

Appendix 2

Underpinning scientific knowledge

Core training (to be completed by ST4)

1. Cancer Biology and Radiobiology

The knowledge defined in this section will be assessed in the Cancer Biology and Radiobiology module of the First FRCR examination

1.1 Principles of tumour biology

Discusses the general principles of tumour biology		
Knowledge	Assessment Methods	GMP
Defines and can distinguish between different types of growth disorder, e.g. dysplasia and carcinoma in situ	First FRCR (Cancer Biology and Radiobiology)	1
Describes the cell cycle, basic cell kinetics, including parameters associated with cell cycle times	First FRCR (Cancer Biology and Radiobiology)	1
Describes the mechanisms of spread, local invasion/migration, metastasis	First FRCR (Cancer Biology and Radiobiology)	1
Describes the effects of tumours: local (e.g. pressure), distant (metastatic and non-metastatic)	First FRCR (Cancer Biology and Radiobiology)	1
Discusses the importance of tumour vasculature and angiogenesis	First FRCR (Cancer Biology and Radiobiology)	1

1.2 General principles of radiobiology

Discusses the general principles of radiobiology		
Knowledge	Assessment Methods	GMP
Describes cellular systems (hierarchical, flexible) and their response to radiation	First FRCR (Cancer Biology and Radiobiology)	1
Contrasts parallel and linear systems	First FRCR (Cancer Biology and Radiobiology)	1
Describes radiation biology models (monolayer, spheroids, animal (normal and transgenic), regrowth curves, clonogenic assay, MTT)	First FRCR (Cancer Biology and Radiobiology)	1
Describes the relevance of LET to cellular damage	First FRCR (Cancer Biology and Radiobiology)	1
Describes radiation damage at the cellular level (including outcome phenotypes, chromosome damage and cell radiosensitivity)	First FRCR (Cancer Biology and Radiobiology)	1
Compares bystander with direct effects of radiation	First FRCR (Cancer Biology and Radiobiology)	1
Compares the effects of low and high dose rate radiation	First FRCR (Cancer Biology and Radiobiology)	1

1.3 Techniques in molecular biology

Describes the principles and use of techniques in molecular biology		
Knowledge	Assessment Methods	GMP
Describes the principles and use of nucleic acid analyses, including electrophoresis, hybridisation, blotting, PCR, sequencing, transfection	First FRCR (Cancer Biology and Radiobiology)	1
Describes the principles and use of micro array techniques	First FRCR (Cancer Biology and Radiobiology)	1
Describes the principles and use of transgenic model	First FRCR (Cancer Biology and Radiobiology)	1

1.4 Genetics of normal and malignant cells

Discusses the genetics of normal and malignant cells		
Knowledge	Assessment Methods	GMP
Describes normal chromosomal structure and function, normal gene transcription and its control	First FRCR (Cancer Biology and Radiobiology)	1
Describes normal DNA repair mechanisms	First FRCR (Cancer Biology and Radiobiology)	1
Describes polymorphisms, mini and microsatellites	First FRCR (Cancer Biology and Radiobiology)	1
Describes chromatin structure and function	First FRCR (Cancer Biology and Radiobiology)	1
Describes methylation, hypomethylation and methylation reversal	First FRCR (Cancer Biology and Radiobiology)	1
Discusses chromosomal and genetic changes in malignancy, point mutations, translocations, deletions, gene amplification and over-expression	First FRCR (Cancer Biology and Radiobiology)	1
Discusses oncogenes, proto-oncogenes, tumour suppressor genes, describing well established examples in each class	First FRCR (Cancer Biology and Radiobiology)	1
Describes protein-protein interactions	First FRCR (Cancer Biology and Radiobiology)	1

1.5 Molecular biology of radiation damage and repair

Discusses the molecular biology of radiation damage and repair		
Knowledge	Assessment Methods	GMP
Describes the basics of experimental molecular radiobiology, including sensitisers and protectors	First FRCR (Cancer Biology and Radiobiology)	1
Explains the molecular processes involved in radiation damage	First FRCR (Cancer Biology and Radiobiology)	1
Explains the molecular processes involved in radiation damage repair	First FRCR (Cancer Biology and Radiobiology)	1
Discusses interaction between radiation and other agents	First FRCR (Cancer Biology and Radiobiology)	1
Describes laboratory experimental DNA damage and repair	First FRCR (Cancer Biology and Radiobiology)	1

1.6 Normal and aberrant mechanisms of cell growth control

Discusses the normal and aberrant mechanisms of cell growth control		
Knowledge	Assessment Methods	GMP
Discusses the control of normal cell growth and behaviour	First FRCR (Cancer Biology and Radiobiology)	1
Contrasts autocrine, paracrine and endocrine growth factors	First FRCR (Cancer Biology and Radiobiology)	1
Discusses altered expression, function and control of these mechanisms in malignancy	First FRCR (Cancer Biology and Radiobiology)	1
Describes signal transduction (MAP kinases)	First FRCR (Cancer Biology and Radiobiology)	1
Describes the role of cyclin kinases	First FRCR (Cancer Biology and Radiobiology)	1
Describes gene promoters and their activity in normal and malignant cells	First FRCR (Cancer Biology and Radiobiology)	1

1.7 Normal tissue radiobiology

Discusses normal tissue radiobiology		
Knowledge	Assessment Methods	GMP
Describes radiation damage at the cellular level, including outcome phenotypes, chromosome damage and cell radiosensitivity	First FRCR (Cancer Biology and Radiobiology)	1
Defines cellular systems (hierarchical and flexible) and describes their response to radiation	First FRCR (Cancer Biology and Radiobiology)	1
Describes normal tissue damage (early and late)	First FRCR (Cancer Biology and Radiobiology)	1
Discusses the concept of normal tissue tolerance	First FRCR (Cancer Biology and Radiobiology)	1
Discusses the factors influencing tolerance	First FRCR (Cancer Biology and Radiobiology)	1
Describes the effects of radiation on different tissues and organs	First FRCR (Cancer Biology and Radiobiology)	1
Lists the tolerance levels for different tissues and organs	First FRCR (Cancer Biology and Radiobiology)	1,2
Discusses organ tolerance to retreatment with radiation	First FRCR (Cancer Biology and Radiobiology)	1,2
Describes the schemes for reporting normal tissue damage	First FRCR (Cancer Biology and Radiobiology)	1,2

1.8 Population radiobiology

Discusses population radiobiology		
Knowledge	Assessment Methods	GMP
Explains the production of the cell survival curve	First FRCR (Cancer Biology and Radiobiology)	1
Describes descriptive models, eg linear quadratic model	First FRCR (Cancer Biology and Radiobiology)	1
Discusses the concept of damage (lethal, sublethal, potentially lethal)	First FRCR (Cancer Biology and Radiobiology)	1
Discusses the concept of repair (early and late)	First FRCR (Cancer Biology and Radiobiology)	1
Describes the effect of cell cycle on radiation sensitivity	First FRCR (Cancer Biology and Radiobiology)	1
Discusses repopulation	First FRCR (Cancer Biology and Radiobiology)	1
Explains the role of the cell survival curve as a basis for fractionation	First FRCR (Cancer Biology and Radiobiology)	1
Defines terms describing cellular sensitivity (SF2, α , β , mean inactivation dose)	First FRCR (Cancer Biology and Radiobiology)	1
Discusses the α/β ratio and its relevance to acute and late responding tissues	First FRCR (Cancer Biology and Radiobiology)	1
Describes isoeffect curves (various forms) and formulae, including BED	First FRCR (Cancer Biology and Radiobiology)	1
Discusses fractionation and its influence on outcome with varying α/β ratio	First FRCR (Cancer Biology and Radiobiology)	1
Defines hyperfractionation, accelerated fractionation and hypofractionation	First FRCR (Cancer Biology and Radiobiology)	1
Discusses the influence of gaps in radiotherapy and their management	First FRCR (Cancer Biology and Radiobiology)	1
Describes the influence of time on radiation response, including dose rate effects	First FRCR (Cancer Biology and Radiobiology)	1
Defines relative biological effect (RBE) and discusses its relationship to LET	First FRCR (Cancer Biology and Radiobiology)	1
Explains the influence of oxygen on radiosensitivity, including oxygen enhancement ratio (OER)	First FRCR (Cancer Biology and Radiobiology)	1
Explains the role of reoxygenation	First FRCR (Cancer Biology and Radiobiology)	1
Explains the relationship between OER and LET	First FRCR (Cancer Biology and Radiobiology)	1
Describes methods of identifying hypoxia experimentally	First FRCR (Cancer Biology and Radiobiology)	1

Knowledge	Assessment Methods	GMP
Discusses hypoxic cell sensitisers and cytotoxins	First FRCR (Cancer Biology and Radiobiology)	1
Describes the uses of high LET radiation	First FRCR (Cancer Biology and Radiobiology)	1
Discusses radiation protectors	First FRCR (Cancer Biology and Radiobiology)	1
Describes low dose hyper-radiosensitivity	First FRCR (Cancer Biology and Radiobiology)	1
Describes effects of total body irradiation	First FRCR (Cancer Biology and Radiobiology)	

1.9 Interaction between radiation and other agents

Discusses the interaction between radiation and other agents		
Knowledge	Assessment Methods	GMP
Discusses the interaction with chemotherapy (before, during or following radiation)	First FRCR (Cancer biology and Radiobiology)	1
Describes the basic principles of the interaction with hyperthermia	First FRCR (Cancer Biology and Radiobiology)	1

1.10 Causation of human cancers

Discusses the causation of human cancers		
Knowledge	Assessment Methods	GMP
Describes environmental factors and influences	First FRCR (Cancer biology and Radiobiology)	1
Discusses carcinogenesis in vitro and in vivo	First FRCR (Cancer biology and Radiobiology)	1
Describes viral carcinogenesis and viruses firmly associated with cancer (HPV, EBV etc)	First FRCR (Cancer biology and Radiobiology)	1
Discusses radiation carcinogenesis including: <ul style="list-style-type: none"> • 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 	First FRCR (Cancer biology and Radiobiology)	1

1.11 Cancer genetics

Discusses cancer genetics		
Knowledge	Assessment Methods	GMP
Outlines inherited syndromes associated with cancer, including ataxia telangiectasia, xeroderma pigmentosa, Nijmegen break syndrome, Li-Fraumeni, Lynch, MEN, Cockayne's, familial polyposis coli, inherited breast cancer syndromes	First FRCR (Cancer biology and Radiobiology)	1
Lists genes conferring susceptibility to cancer	First FRCR (Cancer biology and Radiobiology)	1
Explains the mechanisms whereby such genes can be associated with neoplasia	First FRCR (Cancer biology and Radiobiology)	1
Explains the principles of linkage analysis	First FRCR (Cancer biology and Radiobiology)	1
Outlines the principles of genetic counselling	First FRCR (Cancer biology and Radiobiology)	1

1.12 Physiology of haemopoiesis

Discusses the physiology of haemopoiesis		
Knowledge	Assessment Methods	GMP
Describes marrow structure and organisation	First FRCR (Cancer biology and Radiobiology)	1
Describes the haemopoietic microenvironment	First FRCR (Cancer biology and Radiobiology)	1
Discusses cell lineages and hierarchies	First FRCR (Cancer biology and Radiobiology)	1
Discusses the control mechanisms in normal haemopoiesis	First FRCR (Cancer biology and Radiobiology)	1

1.13 Role of the immune system

Describes the role of the immune system		
Knowledge	Assessment Methods	GMP
Describes cellular involvement in the immune system	First FRCR (Cancer biology and Radiobiology)	1
Describes antigen recognition and processing	First FRCR (Cancer biology and Radiobiology)	1
Outlines the role of dendritic cells	First FRCR (Cancer biology and Radiobiology)	1
Describes the clonal expansion of lymphoid cells in response to stimulation	First FRCR (Cancer biology and Radiobiology)	1
Describes immunological surveillance	First FRCR (Cancer biology and Radiobiology)	1
Outlines the basic principles of tumour immunology	First FRCR (Cancer biology and Radiobiology)	1

2. Clinical Pharmacology

The knowledge defined in this section will be assessed in the Clinical Pharmacology module of the First FRCR examination

2.1 Mode of action of cytotoxic drugs

Describes the mode of action of cytotoxic drugs		
Knowledge	Assessment Methods	GMP
Describes the mechanisms of action	First FRCR (Clinical pharmacology)	1
Contrasts phase specific and cycle specific drugs	First FRCR (Clinical pharmacology)	1
Describes the mechanisms of cell death	First FRCR (Clinical pharmacology)	1
Discusses the mechanisms of drug resistance	First FRCR (Clinical pharmacology)	1
Describes drug resistance modifiers	First FRCR (Clinical pharmacology)	1

2.2 Drug design and development

Discusses drug design and development.		
Knowledge	Assessment Methods	GMP
Describes novel therapeutic targets	First FRCR (Clinical pharmacology)	1
Outlines the process of new drug discovery and development	First FRCR (Clinical pharmacology)	1
Outlines the principles of preclinical assessment of candidate compounds	First FRCR (Clinical pharmacology)	1
Discusses the role and design of clinical studies (Phase I, II, III, IV)	First FRCR (Clinical pharmacology)	1

2.3 Pharmacokinetics and pharmacodynamics

Discusses pharmacokinetics and pharmacodynamics		
Knowledge	Assessment Methods	GMP
Discusses the general principles of pharmacokinetics	First FRCR (Clinical pharmacology)	1
Explains the role of the route and timing of administration	First FRCR (Clinical pharmacology)	1
Discusses the importance of plasma concentration and its relationship to drug actions	First FRCR (Clinical pharmacology)	1
Defines AUC and discusses its importance	First FRCR (Clinical pharmacology)	1
Discusses drug activation, metabolism and clearance	First FRCR (Clinical pharmacology)	1
Discusses the importance of protein and tissue binding	First FRCR (Clinical pharmacology)	1
Describes the importance of drug concentration at target site	First FRCR (Clinical pharmacology)	1

2.4 Clinical use of systemic therapies

Discusses the principles of clinical use of systemic therapies		
Knowledge	Assessment Methods	GMP
Describes dose response curves	First FRCR (Clinical pharmacology)	1
Explains the concept of dose intensity	First FRCR (Clinical pharmacology)	1
Discusses the effects of single agent and combination therapy	First FRCR (Clinical pharmacology)	1
Explains the role of adjuvant and neo-adjuvant therapy	First FRCR (Clinical pharmacology)	1
Describes the principles of regional therapy	First FRCR (Clinical pharmacology)	1
Discusses targeting of drugs	First FRCR (Clinical pharmacology)	1
Outlines modification of drug resistance	First FRCR (Clinical pharmacology)	1
Describes the clinical pharmacology and technology of continuous infusion	First FRCR (Clinical pharmacology)	1
Describes the clinical pharmacology of intrathecal treatment	First FRCR (Clinical pharmacology)	1

2.5 Toxicity of chemotherapy

Discusses the toxicity of chemotherapy		
Knowledge	Assessment Methods	GMP
Describes the dose limiting and common toxicities	First FRCR (Clinical pharmacology)	1,2
Describes dose-related and idiosyncratic toxicity	First FRCR (Clinical pharmacology)	1,2
Defines the concepts of early, intermediate and late toxicity	First FRCR (Clinical pharmacology)	1
Discusses the mechanisms of toxicity	First FRCR (Clinical pharmacology)	1
Discusses chemical and other factors modifying drug toxicity	First FRCR (Clinical pharmacology)	1,2
Describes safe handling of cytotoxic drugs	First FRCR (Clinical pharmacology)	1,2

2.6 Clinical pharmacology of analgesics

Discusses the clinical pharmacology of analgesics		
Knowledge	Assessment Methods	GMP
Outlines the clinical pharmacology of morphine and derivatives	First FRCR (Clinical pharmacology)	1
Discusses the use of drug combinations	First FRCR (Clinical pharmacology)	1
Describes different formulations, e.g. slow release and patch formulations	First FRCR (Clinical pharmacology)	1

2.7 Clinical pharmacology of steroids and anti-emetics

Discusses the clinical pharmacology of steroids and anti-emetics		
Knowledge	Assessment Methods	GMP
Discusses the use of steroids with chemotherapy	First FRCR (Clinical pharmacology)	1
Lists the classes of antiemetics and discusses their use	First FRCR (Clinical pharmacology)	1

2.8 Drug interactions in cancer treatment

Discusses drug interactions in cancer treatment		
Knowledge	Assessment Methods	GMP
Discusses common or important interactions between drugs used in cancer therapy and other commonly used agents	First FRCR (Clinical Pharmacology)	1,2

2.9 Endocrine therapy

Discusses the principles of endocrine therapy		
Knowledge	Assessment Methods	GMP
Describes their mechanisms of action	First FRCR (Clinical Pharmacology)	1
Describes the mechanism of resistance	First FRCR (Clinical Pharmacology)	1
Lists the common side-effects	First FRCR (Clinical Pharmacology)	1
Discusses the effect of combination with other therapies	First FRCR (Clinical Pharmacology)	1

2.10 Biological and Novel therapies

Discusses the principles of biological and novel therapies		
Knowledge	Assessment Methods	GMP
Discusses biological therapies, their mechanism of action and their combination with standard therapy	First FRCR (Clinical Pharmacology)	1
Discusses the mode of action of interferons, interleukins, growth factors, antibody therapy, small molecule inhibitors of signalling pathways, gene therapy and immunotherapy	First FRCR (Clinical Pharmacology)	1
Describes novel targets for anti-cancer drugs, including vasculature, cell signal control and oncogene products	First FRCR (Clinical Pharmacology)	1
Outlines mode of action of bioreductive drugs	First FRCR (Clinical Pharmacology)	1
Outlines mode of action cancer vaccines	First FRCR (Clinical Pharmacology)	1

2.11 High dose therapy

Explains the basic principles of high-dose therapy		
Knowledge	Assessment Methods	GMP
Explains the clinical pharmacology and rationale of high-dose therapy	First FRCR (Clinical Pharmacology)	1
Describes methods for protection/rescue of stem cells	First FRCR (Clinical Pharmacology)	1,2
Lists unusual toxicities due to high dose therapy	First FRCR (Clinical Pharmacology)	1,2

3. Medical Statistics

The knowledge defined in this section will be assessed in the Medical Statistics module of the First FRCR examination.

3.1 Types of data

Recognises different types of data		
Knowledge	Assessment Methods	GMP
Presents and summarises individual variables	First FRCR (Medical Statistics)	1
Recognises categorical data (nominal, ordinal)	First FRCR (Medical Statistics)	1
Recognises discrete and continuous numerical data	First FRCR (Medical Statistics)	1
Recognises symmetric and skewed distribution	First FRCR (Medical Statistics)	1
Describes the normal distribution	First FRCR (Medical Statistics)	1
Interprets bar charts and histograms	First FRCR (Medical Statistics)	1
Defines and applies measures of central tendency and spread	First FRCR (Medical Statistics)	1

3.2 Sampling

Explains sampling		
Knowledge	Assessment Methods	GMP
Describes the concept of a source population	First FRCR (Medical Statistics)	1
Explains random sampling	First FRCR (Medical Statistics)	1
Explains estimation of population statistics	First FRCR (Medical Statistics)	1
Describes standard error of a sample mean and of a proportion, and their differences	First FRCR (Medical Statistics)	1
Explains and uses confidence intervals	First FRCR (Medical Statistics)	1
Explains reference ranges	First FRCR (Medical Statistics)	1

3.3 Statistical inference

Explains the principles of statistical inference		
Knowledge	Assessment Methods	GMP
Explains hypothesis testing and estimation	First FRCR (Medical Statistics)	1
Contrasts Type I and II errors	First FRCR (Medical Statistics)	1
Interprets p-values and confidence intervals	First FRCR (Medical Statistics)	1
Defines the difference between statistical and clinical significance	First FRCR (Medical Statistics)	1

3.4 Tests used to compare two or more groups

Identifies the tests used to compare two or more groups		
Knowledge	Assessment Methods	GMP
Describes when to apply tests for comparing means, e.g. t-tests, paired-t, Mann-Whitney, Wilcoxon's signed ranks, ANOVA and Kruskal-Wallis	First FRCR (Medical Statistics)	1
Describes when to apply tests for comparing percentages, e.g. chi squared, Fisher's exact and McNemar's	First FRCR (Medical Statistics)	1

3.5 Association between variables

Interprets measures and tests of association between variables		
Knowledge	Assessment Methods	GMP
Interprets the meaning of correlation and regression analysis	First FRCR (Medical Statistics)	1
Interprets the meaning of scatter plots	First FRCR (Medical Statistics)	1

3.6 Screening tests

Describes the statistical basis of screening tests		
Knowledge	Assessment Methods	GMP
Interprets the meaning of sensitivity, specificity and positive and negative predictive values	First FRCR (Medical Statistics)	1,2

3.7 Survival analysis

Discusses survival analysis		
Knowledge	Assessment Methods	GMP
Lists types of time-to-event data	First FRCR (Medical Statistics)	1
Describes the use of Kaplan-Meier and actuarial survival curves	First FRCR (Medical Statistics)	1
Describes the possible methods of summarizing survival data	First FRCR (Medical Statistics)	1
Outlines methods used to compare groups: <ul style="list-style-type: none"> • logrank test for two or more groups, including ordered groups • Cox's proportional hazards regression model • hazard ratios and their interpretation 	First FRCR (Medical Statistics)	1

3.8 Design and analysis of clinical trials

Discusses the design and analysis of clinical trials		
Knowledge	Assessment Methods	GMP
Compares the design and role of phases I-IV of clinical trials	First FRCR (Medical Statistics)	1
Explains the need for randomization and the problems with non-randomised studies and historical controls	First FRCR (Medical Statistics)	1
Describes the methods of randomisation (simple, block, stratified minimisation)	First FRCR (Medical Statistics)	1
Explains the concepts of blinding/masking	First FRCR (Medical Statistics)	1
Describes the possible trial designs: parallel group, cross-over, factorial	First FRCR (Medical Statistics)	1
Describes the contents of a trial protocol	First FRCR (Medical Statistics)	1
Discusses the ethical basis for research and of what constitutes informed consent	First FRCR (Medical Statistics)	1
Describes the possible measures of response including: <ul style="list-style-type: none"> • tumour regression • quality of life • morbidity • local and regional recurrence • distant metastases • death 	First FRCR (Medical Statistics)	1
Outlines the principles of: <ul style="list-style-type: none"> • sample size calculation • Interim analyses • Intent-to-treat analysis 	First FRCR (Medical Statistics)	1
Outlines the role and basic principles of meta-analysis	First FRCR (Medical Statistics)	1

3.9 Collection and use of epidemiological data

Outlines the collection and use of epidemiological data		
Knowledge	Assessment Methods	GMP
Contrasts the design and interpretation of retrospective (case control) and prospective (cohort) studies	First FRCR (Medical Statistics)	1
Defines the principles of odds ratios and relative risks	First FRCR (Medical Statistics)	1
Defines mortality rates and standardised mortality rates	First FRCR (Medical Statistics)	1
Outlines cancer registration and follow-up	First FRCR (Medical Statistics)	1
Outlines trends in cancer incidence and mortality for core cancers	First FRCR (Medical Statistics)	1

4. Physics

The knowledge defined in this section will be assessed in the Physics module of the First FRCR examination.

4.1 Physics relevant to radiotherapy

Discusses the basic physics relevant to radiotherapy		
Knowledge	Assessment Methods	GMP
Describes atomic structure, atomic and mass numbers	First FRCR (Physics)	1
Describes electron shells and energy levels	First FRCR (Physics)	1
Describes electromagnetic radiation and the electromagnetic spectrum	First FRCR (Physics)	1
Describes energy quantisation	First FRCR (Physics)	1
Explains the relationship between wavelength, frequency and energy	First FRCR (Physics)	1
Describes an x- or gamma-ray beam (quality, energy, intensity, size)	First FRCR (Physics)	1
Explains the basic principles of production of x- or gamma-rays	First FRCR (Physics)	1
Contrasts continuous and discrete spectra	First FRCR (Physics)	1
Describes attenuation, absorption, scattering of x-rays	First FRCR (Physics)	1
Defines attenuation coefficients and half value layer	First FRCR (Physics)	1

4.2 Electromagnetic radiation and its interaction with matter

Discusses electromagnetic radiation and its interaction with matter		
Knowledge	Assessment Methods	GMP
Discusses the nature of the following effects and their dependence on the properties of the irradiated material (e.g. density, atomic number), their variation with energy and their relative importance in therapy and imaging: <ul style="list-style-type: none">• Elastic scattering• Compton effect• Photoelectric effect• Pair production• Photonuclear interactions• Auger effect• Scattered radiation• Secondary electrons• Linear energy transfer• Dependence of range of electrons on their energy	First FRCR (Physics)	1

4.3 Interaction of sub atomic particles with matter

Discusses the interaction of sub atomic particles with matter		
Knowledge	Assessment Methods	GMP
Discusses: <ul style="list-style-type: none"> • Ionisation and excitation due to charged particles • Electrons <ul style="list-style-type: none"> ▪ 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 	First FRCR (Physics)	1

4.4 Radiation dosimetry

Discusses radiation dosimetry		
Knowledge	Assessment Methods	GMP
Discusses: <ul style="list-style-type: none"> • Variation of absorbed dose in different tissues and materials • Concept of exposure and KERMA • the principles of 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 • The advantages and disadvantages of the following: <ul style="list-style-type: none"> ▪ ionisation methods (ionisation chamber, Geiger counter, diodes) ▪ chemical methods, primarily films ▪ thermoluminescence (TLD) ▪ scintillation counters ▪ calorimetry • Calibration methods <ul style="list-style-type: none"> ▪ intercomparisons ▪ standards (local and national) ▪ corrections ▪ constancy checks • Practical dose measurements <ul style="list-style-type: none"> ▪ introduction to the derivation of isodose curves ▪ central axis depth dose profiles 	First FRCR (Physics)	1,2

4.4 Physics of teletherapy beams

Discusses the physics of teletherapy beams (x-rays)

Knowledge	Assessment Methods	GMP
Lists the X-rays beams used in clinical practice	First FRCR (Physics)	1
Describes energy ranges	First FRCR (Physics)	1
Explains build up and skin sparing for x-rays	First FRCR (Physics)	1
Defines isodose curves for x-rays	First FRCR (Physics)	1
Compares fixed FSD and isocentric approaches	First FRCR (Physics)	1
Explains the principles of wedges and wedge angles	First FRCR (Physics)	1
Describes the effect of trays	First FRCR (Physics)	1
Describes output factors	First FRCR (Physics)	1
Describes beam geometry <ul style="list-style-type: none"> • magnification and penumbra • field size definition 	First FRCR (Physics)	1

4.5 Electron beam physics

Discusses electron beam physics

Knowledge	Assessment Methods	GMP
Lists the electron beams used in clinical practice	First FRCR (Physics)	1
Describes the energy ranges	First FRCR (Physics)	1
Defines percentage depth dose	First FRCR (Physics)	1
Discusses the factors affecting depth dose	First FRCR (Physics)	1
Explains build up and skin sparing for electrons	First FRCR (Physics)	1
Describes the isodose curves for electrons	First FRCR (Physics)	1
Describes the effects of surface obliquity and inhomogeneities on dose distributions	First FRCR (Physics)	1
Discusses internal shielding	First FRCR (Physics)	1

4.6 Radiotherapy treatment planning

Explains the principles of radiotherapy treatment planning		
Knowledge	Assessment Methods	GMP
Describes the data required for treatment planning	First FRCR (Physics)	1
Discusses the techniques available for immobilisation and their accuracy	First FRCR (Physics)	1
Discusses the effects of patient and organ movement	First FRCR (Physics)	1
Describes the methods of tumour localisation: direct visual, simulator, CT, MRI, ultrasound	First FRCR (Physics)	1
Discusses separation and contour information (uniplanar, multiplanar)	First FRCR (Physics)	11
Explains transposition of patient data: magnification, target volumes, sensitive structures, dose modifying structures	First FRCR (Physics)	1
Explains use of: <ul style="list-style-type: none"> • a simulator • a CT scanner • CT simulator • MRI • PET 	First FRCR (Physics)	1
in radiotherapy planning		
Compares fixed FSD v isocentric planning	First FRCR (Physics)	1
Explains coplanar planning in a uniform medium	First FRCR (Physics)	1
Describes isodose distributions in each of the following situations, their uses and critical assessment: <ul style="list-style-type: none"> • single field • isodose summation • multifield planning • weighting 	First FRCR (Physics)	1
Outlines the principles of: <ul style="list-style-type: none"> • conformal therapy • arc and rotational therapy • non-coplanar planning • stereotactic localisation 	First FRCR (Physics)	1
Explains the effects of: <ul style="list-style-type: none"> • Tissue compensators • Surface obliquity • Inhomogeneous media 	First FRCR (Physics)	1
Discusses volume definition including ICRU 50, 62	First FRCR (Physics)	1

Knowledge	Assessment Methods	GMP
Discusses dose prescription including ICRU 50, 62)	First FRCR (Physics)	1
Explains the principles of dose calculations in the presence of extensive shielding (eg sector or Clarkson integration)	First FRCR (Physics)	1
Explains the principles of field matching	First FRCR (Physics)	1
Outlines the principles of Total Body Irradiation (TBI)	First FRCR (Physics)	1
Describes the principles of CT treatment planning: <ul style="list-style-type: none"> • 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) 	First FRCR (Physics)	1
Outlines the principles of: <ul style="list-style-type: none"> • inverse planning • intensity modulated radiotherapy 	First FRCR (Physics)	1

4.7 Beam therapy equipment

Explains the principles of beam therapy equipment		
Knowledge	Assessment Methods	GMP
Outlines the principles of superficial and orthovoltage x-ray production	First FRCR (Physics)	1
Outlines the principles of the linear accelerator	First FRCR (Physics)	1
Outlines the basic principles of the following: <ul style="list-style-type: none"> • microwave production • wave guide construction • electron beam production • x-ray production, beam control and stability • linear accelerator head construction construction of a cobalt machine • Output 	First FRCR (Physics)	1
Describes the concept and definition of the isocentre	First FRCR (Physics)	1
Explains the importance of source size	First FRCR (Physics)	1

Knowledge	Assessment Methods	GMP
<p>Describes the techniques for defining the beam geometry:</p> <ul style="list-style-type: none"> • collimators • applicators • multileaf collimators • cast blocks 	First FRCR (Physics)	1
Explains the factors influencing penumbra	First FRCR (Physics)	1
Defines beam quality	First FRCR (Physics)	1
Discusses the use and effect on depth dose of wedges and applicators and the different types available	First FRCR (Physics)	1
Describes the shielding techniques available and the materials used in their construction	First FRCR (Physics)	1
Explains the concepts of transmission, scatter and doses under shields	First FRCR (Physics)	1
<p>Discusses the factors involved in accurately irradiating the target:</p> <ul style="list-style-type: none"> • the treatment couch • positioning of the patient • lasers • pointers • light fields • monitoring radiation output • control of the accelerator 	First FRCR (Physics)	1,2
<p>Describes the functioning of multileaf collimators:</p> <ul style="list-style-type: none"> • edge definition • leaf leakage • influence of leaf size 	First FRCR (Physics)	1
Outlines the principles of stereotactic equipment	First FRCR (Physics)	1

4.8 Quality assurance in radiotherapy

Describes quality assurance in radiotherapy		
Knowledge	Assessment Methods	GMP
Defines quality assurance and quality control	First FRCR (Physics)	1,2
Lists the parameters that should be included when writing a radiotherapy prescription	First FRCR (Physics)	1
Describes the processes that are undertaken to ensure that the prescription is correctly implemented: <ul style="list-style-type: none"> • The role of computer verification • Manual checking • Monitoring accuracy of treated volume: verification films, mega-voltage imaging, aware of IGRT • Monitoring accuracy of positioning (laser, light-fields, mechanical pointers, tolerances) • Monitoring accuracy of radiation output: symmetry and field flatness (tolerances) 	First FRCR (Physics)	1,2
Describes the rules for reporting near misses and errors including the legal requirements	First FRCR (Physics)	1,2

4.9 Radioactive sources in therapy

Describes the use of radioactive sources in therapy		
Knowledge	Assessment Methods	GMP
Describes the basic principles of radioactivity including: <ul style="list-style-type: none"> • 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) • specific forms of sources (^{198}Au, ^{192}Ir, ^{137}Cs, ^{125}I, ^{90}Sr) • 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 • methods of measurement of activity • principles of storage and movement control • methods of source handling • aware of leak testing and inspection of sources • safety devices available • methods of measurement in air KERMA rate 	First FRCR (Physics)	1,2

4.10 Brachytherapy

Discusses the principles of brachytherapy		
Knowledge	Assessment Methods	GMP
Outlines the principles of clinical use	First FRCR (Physics)	<u>1</u>
Describes the distribution rules and dose calculation basis for Paris system	First FRCR (Physics)	<u>1</u>
Describes the gynaecological intracavitary brachytherapy systems	First FRCR (Physics)	<u>1</u>
Describes the sources used and the dose distributions	First FRCR (Physics)	1
Describes how the dose is specified	First FRCR (Physics)	1
Explains the principles of afterloading	First FRCR (Physics)	1,2
Discusses the types of afterloading, including manual, remote, low, intermediate and high dose rate	First FRCR (Physics)	1,2
Discusses use of imaging in brachytherapy	First FRCR (Physics)	1

4.11 Unsealed sources in therapy

Discusses the principles of the use of unsealed sources in therapy		
Knowledge	Assessment Methods	GMP
Describes the concepts of stability and shelf life	First FRCR (Physics)	1
Defines the difference between physical and biological half life	First FRCR (Physics)	1
Lists the radiopharmaceuticals in common clinical use in oncology	First FRCR (Physics)	1
Describes their therapeutic applications	First FRCR (Physics)	1
Explains methods for dose calculation	First FRCR (Physics)	1

4.12 Radiation protection

Discusses the principles of radiation protection		
Knowledge	Assessment Methods	GMP
Discusses the risks of radiation	First FRCR (Physics)	1,2
Describes the effects of total body irradiation at different dose levels	First FRCR (Physics)	1
Compares stochastic and non-stochastic processes	First FRCR (Physics)	1
Discusses quality factors and dose equivalent	First FRCR (Physics)	1,2
Describes the statutory framework	First FRCR (Physics)	1,2
Discusses background radiation	First FRCR (Physics)	1,2
Describes low level exposure effects	First FRCR (Physics)	1,2
Lists the radiation exposure limits for different groups	First FRCR (Physics)	1,2
Describes the classification of staff, designated areas	First FRCR (Physics)	1,2
Outlines IRR 1999	First FRCR (Physics)	1,2
Outlines IR(ME)R 2000	First FRCR (Physics)	1,2
Outlines ARSAC	First FRCR (Physics)	1,2
Outlines Radioactive Substances Act 1993	First FRCR (Physics)	1,2
Discusses local rules	First FRCR (Physics)	1,2
Defines controlled areas	First FRCR (Physics)	1,2
Explains protection mechanisms, including time, distance, shielding	First FRCR (Physics)	1,2
Explains the design of treatment rooms: <ul style="list-style-type: none"> • Primary/secondary barriers • Transmission through barriers, elementary calculations • Mazes, doors and interlocks • Leakage and scattered radiation 	First FRCR (Physics)	1,2
Describes the monitoring of personnel: <ul style="list-style-type: none"> • construction and operating of film badge • TLD badge • direct reading dosimeter 	First FRCR (Physics)	1,2
Describes the dose reporting mechanisms	First FRCR (Physics)	1,2