SPECIALTY TRAINING CURRICULUM

FOR

NUCLEAR MEDICINE

MAY 2007

Joint Royal Colleges of Physicians Training Board

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1 RATIONALE

1.1 Introduction

The purpose of this curriculum is to train a specialist in Nuclear Medicine. The curriculum describes the competencies required to complete a Certificate in Training (CCT) and to be included on the Specialist Register in Nuclear Medicine. The CCT specialist will be able to work as a consultant specialist within the National Health Service and will have the knowledge, skills and attitudes required to do this. It is expected that the trainee will be competent in the understanding of the scientific knowledge base of nuclear medicine and in the practice of diagnostic and therapeutic nuclear medicine including. The trainee in Nuclear Medicine needs to gain a broad view of the needs of the community he or she serves. This requires not only the acquisition of certain knowledge and skills but also the development of appropriate attitudes enabling the trainee to look after the interests of patients, to work with other relevant health care professionals, to keep up with developments in the field and to bring these developments into the clinical arena.

1.2 Definition of Nuclear Medicine

Nuclear Medicine is the specialty responsible for the administration of unsealed radioactive substances to patients for diagnosis, therapy or research (in contrast to radionuclide radiology which does not include the use of radionuclides for therapy). Trainees will require appropriate instruction in the clinical, scientific and legal aspects of the specialty. Specialists in Nuclear Medicine have ultimate responsibility for Nuclear Medicine services and must hold the appropriate certificate from Health Ministers to administer radioactive substances.

1.3 Responsibility for the curriculum

The Medical Director of the JRCPTB is responsible for the curriculum

The content of the curriculum were chosen by the Specialist Advisory Committee (SAC) in Nuclear Medicine. Regular meetings were held by the SAC involving all relevant stakeholders (guidance was given by the JRCPTB and from PMETB). The curriculum was drawn up by the SAC and submitted for approval by the JRCPTB. The majority of the SACs are teachers, trainers and trainees in the specialty. There has been special involvement of the Royal College of Radiologists as well as the Royal Colleges of Physicians as it is understood that this specialty is of interest to both Royal Colleges.

1.4 Duration and organisation of training

Although this curriculum is competency based, the duration of training must meet the European minimum of 4 (four) years for post registration in full time training adjusted accordingly for flexible training (EU directive 93/16/EEC requires that flexible training can be no less than 50% whole time equivalent). The SAC has advised that training from ST1 will usually be completed in 6 (six) years in full time training

1.5 Requirements for Entry into training in Nuclear Medicine

In view of the multi-disciplinary nature of Nuclear Medicine, the specialty is considered to be strengthened by inclusion of practitioners from a variety of clinical backgrounds. Thus, this curriculum allows for entry into specialty training not only from a background in clinical

medicine but also from radionuclide radiology and other specialties such as surgery and paediatrics.

Entry from Clinical Medicine:
Applicants for specialist training year 3 should have completed core training (core medical training (CMT) or acute care common stem (medicine) ACCS(M)) and by completion of their CCT gained MRCP (UK) or equivalent. Core training is defined as successful completion of approved Foundation year 2 posts and approved core training.

Entry from Radionuclide Radiology.
Applicants for Specialty Training year 3 should have FRCR and undergone sub-speciality training in Radionuclide radiology. Applicants should have successfully completed approved Foundation year 2 posts and either a) successfully completed approved core medical training or b) provide other evidence of achievement of core medical competencies. If there is insufficient evidence of core medical competencies, applicants may be admitted to Nuclear Medicine training only if the training period is extended to enable the provision of additional core medical training.

Entry from other clinical backgrounds:
Applicants without the MRCP part 1 or FRCR who compete for specialty training year 3 posts must provide evidence of appropriate knowledge, training and experience. As a minimum they must have evidence of completion of foundation competencies. If there is insufficient evidence of core medical competencies, applicants may be admitted to Nuclear Medicine training only if the training period is extended to enable the provision of additional core medical training. Overseas graduates must also provide evidence of satisfactory completion of appropriately supervised general professional training.

1.6 Relationship to other curricula:

The Nuclear Medicine Specialty Curriculum builds on the knowledge, skills and attitudes obtained in core training which follows on from the Foundation curriculum. The JRCPTB generic curriculum complements both the specialty and core training curricula, and runs through from ST1 to CCT. Thus, Nuclear Medicine training will consolidate and extend many competencies learnt in earlier stages of training including the following:

- have acquired and developed team working and leadership skills
- work effectively with other healthcare professionals
- are able to identify and take responsibility for their own educational needs and the attainment of these needs
- are effective educators of both patients and colleagues
- manage time and resources to the benefit of themselves, their patients and colleagues
- apply appropriate knowledge and skill in the diagnosis of patients referred to them
- are able to act as safe independent practitioners while recognising the limitation of their own expertise and the obligation to seek assistance of colleagues where appropriate
- are competent to perform the core investigations and therapy required in Nuclear Medicine.
- can use effectively current methods in information technology
- use skills of lifelong learning to keep up to date with developments in Nuclear medicine
- develop clinical practice based on analysis of relevant clinical trials and on understanding of research methodologies

- are able to use the tools of audit and clinical governance to modify, improve and maintain standards in clinical practice
- are able to work within the legal framework relating to the use of radioactive materials.

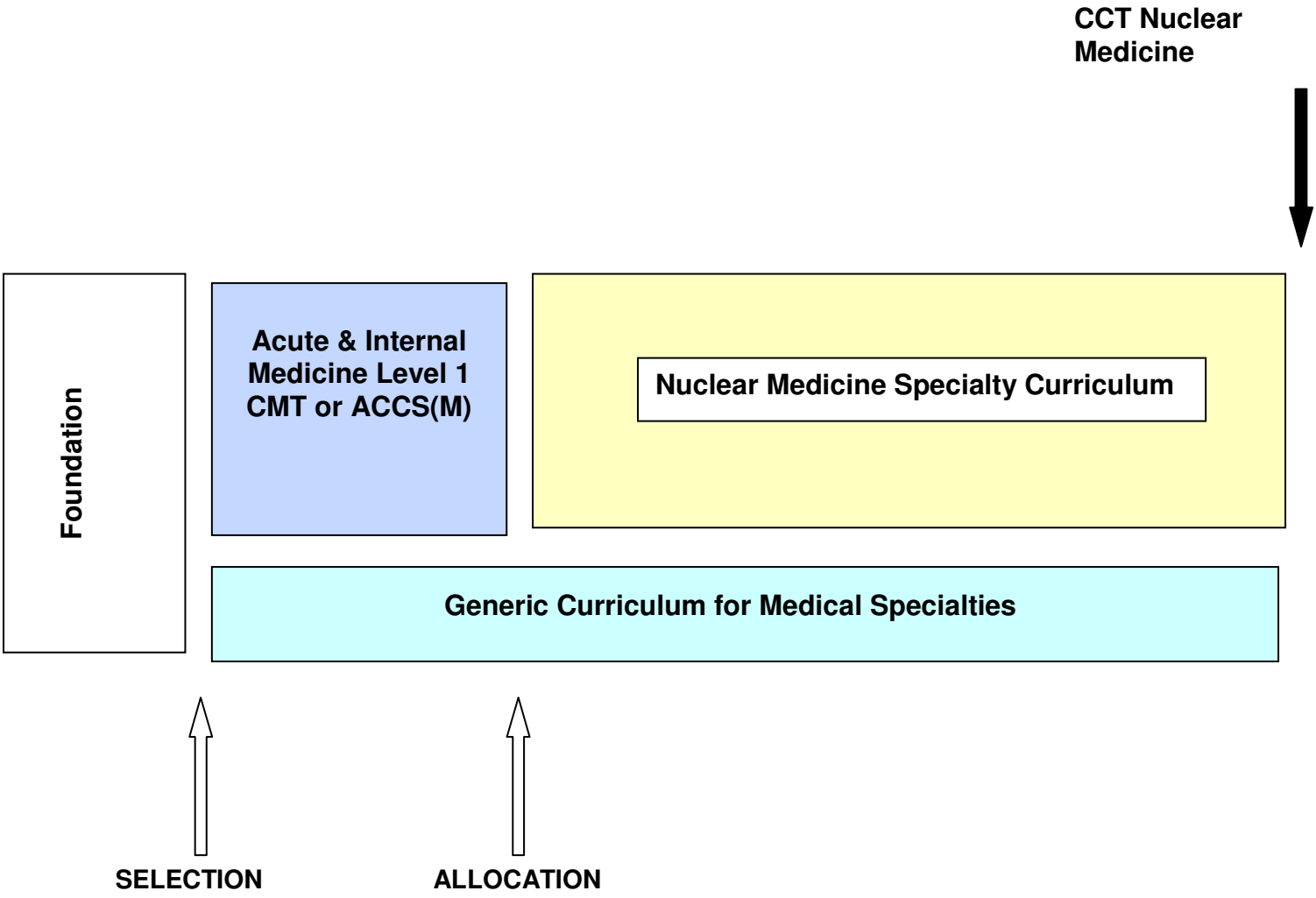
This curriculum also relates to the curriculum for radionuclide radiology administered by the Royal College of Radiologists. Competencies achieved during radionuclide radiology may be transferred with a reduction in the training period in Nuclear Medicine as outlined above.

2. CONTENT OF LEARNING

2.1 General

This specialty curriculum is complementary to the generic curriculum which applies to all 28 physicianly specialities. The generic curriculum follows the headings of good medical practice and runs through from core training to CCT. Trainees should read and understand both their specialty curriculum and the generic curriculum. Both curricula should be seen as integrated so that generic competencies are acquired at all stages of specialty training. Some generic components are also further expanded and deepened for some specialties (eg palliative medicine). When planning specialty programmes, deaneries and trainers should ensure that both specialty and generic competencies can be acquired and assessed.

The following diagram shows the training path of a trainee in Nuclear Medicine



2.2 Specific skills to be acquired

These will include:

1. Basic radiation safety:

The trainee will be able to ensure the safe handling of radiopharmaceuticals both as administered to patients to him/herself, other staff members and the patient's family and others in whom they are in close contact. Special note will be taken of women who may be or who are pregnant and lactating mothers. The trainee will learn and apply the principles of ALARP (as low as reasonably practical) as defined as lowest radiation dose to the patient to achieve a diagnostic image or therapeutic response. Competency should be obtained by the end of year 1 with consolidation over the training period.

2. Understanding of the legal requirements for safe handling of radioisotopes:

The trainee will be taught the legal framework for the safe administration of radiopharmaceuticals including the general instructions for ionising radiation (IR(ME)R 2000)

and those specific to the practice of nuclear medicine (MARS and ARSAC regulation) Competence will be obtained by the time of their CCT

3. Basic science underpinning safe practice of nuclear medicine:

The trainees should acquire an understanding of the different forms of radioactive decay, their effects on human tissue, how basic nuclear medicine imaging devices work and the factors which effect image quality. This should be achieved within the first year of the trainees appointment with further in depth knowledge gained before CCT

4. Assessment of patient's condition and appropriateness of diagnostic test:

An understanding of why nuclear medicine tests are required and how the patient's condition can be affect the interpretation of the diagnostic mage these skills will be acquired throughout the course

5. An understanding of how nuclear medicine test should be conducted safely and the skills report those tests accurately and understand how these results fit into the patient's ongoing management: These will include interaction with referral clinicians both informally and through formal MDMs

Training in these areas will be delivered in a spiral of learning starting with the most routine tests in years 1 and 3 and more complex and rare studies in years 3 and 4

6. To understand the appropriate and safe administration of radionuclide therapy and relevant patient aftercare for the patient and their families:

This will include the indication for radionuclide therapy, patient preparation. Radiation protection for both nuclear medicine and other hospital staff and the patient's family. The legal framework for administration of radionuclide therapy. The mechanisms required for administration, expected side effects and effective follow-up following therapy. Training in these aspects will be delivered throughout the 4 years but will be a main focus of year 4 to allow those with radionuclide radiology to gain a CCT in Nuclear Medicine

7. Communication with patient and other members of the nuclear medicine team:

These skills will also be strengthened through the generic curriculum but with special emphasis on the uses of radionuclides for diagnosis and therapy

8. Understanding the inter-relationship of nuclear medicine studies and other diagnostic tests:

Training in these aspects will occur both throughout the course but also with special reference to cross-sectional radiology as a specific rotation.

9. Building skills in communicating results of investigations with clinicians:

This will be occurring throughout the course aided by the generic training and skills learnt in Foundation years and core medical training or equivalent.

10. Safe and appropriate uses of interventions such as cardiac testing:

This will include both physical and pharmacological stress and maintaining skills in cardiac resuscitation again building on skills gained in Foundation and Core Medical Training.

11. Understanding the role of the Nuclear Medicine Physician as a medical profession in the health service

12. Promoting personal and professional development.

Common Objectives:

Certain goals have been identified as common to all of the stated objectives that form the curriculum of Nuclear Medicine Training. In the following pages the term 'evaluate' in the 'Objectives' column is taken to incorporate all of the following abilities:

1. To define the indications for radionuclide imaging of the particular diagnostic test.
2. To understand the role of comparative tests for the stated indication.
3. To prepare the patient for the test.
4. To assess the radiation protection issues involved and discuss these with the patient and carers.
5. To perform the investigation and analysis.
6. To provide quality assurance for the scan procedure.
7. To assess and interpret the resultant images.
8. To provide a written report of the test.
9. To liaise with the referring clinician.
10. To audit the results of the test.
11. To understand the indications for radionuclide therapy
12. To communicate with the patient the requirements for safe administration of radionuclide therapy
13. To know expected side effects of treatment and warn the patient of these
14. To conduct the radionuclide therapy safely
15. To audit the results of the therapy.

3. MODEL OF LEARNING AND LEARNING EXPERIENCES

Trainees will pursue the learning outcomes described in the curriculum through a variety of learning methods. There must be robust arrangements for quality assurance in place to ensure consistent local implementation of the curriculum. Most competencies are acquired over a sustained period of experience

Learning about the speciality of Nuclear Medicine, both theoretical and practical, is facilitated by:

1) Local department of nuclear medicine-based experiential learning, on-site tutorial based teaching and attendance at relevant clinics, post graduate grand rounds and multidisciplinary meetings will provide the main environments for delivering the curriculum throughout the training period. Attachments to other training departments will be organised to supplement the learning experiences as required. This department based learning experience will achieve knowledge, skills, attitudes and expertise over the course of the training programme (60%).

2) Independent, self directed, reflective learning will supplement the knowledge based learning (20%).

3) Externally delivered education will supplement the locally delivered knowledge focused training, usually occurring in the middle and later years of the programme (20%),

The majority of the curriculum is suited to delivery by **work-based experiential learning** and **on-the-job supervision**. Where it is clear from trainees' experience that parts of the curriculum are not being delivered within their work place, appropriate off-the job education or rotations to other work places will be arranged. The key will be regular work-based assessment by educational supervisors who will be able to assess, with the trainee, their on-going progress and whether parts of the curriculum are not being delivered within their present work place.

Because trainees will achieve competencies at different rates, it is not possible to stipulate the numbers of nuclear medicine procedures that should comprise the work-based experiential learning. However, the core experience of a typical trainee is given in appendix 3.

The curriculum will be blueprinted so that key competencies will be delivered, and the various assessments of knowledge, skills, behaviours and attitudes will be fit for purpose and give coverage across the domains of the curriculum by a process of sampling. All assessments will be appropriate to the training level of the trainee and will be valid, reliable, systematically collected, judged against pre-determined criteria and appropriately weighted. Feedback will be given confidentially to each trainee with suggestions for improvements where appropriate.

Trainees will however be expected to complete the MRCP prior to attaining a CCT. In addition there will be a formal knowledge based examination (KBA) to be completed satisfactorily by the time of the penultimate year assessment as well as day to day assessment of knowledge by clinical supervisors and reported to programme directors through annual reports.

Each year there will be an assessment of progress (RITA) led by the deanery utilising reports from educational and research supervisors and academic mentors with the results of formal assessments. There will be an interview with experienced teachers and assessors covering the various clinical areas in which trainees work. If trainees fail to meet the expected standards they may be asked to have targeted training or even repeat part of or a whole year of training if

needed. Repeated failure to make satisfactory progress may mean that trainees will be asked to leave the training programme. This decision will always involve the postgraduate dean.

The curriculum will be delivered through a variety of learning experiences. Trainees will learn from practice (work-based training); trainees will have opportunities for concentrated practice in skills and procedures where appropriate; they will also learn from peers.

Competence may be attained by the following methods of teaching and learning as outlined below in Table 1.

Table1.

Key	Teaching and Learning Method
1	**Taught Courses**
2	**Personal Self directed Study**
3	**Local Tutorials**
4	**Vetting Request Forms**
5	**Task-specific on-the-job training**
6	**Tutored-reporting of scans**
7	**Tailored clinical experience**
8	**Multidisciplinary meetings**
9	**Post-graduate education courses**
10	**Research projects**
11	**Audit projects**
12	**Planning and delivery of teaching**
13	**Distance/interactive learning**
14	**Reflection**
15	**Problem solving**

Research

Trainees who wish to acquire extensive research competencies, in addition to those specified in the generic element of the curriculum, may undertake a research project as an ideal way of obtaining those competencies, all options can be considered including taking time out of programme to complete a specified project or research degree. Time out of programme needs prospective approval from the SAC and the support of the Postgraduate Dean. Funding will need to be identified for the duration of the research period. A maximum period of 3 years out of programme is allowed.

4. ASSESSMENT STRATEGY

The domains of Good Medical Practice will be assessed using both workplace-based assessments and examination of knowledge and clinical skills, which will sample across the domains of the curriculum i.e. knowledge, skills and attitudes. The assessments will be supported by structured feedback for trainees within the training programme of CPT. Assessment tools will be both formative and summative and will be selected on the basis of their fitness for purpose.

It is likely that the workplace-based assessment tools will include miniCEX (clinical examination exercise), DOPS (direct observation of procedural skills) and MSF (multi-source feedback).The Federation of the Royal Colleges of Physicians has piloted these methods and has demonstrated their validity and reliability. It is proposed that the examination and assessment of knowledge will utilise elements of the MRCP(UK) examination relevant to training.

An assessment blueprint will be developed which will map the assessment methods on to the curriculum in a systematic way. The blueprint will ensure that there is appropriate sampling across the curriculum. The SAC will be responsible for the blueprinting exercise.

5. SUPERVISION AND FEEDBACK:

The educational supervisor will meet regularly with the trainee to discuss progress and to feed back appraisal and assessment. This will ensure the trainee understands what development is required. An important component of this will be the completion of work based assessments including Case-based Discussion (Diagnostic Nuclear Medicine), the mini CEX (Nuclear Medicine Therapy), and DOPS - Direct Observation of Procedures and Skills. Opportunities for feedback will arise during appraisal meetings, when trainees are being assessed, in the workplace setting, and through discussions with supervisors, trainers, assessors and those within the team.

Training record

The trainee will maintain a Training Record. It will be counter-signed as appropriate by the Educational Supervisor(s) to confirm satisfactory fulfilment of the required training experience and the acquisition of the competencies that are enumerated in the Speciality Curriculum. It will remain the property of the trainee and must be produced at the annual assessments.

Appraisal

The educational supervisor appointed to the trainee will provide regular appraisals (3-4 monthly). These will provide the opportunity to develop a learning plan and the ways to facilitate the achievement of this plan. The appraisal is confidential unless the trainee and supervisor agree that it can form part of the record. The supervisors will have been trained in appraisal and should have training in educational supervision.

Supervision of practice and safety of doctor and patient

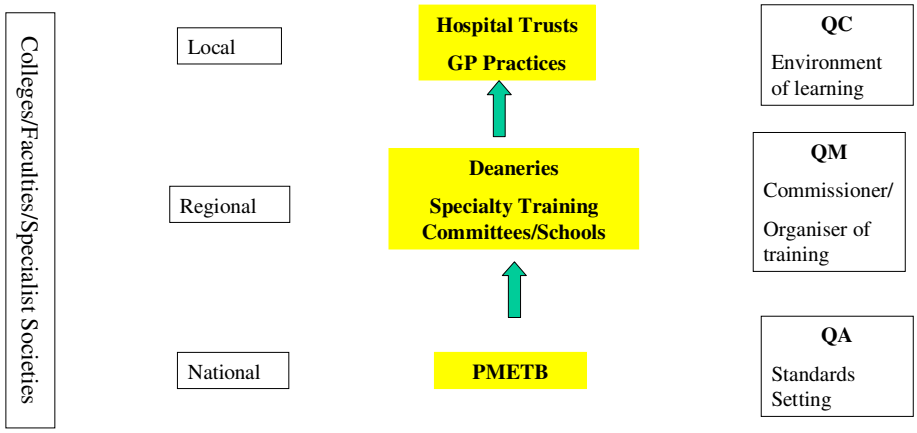
The quality of the trainee's reports will be audited and the results discussed between the educational supervisor and the trainee. The educational supervisor, when meeting with the trainee, will also discuss issues of clinical governance, risk management and the report of any untoward clinical incidents involving the trainee. The educational supervisor is part of the clinical specialty team thus if the clinical directorate (clinical director) have any concerns about

the performance of the trainee, or there were issues of doctor or patient safety, these would be discussed with the educational supervisor. This would not detract from the statutory duty of the trust to deliver effective clinical governance through its management systems.

6. MANAGING CURRICULUM IMPLEMENTATION

Deaneries are responsible for quality management, PMETB will quality assure the deaneries and educational providers are responsible for local quality control, to be managed by the deaneries. The role of the Colleges in quality management remains important and will be delivered in partnership with the deaneries. The College role is one of quality review of deanery processes and this will take place within the SACs on a regular basis.

The Organisation and Quality Assurance of PG Training



7. CURRICULUM REVIEW AND UPDATING

The specialty curriculum, along with the core medical training, acute medicine and generic curricula will be reviewed regularly. The curricula should be regarded as living documents and the SAC will ensure that it will respond swiftly to new developments. In addition the curriculum in haematology will be subject to 3 yearly formal review within the SAC. This will be informed by curriculum evaluation and monitoring. The SAC will have available to it the trainees' questionnaire (PMETB to provide) plus specialty specific questionnaires, reports from other sources such as educational supervisors, programme directors, specialty deans, other contacts such as at PYAs which SAC members attend, service providers and patients.

Trainee involvement in curriculum review will be facilitated through the involvement of trainees in local faculties of education and through informal feedback during appraisal, RITA, College meetings

The SAC will respond rapidly to changes in health service delivery. Regular review will ensure the coming together of all the stakeholders needed to deliver an up to date modern specialty

curriculum. The curriculum will indicate the last date of formal review monitoring and document revision.

Curriculum revision needs to be informed by a review of how the trained CCT specialist performs within the National Health Service. There are two aspects to this:

1 Specific to the person
Was the trained specialist able to carry out the duties of the consultant post they were appointed to, ie did they have the requisite skills, knowledge and attitudes required for the post, did the possession of a CCT in that specialty meet the requirements of the person specification?

2 Specific to the role
Did the specialty competencies meet the requirements of the service, i.e. was the design of the specialist fit for purpose?

8. EQUALITY AND DIVERSITY

In the exercise of these powers and responsibilities, the Royal Colleges of Physicians will comply, and ensure compliance, with the requirements of relevant legislation, such as the:

- Race Relations (Amendment) Act 2000;
- Disability Discrimination Act 1995 and Special Educational Needs and Disabilities Act 2001;
- The Disability Discrimination Act 1995 (amendment) (further and higher education) regulations 2006
- Age Discrimination Act in October 2006

The Federation of the Royal Colleges of Physicians believes that equality of opportunity is fundamental to the many and varied ways in which individuals become involved with the Colleges, either as members of staff and Officers, as advisers from the medical profession, as members of the Colleges' professional bodies or as doctors in training and examination candidates. Accordingly, it warmly welcomes contributors and applicants from as diverse a population as possible, and actively seeks to recruit people to all its activities regardless of race, religion, ethnic origin, disability, age, gender or sexual orientation.

The JRCPTB believes that equality of opportunity is fundamental to the many and varied ways in which individuals become involved with the Colleges, either as members of staff and Officers, as advisers from the medical profession, as members of the Colleges' professional bodies or as doctors in training and examination candidates. Accordingly, it warmly welcomes contributors and applicants from as diverse a population as possible, and actively seeks to recruit people to all its activities regardless of race, religion, ethnic origin, disability, age, gender or sexual orientation.

Deanery quality assurance will ensure that each training programme complies with the equality and diversity standards in postgraduate medical training as set by PMETB.

Compliance with anti-discriminatory practice will be assured through:

- Monitoring of recruitment processes
- Ensuring all College representatives and Programme Directors have attended appropriate training sessions prior to appointment or within 12 months of taking up post
- Ensuring trainees have an appropriate, confidential and supportive route to report examples of inappropriate behaviour of a discriminatory nature
- Monitoring of College examinations
- Ensuring all assessments discriminate on objective and appropriate criteria and do not unfairly disadvantage trainees because of gender, ethnicity, sexual orientation or disability (other than that which would make it impossible to practise safely as a physician). All efforts shall be made to ensure the participation of people with a disability in training.

Statutory responsibilities

The Royal Colleges of Physicians will comply, and ensure compliance, with the requirements of legislation, such as the:

- Human Rights Act 1998
- Freedom of Information Act 2001
- Data Protection Acts 1984 and 1998

Appointment of trainees

All adverts shall include the possibility of full time or part time appointment. There will be a formal meeting of the appointments committee for both the short listing as well as actual appointment. The appointments committee should have a lay chairman and all proceedings are recorded by the nuclear medicine administrator from the London Deanery.

NUCLEAR MEDICINE CURRICULUM

The content of learning is outlined in the following pages. The learning experiences appropriate to each area are indicated as a footnote with reference to table 1. The training objectives, competencies achieved, learning methods and assessment typical for each year of training are outlined in Appendix 2.

All trainees must be able to meet the objectives of the nuclear medicine curriculum. It is however recognised that some Nuclear Medicine investigations are performed infrequently making it difficult for the trainee to achieve competence during the period of training. The curriculum takes account of this by making the acquisition of certain skills **optional** (those marked with an asterisk in the curriculum). Nevertheless, the knowledge surrounding these skills remains core even where practical experience is optional.

Teaching and learning methods for all models are outlined in Table one below.

Table 1.

Key	Teaching and Learning Method
1	**Taught Courses**
2	**Personal Self directed Study**
3	**Local Tutorials**
4	**Vetting Request Forms**
5	**Task-specific on-the-job training**
6	**Tutored-reporting of scans**
7	**Tailored clinical experience**
8	**Multidisciplinary meetings**
9	**Post-graduate education courses**
10	**Research projects**
11	**Audit projects**
12	**Planning and delivery of teaching**
13	**Distance/interactive learning**
14	**Reflection**
15	**Problem solving**

CORE NUCLEAR MEDICINE CURRICULUM: BASIC SCIENCE

Objective: to provide the trainee with a working knowledge of the basic science appropriate to Nuclear Medicine			
Subject	**Knowledge**	**Skills**	**Attitudes**
I Physics and mathematics	A. Structure and modes of decay of radioactive atoms B. Interaction of emissions from radioactive atoms with matter C. Biological implications of and radiation hazards from ionising radiation. D. Molecular biology E. Probability theory F.Parametric and non-parametric statistics G. Appropriate mathematics and physics applied to radionuclide tracer theory, modelling of tracer kinetics and quantitative imaging.	Practices these effectively	Recognises the need to understand the basic science appropriate to Nuclear Medicine.

Teaching and Learning Methods 1, 2, 3, 9, 13,15 (see Table 1).

Objective: to provide the trainee with a working knowledge of the basic science appropriate to Nuclear Medicine			
Subject	**Knowledge**	**Skills**	**Attitudes**
II Instrumentation and computers.	A. Theory of systems used to detect and analyse emissions from radioactive atoms B. Knowledge of how detection systems are used, calibrated and tested in Nuclear Medicine C. Principles of collimation and practical experience with the use of collimators D. Principles of single-photon emission tomography and co-incidence counting E. Principles of image reconstruction.	A. Practical experience with the use of monitoring devices, probes, well counters, dose calibrators, gamma cameras, and positron emission tomography systems B. Use of computers to display and process images	A. Willing to learn new skills and keep up to date with developments in technology

Teaching and Learning Methods 1, 2, 3, 5, 9, 10, 13, 15 (see Table 1).

Objective: to provide the trainee with a working knowledge of the basic science appropriate to Nuclear Medicine			
Subject	**Knowledge**	**Skills**	**Attitudes**
III Radiation biology and radiation protection.	A. Theory of biological effects of high and low-level radiation from unsealed sources B. Calculation of radiation dose from radiopharmaceuticals (Effective dose [ED]) C. Basic principles of radionuclide therapy D. Nature of the cancerous process and the radiobiological basis of cancer radionuclide therapy E. Management of radiation accidents relating to Nuclear Medicine.	A. The safe handling of radiopharmaceuticals B. Deploy appropriate signs in Nuclear Medicine Departments. C. Write local rules for the use of unsealed source radiation D. Demonstrate ability to handle incidents of radioactive spillage or contamination	A. Appreciate the importance of safe handling of radiopharmaceuticals for self and for others

Teaching and Learning Methods 1, 2, 3, 5 ,15(see Table 1).

Objective: to provide the trainee with a working knowledge of the basic science appropriate to Nuclear Medicine			
Subject	**Knowledge**	**Skills ***	**Attitudes**
IV Radiochemistry and radiopharmacy.	A. Production of radionuclides using reactors, cyclotrons and generators B. Physical properties of radionuclides, clinical applications. C. Physicochemical and biological properties of different radiopharmaceuticals in routine clinical practice, clinical trials and under development D. Different formulations used in Nuclear Medicine E. Cell Labelling techniques F.Principles of Quality Assurance (QA) in the radiopharmacy G. Quality control parameters which determine the quality of radiopharmaceuticals including radionuclide & radiochemical purity H. Principles of aseptic preparation	A. Perform elution of a technetium generator B. Prepare a cold kit C. Perform cell labelling D. Perform simple tests of radionuclide and radiochemical purity E. Demonstrate techniques of aseptic preparation	A. Show attention to detail in handling radiopharmaceuticals and in ensuring radiochemical and radionuclide purity and also aseptic technique.

Teaching and Learning Methods 1, 2, 3, 5, 8, 9, 10, 11, 13,15 (see Table 1).

Objective: to provide the trainee with a working knowledge of the basic science appropriate to Nuclear Medicine			
Subject	**Knowledge**	**Skills**	**Attitudes**
V Tracer principles and techniques and in vitro studies.	A. Kinetics of radioactive tracers used in Nuclear Medicine B. Use of principles of kinetics and modelling techniques to calculate parameters such as glomerular filtration rate etc. C. Physiological principles of tracer techniques D. Errors associated with the quantitative measurements E. Principles of RIA (Radioimmunoassay) F.Principles of ELISA (Enzyme-linked immunoadsorbant assay)	See individual non-imaging diagnostics	See individual non-imaging diagnostics

Teaching and Learning Methods 1, 2, 3, 5, 6, 9, 13,15 (see Table 1).

Objective: to provide the trainee with a working knowledge of the basic science appropriate to Nuclear Medicine			
Subject	**Knowledge**	**Skills**	**Attitudes**
VI The regulatory framework of Nuclear Medicine.	A. National and international regulatory requirement on the practice of nuclear medicine including: IRR99; MARS legislation; ARSAC; RSA 93; IR(ME)R 2000; Medical guidance notes; Product licenses and other appropriate legislation. B. Regulatory requirements which apply to the design and operation of radiopharmacies GMP 1997 (Orange Guide) C. Regulations controlling transport of radioactive materials in the UK RM(Road Transport) (GB) R 1996 D. Mechanism by which the regulations are applied and policed within the UK E. Health and safety regulations governing safe practice e.g. COSHH Regulations 1999 F.ALARA (as low as reasonably achievable) and ALARP (as low as reasonably practical) G. Any subsequent revisions of or additions to the above legislation.	A. Demonstrate ability to translate the regulations into local practice	A. Show willingness to keep up with developments in the regulations governing nuclear medicine B. Appreciates the need to work with others in ensuring that the regulations are strictly adhered to.

Teaching and Learning Methods 1, 2, 3, 8, 9, 13 ,15(see Table 1).

CORE IMAGING: CARDIOVASCULAR SYSTEM

Objective. To provide the trainee with the knowledge, skills and attitudes to evaluate coronary artery disease using radionuclide techniques.			
Subject	**Knowledge**	**Skills**	**Attitudes**
I Myocardial perfusion and infarct imaging (see also PET imaging)	A. Cardiac & coronary anatomy, cardiac physiology and pathophysiology. B. Principles of myocardial perfusion and SPECT imaging including ECG-gated SPECT. C. Radiopharmaceuticals currently used for myocardial perfusion imaging (e.g. ^{201}Tl and the ^{99m}Tc-labelled tracers) and infarction imaging (e.g. ^{99m}Tc-pyrophosphate and antimyosin antibodies) and those in development. D. Principles of physiological and pharmacological stress tests E. Imaging protocols used to evaluate myocardial viability, ischaemia and function. F.Indications for myocardial perfusion and infarction imaging G. Role of comparative assessment methods including the exercise ECG, stress echocardiography and coronary angiography. H. Radiation protection issues	A. Preparation of the patient prior to the test. B. Measurement and drawing up of tracer. C. Performance of cardiac stress test using physiological or pharmacological techniques D. Injection of the tracer. E. Setting up of instrumentation for ECG-gating and SPECT acquisition. F.Performance of the scans developing good technique allied to a knowledge of the pitfalls G. Techniques of tomographic reconstruction, qualitative and quantitative analysis, and display, including knowledge of image artefacts. H. Image interpretation and reporting including sufficient number of patient studies to assess utility, sources of error, normal variants and artefacts. I. Audit outcome of scan results.	A. Recognise the importance of proper vetting of request forms and for patient evaluation prior to the test. B. Show willingness to provide explanation to patient as to nature of the investigation and to put them at ease. C. Appreciate the importance of timely reporting and of prompt and accurate communication of the result to the referring clinician. D. Consider the importance of audit in the outcome of results E. Show openness to critical feedback of reports F.Appreciate the importance of keeping up-to-date with developments and with relevant medical literature. G. Show awareness of health and safety issues

Teaching and Learning Methods 1-14 (See Table 1)

CORE NUCLEARMEDICINE CURRICULUM: CARDIOVASCULAR SYSTEM

Objective To provide the trainee with the knowledge, skills and attitudes to evaluate ventricular function using radionuclide techniques			
Subject	**Knowledge**	**Skills**	**Attitudes**
II Radionuclide ventriculography	A. Cardiac physiology and pathophysiology. B. Principles of radionuclide ventriculography (first pass and equilibrium techniques, rest and exercise studies) C. Radiopharmaceuticals used for assessment of radionuclide ventriculography (^{99m}Tc-labelled red cells) D. Indications for radionuclide ventriculography. E. Role of comparative techniques such as echocardiography and contrast ventriculography. F.Radiation protection issues	A. Preparation of the patient prior to the test. B. Measurement and drawing up of tracer. C. Injection of the tracer. D. Setting up of instrumentation for gated acquisition. E. Performance of rest and stress scans developing good technique allied to a knowledge of the pitfalls F.Data processing and quantification. G. Image interpretation and reporting of sufficient number of patient studies to assess utility, sources of error, normal variants and artefacts. H. Audit outcome of results	A. Recognise the need for proper vetting of request forms and for patient evaluation prior to the test. B. Show willingness to provide explanation to patient as to nature of the investigation and to put them at ease. C. Appreciate the importance of timely reporting and of prompt and accurate communication of the result to the referring clinician. D. Consider the importance of audit in the outcome of results E. Show openness to critical feedback of reports F.Appreciate the importance of keeping up-to-date with developments and with relevant medical literature. G. Show awareness of health and safety issues

Teaching and Learning Methods 1-14 (See Table 1)

CORE CURRICULUM: CENTRAL NERVOUS SYSTEM

Objective: To provide the trainee with the knowledge, skills and attitudes to evaluate the central nervous system (cns) using radionuclide techniques.			
Subject	**Knowledge**	**Skills**	**Attitudes**
Central nervous system imaging	A. Basic neuroanatomy, neurophysiology and neurochemistry. B. Radiopharmaceuticals currently in use for cns imaging and those in development. C. Indications for cerebral blood flow (rCBF) imaging using tracers such as HMPAO. D. Indications for blood-brain barrier imaging. E. Indications for neuroreceptor imaging. F.Role of comparative imaging tests such as ultrasound, CT and MR scanning G. Radiation protection issues H. CSF leaks?	A. Preparation of the patient prior to the test. B. Choice of radiopharmaceutical and imaging protocol. C. Radiotracer preparation and its quality assurance. D. Radiopharmaceutical injection E. Setting up of instrumentation for SPECT acquisition and performance of scan. F.Data processing, image reconstruction and quantification G. Image interpretation and reporting of sufficient number of patient studies to assess utility, sources of error, normal variants and artefacts. H. Audit outcome of studies	A. Recognise the importance of proper vetting of request forms and of patient evaluation prior to the test. B. Show willingness to provide explanation to patient as to nature of the investigation and to put them at ease. C. Appreciate the importance of timely reporting and of prompt and accurate communication of the result to the referring clinician. D. Consider the importance of audit in the outcome of results E. Show openness to critical feedback of reports F.Appreciate the importance of keeping up-to-date with developments and with relevant medical literature. G. Show awareness of health and safety issues

Teaching and Learning Methods 1-14 (See Table 1)

CORE IMAGING: ENDOCRINE SYSTEM

Objective To provide the trainee with the knowledge, skills and attitudes to evaluate endocrine disorders using radionuclide techniques.			
Subject	**Knowledge**	**Skills**	**Attitudes**
Adrenal Imaging	A. Basic science including the biochemistry of adrenal disorders. B. Clinical syndromes associated with adrenal disease. C. Basic science of adrenal imaging with ^{123}I MIBG and cholesterol imaging agents. D. Indications for radionuclide adrenal imaging. E. Sensitivity and specificity of the tests. F.Role of comparative tests in the diagnosis of adrenal disorders. G. Radiation protection associated with ^{123}I MIBG and cholesterol imaging agents	A. Preparation of the patient prior to the test. B. Measurement and drawing up of the tracer. C. Injection of the radiopharmaceuticals. D. Performance of the scans developing good technique allied to a knowledge of the pitfalls associated with the study E. Use of renal subtraction scanning F.Image processing and display. G. Image interpretation including the reporting of sufficient number of patient studies to assess utility, sources of error, normal variants and artefacts. H. Audit of the outcome of the tests	A. Recognise the importance of proper vetting of request forms and of patient evaluation prior to the test. B. Show willingness to provide explanation to patient as to nature of the investigation and to put them at ease. C. Appreciate the importance of timely reporting and of prompt and accurate communication of the result to the referring clinician. D. Consider the importance of audit in the outcome of results E. Show openness to critical feedback of reports F.Appreciate the importance of keeping up-to-date with developments and with relevant medical literature. G. Show awareness of health and safety issues

Teaching and Learning Methods 1, 2, 3, 4, 5, 6, 8-13 (See Table 1)

CORE IMAGING: ENDOCRINE SYSTEM

Objective. To provide the trainee with the knowledge, skills and attitudes to evaluate thyroid disorders using radionuclide techniques*			
Subject	**Knowledge**	**Skills**	**Attitudes**
Thyroid Scans and Uptake Measurements	A. Developmental anatomy physiology and biochemistry of the thyroid gland. B. Clinical presentation and management of thyroid disorders. C. Science of thyroid imaging and uptake using $^{99m}TcO_4$ and ^{123}I tracers and the perchlorate discharge test. D. Indications for radionuclide thyroid imaging E. Role of complementary and comparative investigations including thyroid biochemistry, immunology, ultrasound and CT scans and FNA in the evaluation of thyroid disorders. F.Radiation protection associated with the radiopharmaceuticals.	A. Preparation of the patient for the test. B. Clinical evaluation of the thyroid gland. C. Measurement and drawing up of the radiopharmaceuticals. D. Injection of the tracer E. Choice of collimator F.Performance of the scans developing good technique allied to knowledge of the pitfalls associated with the study. G. Data and image processing, quantification and image display. H. Image interpretation and reporting of sufficient number of patient studies to assess the utility, pitfalls, normal variants and artefacts. I. Correlating the scan and clinical findings J. Audit of outcome.	A. Recognise the importance of proper vetting of request forms and of patient evaluation prior to the test. B. Show willingness to provide explanation to patient as to nature of the investigation and to put them at ease. C. Appreciate the importance of timely reporting and of prompt and accurate communication of the result to the referring clinician. D. Consider the importance of audit in the outcome of results E. Show openness to critical feedback of reports F.Appreciate the importance of keeping up-to-date with developments and with relevant medical literature. G. Show awareness of health and safety issues

*** Includes attendance at Thyroid clinics.**

Teaching and Learning Methods 1-114 (See Table 1)

CORE IMAGING: ENDOCRINE SYSTEM

Objective To provide the trainee with the knowledge, skills and attitudes to evaluate parathyroid disorders using radionuclide techniques.			
Subject	**Knowledge**	**Skills**	**Attitudes**
Parathyroid Imaging	A. Developmental anatomy and physiology of the parathyroid glands B. Clinical presentation of hyperparathyroidism. C. Basic science of parathyroid imaging using $^{201}Tl/^{99m}Tc$ and 99mTc/^{123}I subtraction and washout ^{99m}TcMIBI imaging as well as those tracers/protocols in development. D. Indications for radionuclide parathyroid imaging. E. Role of comparative tests in the evaluation of parathyroid disorders including ultrasound, selective venous catheterisation etc. F.Utility of intra-operative probe detection. G. Radiation protection associated with the scans.	A. Preparation of the patient prior to the test(s). B. Choice of imaging protocol. C. Measurement and drawing up of the radiopharmaceuticals. D. Administration of the radiopharmaceuticals. E. Performing the scans developing good technique allied to knowledge of the pitfalls associated with the study. F.Image processing and display. G. Image interpretation and reporting of sufficient number of patient studies to assess utility, pitfalls, normal variants and artefacts. H. Audit of outcomes.	A. Recognise the importance of proper vetting of request forms and of patient evaluation prior to the test. B. Show willingness to provide explanation to patient as to nature of the investigation and to put them at ease. C. Appreciate the importance of timely reporting and of prompt and accurate communication of the result to the referring clinician. D. Consider the importance of audit in the outcome of results E. Show openness to critical feedback of reports F.Appreciate the importance of keeping up-to-date with developments and with relevant medical literature. G. Show awareness of health and safety issues

Teaching and Learning Methods 1-6, 8-14 (See Table 1)

CORE IMAGING: GASTROINTESTINAL SYSTEM

Objective. To provide the trainee with the knowledge, skills and attitudes to evaluate gastrointestinal disorders using radionuclide techniques.			
Subject	**Knowledge and skills**	**Skills***	**Attitudes**
I Salivary Gland Imaging	A. Physiology and pathophysiology of salivary gland disorders. B. Basic science of salivary gland function using $^{99m}TcO_4$. C. Indications for radionuclide salivary gland studies. D. Comparative investigations E. Radiation protection issues.	A. Preparation of the patient prior to the test. B. Measurement and drawing up of the radiopharmaceutical. C. Radiopharmaceutical and salivary gland excretory stimulation administration. D. Performing the scans developing good technique and a knowledge of the pitfalls associated with the study. E. Data processing, image display and quantification. F.Image interpretation and reporting of sufficient number of patient studies to assess utility, pitfalls, normal variants and artefacts. G. Audit of outcome	A. Recognise the importance of proper vetting of request forms and of patient evaluation prior to the test. B. Show willingness to provide explanation to patient as to nature of the investigation and to put them at ease. C. Appreciate the importance of timely reporting and of prompt and accurate communication of the result to the referring clinician. D. Consider the importance of audit in the outcome of results E. Show openness to critical feedback of reports F.Appreciate the importance of keeping up-to-date with developments and with relevant medical literature. G. Show awareness of health and safety issues

*** Optional ?**

Teaching and Learning Methods 1-6, 8-14 (See Table 1)

Objective. To provide the trainee with the knowledge, skills and attitudes to evaluate gastrointestinal disorders using radionuclide techniques.			
Subject	**Knowledge**	**Skills***	**Attitudes**
II Oesophageal transit and gastro-oesophageal reflux.	A. Physiology and pathophysiology of oesophageal transit and the lower oesophageal sphincter. B. Basic science of oesophageal motility and gastro-oesophageal reflux using tracers e.g. ^{99m}Tc colloid or DTPA. C. Indications for radionuclide oesophageal transit and reflux measurements. D. Comparative investigations including oesophageal imaging and manometry. E. Radiation protection issues.	A. Preparation of the patient prior to the test B. Measurement and drawing up of the radiopharmaceutical. C. Radiopharmaceutical administration including patient instruction and positioning. D. Performing the scans using appropriate acquisition techniques and knowledge of the pitfalls associated with the study. E. Image processing including quantification and display. F.Image and data interpretation and reporting of sufficient number of patient studies to assess utility, pitfalls, normal variants and artefacts. G. Audit of outcome.	A. Recognise the importance of proper vetting of request forms and of patient evaluation prior to the test. B. Show willingness to provide explanation to patient as to nature of the investigation and to put them at ease. C. Appreciate the importance of timely reporting and of prompt and accurate communication of the result to the referring clinician. D. Consider the importance of audit in the outcome of results E. Show openness to critical feedback of reports F.Appreciate the importance of keeping up-to-date with developments and with relevant medical literature. G. Show awareness of health and safety issues

*** Optional**

Teaching and Learning Methods 1-13 (See Table 1)

Objectives. To provide the trainee with the knowledge, skills and attitudes to evaluate gastrointestinal disorders using radionuclide techniques.			
Subject	**Knowledge**	**Skills**	**Attitudes**
III Gastrointestinal Transit Measurements	A. Physiology and pathophysiology of gastric emptying and small bowel and colonic transit. B. Clinical conditions known to lead to gastroparesis and to slow transit constipation C. Radiopharmaceuticals used to assess solid and liquid phase gastric emptying and to define the limits of the stomach. D. Radiopharmaceuticals used to assess small and large bowel transit including the use of large bowel stimulants. E. Indications for the above studies. F.Comparative tests of gastric emptying, small bowel and colonic transit assessment. G. Radiation protection issues.	A. Preparation of the patient prior to the test(s). B. Preparation and administration of radiopharmaceuticals. C. Performing the scans using appropriate acquisition techniques and a knowledge of the pitfalls. D. Data processing with ROI positioning and calculation of T½ emptying. E. Recognition of patterns of emptying (e.g. gastric dumping). F.Image interpretation and reporting of sufficient number of patient studies to assess utility, sources of error, normal variants and artefacts. G. Audit of outcome.	A. Recognise the importance of proper vetting of request forms and of patient evaluation prior to the test. B. Show willingness to provide explanation to patient as to nature of the investigation and to put them at ease. C. Appreciate the importance of timely reporting and of prompt and accurate communication of the result to the referring clinician. D. Consider the importance of audit in the outcome of results E. Show openness to critical feedback of reports F.Appreciate the importance of keeping up-to-date with developments and with relevant medical literature. G. Show awareness of health and safety issues

Teaching and Learning Methods 1-6, 8-14 (See Table 1)

Objective. To provide the trainee with the knowledge, skills and attitudes to evaluate gastrointestinal disorders using radionuclide techniques.			
Subject	**Knowledge**	**Skills**	**Attitudes**
IV Gastrointestinal blood loss and Meckel's diverticulum imaging	A. Anatomy and pathophysiology of gastrointestinal (GI) blood loss and Meckels diverticulum. B. Basic science of measuring GI bleeding using radionuclides including ^{99m}Tc colloid or labelled autologous red cells (in vivo or in vitro) C. Principles of detection of Meckel's diverticulum using $^{99m}TcO_4$. D. Indications for GI blood loss studies and Meckel's test. E. Comparative tests for sources of GI blood loss and diagnosis of Meckels diverticulum. F.Radiation protection issues.	A. Preparation of the patient prior to the test. B. Measurement and drawing up of the radiopharmaceutical. C. Preparation and administration of radiopharmaceutical. D. Performing the scans developing good technique and a knowledge of the pitfalls associated with the study. E. Data processing and image display. F.Image interpretation and reporting of sufficient number of patient studies to assess utility, sources of error, normal variants and artefacts. G. Audit of outcome	A. Recognise the importance of proper vetting of request forms and of patient evaluation prior to the test. B. Show willingness to provide explanation to patient as to nature of the investigation and to put them at ease. C. Appreciate the importance of timely reporting and of prompt and accurate communication of the result to the referring clinician. D. Consider the importance of audit in the outcome of results E. Show openness to critical feedback of reports F.Appreciate the importance of keeping up-to-date with developments and with relevant medical literature. G. Show awareness of health and safety issues

Teaching and Learning Methods 1-14 (See Table 1)

Objective. To provide the trainee with the knowledge, skills and attitudes to evaluate gastrointestinal disorders using radionuclide techniques.			
Subject	**Knowledge**	**Skills***	**Attitudes**
V Hepatic and Splenic function assessment.	A. Anatomy and physiology of the liver blood flow, Kupffer cell and the spleen. B. Radiopharmaceuticals used to evaluate hepatic reticuloendothelial (RES) function and suspected liver haemangioma. C. Hepatic blood flow measurements, first pass techniques, calculation of hepatic perfusion index (HPI) and choice of tracer (^{99m}Tc colloid or ^{99m}TcO4) D. Assessment of hypersplenism using colloid or denatured red cells. E. Comparative tests of hepatic blood flow, RES and splenic function. F.Radiation protection issues	A. Preparation of the patient prior to the test. B. Choice of appropriate radiopharmaceutical and imaging protocol. C. Administration of the radiopharmaceutical. D. Performing the scans ensuring good technique and developing knowledge of the pitfalls. E. Data processing, calculation of the HPI and image display. F.Data and image interpretation and reporting of sufficient number of patient studies to assess utility, pitfalls, normal variants and artefacts. G. Audit of outcome	A. Recognise the importance of proper vetting of request forms and of patient evaluation prior to the test. B. Show willingness to provide explanation to patient as to nature of the investigation and to put them at ease. C. Appreciate the importance of timely reporting and of prompt and accurate communication of the result to the referring clinician. D. Consider the importance of audit in the outcome of results E. Show openness to critical feedback of reports F.Appreciate the importance of keeping up-to-date with developments and with relevant medical literature. G. Show awareness of health and safety issues

*** Optional**

Teaching and Learning Methods 1-6, 8- 14 (See Table 1)

Objective. To provide the trainee with the knowledge, skills and attitudes to evaluate gastrointestinal disorders function using radionuclide techniques.			
Subject	**Knowledge**	**Skills**	**Attitudes**
VI Hepatobiliary function	A. Clinical spectrum of biliary disorders including knowledge of operative procedures B. Physiology and pathophysiology of bile formation, gallbladder and sphincter of Oddi function. C. Basic science of ^{99m}Tc HIDA derivatives and pharmacology of cholecystokinin analogues. D. Use of ^{99m}Tc HIDA or derivatives to evaluate ➢Biliary obstruction ➢Acute cholecystitis ➢Biliary leaks ➢Gallbladder dyskinesia ➢Sphincter of Oddi dysfunction ➢Duodenogastric bile reflux E. Alternative methods of assessing the biliary tract. F.Radiation protection issues	A. Preparation of the patient prior to the test. B. Measurement and drawing up of the radiopharmaceutical. C. Choice of imaging protocol and administration of the radiopharmaceutical. D. Performing the scan ensuring good technique and awareness of the pitfalls of the study E. Timing the administration of the gall bladder provocation agent. F.Data processing and quantification of gallbladder function G. Image interpretation and reporting sufficient numbers of patient studies to assess utility, sources of error, normal variants and artefacts. H. Audit	A. Recognise the importance of proper vetting of request forms and of patient evaluation prior to the test. B. Show willingness to provide explanation to patient as to nature of the investigation and to put them at ease. C. Appreciate the importance of timely reporting and of prompt and accurate communication of the result to the referring clinician. D. Consider the importance of audit in the outcome of results E. Show openness to critical feedback of reports F.Appreciate the importance of keeping up-to-date with developments and with relevant medical literature. G. Show awareness of health and safety issues

Teaching and Learning Methods 1-6, 8- 14 (See Table 1)

CORE IMAGING: INFECTION/INFLAMMATION

Objective. To provide the trainee with the knowledge, skills and attitudes to evaluate sites of infection/inflammation using radionuclide techniques.			
Subject	**Knowledge**	**Skills**	**Attitudes**
Imaging sites of infection or inflammation	A. Basic science of infection/inflammation including cellular mechanisms B. Clinical spectrum of occult sepsis C. Radiopharmaceuticals used for infection/inflammation imaging including ^{67}Gallium citrate, ^{99m}TcHMPAO or ^{111}Indium autologous white cells, ^{99m}TcHIG and other infection/inflammation imaging agents in current use or in development. D. Indications for use of radioactive tracers to image occult infection or inflammation E. Role of complementary and comparative investigations for the diagnosis of occult infection or inflammation. F.Radiation protection issues	A. Patient preparation. B. Choice of appropriate radiopharmaceutical and imaging protocol. C. Preparation (including cell labelling skills) and administration of the radiopharmaceutical. D. Performing the scans ensuring good technique and developing knowledge of the pitfalls. E. Image processing and display. F.Image interpretation and reporting of sufficient number of patient studies to assess utility, sources of error, normal variants and artefacts. G. Audit	A. Recognise the importance of proper vetting of request forms and of patient evaluation prior to the test. B. Show willingness to provide explanation to patient as to nature of the investigation and to put them at ease. C. Appreciate the importance of timely reporting and of prompt and accurate communication of the result to the referring clinician. D. Consider the importance of audit in the outcome of results E. Show openness to critical feedback of reports F.Appreciate the importance of keeping up-to-date with developments and with relevant medical literature. G. Show awareness of health and safety issues

Teaching and Learning Methods 1-6, 8- 14 (See Table 1)

CORE CURRICULUM: LYMPHOSCINTIGRAPHY

Objective. To provide the trainee with the knowledge, skills and attitudes to evaluate regional lymphatic drainage using radionuclide techniques (see common objectives)			
Subject	**Knowledge**	**Skills**	**Attitudes**
Lymphoedema evaluation and Sentinel Node Localisation	A. Regional lymphatic anatomy and physiology. B. Mechanisms of tumour spread and concept of the sentinel node. C. Basic science of radiopharmaceuticals used to identify regional lymphatic drainage. D. Indications for lymphoscintigraphy. E. Comparative regional lymphatic localisation techniques. F.Radiation protection issues	A. Preparation of the patient prior to the test. B. Choice of radiopharmaceutical. C. Injection techniques. D. Performing the scans ensuring good technique and knowledge of the pitfalls. E. Surface localisation of the sentinel node F.Calibration and use of the hand-held probe. G. Performance and reporting of sufficient number of patient studies to assess utility, sources of error, normal variants and artefacts. H. Audit	A. Recognise the importance of proper vetting of request forms and of patient evaluation prior to the test. B. Show willingness to provide explanation to patient as to nature of the investigation and to put them at ease. C. Appreciate the importance of timely reporting and of prompt and accurate communication of the result to the referring clinician. D. Consider the importance of audit in the outcome of results E. Show openness to critical feedback of reports F.Appreciate the importance of keeping up-to-date with developments and with relevant medical literature. G. Show awareness of health and safety issues

Teaching and Learning Methods 1-6, 8- 14 (See Table 1)

CORE IMAGING: ONCOLOGY

Objective. To provide the trainee with the knowledge, skills and attitudes to evaluate cancer using radionuclide techniques (see also PET section).			
Subject	**Knowledge**	**Skills**	**Attitudes**
Imaging tumour sites using radionuclide techniques	A. Basic science of tumour biology, metabolism, and spread B. Characteristics of solid organ tumours and haematological malignancies. C. Principles of tumour localisation. D. Radiopharmaceuticals currently used to detect tumours (e.g. ^{67}Ga, ^{201}Tl, pentavalent DMSA, 18FDG radiolabelled antibodies, and peptides) and those in development. E. Knowledge of imaging protocols including whole body or planar static imaging, SPECT and SPECT/CT F.Indications for radionuclide tumour imaging including sensitivity and specificity of the investigations G. Role of comparative tumour imaging techniques including CT and MR imaging. H. Radiation protection issues	A. Preparation of the patient prior to the test. B. Measurement and drawing up of tracer. C. Injection of the tracer. D. Performing the scan aiming for good technique and awareness of the pitfalls of the study. E. Image reconstruction and display F.Image interpretation and reporting of sufficient number of patient studies to assess utility, sources of error, normal variants and artefacts. G. Review of sequential data on patients and comparison with other methods of assessment H. Audit of outcome	A. Recognise the importance of proper vetting of request forms and of patient evaluation prior to the test. B. Show willingness to provide explanation to patient as to nature of the investigation and to put them at ease. C. Appreciate the importance of timely reporting and of prompt and accurate communication of the result to the referring clinician. D. Consider the importance of audit in the outcome of results E. Show openness to critical feedback of reports F.Appreciate the importance of keeping up-to-date with developments and with relevant medical literature. G. Show awareness of health and safety issues

Teaching and Learning Methods 1-14 (See Table 1)

CORE IMAGING: OPHTHALMIC SYSTEM

Objective. To provide the trainee with the knowledge, skills and attitudes to evaluate nasolacrimal drainage using radionuclide techniques.			
Subject	**Knowledge and skills**	**Skills ***	**Attitudes**
NASOLACRIMAL DRAINAGE	A. Physiology and pathophysiology of nasolacrimal ducts. B. Basic science of nasolacrimal drainage using $^{99m}TcO_4$. C. Indications for measurement of nasolacrimal drainage. D. Comparative tests. E. Radiation protection issues.	A. Preparation of the patient prior to the test. B. Ocular radiopharmaceutical instillation techniques. C. Performing the scans developing good technique and a knowledge of the pitfalls associated with the study. D. ROI placement and quantification. E. Image interpretation and reporting of sufficient number of patient studies to assess utility, sources of error, normal variants and artefacts. F.Audit.	A. Recognise the importance of proper vetting of request forms and of patient evaluation prior to the test. B. Show willingness to provide explanation to patient as to nature of the investigation and to put them at ease. C. Appreciate the importance of timely reporting and of prompt and accurate communication of the result to the referring clinician. D. Consider the importance of audit in the outcome of results E. Show openness to critical feedback of reports F.Appreciate the importance of keeping up-to-date with developments and with relevant medical literature. G. Show awareness of health and safety issues

*** Optional**

Teaching and Learning Methods 1-4, 8-11 (See Table 1)

CORE IMAGING: PAEDIATRICS

Objective. To provide the trainee with the knowledge, skills and attitudes to assess disorders in children using radionuclide techniques.			
Subject	**Knowledge**	**Skills**	**Attitudes**
Imaging children using radionuclides	A. Understanding of growth and maturation in children with special reference to the handling of radiotracers by immature organs. B. Specific indications for radionuclide investigations in children especially of the renal tract, biliary tract and skeleton. C. Comparative diagnostic investigations in children (ultrasound, CT imaging, MR scans etc) D. Knowledge of statutory issues relating to children (e.g. Children's' Act) E. Principles of consent in children F.Radiation protection issues appropriate to children G. Knowledge of Child Protection Issues	A. General preparation of the child for the test. B. Specific preparation of the child for particular tests. C. Choice of radiopharmaceutical dose and imaging protocol appropriate to the child. D. Use of injection techniques appropriate to children. E. Performing each stage of the scan in children. F.Image interpretation and reporting of sufficient number of patient studies to assess utility, sources of error, normal variants and artefacts in children. G. Audit of the outcome of results. H. Maintenance of a safe environment	A. Recognise the importance of proper vetting of request forms and of patient evaluation prior to the test. B. Show willingness to provide explanation to patient as to nature of the investigation and to put them at ease. C. Appreciate the importance of timely reporting and of prompt and accurate communication of the result to the referring clinician. D. Consider the importance of audit in the outcome of results E. Show openness to critical feedback of reports F.Appreciate the importance of keeping up-to-date with developments and with relevant medical literature. G. Show awareness of health and safety issues H. Show awareness of child protection issues

Teaching and Learning Methods 1-14 (See Table 1)

CORE IMAGING: PULMONARY SYSTEM

Objective. To provide the trainee with the knowledge, skills and attitudes to evaluate pulmonary disorders using radionuclide techniques (see common objectives)			
Subject	**Knowledge**	**Skills**	**Attitudes**
I Pulmonary Embolism (PE)	A. Clinical risk factors and presentation of PE. B. Basic science of pulmonary perfusion and ventilation C. Indications for and evidence base supporting ventilation perfusion (VQ) imaging D. Principles of perfusion imaging. E. Knowledge of ventilation agents including ? ^{89} Krypton, ^{99m}Tc DTPA and Technegas F.Characteristics of aerosol and gas delivery systems. G. Role of comparative imaging techniques including contrast pulmonary angiography and CTPA H. Contribution of D-dimer measurements, leg ultrasound and contrast venography to facilitate diagnosis of PE. I. Radiation protection issues	A. Preparation of the patient prior to the test. B. Choice of radiopharmaceutical and imaging protocol. C. Techniques of radiopharmaceutical injection and inhalation D. Performing the scans ensuring good technique and developing knowledge of the pitfalls. E. Data processing and image display F.Image interpretation and reporting of sufficient number of patient studies to assess utility, sources of error, normal variants and artefacts. G. Audit of outcome	A. Recognise the importance of proper vetting of request forms and of patient evaluation prior to the test. B. Show willingness to provide explanation to patient as to nature of the investigation and to put them at ease. C. Appreciate the importance of timely reporting and of prompt and accurate communication of the result to the referring clinician. D. Consider the importance of audit in the outcome of results E. Show openness to critical feedback of reports F.Appreciate the importance of keeping up-to-date with developments and with relevant medical literature. G. Show awareness of health and safety issues

Teaching and Learning Methods 1-14 (See Table 1)

CORE IMAGING: PULMONARY SYSTEM

Objective. To provide the trainee with the knowledge, skills and attitudes to evaluate pulmonary disorders using radionuclide techniques.			
Subject	**Knowledge and skills**	**Skills ***	**Attitudes**
II Regional Ventilation, Mucociliary and Small Solute Clearance	A. Clinical features and management of obstructive pulmonary disease, bronchiectasis and alveolitis. B. Basic science of regional ventilation, the mucociliary escalator and alveolar-capillary membrane integrity C. Principles of aerosol physics D. Characteristics of aerosol delivery systems. E. Indications for measurement of regional ventilation and small solute clearance including evidence base F.Radiation protection issues	A. Preparation of the patient prior to the test. B. Choice of radiopharmaceutical and imaging protocol. C. Techniques of radiopharmaceutical delivery D. Performing the test ensuring good technique and developing knowledge of the pitfalls. E. Data processing, image display and quantification F.Image interpretation and reporting of sufficient number of patient studies to assess utility, sources of error, normal variants and artefacts. G. Audit	A. Recognise the importance of proper vetting of request forms and of patient evaluation prior to the test. B. Show willingness to provide explanation to patient as to nature of the investigation and to put them at ease. C. Appreciate the importance of timely reporting and of prompt and accurate communication of the result to the referring clinician. D. Consider the importance of audit in the outcome of results E. Show openness to critical feedback of reports F.Appreciate the importance of keeping up-to-date with developments and with relevant medical literature. G. Show awareness of health and safety issues

*** Optional**

Teaching and Learning Methods 1-6, 8- 14 (See Table 1)

CORE IMAGING: SKELETAL SYSTEM

Objective. To provide the trainee with the knowledge, skills and attitudes to evaluate the skeletal disorders using radionuclide techniques.			
Subject	**Knowledge**	**Skills**	**Attitudes**
I Bone scans	A. Anatomy and physiology of the skeleton B. Clinical presentation and management of disorders affecting the skeleton. C. Basic science of ^{99m}Tc diphosphonate bone scans D. Basic science of ^{99m}Tc colloid bone marrow scans E. Indications for bone and marrow scans including understanding of the evidence base F.Use of bone scans in conjunction with other radionuclide imaging to assess bone or peri-prosthetic infections (see section on infection/inflammation) G. Knowledge of imaging protocols including three-phase imaging, whole body or spot planar static imaging SPECT and SPECT/CT H. Role of comparative imaging (plain XR, CT and MR scans) for the assessment of skeletal disorders. I. Radiation protection issues	A. Preparation of the patient for and during the test. B. Choice of appropriate imaging protocol. C. Radiopharmaceutical injection D. Performing the test ensuring good technique and developing knowledge of the pitfalls. E. Image reconstruction, display, interpretation and reporting of sufficient number of patient studies to assess utility, sources of error, normal variants and artefacts. F.Audit	A. Recognise the importance of proper vetting of request forms and of patient evaluation prior to the test. B. Show willingness to provide explanation to patient as to nature of the investigation and to put them at ease. C. Appreciate the importance of timely reporting and of prompt and accurate communication of the result to the referring clinician. D. Consider the importance of audit in the outcome of results E. Show openness to critical feedback of reports F.Appreciate the importance of keeping up-to-date with developments and with relevant medical literature. G. Show awareness of health and safety issues

Teaching and Learning Methods 1-14 (See Table 1)

CORE CURRICULUM: SKELETAL SYSTEM

Objective. To provide the trainee with the knowledge, skills and attitudes to evaluate skeletal disorders.			
Subject	**Knowledge**	**Skills ***	**Attitudes**
II Bone densitometry	A. Clinical risk factors, presentation and management of osteoporosis. B. Basic physiology and biochemistry of bone metabolism. C. Basic science of DEXA scans and other methods e.g. USS, QCT etc D. Indications for bone densitometry measurements including knowledge of the evidence base E. Quality control F.Radiation protection issues	A. Preparation of the patient for the test. B. Performing the test ensuring good technique and developing knowledge of the pitfalls. C. Data analysis and computation of scan results D. Interpretation of the results E. Ability to give advice with regard to therapy	A. Recognise the importance of proper vetting of request forms and of patient evaluation prior to the test. B. Show willingness to provide explanation to patient as to nature of the investigation and to put them at ease. C. Appreciate the importance of timely reporting and of prompt and accurate communication of the result to the referring clinician. D. Consider the importance of audit in the outcome of results E. Show openness to critical feedback of reports F.Appreciate the importance of keeping up-to-date with developments and with relevant medical literature. G. Show awareness of health and safety issues

*** Optional**

Teaching and Learning Methods 1-13 (See Table 1)

CORE IMAGING: UROGENITAL SYSTEM

Objective. To provide the trainee with the knowledge, skills and attitudes to evaluate urogenital disorders using radionuclide techniques.			
Subject	**Knowledge**	**Skills**	**Attitudes**
Renal and bladder function	A. Basic science associated with the urogenital tract. B. Radiopharamaceuticals used for renal imaging (e.g. DMSA, DTPA and MAG3). C. Principles of dynamic renography D. Computation of differential renal function E. Computation of renal transit/drainage F.The use of interventions such as Frusemide and Captopril G. Urodynamic studies (reflux, cystography) H. Assessment of renal transplants. I. Assessment of testicular torsion and varicoceles J. Role of comparative renal imaging such as ultrasound, CT etc) K. Radiation protection issues	A. Preparation of the patient prior to the test. B. Choice of radiopharmaceutical and imaging protocol. C. Techniques of radiopharmaceutical injection for renal studies D. Performing the scans ensuring good technique and developing knowledge of the pitfalls. E. Data processing, display and quantification F.Image interpretation and reporting of sufficient number of patient studies to assess utility, sources of error, normal variants and artefacts. G. Audit.	A. Recognise the importance of proper vetting of request forms and of patient evaluation prior to the test. B. Show willingness to provide explanation to patient as to nature of the investigation and to put them at ease. C. Appreciate the importance of timely reporting and of prompt and accurate communication of the result to the referring clinician. D. Consider the importance of audit in the outcome of results E. Show openness to critical feedback of reports F.Appreciate the importance of keeping up-to-date with developments and with relevant medical literature. G. Show awareness of health and safety issues

Teaching and Learning Methods 1- 14 (See Table 1)

CORE IMAGING: PET SCANNING

Objective. To provide the trainee with the knowledge, skills and attitudes to have a working knowledge of PET scanning			
Subject	**Knowledge**	**Skills**	**Attitudes**
I Basic science appropriate to PET Scanning	A. Theory of the production and decay of positron radionuclides used in clinical PET B. Compartmental analysis methods C. Appropriate mathematics and physics applied to PET tracer theory, modelling of tracer kinetics and quantitative imaging. D. Radiopharmacy of the tracers used in PET E. Physiological principles of the techniques F.Dosimetry of the various tracers used. G. Legal aspects associated with tracers H. Methods of measurement of tracer activity and scanning equipment I. Errors associated with the quantitative measurements J. Knowledge of gamma camera and dedicated PET systems K. Method of acquiring PET images		

Teaching and Learning Methods 1- (See Table 1)

Objective. To provide the trainee with the knowledge, skills and attitudes to have a working knowledge of PET scanning			
Subject	**Knowledge**	**Skills**	**Attitudes**
II PET in Oncology	A. Basic science of tumour metabolism B. PET tracers used for tumour detection including FDG and methionine C. Normal variation in tracer distribution in whole body and local views. D. PET in tumour diagnosis e.g. pulmonary nodules. E. PET in tumour staging e.g. lung cancer, lymphoma, germ cell tumours etc. F.PET in the detection of recurrent disease e.g. colorectal cancer. G. Role of PET tracer imaging compared to other imaging methods including CT and MR scans. H. Radiation protection issues	A. Preparation of the patient prior to the test. B. Measurement and drawing up of tracer. C. Injection of the tracer. D. Methods of scanning and data manipulation. E. Image reconstruction and display F.Image interpretation and reporting of sufficient number of patient studies to assess utility, sources of error, normal variants and artefacts. G. Review of sequential data on patients and comparison with other methods of assessment H. Audit of results	A. Recognise the importance of proper vetting of request forms and of patient evaluation prior to the test. B. Show willingness to provide explanation to patient as to nature of the investigation and to put them at ease. C. Appreciate the importance of timely reporting and of prompt and accurate communication of the result to the referring clinician. D. Consider the importance of audit in the outcome of results E. Show openness to critical feedback of reports F.Appreciate the importance of keeping up-to-date with developments and with relevant medical literature. G. Show awareness of health and safety issues

Teaching and Learning Methods 1-14 (See Table 1)

Objective. To provide the trainee with the knowledge, skills and attitudes to have a working knowledge of PET scanning			
Subject	**Knowledge**	**Skills**	**Attitudes**
III PET in Neuropsychiatry	A. Basic neurophysiology, neurochemistry and cross-sectional neuroanatomy. B. PET tracers used for brain imaging. C. Normal variation in PET tracer distribution within the brain. D. Role of PET in the diagnosis of common brain disorders such as epilepsy and dementia. E. PET in the evaluation of brain tumours. F.Role of PET tracer imaging compared to other imaging methods including CT and MR scans. G. Radiation protection issues	A. Preparation of the patient prior to the test. B. Measurement and drawing up of tracer. C. Injection of the tracer. D. Methods of scanning and data manipulation. E. Image reconstruction and display F.Image interpretation and reporting of sufficient number of patient studies to assess utility, sources of error, normal variants and artefacts. G. Review of sequential data on patients and comparison with other methods of assessment H. Audit of results	A. Recognise the importance of proper vetting of request forms and of patient evaluation prior to the test. B. Show willingness to provide explanation to patient as to nature of the investigation and to put them at ease. C. Appreciate the importance of timely reporting and of prompt and accurate communication of the result to the referring clinician. D. Consider the importance of audit in the outcome of results E. Show openness to critical feedback of reports F.Appreciate the importance of keeping up-to-date with developments and with relevant medical literature. G. Show awareness of health and safety issues

Teaching and Learning Methods 1-14 (See Table 1)

Objective. To provide the trainee with the knowledge, skills and attitudes to have a working knowledge of PET scanning			
Subject	**Knowledge**	**Skills**	**Attitudes**
IV PET in Cardiology	A. Coronary and cardiac anatomy, cardiac physiology and pathophysiology. B. Assessment of myocardial ischaemia using ^{82}Rb, ^{13}N-ammonia, ^{15}O-water.. C. FDG PET for assessment of myocardial viability. D. Control and monitoring of glucose metabolism for FDG injection. E. Principles of pharmacological cardiac stress tests F.Normal variation in FDG tracer distribution within the heart. G. Role of PET tracer imaging compared to other imaging methods including cardiac stress echo and coronary angiography. H. Radiation protection issues	A. Preparation of the patient prior to the test. B. Measurement and drawing up of tracer. C. Performance of cardiac stress testing using pharmacological techniques. D. Injection of the FDG, NH_3 and any new tracers. E. Production of parametric perfusion images and calculation of numeric results F.Image interpretation and reporting of sufficient number of patient studies to assess utility, sources of error, normal variants and artefacts. G. Review of sequential data on patients and comparison with other methods of assessment H. Audit of results	A. Recognise the importance of proper vetting of request forms and of patient evaluation prior to the test. B. Show willingness to provide explanation to patient as to nature of the investigation and to put them at ease. C. Appreciate the importance of timely reporting and of prompt and accurate communication of the result to the referring clinician. D. Consider the importance of audit in the outcome of results E. Show openness to critical feedback of reports F.Appreciate the importance of keeping up-to-date with developments and with relevant medical literature. G. Show awareness of health and safety issues

Teaching and Learning Methods 1-14 (See Table 1)

CORE IMAGING: MULTI-MODALITY IMAGING INCORPORATING NUCLEAR MEDICINE AND COMPUTED TOMOGRAPHY

Objective: To provide the trainee with the knowledge, skills and attitudes to have a working knowledge of Cross-sectional imaging using CT scanning in the context of PET-CT and SPECT-CT			
Subject	**Knowledge**	**Skills**	**Attitudes**
CT Scanning in the context of PET-CT and SPECT-CT	I. Cross-sectional anatomy and normal variants as demonstrated by CT. J. Basic Science of CT Imaging K. CT Scanner, PET-CT and SPECT-CT hardware L. CT protocols for PET-CT and SPECT-CT and how they differ from diagnostic CT. M. The indications, contraindications, complications and principles for use of gastro-intestinal and intravenous CT contrast media. N. Principles of co-registering CT images with PET and SPECT and other CT post-image acquisition processing techniques. O. The applications of CT in the brain, head & neck, chest, abdomen and pelvis, musculoskeletal system and vascular system. P. Radiation protection issues of CT Imaging Q. Legal aspects associated with CT Imaging	I. Preparation of the patient prior to the test J. Assessment of the need and/or contra-indications for CT contrast media and treatment of complications. K. Assessment of CT image quality and identification of artefacts. L. Image interpretation of a sufficient number of PET-CT and/or SPECT-CT studies to assess utility, sources of error, normal variants and artefacts, including an ability to (i) assign PET/SPECT abnormalities to specific anatomical structures, (ii) assimilate CT appearances into the assessment of the significance of PET or SPECT findings, and (iii) recognise CT abnormalities that are not associated with radiotracer uptake. M. Review of sequential data on patients and comparison with other methods of assessment. N. Audit of results	H. Recognise the importance of proper vetting of request forms and of patient evaluation prior to the test. I. Show willingness to provide explanation to patient as to nature of the investigation and to put them at ease. J. Appreciate the importance of timely reporting and of prompt and accurate communication of the result to the referring clinician. K. Recognise the limitations of CT imaging used for PET-CT and SPECT-CT and the need for an additional radiological opinion or examination where necessary. L. Appreciate the importance of keeping up-to-date with hardware and software developments and with the relevant medical literature. M. Show awareness of health and safety issues.

Teaching and Learning Methods 1-14 (See Table 1)

CORE IMAGING: NON-IMAGING DIAGNOSTICS

Objective. To provide the trainee with the knowledge, skills and attitudes to employ radionuclide non-imaging diagnostic tests in the measurement of human disease.			
Subject	**Knowledge**	**Skills**	**Attitudes**
I Glomerular Filtration Rate	A. Physiology and pathophysiology of glomerular filtration (GFR). B. Indications for GFR measurements. C. Methodology of GFR measurements using ^{51}Cr-EDTA or ^{99m}Tc-DTPA including single and multiple sample techniques and volume of distribution D. Role of comparative methods of measuring GFR E. Radiation protection issues	A. Preparation of the patient prior to the test. B. Preparation and injection of ^{51}Cr-EDTA and timing of blood samples C. Data processing and calculation of GFR including application of mono and bi-exponential fits and surface area correction. D. Assessing the sources of error and reviewing sequential data on patients comparing the outcome with the serum urea and creatinine. E. Audit of results	A. Recognise the importance of proper vetting of request forms and of patient evaluation prior to the test. B. Show willingness to provide explanation to patient as to nature of the investigation and to put them at ease. C. Appreciate the importance of timely reporting and of prompt and accurate communication of the result to the referring clinician. D. Consider the importance of audit in the outcome of results E. Show openness to critical feedback of reports F.Appreciate the importance of keeping up-to-date with developments and with relevant medical literature. G. Show awareness of health and safety issues

Teaching and Learning Methods 1-14,15 (See Table 1)

Objective. To provide the trainee with the knowledge, skills and attitudes to employ radionuclide non-imaging diagnostic tests in the measurement of human disease.			
Subject	**Knowledge**	**Skills**	**Attitudes**
II Gastrointestinal measurements including B12 absorption, SeHCAT and urea breath tests	A. Basic science of malabsorption B. Methodology and indications for B12 absorption tests C. Methodology and indications for SeHCAT D. Methodology and indications for ^{14}C-urea breath tests and other ^{14}C tests. E. Comparative tests that are available F. Radiation protection issues	A. Preparation of the patient prior to the test. B. Administration of the radiopharmaceutical C. Collection and measurement of the samples D. Calculation of the results E. Reporting sufficient numbers of studies to assess utility and sources of error. F. Review of sequential data before and after treatment G. Audit of results	A. Recognise the importance of proper vetting of request forms and of patient evaluation prior to the test. B. Show willingness to provide explanation to patient as to nature of the investigation and to put them at ease. C. Appreciate the importance of timely reporting and of prompt and accurate communication of the result to the referring clinician. D. Consider the importance of audit in the outcome of results E. Show openness to critical feedback of reports F. Appreciate the importance of keeping up-to-date with developments and with relevant medical literature. G. Show awareness of health and safety issues

Teaching and Learning Methods 1-15 (See Table 1)

Objective. To provide the trainee with the knowledge, skills and attitudes to employ radionuclide non-imaging diagnostic tests in the measurement of human disease.			
Subject	**Knowledge**	**Skills**	**Attitudes**
III Plasma volume, red cell mass, blood cell survival and ferrokinetic studies*	A. Basic science of red cell mass and survival B. Methodology and indications for red cell mass measurement C. Methodology and indications for red cell survival measurement D. Radiation protection issues	A. Preparation of the patient prior to the test. B. Administration of the radiopharmaceutical C. Collection and measurement of the samples D. Calculation of the results E. Assessment of the sources of error F. Reporting sufficient numbers of studies to assess utility and pitfalls G. Audit of the use the clinician makes of the results	A. Recognise the importance of proper vetting of request forms and of patient evaluation prior to the test. B. Show willingness to provide explanation to patient as to nature of the investigation and to put them at ease. C. Appreciate the importance of timely reporting and of prompt and accurate communication of the result to the referring clinician. D. Consider the importance of audit in the outcome of results E. Show openness to critical feedback of reports F. Appreciate the importance of keeping up-to-date with developments and with relevant medical literature. G. Show awareness of health and safety issues

*** Plasma volume and Ferrokinetic studies (non-core)**

Teaching and Learning Methods 1-15 (See Table 1)

CURRICULUM: THERAPY

Objective. To provide the trainee with the knowledge, skills and attitudes to prescribe, administer and monitor the use of radiopharmaceuticals for therapy.			
Subject	**Knowledge**	**Skills**	**Attitudes**
I ^{131}I therapy for thyrotoxicosis	A. Clinical presentation, and diagnosis of thyrotoxicosis B. Causes of thyrotoxicosis including autoimmune thyroid disease, single toxic thyroid nodule and toxic multinodular goitre etc. C. Drug treatment of thyrotoxicosis. D. Patient selection for ^{131}I therapy and awareness of alternative treatment options. E. Statutory and environmental factors governing the use of ^{131}I therapy for thyrotoxicosis F.Radiation protection issues	A. Obtaining informed consent for therapy B. Providing appropriate radiation protection instructions to the patient/carer/family members. C. Ability to assess the presence and therapy of dysthyroid eye disease. D. Instructing patient when to stop antithyroid medication. E. Assessing and administering the appropriate activity of ^{131}I F.Assessing response to therapy. G. Auditing the outcome of therapy	A. Recognise the importance of proper vetting of request forms and of patient evaluation prior to the test. B. Show willingness to provide explanation to patient as to nature of the investigation and to put them at ease. C. Appreciate the importance of timely reporting and of prompt and accurate communication of the result to the referring clinician. D. Consider the importance of audit in the outcome of results E. Show openness to critical feedback of reports F.Appreciate the importance of keeping up-to-date with developments and with relevant medical literature. G. Show awareness of health and safety issues

***Includes attendance at Thyroid Clinics**

Teaching and Learning Methods 1-15 (See Table 1)

Objective. To provide the trainee with the knowledge, skills and attitudes to prescribe, administer and monitor the use of radiopharmaceuticals for therapy.			
Subject	**Knowledge and skills**	**Skills**	**Attitudes**
II Radiation synovectomy	A. Joint anatomy and pathogenesis of inflammatory arthritis B. Principles of radiation synovectomy using ^{90}Ycolloid, ^{186}Re sulphide and ^{169}Er citrate. C. Patient selection for radiation synovectomy and awareness of alternative treatment options. D. Knowledge of efficacy and potential complications of treatment. E. Radiation protection issues	A. Obtaining informed consent for therapy B. Providing appropriate radiation protection instructions to the patient/carer C. Measurement and drawing up of radiopharmaceutical. D. Performance of intra-articular injection of the radiopharmaceutical E. Use of intra-articular corticosteroids where appropriate F.Ensuring adequate immobilisation of the injected limb to prevent lymphatic uptake. G. Response and toxicity monitoring. H. Auditing the outcome of therapy	A. Recognise the importance of proper vetting of request forms and of patient evaluation prior to the test. B. Show willingness to provide explanation to patient as to nature of the investigation and to put them at ease. C. Appreciate the importance of timely reporting and of prompt and accurate communication of the result to the referring clinician. D. Consider the importance of audit in the outcome of results E. Show openness to critical feedback of reports F.Appreciate the importance of keeping up-to-date with developments and with relevant medical literature. G. Show awareness of health and safety issues

Teaching and Learning Methods 1-14 (See Table 1)

CURRICULUM: THERAPY

Objective. To provide the trainee with the knowledge, skills and attitudes to prescribe, administer and monitor the use of radiopharmaceuticals for therapy.			
Subject	**Knowledge**	**Skills***	**Attitudes**
III ^{32}P for the treatment of polycythemia rubra vera or essential thrombocythemia	A. Clinical characteristics of polycythemia rubra vera (PRV) and essential thrombocythemia (ET) B. Principles of radiobiology in targeted radionuclide therapy C. Nature of ^{32}P therapy D. Patient selection for ^{32}P therapy in PRV and ET including awareness of alternative treatment options. E. Knowledge of efficacy and potential complications of treatment. F.Radiation protection issues	A. Obtaining informed consent for therapy B. Providing appropriate radiation protection instructions to the patient/carer C. Measurement and drawing up of radiopharmaceutical. D. Injection of ^{32}P. E. Response and toxicity monitoring. F.Auditing the outcome of therapy	A. Recognise the importance of proper vetting of request forms and of patient evaluation prior to the test. B. Show willingness to provide explanation to patient as to nature of the investigation and to put them at ease. C. Appreciate the importance of timely reporting and of prompt and accurate communication of the result to the referring clinician. D. Consider the importance of audit in the outcome of results E. Show openness to critical feedback of reports F.Appreciate the importance of keeping up-to-date with developments and with relevant medical literature. G. Show awareness of health and safety issues

***Optional**

Teaching and Learning Methods 1-14 (See Table 1)

CURRICULUM: THERAPY

Objective. To provide the trainee with the knowledge, skills and attitudes to prescribe, administer and monitor the use of radiopharmaceuticals for therapy.			
Subject	**Knowledge**	**Skills**	**Attitudes**
IV Unsealed source therapy for the treatment of locally advanced or metastatic malignant disease.	A. Principles of radiobiology in cancer therapy B. Characteristics of therapeutic radionuclides. C. Tumours which are amenable to treatment with targeted radionuclide therapy. D. Radiopharmaceuticals licensed for targeted therapy including ^{131}I, ^{89}Strontium, ^{131}IMIBG and ^{90Y}Octreotide. E. Patient selection including appropriateness of therapy and awareness of alternative treatment options. F.Statutory and environmental factors including radiation protection physics. G. Therapeutic radiopharmaceutical administration systems H. Principles of pre- and post-therapy dosimetry	A. Obtaining informed consent for therapy B. Providing appropriate radiation protection instructions to the patient. C. Patient preparation D. Measurement and drawing up of radiopharmaceutical E. Injection of the radiopharmaceutical using the appropriate administration system. F.Monitoring vital signs post-therapy G. Response and toxicity monitoring. H. Audit of outcomes I. Dose calculations , pre and post treatment	A. Recognise the importance of proper vetting of request forms and of patient evaluation prior to the test. B. Show willingness to provide explanation to patient as to nature of the investigation and to put them at ease. C. Appreciate the importance of timely reporting and of prompt and accurate communication of the result to the referring clinician. D. Consider the importance of audit in the outcome of results E. Show openness to critical feedback of reports F.Appreciate the importance of keeping up-to-date with developments and with relevant medical literature. G. Show awareness of health and safety issues

Teaching and Learning Methods 1- 15 (See Table 1)

APPENDIX 1: LEARNING CONTENT ANTICIPATED DURING TRAINING IN RADIONUCLEOTIDE RADIOLOGY

SECTION 1

This section will normally be undertaken as part of the First FRCR training. The objective will be to give specialist registrars a basic knowledge of radionuclide techniques including normal appearances and common artefacts.

SCIENTIFIC PRINCIPLES

Physics

- Atomic structure
- Radioactive decay
- Interaction of radiation with matter
- Biological implications of radiation

Instrumentation

- Principals of radiation detectors
- Nuclear Medicine detectors - gamma cameras (including SPECT), scanners, non-imaging probes, whole body counters, monitoring devices, PET, scintillation counters, dose calibrators
- Collimation

Radiation Biology and Protection

- Biological effects of high and low level radiation
- Calculation of radiation dose from radiopharmaceuticals
- Effective dose equivalent
- ALARA
- ARSAC

Radiopharmacy/Radiochemistry

- Properties of commonly used diagnostic radionuclides
- Principles of localisation of radiopharmaceuticals

Clinical

Normal appearances, common artefacts, mode of pharmaceutical uptake, complications etc., of:

- Skeletal (including three phase studies)
- Pulmonary
- Gallium (Ga^{67}) imaging
- Renal (including varieties of renograms)
- Cardiac
- Brain
- Thyroid
- Parathyroid
- Adrenal
- Biliary

Competency achieved

Knowledge and understanding of Basic Science
Ability to undertake and supervise simple procedures
Knowledge and understanding of normal appearances

Assessment
Trainer's Report
Trainee's Record
Annual Assessment
First FRCR Examination

SECTION II

This section is designed to be undertaken during training for the Final FRCR. The objective is to give specialist registrars sufficient knowledge to understand the principles and indications of common radionuclide techniques and how these relate to other imaging modalities.

Knowledge of Radionuclide Diagnostic Procedures in the following topic areas

Skeletal Disorders
Cardiology
Lung Diseases
Gastroenterology
Hepato-Biliary Diseases
Nephro-Urology
Neurology and Psychiatry
Endocrinology
Haematology
Oncology
Infection
Paediatrics

Including
All relevant radiopharmaceuticals and imaging devices
Significance of normal/abnormal findings
Correlation with other diagnostic tests
Strengths and weaknesses compared to other imaging modalities
Preparation of patients, precautions (including drug effects), complications
Principles of cell labelling

Other Clinical Experience
Range and limitations

Competency achieved
Perform clinical studies with appropriate supervision
Report images under consultant supervision

Assessment
Trainer's Report
Log-book
Annual Assessment

SECTION III

This Section will normally be undertaken during sub-specialty training in radionuclide radiology. The objective is to give the specialist registrar sufficient knowledge of all aspects of Radionuclide Imaging to allow him/her to manage an imaging service and obtain ARSAC certification for routine imaging procedures. The registrar should undertake at least one piece of prospective or retrospective research.

Computing and Image Processing

- Principles
- Applications to nuclear medicine data acquisition, processing and display

Radiation Biology and Protection

- Diagnosis and treatment of radiation exposure
- Management of radiation accidents

Radiopharmacy/Radiochemistry

More detailed knowledge:

(a) Properties of commonly used diagnostic radionuclides
(b) Production of radionuclides by reactors, cyclotron and radionuclide generators
(c) Principles of localisation of radiopharmaceuticals
(d) Quality control

Clinical Aspects

More detailed knowledge of radionuclide diagnostic imaging and common non-imaging procedures in the following topic areas:

- Skeletal Disorders
- Cardiology
- Lung Diseases
- Gastroenterology
- Hepato-biliary Diseases
- Nephro-Urology
- Neurology and Psychiatry
- Endocrinology
- Haematology
- Oncology (including Positron Emission Tomography [PET] and PET-CT)
- Infection
- Paediatrics
- Other less common applications

Including:

- Protocols for study performance and analysis including the use of SPEC and PET-CT.
- Preparation of patients, precautions (including drug effects), complications
- Special Protocols for paediatric studies
- Quality assurance

Significance of normal/abnormal findings
Test evaluation

Sensitivity/specificity/predictive value
Bayes' theorem
Concepts of risks benefit and cost-benefit analysis

Legal/Regulatory Requirements
Including:
Product Licences
Radiopharmacy Aspects
Waste Disposal
Radiopharmaceutical Transport

Competency Achieved

Fully competent in the performance and interpretation of all diagnostic areas
Comprehensive knowledge of science principles, benefits and dangers of Radionuclide Imaging
To provide a Radionuclide Radiology service in conjunction with all other imaging modalities
Sufficient knowledge to be granted an ARSAC licence for Radionuclide Imaging

Assessment

Trainer's Report
Trainee's Logbook
Final RITA Form
Recommendations for CCST in Radiology with special interest in Radionuclide Radiology

APPENDIX 2: NUCLEAR MEDICINE TRAINING PROGRAMME-YEAR 1

Training objectives

Obtain introduction to basic science, clinical procedures, radiation protection and generics (see below)*

Competency achieved

Knowledge of understanding of basic sciences
Ability to supervise and report some simple procedures
Draw up and inject radiopharmaceuticals
Perform simple data manipulation
Basic resuscitation

Training

Start MSc course or in-house course for theoretical aspects of training.
Observe diagnostic and therapy procedures
Receive 'in-house' training
Clinical procedures
Basic sciences

Assessment

Training record
Trainee's report
Educational Supervisor's report

*** Generics**
Term used to cover legal and regulatory matters, research & development, management, audit, teaching, communication skills, social, attitudinal/behavioural skills

NUCLEAR MEDICINE TRAINING PROGRAMME-YEAR 2

Training objectives

Further basic science training
Achieve competency in certain clinical techniques, including cardiac SPECT
SPECT or PET, renal interventional studies, paediatrics
Become knowledgeable in radiation protection
Develop generic skills

Competency achieved

Vetting of requests and selecting appropriate investigations
Report accurately range of simple diagnostic investigations unsupervised (prior to reports being verified by consultant)
Perform physical/pharmacological stress testing
Manage uncomplicated therapy cases e.g. I131 for thyrotoxicosis
Perform more advanced data manipulation.
Produce research paper (regionally or nationally)
Give oral presentation
Advanced/intermediate resuscitation
Management of complications following radionuclide administration

Training

Complete MSc or other course
Perform clinical studies with varying degrees of supervision
Review images (brought by radiographer/technical staff)
Participate in departmental/hospital training programmes (generics)

Assessment

Training record
Trainee's record
Educational Supervisor's report
Year 2 assessment and MSc-final examination

NUCLEAR MEDICINE TRAINING PROGRAMME – YEAR 3

Training objectives

Complete basic science training
To become competent in most clinical procedures
To start to develop at least one area of special interest
To improve generic skills

Competency achieved

Elect, perform and interpret most diagnostic procedures
Manage most therapeutic procedures, including P32, I131 for thyroid carcinoma, joint and bone palliation, see I131MIBG therapy
Presentation of oral and written data for teaching or research

Training

Receive training and supervision appropriate for the difficulty of the procedure Attend advanced courses/conferences, including formal management training courses.
Spend periods of attachment to other specialised departments e.g. paediatrics, radiology, CT/MRI, PET.

Assessment

Training record
Trainee's assessment
Educational Supervisor's assessment

Penultimate Year Assessment (Year 3) – KEY ASSESSMENT

NUCLEAR MEDICINE TRAINING PROGRAMME – YEAR 4

Training objectives

Complete clinical, scientific and generic training to specialist level
To be knowledgeable of the value of diagnostic and therapeutic procedures in clinical investigation and treatment.

Competency achieved

Fully competent in all clinical areas
To have comprehensive knowledge in basic sciences, dosimetry, and radiation protection
To have well developed generic skills
To have defined area(s) of special interest

Training

Complete clinical training, including experience in more difficult or unusual conditions
Attend appropriate courses/conferences
Complete attachments to specialised units
Travelling fellowship (optional)

Assessment

Training record
Trainer's assessment
Educational Supervisor's assessment

Assessment 4-**Recommendation for CCT**

APPENDIX 3: CORE CLINICAL EXPERIENCE OF A TYPICAL TRAINEE

1. In Vivo Diagnostic Procedures

Core experience entails responsibility (including indication, performance and interpretation) for a sufficient number of various in vivo diagnostic radionuclide procedures. These should include a wide range of pathology, and include paediatric studies. Trainees will be expected to be able to demonstrate competence as well as experience in these procedures.

A suggested number for each procedure is as follows:

Clinical System	Number of Studies
a. Central nervous system	150
b. Skeletal system	1000
c. Cardiovascular system (at least 80% SPET perfusion with stress)	500
d. Pulmonary system	300
e. Gastro-intestinal system	150
f. Urogenital system	400
g. Endocrine system	400
h. Haematopoietic and lymphatic system (including sentinel node studies)	70
i. Tumours and inflammation	100
j. Paediatric studies	100
k PET Scanning	100

SPET (Single Photon Emission Tomography) studies where relevant.

It is accepted that trainees develop competence at different rates, so these numbers are not absolute but guidelines for the trainee and trainer to ensure an overall balance in providing both depth and breadth of training.

2. Therapy

Training in therapeutic applications must include clinical evaluation, supervision and follow up of patients having therapeutic doses of radionuclides, including aspects of dosimetry and radiation protection. Trainees will be expected to participate in thyroid clinics (both new patient and follow-up), and may need to attend joint clinics with other disciplines, e.g. oncologists, to gain experience in the less common procedures. As in diagnosis suggested numbers are a guide only.

Number of new therapies

1 Thyroid patients

Benign disease **60**

Malignant disease **20**

2 Other radionuclide treatments **10**