- *Chondrosarcoma*
- *Osteosarcoma*
- *Ewing's tumour*

§ Paediatric Tumours
- *Medulloblastoma*
- *Neuroblastoma*
- *Nephroblastoma*
- *Retinoblastoma*

§ Lymphoproliferative and Myeloproliferative Disorders
- *Hodgkin's lymphoma*
- *Non-Hodgkin's lymphomas*
- *Plasma cell malignancies*
- *Acute and chronic leukaemias*

§ Skin
- *Basal cell carcinoma*
- *Squamous cell carcinoma*
- *Malignant melanoma*
- *Cutaneous lymphoma*
- *Kaposi's sarcoma*

§ Endocrine
- *Breast*
- *Thyroid*
- *Parathyroid*
- *Pituitary*
- *Adrenal*

For each of the tumour types and sites listed at paragraph 2.1.4:

(a) Management

- Initial staging investigations including imaging and tumour markers
- Relevant prognostic factors
- Assessment for treatment
- Role of surgery
- A management plan, or, where applicable, a range of such plans
- Ionising Radiation Regulations
- Roles of surgery, radiotherapy and cytotoxic chemotherapy in multi-modality approaches to cancer treatment

(b) Pathology

- The range of tumours that can occur
- Their aetiology, incidence and epidemiology
- A brief morphology of the common tumours
- The natural history of the disease including likely presentation, characteristic growth and metastatic pattern
- Staging classifications, e.g. TNM, FIGO
- Use of tumour markers in diagnosis and treatment of tumours
- Use of specialised pathology techniques, e.g. immunocytochemistry
- Interpretation of clinicopathological data in the tumour site specialised multidisciplinary approach to patient management

(c) Radiotherapy

- The role of irradiation in radical and palliative management
- Where radical radiotherapy is a treatment option:
  - Staging investigations
  - A definition of tumour volume and target volume boundaries
  - ICRU reports 50 and 62
  - An acceptable radiotherapeutic technique, or, where applicable, a range of such techniques
  - The correct treatment position
  - Details of the target volume localisation process
  - Use of CT axial images, 3D planning
  - Verification techniques such as laser alignment, skin tattoos, orthogonal and portal films
  - The approximate dose distributions for the chosen technique
  - An appropriate dose/fractionation regime
  - Relevant dose modifying factors (changes in fractionation, age, target volume, intercurrent infections, previous therapies)
  - Details of the set-up instructions for radiographers
  - Appropriate responses to changes of patient parameters or interruptions during treatment
  - The possible acute and late side effects of the irradiation
  - Radiation dose modifying factors, chemotherapy timing in all forms of chemoradiation schedules

(d) Drug Therapy

- The role of cytotoxic, hormonal and biological drugs therapies in radical and palliative management
- Radical and palliative regiment in common use including dosage, scheduling, toxicities and outcome
- The techniques of stem cell mobilisation and the procedures for stem cell and bone marrow harvesting

- The timing of total body irradiation, the re-infusion of bone marrow or stem cells and patient support during the engraftment

(e) Outcomes

- The expected outcomes of treatment

2.1.5 Drug Therapy

(a) Cytotoxic Chemotherapy

- A basic knowledge of the pharmacokinetics, therapeutic uses, dose ranges and toxicities of the currently used cytotoxic agents
- Where applicable, a range of multi-agent chemotherapy regimens and details of their administration

(b) Hormone Therapy

- A basic knowledge of the therapeutic use and toxicities of currently used hormone therapy

(c) Biological Therapies

- A basic knowledge of the clinical uses of currently used biological therapies including interferons, colony stimulating factors, other growth factors and preparations such as Herceptin

2.1.6 Oncological Emergencies

- The management of the following complications when they are related to cancer:
  - Ureteric obstruction
  - Spinal cord compression
  - Haemorrhage
  - Mediastinal obstruction

2.1.7 Radiotherapy for Benign Disease

- The indications for radiotherapy in the treatment of benign conditions, including suitable techniques and dosage schedules, and likely benefits and risks

2.1.8 Complications of Treatment

- The acute and late complications of oncological treatment and their management including:
  - Skin reactions
  - Nausea and vomiting
  - Diarrhoea
  - Oedema
  - Bone marrow toxicity
  - Neutropenic sepsis
  - Drug reactions
  - Cytotoxic extravasation
  - Alopecia
  - Cataract
  - Skin atrophy and ulceration
  - Colitis, proctitis, gut strictures and perforation
  - Renal effects
  - Cardiac effects
  - Pulmonary effects
  - Fibrosis and lymphoedema

- Endocrine effects (thyroid, pituitary and salivary gland)
- Effects on fertility
- Incidence of second and radiation induced cancers

2.1.9 Symptom Control and Continuing Care

- The available medical and surgical techniques for the control of pain, nausea, vomiting and malignant effusions
- Treatment of various cancer related conditions and paraneoplastic syndromes including:
  - Hypercalcaemia
  - Ectopic hormone production
  - Raised intra-cranial pressure
  - Anaemia

2.1.10 Current Research and Literature

- Current major research in progress in the form of multi-centre trials
- Recent major publications in oncology journals

2.2 *SKILLS AND CLINICAL EXPERIENCE*

Candidates need to have gained a wide range of experience in the areas of patient investigation, diagnosis, treatment with radiation, chemotherapy, hormonal therapy, biological therapy and in palliative and supportive care and to have gained the practical experience detailed below.

2.2.1 Radiotherapy Basic Techniques

(a) Positioning the Patient

- Setting up of a patient in each of the three basic treatment positions (supine, prone and lateral) to allow the patient to be planned and treated effectively and without discomfort
- Setting up the source skin distance for fixed FSD, and extended FSD treatment
- Setting up patients using laser beam alignment
- Making temporary and permanent marks on the patient for field positions (Gentian violet, tattoo)

(b) Immobilisation Techniques

- Application of some of the following immobilisation techniques: head-clamp, Velcro strap, polystyrene beads, vacuum bag, breast armrest
- The construction of thermoplastic beam direction shell

(c) Methods of Target Volume Determination

- Performance of planning
- using direct vision of the tumour (e.g. skin tumours)
- from surface landmarks (e.g. the parotid bed, breast tumours)
- with direct screening using simulator (e.g. lung tumours, bone metastases), including opacification techniques (e.g. barium swallow, cystogram)
- by volume transfer to orthogonal radiographs (e.g. head and neck tumours, brain tumours)
- Volume determination from planning CT scans for creating a central axis plan and for 3-dimensional CT planning

(d) Outline Techniques

- § Use of manual techniques (flexi-curves, plaster of Paris bandage) and CT derived outlines

(e) Basic Field Arrangements

- § Planning of treatments (under supervision where necessary) using the following field arrangements:
- § Single direct field
- § Opposed pair of fields using equal and unequal weightings
- § Opposed pair using wedges
- § Wedged right-angled pair
- § Wedged oblique pair
- § Plans using 3 and 4 fields
- § Total body irradiation

(f) Tissue Compensation

- § Planning of patients requiring tissue compensation using bolus, wedges and remote tissue compensators

(g) Shielding

- § Planning of patients using lead cut outs and lead masks for simple superficial tumours
- § Knowledge of the thickness of lead required for superficial, orthovoltage and electron treatments at various energies
- § Prescription and insertion of eye shields

(h) Megavoltage Techniques

- § Planning of patients incorporating simple lead blocking techniques using standard blocks and cast blocks from templates

(i) Electrons

- § The indications for, and planning of, electron treatments, including the selection of electron energy
- § A technique for total skin electron therapy and experience of its use

(j) Dose Calculation

- § Proficiency in the use of equivalent square tables
- § Performance of depth dose calculations for single fields and opposed fields using various energies
- § The principles applied to convert dose to machine units for a range of machines
- § The principles of computer based treatment planning

(k) Radiotherapy Prescriptions

- § Writing radiotherapy prescriptions (countersigned where necessary) for all the field arrangements mentioned above
- § Understanding of dose specification as in ICRU50 and 62

(l) Radiotherapy Machines

- § Planning of patients for treatment on a full spectrum of equipment, including superficial x-ray therapy, megavoltage x-ray therapy and megavoltage electron therapy (also orthovoltage x-ray therapy and cobalt-60 therapy, if available)

(m) Quality Assurance in External Beam Therapy

- Requesting portal imaging and interpreted their appearance satisfactorily in all sites
- Principles of in vivo dosimetry and interpretation of results

(n) Brachytherapy

- The insertion and removal of radioactive sources manually or using an appropriate afterloading device
- Interpretation of subsequent check films
- Interpretation of the corresponding dose calculation and writing of an appropriate prescription
- Removal of live sources and the afterloading device
- The placement of implants
- Principles of oral and intravenous radionuclide therapy

(o) Radiation Safety

- The role of the radiation safety and radiation protection supervisor
- The meaning of and requirements for controlled and supervised areas and their location
- The procedure to be adopted in the case of a spill of radioactive material
- Quality assurance practices in radiotherapy and the procedures for dealing with errors in treatment delivery

2.2.2 Radiotherapy Assessment and the Care of Patients on Treatment

(a) Treatment Review Clinics

- Regular weekly treatment review clinics

(b) Treatment Checks

- Assessment of patient position and treatment field placement(s) in relation to the target volume at the start of treatment
- Performance of checks during the course of treatment on the implementation of the treatment plan, position of shielding for critical normal structures and the use of portal imaging
- Assessment of changes occurring in patient parameters during treatment and resultant modification of treatment when appropriate
- Assessment of normal tissue reactions to radiotherapy
- Use of dose volume histograms and in vivo radiation dosimetry techniques

(c) Symptom Control

- Giving advice on skin care during radiation treatment and on the management of skin reactions, including desquamation
- Managing mucosal reactions in oral cavity, oropharynx, nasopharynx, trachea, oesophagus, anus and vagina
- Giving dietary advice during abdominal radiotherapy
- Managing radiation induced nausea and vomiting, diarrhoea, dysphagia, xerostomia and cystitis
- Giving prophylaxis for radiation induced cerebral oedema
- Giving advice on timing and extent of hair loss with respect to radiation dose

(d) Follow-up

- Managing acute and chronic radiation sequelae, such as pneumonitis, cystitis, chronic bowel complications, gynaecological sequelae (vaginal stenosis, vaginal dryness, infertility and dyspareunia)

2.2.3 Drug Therapy

(a) Access Technique for Sampling and Delivery

- Insertion and maintenance of intravenous lines for both sampling of blood and delivery of chemotherapy, including temporary sharp cannulation (butterfly type) and intermediate term flexible cannulation (venflon type)
- Arranging the insertion of Hickman or temporary long lines and subcutaneous implanted lines (portacath type), their use for sampling (where possible) and the delivery of chemotherapy and maintenance for protracted used
- Principles, regulations and guidelines for the delivery of intrathecal chemotherapy

(b) Drug Delivery

- The indications and eligibility of a wide variety of cytotoxic agents, and their side-effect profiles as single agents and in combinations
- Prescription and delivery of drugs in current usage

(c) Support Techniques

- Pre-hydration and maintenance of urine flow and modification of urine pH during chemotherapy delivery
- Prescription of protective agents, e.g. folinic acid (oral and iv) with MTX level monitoring or Mesna with appropriate chemotherapy regimens
- The use of anti-emetics
- The appropriate use of colony stimulating factors
- The appropriate use of bone marrow reconstitution techniques after high dose chemotherapy/TBI

(d) Management of Acute Complications

- Managing extravasation reactions caused by vesicant drugs
- Managing patients with chemotherapy induced neutropenia, with and without pyrexia
- Managing chemotherapy induced thrombocytopenia, including the use of platelet transfusions

(e) Treatment with Hormonal Therapy

- Implementation of hormone treatment for breast and prostate cancer

(f) Treatment with Biological Therapies

2.2.4 Supportive and Palliative Care

(a) Pain Relief

- Drug treatment
  - A wide range analgesic techniques, including simple analgesics, mild and strong opioids, given by a variety of routes
  - Management of the complications of analgesics, including constipation, nausea, gastro-intestinal discomfort and analgesic intolerance
- Mechanical methods
  - Prescription, siting and evaluation of TENS analgesia

- Referral of patients with refractory pain for procedures such as a nerve block, intrathecal analgesia, rhizotomy or orthopaedic stabilisation
- Radiotherapy
  - Use of radiation to treat painful metastatic disease with single fractions, multiple fractions and hemi-body radiotherapy

(b) Nausea and Vomiting

- Treatment of nausea and vomiting arising in advanced illness using anti-emetics
- Palliative management of sub-acute intestinal obstruction

(c) Anorexia and Dysphagia

- Management, where appropriate, with corticosteroids, progestogens and nasal gastric feeding

(d) Pleural Effusions and Ascites

- Drainage of pleural effusions and ascites
- Other treatments, such as talc pleurodesis

(e) Depression and Anxiety

- Treatment of depression at all stages of cancer management, using counselling and drug techniques with anti-depressants
- Treatment of anxiety with counselling, anxiolytics and major tranquillisers

(f) Hospice Care

- Awareness of local hospice facilities
- A one week (at least) attachment to a hospice or palliative care team

(g) Counselling

- Counselling of patients and relatives at all stages of the disease

2.2.5 Investigational Techniques

(a) Laboratory Investigations

- Interpretation of the results of haematological, biochemical and radio-immune assay investigations

(b) Radiology

- Attendance at regular radiological meetings involving a clinical radiology specialist for the review of plain x-rays, CT scans, magnetic resonance imaging and/or ultrasound covering the whole spectrum of cancer radiology
- Current indications and techniques in interventional procedures

(c) Pathology

- Attendance at regular pathological review sessions / clinico-pathological conferences

(d) Other Procedures

- Indirect laryngoscopy
- Lumbar puncture
- Fibreoptic naso-endoscopy & laryngoscopy
- Pelvic EUA and cystoscopy

2.2.6 Site or Disease Specific Procedures

- Assessment, treatment and follow-up, in detail, for each of the anatomical sites and types of tumour listed at paragraph 4 of the "Knowledge" section above
- Presentation and assessment of patients discussed at multidisciplinary team meeting
- Staging
- Radiotherapy:- adjuvant, radical and palliative
- Chemotherapy:- adjuvant, radical and palliative
- Hormone and biological therapy
- Palliative care
- Appropriate follow up
- Acute and late side effects of treatment

2.2.7 Clinical Trials, Literature and Research

- The aims and format of Phase I to IV clinical trials
- Obtaining informed consent, following study protocols and using data forms
- Research programmes (although research experience is not a prerequisite)
- Major areas of current research and of recent important publications
- Submission of a research project to an ethics committee
- Structure and functioning of clinical and research cancer networks

2.2.8 Communication and Publication

- Effective communication with colleagues, patients and their carers
- Giving clear and comprehensive descriptions of disease processes, investigations and treatment
- Clear expression in English and production of legible script
- Preparing work for publication

2.2.9 Outpatient and Joint Clinics

- Participation in joint consultative clinics and regular general oncology outpatient sessions
- Seeing review and new patients and planning their overall management

2.2.10 Resource Management and Quality Assurance

- Introduction to the resource management and quality assurance of an oncology service, so as to be able to develop these skills at a later stage

3.0 HIGHER TRAINING PRIOR TO EXIT ASSESSMENT

3.1 The two years of Higher Training aim at providing a broad knowledge-based exposure to various aspects of oncology including the development of special fields of interest such as Breast, Gastrointestinal, Genitourinary, Head & Neck, Lung, Gynaecological, Neuro-oncology, Musculoskeletal, Palliative care etc.

3.2 The program differs from Basic Training in that more emphasis will be put on independent performance and supervising responsibility.

3.3 In addition to clinical training, trainees are given the opportunities to lead or involve in:

- Teaching activities: (to clinicians, junior trainees, radiographers, nurses, medical students and other discipline whenever required) to attain in-depth knowledge of a subject and to improve on presentation skills. Management of and contribution to teaching materials.
- Audit and quality assurance activities.
- Academic activities: research techniques, presentation skills, literature review. At least one research project (with trainee being the first author / principal investigator) is to be presented at College's Annual Scientific Meeting or regional / international radiology / oncology conferences), published / accepted for publication (in the Journal of the College or other professional journals).
- Nurture of professional attitude (ethical standards, legal responsibility, professional image, contribution towards professional organizations and activities, co-ordination with clinical colleagues for better healthcare).
- Administrative skills and practice.

3.4 Subspecialization training **during Higher Training** with a defined period and documented workload. Sessional attachment to another hospital may be required.

3.5 Trainees who are interested in subspecialty development can enter Subspecialty Training in conjunction with Higher Training in general oncology. (Please refer to the training guidelines for the corresponding subspecialty.)

SUGGESTED READING LIST FOR PART I EXAMINATION

Cancer Biology

- The Basic Science of Oncology – *Tannock & Hill, 3rd Edt 1998 (McGraw-Hill)*
- Cancer Biology – *Ruddon, 1995 (Oxford University Press)*
- The Genetic Basis of Humman Cancer – *Vogelstein & Kinzler, 2nd Edt 2002*
- Introduction to the Cellular and Molecular Biology of Cancer – *Franks & Teich, 3rd Edt 1997 (Oxford University Press)*
- Molecular Biology for Oncologists – *Yarnold, Stratton & McMillan, 2nd Edt 1996 (Nelson Thornes)*
- Molecular Biology of the Cell – *Alberts, Johnson, Lewis, Raff, Roberts & Walter, 4th Edt 2002 (Garland Sciences)*
- Molecular Cell Biology – *Lodish, Berk, Zipursky, Matsudaira, Baltimore & Darnell, 4th Edt 1999 (W H Freeman)*
- Oxford Textbook of Oncology – *Souhami, Tannock, Hohenberger & Horiot 2nd Edt 2001 [Sections 1 & 2] (Oxford University Press)*

Clinical Pharmacology

- The Cancer Chemotherapy Handbook – *Fischer, Knobf, Durivage, 5th Edt 1997 (Mosby)*
- Cancer: Principles and Practice of Oncology – *de Vita, Hellman & Rosenberg, 6th Edt 2002 (Lippincott Williams & Wilkins)*
- Oxford Textbook of Oncology– *Souhami, Tannock, Hohenberger & Horiot 2nd Edt 2001 [Sections 4.9-4.29] (Oxford University Press)*
- Oxford Textbook of Palliative Medicine – Doyle, Hanks, MacDonald, *2nd Edt 1997 [Sections 7 & 9] (Oxford University Press)*

Medical Statistics

- An introduction to Medical Statistics – *Bland 3rd Edt 2000 (Oxford University Press)*
- Epidemiology for the Uninitiated – *Coggon, Rose & Barker 4th Edt 1997 (BMJ Books)*
- Medical Statistics at a Glance – *Petrie & Sabin 2000 (Blackwell Science UK)*
- Medical Statistics: A Commonsense Approach – *Campbell & Machin 3rd Edt 1999 (John Wiley & Sons)*
- Practical Statistics for Medical Research – *Altman 1990 (Chapman & Hall)*

Additional Reading

- The Causes of Cancer: Quantitative Estimates of Avoidable Risks of Cancer in the United States Today – *Doll & Peto 1981 (Oxford University Press)*
- Clinical Epidemiology: A Basic Science for Clinical Medicine – *Sackett, Haynes, Tugwell & Guyatt 2nd Edt 1991 (Lippincott Williams & Wilkins)*
- Clinical Trials: A Practical Approach – *Pocock 1983 (John Wiley & Sons Ltd)*

Physics

- The Physics of Radiation Therapy – *Khan 2nd Edt 1994 (Lippincott Williams & Wilkins) [Chapters: 1, 2, 3, 4(omit 4.2,4.4,4.5), 5, 7.1-7.2, 8(omit 8.4&8.7), 9(omit 9.4c-d), 10, 11.1-11.7, 12.2-12.6, 13, 14, 15.1-15.8, 16]*
- Radiotherapy Physics in Practice – *Williams & Thwaites 2nd Edt 2000 [Chapters:2 (section 5), 7, 9(sections 1.1-1.4), 10, 12, 13(omit section 3)] (Oxford University Press)*
- ICRU Report 50 & 62
- Practical Radiotherapy Planning – *Dobbs, Barrett & Ash 3rd Edt 1999 [Introductory chapters] (Arnold)*
- A Primer on Theory and Operation of Linear Accelerators in Radiation Therapy – *Karzmark & Morton (Atlantic Books)*

Radiobiology

- Basic Clinical Radiobiology – *Steel 3rd Edt 2002 (Arnold)*

Additional Reading

- The Basic Science of Oncology – *Tannock & Hill 3rd Edt 1998 (McGraw-Hill)*
- Radiobiology for the Radiologist – *Hall 5th Edt 2002 (Lippincott Williams & Wilkins)*

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