MODERNISING SCIENTIFIC CAREERS

Scientist Training Programme
MSc in CLINICAL SCIENCE
Curriculum
MEDICAL PHYSICS

2013/14
# CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>READERSHIP</td>
<td>5</td>
</tr>
<tr>
<td>Section 1: Introduction to Modernising Scientific Careers (MSC) and the Scientist Training Programme (STP)</td>
<td>6</td>
</tr>
<tr>
<td>1.1 Introduction to Modernising Scientific Careers (MSC)</td>
<td>6</td>
</tr>
<tr>
<td>1.2 Introduction to the Scientist Training Programme (STP)</td>
<td>6</td>
</tr>
<tr>
<td>1.3 Scientist Training Programme Outcomes: 2013/14</td>
<td>7</td>
</tr>
<tr>
<td>1.4 Overview of the MSc Clinical Science Programme</td>
<td>9</td>
</tr>
<tr>
<td>Section 2: Entry Routes, Award Title, Delivery, Accreditation of Prior Learning</td>
<td>11</td>
</tr>
<tr>
<td>2.1 Entry Routes</td>
<td>11</td>
</tr>
<tr>
<td>2.2 Progression</td>
<td>11</td>
</tr>
<tr>
<td>2.3 Award Titles</td>
<td>11</td>
</tr>
<tr>
<td>2.4 Mode of Delivery</td>
<td>12</td>
</tr>
<tr>
<td>2.5 Relevant Quality Assurance Agency (QAA) Code(s) of Practice</td>
<td>12</td>
</tr>
<tr>
<td>2.6 Awarding Body</td>
<td>12</td>
</tr>
<tr>
<td>2.7 Accreditation of Prior Learning</td>
<td>12</td>
</tr>
<tr>
<td>2.8 Programme Delivery and Monitoring</td>
<td>12</td>
</tr>
<tr>
<td>Section 3: The MSc Clinical Science Curriculum</td>
<td>14</td>
</tr>
<tr>
<td>3.1 Purpose</td>
<td>14</td>
</tr>
<tr>
<td>3.2 Curriculum Development and Maintenance</td>
<td>14</td>
</tr>
<tr>
<td>3.3 Tender Process and Monitoring</td>
<td>15</td>
</tr>
<tr>
<td>3.4 MSC Accreditation</td>
<td>15</td>
</tr>
<tr>
<td>3.5 Programme Delivery</td>
<td>15</td>
</tr>
<tr>
<td>3.6 Academic Induction</td>
<td>16</td>
</tr>
<tr>
<td>3.7 Teaching and Learning</td>
<td>16</td>
</tr>
<tr>
<td>3.8 Interprofessional Learning</td>
<td>18</td>
</tr>
<tr>
<td>3.9 Patient and Public Involvement</td>
<td>18</td>
</tr>
<tr>
<td>Section 4: Assessment</td>
<td>19</td>
</tr>
<tr>
<td>4.1 Purpose of Assessment</td>
<td>19</td>
</tr>
<tr>
<td>4.2 Key areas that must be covered by the Assessment Strategy include</td>
<td>20</td>
</tr>
<tr>
<td>Section 5: Trainee Supervision, Support and Mentoring</td>
<td>21</td>
</tr>
<tr>
<td>5.1 Fitness to Practise</td>
<td>21</td>
</tr>
<tr>
<td>Section 6: Progression, Annual Monitoring of Progress, Equality and Diversity, Curriculum Review and Updating</td>
<td>22</td>
</tr>
<tr>
<td>6.1 Progression</td>
<td>22</td>
</tr>
<tr>
<td>6.2 Annual Monitoring of Progress</td>
<td>22</td>
</tr>
<tr>
<td>6.3 Equality and Diversity</td>
<td>22</td>
</tr>
<tr>
<td>6.4 Curriculum Review and Updating</td>
<td>23</td>
</tr>
<tr>
<td><a href="mailto:msc.hee@nhs.net">msc.hee@nhs.net</a> Section 7: Relationships and Partnerships</td>
<td>23</td>
</tr>
<tr>
<td>Section 7: Relationships and Partnerships</td>
<td>24</td>
</tr>
<tr>
<td>7.1 National School of Healthcare Science</td>
<td>24</td>
</tr>
<tr>
<td>7.2 The Academy for Healthcare Science</td>
<td>24</td>
</tr>
<tr>
<td>Section 8: Professional Practice</td>
<td>26</td>
</tr>
<tr>
<td>Section 9: MSc Clinical Science (Medical Physics)</td>
<td>28</td>
</tr>
<tr>
<td>9.1 Overview of STP in Medical Physics</td>
<td>28</td>
</tr>
<tr>
<td>9.2 Medical Physics Route Map</td>
<td>28</td>
</tr>
<tr>
<td>Section 10: Generic Modules</td>
<td>30</td>
</tr>
</tbody>
</table>
Generic Curriculum .................................................................................................. 30

Introduction to Healthcare Science, Professional Practice and Clinical Leadership .................................................................................................................. 30

Research Methods .................................................................................................. 36

Section 11: Division/Theme-Specific Modules ......................................................... 39

Introduction to Specialist Medical Physics ............................................................. 39

Section 11.1: Rotational Work Based Modules for Medical Physics .......................... 42

Imaging with Non-Ionising Radiation (INIR) .......................................................... 42

Imaging with IR (IIR) ............................................................................................. 43

Radiation Safety Physics (RADS) ......................................................................... 44

Radiotherapy Physics (RP) ................................................................................... 44

Section 12: MSc Specialist Modules for Imaging with Non-Ionising Radiation ............. 46

Imaging with Non-Ionising Radiation 1 ................................................................. 47

Research Project in Imaging with Non-Ionising Radiation .................................... 48

Imaging with Non-Ionising Radiation 2 ................................................................. 50

Section 12.1: Specialist Work Based Modules for Imaging with Non-Ionising Radiation .................................................................................................................. 52

Ultrasound Imaging (INIR1) .................................................................................. 52

Magnetic Resonance Imaging (INIR2) .................................................................. 53

Exposure Measurement (INIR4) ........................................................................... 53

Risk, Safety and Bioeffects (INIR5) ...................................................................... 53

Diagnostic Equipment Performance (INIR6) ......................................................... 54

Emerging Technologies (INIR7) ........................................................................... 54

Information and Communication Technology (INIR8) ............................................ 54

Section 13: MSc Specialist Modules for Imaging with Ionising Radiation ................. 56

Imaging with Ionising Radiation 1 ......................................................................... 57

Research Project in Imaging with Ionising Radiation ............................................ 58

Imaging with Ionising Radiation 2 ......................................................................... 60

Section 13.1: Specialist Work Based Modules for Imaging with Ionising Radiation ................................. 62

Radionuclide Imaging (IIR1) ................................................................................. 62

Non-Imaging Radionuclide Tests (IIR2) ................................................................ 63

Radionuclide Therapy (IIR3) ................................................................................... 63

Radiopharmacy (IIR4) ........................................................................................... 64

Radiation Protection (IIR5) .................................................................................... 64

Diagnostic Radiology: Equipment Performance (IIR6) .......................................... 65

Diagnostic Radiology: Image Optimisation and Patient Dose Measurement (IIR7) .... 65

Information and Communication Technology (IIR8) ............................................ 66

Section 14: MSc Specialist Modules for Radiation Safety Physics ............................ 67

Radiation Safety 1 ................................................................................................. 68

Research Project in Radiation Safety Physics .......................................................... 70

Radiation Safety 2 .................................................................................................. 71

Section 14.1: Specialist Work Based Modules for Radiation Safety Physics ............... 72

Risk Assessment and New Facilities (RADS1) ...................................................... 72

Diagnostic Radiology: Equipment Performance (RADS2) .................................... 73

Patient Dose Assessment and Optimisation (RADS3) ............................................ 73

Non-Ionising Sources: Radiation Risks, Safety and Bioeffects (RADS5) ............... 74

Assess, Audit and Interpret Radiation Dose Monitoring (RADS8) .......................... 74

Radiation Governance Framework (RADS7) ......................................................... 75

Information and Communication Technology (RADS11) ....................................... 75
Section 15: Specialist MSc Modules for Radiotherapy Physics

Radiotherapy 1
Research Project in Radiotherapy Physics
Radiotherapy Physics 2

Section 15.1: Specialist Work Based Modules for Radiotherapy Physics
Dosimetry and Treatment Equipment (RP1)
Treatment Planning (RP2)
Brachytherapy (RP3)
Computing Related to Radiotherapy (RP4)

Appendix 1: Contributor List
Appendix 2: Programme Amendments
Appendix 3: Good Scientific Practice
Appendix 4: Glossary
READERSHIP

This Scientist Training Programme (STP) MSc Clinical Science curriculum describes the MSc Clinical Science programmes that, together with the work based learning guide, provide the details of each themed STP in the UK for:

- academic and administrative staff, including external examiners within Higher Education Institutions (HEIs);
- trainees, host departments and managers of services that employ healthcare science staff;
- work based trainers, including all those involved in supervising, mentoring, coordinating, assessing and delivering STP education and training;
- Local Education and Training Boards (LETBs) and all healthcare science education and training commissioning organisations in the UK;
- patients and the public;
- Modernising Scientific Careers (MSC) accreditation panels.

A glossary of terms used is provided in the Appendices.
Section 1: Introduction to Modernising Scientific Careers (MSC) and the Scientist Training Programme (STP)

1.1 Introduction to Modernising Scientific Careers (MSC)

1. The healthcare science (HCS) workforce plays a central role in safe and effective patient care across all pathways of care from health and wellbeing to end of life. There are approximately 55,000 employees in the healthcare science workforce in the NHS in the UK, and approximately 80% of all diagnoses can be attributed to their work.

2. Healthcare science involves the application of science, technology and engineering to health. Good Scientific Practice (GSP) [Appendix 3] sets out the principles and values on which good practice within healthcare science is founded. It makes explicit the professional standards of behaviour and practice that must be achieved and maintained by all those who work in healthcare science. GSP and the Education and Training Standards of the Health and Care Professions Council (HCPC) together form the basis for all MSC training curricula which contextualise the Standards of Proficiency set down by the HCPC in a way that is accessible to the profession and the public.

3. The healthcare science workforce and services have traditionally been grouped into three broad areas called divisions, namely: Life Sciences/Clinical Laboratory Sciences, Physical Sciences/Medical Physics and Biomedical Engineering, and Physiological Sciences/Clinical Physiology Sciences. Within each division there are a number of healthcare science specialisms. With advances in scientific technology, changes to the delivery of healthcare scientific services and the development of MSC, the boundaries between these divisions have been shifting. MSC recognises this important change and to date has identified twelve STP themes within healthcare science, which enables training across a total of 28 healthcare science specialisms, with curricula for additional specialisms still under development.

1.2 Introduction to the Scientist Training Programme (STP)

4. The STP is designed to provide healthcare scientist trainees with strong science-based, patient-centred clinical training in a specialist area of healthcare science. Initial rotational training provides a broad base of knowledge, skills and experience across a group of related cognate specialisms reflective of the evolving clinical and scientific changes and requirements followed by specialisation in a single HCS specialism. STP is a three-year pre-registration postgraduate academic (MSc Clinical Science) and work based programme.

5. Recruitment to the programme is competitive, and in England a national recruitment process is led by the National School of Healthcare Science (NSHCS). Following induction, workplace training commences with a rotational training programme in a themed group of up to four healthcare science specialisms, followed by training in a specific specialism.
6. The STP is an integrated training programme combining academic study leading to the award of a specifically commissioned MSc in Clinical Science and a work based training programme. Completion of both will lead to the award of a Certificate of Completion of the Scientist Training Programme (CSTP) by the NSHCS. Graduates are eligible to apply to the Academy for Healthcare Science for a Certificate of Attainment and will then be eligible to apply to HCPC for registration as a Clinical Scientist.

1.3 Scientist Training Programme Outcomes: 2013/14

Graduates of the STP will possess the essential knowledge, skills, experience and attributes required of a newly qualified Clinical Scientist. STP graduates will have clinical and specialist expertise in a specific healthcare science specialism, underpinned by broader knowledge and experience within a healthcare science division or theme. They will be competent to undertake complex scientific and clinical roles, defining and choosing investigative and clinical options, and making key judgements about complex facts and clinical situations within a quality assurance framework. Many will work directly with patients and all will have an impact on patient care and outcomes. They will be involved, often in lead roles, in innovation and improvement, research and development, and/or education and training.

On completion of the STP all graduates should be able to demonstrate the following.

**Professional Practice**

1. Professional practice that meets the professional standards of conduct, performance and ethics defined by Good Scientific Practice and the regulator (HCPC), and is safe, lawful and effective, and within the scope of practice for the role undertaken, while maintaining fitness to practise.

2. Personal qualities that encompass communication skills, self-management, self-awareness, acting with integrity and the ability to take responsibility for self-directed learning, maintaining their own health and wellbeing, critical reflection and action planning to maintain and improve performance.

3. The ability to be an independent self-directed learner acting autonomously in a non-discriminatory manner when planning and implementing tasks at a professional level, contributing to the education and training of colleagues and providing mentoring, supervision and support as appropriate.

4. The ability to work, where appropriate, in partnership with other professionals, often as part of a multidisciplinary team, supporting staff, service users and their relatives and carers while maintaining confidentiality.

5. The ability to work with public, service users, patients and their carers as partners in their care, embracing and valuing diversity.

**Scientific and Clinical Practice**

6. A systematic understanding of relevant knowledge, and a critical awareness of current problems, future developments and innovation in health and healthcare science practice, much of which is at, or informed by, the forefront of their professional practice in a healthcare environment.
7. High-quality clinical and scientific practice that applies basic, core scientific knowledge, skills and experience in a healthcare setting, places the patient and the public at the centre of care, prioritising patient safety and dignity and reflecting NHS/health service values and the NHS Constitution.

8. The ability to perform quality assured appropriate diagnostic or monitoring procedures, treatment, therapy or other actions safely and skilfully, adhering to applicable legislation and in compliance with local, national and international guidelines.

9. The ability to deal with complex scientific and clinical issues both systematically and creatively, make sound judgements in the absence of complete data, and communicate their conclusions clearly to specialist and non-specialist audiences, including patients and the public.

10. The ability to define and choose investigative and scientific and/or clinical options, and make key judgements about complex facts in a range of situations.

11. Originality in the application of knowledge, together with a practical understanding of how established techniques of research and enquiry are used to create and interpret knowledge in healthcare and healthcare science and their specialism.

Research, Development and Innovation

12. A comprehensive understanding of the strengths, weaknesses and opportunities for further development of healthcare and healthcare science as applicable to their own clinical practice, research, audit, innovation and service development, which either directly or indirectly leads to improvements in patient experience, clinical outcomes and scientific practice.

13. Conceptual understanding and advanced scholarship in their specialism, enabling them to critically evaluate and critique current research and innovation methodologies and, where appropriate, propose new research questions and hypotheses.

Clinical Leadership

14. Scientific and clinical leadership based on the continual advancement of their knowledge, skills and understanding through the independent learning required for continuing professional development.

15. The ability to critique, analyse and solve problems, define and choose investigative and scientific and/or clinical options, and make key judgements about complex facts in a range of situations.
1.4 Overview of the MSc Clinical Science Programme

7. This document sets out the proposed structure, high-level learning outcomes and indicative content for the proposed three-year, part-time Masters in Clinical Sciences that forms part of the Scientist Training Programme (STP). The programme combines and integrates the generic professional practice learning, themed learning in a group of specialisms and individual specialist programmes.

8. Figure 1 depicts the overall structure and timing of each STP programme while Figure 2 depicts the broad framework around which all MSc Clinical Science programmes must be structured. However, each division within the Modernising Scientific Careers Programme (MSC) has interpreted and adapted this framework.

Figure 1: Modernising Scientific Careers: Scientist Training Programme (STP): Diagrammatic representation of employment-based, pre-registration, three-year NHS-commissioned education and training programme
Figure 2: High-Level Framework for MSc Clinical Science

<table>
<thead>
<tr>
<th>Year 3 Specialist Practice</th>
<th>Healthcare Science</th>
<th>Specialist Learning with integrated Professional Practice</th>
<th>Research Project</th>
<th>Students would usually begin a work based research project in Year 2 and complete the project in Year 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 1 Core Modules</td>
<td>Healthcare Science</td>
<td>Integrating science and Professional Practice [20]</td>
<td>Healthcare Science</td>
<td>Integrating underpinning knowledge required for each rotational element with Professional Practice [40]</td>
</tr>
</tbody>
</table>

**Legend:**
- **Generic Modules:** Common to all divisions of healthcare science
- **Division/Theme-Specific Modules:** Common to a division or theme
- **Specialist Modules:** Specific to a specialism
Section 2: Entry Routes, Award Title, Delivery, Accreditation of Prior Learning

2.1 Entry Routes

9. In England there are two routes of entry into STP. Through the direct entry route, the trainee will be competitively appointed. Alternatively, some STP trainees may enter into training with support of their employers through an in-service training route, as long as employers can demonstrate the ability to support STP training by meeting work based accreditation standards. In both cases potential STP applicants must participate in the national recruitment/assessment process and meet the minimum entry requirements for the academic and work based programme. For direct entry applicants, this will be a competitive process, whereas in-service trainees will be required to go through the national recruitment process to ensure that they meet the standards for entry into STP.

2.2 Progression

10. No condonement/compensation of modules and no aggregation of marks are permitted. Students must pass all modules to be eligible for the final award.

2.3 Award Titles

11. The title of the degree programme should be consistent with current MSC terminology. The award titles are:

<table>
<thead>
<tr>
<th>Life Sciences</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSc Clinical Science (Blood Sciences)</td>
</tr>
<tr>
<td>MSc Clinical Science (Cellular Sciences)</td>
</tr>
<tr>
<td>MSc Clinical Science (Genetics)</td>
</tr>
<tr>
<td>MSc Clinical Science (Infection Sciences)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Physical Sciences and Biomedical Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSc Clinical Science (Medical Physics)</td>
</tr>
<tr>
<td>MSc Clinical Science (Clinical Engineering)</td>
</tr>
<tr>
<td>MSc Clinical Science (Reconstructive Science)</td>
</tr>
<tr>
<td>MSc Clinical Science (Clinical Pharmaceutical Science)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Physiological Sciences</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSc Clinical Science (Cardiac, Critical Care, Vascular, Respiratory and Sleep Sciences)</td>
</tr>
<tr>
<td>MSc Clinical Science (Gastrointestinal Physiology and Urodynamic Science)</td>
</tr>
<tr>
<td>MSc Clinical Science (Neurosensory Sciences)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Across all Divisions</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSc Clinical Science (Clinical Bioinformatics)</td>
</tr>
</tbody>
</table>

In accordance with their own discretion and regulations, HEIs may be able to seek a variation in the award title to enable the specialism to be identified. This
should be raised as part of MSC Accreditation and discussed with the commissioner.

2.4 Mode of Delivery: Part-time

2.5 Relevant Quality Assurance Agency (QAA) Code(s) of Practice

12. HEIs should adhere to the current QAA Code of Practice for the Assurance of Academic Quality and Standards in Higher Education. At the time of preparing this document the QAA is in the final stages of a major review of the Code of Practice and is expected to publish ‘The UK Quality Code for Higher Education’. Further details can be found on the QAA website: http://www.qaa.ac.uk/Pages/default.aspx

2.6 Awarding Body

13. While the full programme could be delivered and awarded by a single university provider, equally a collaborative partnership between a number of universities may be preferable. It would be expected that where collaborative provision is proposed a memorandum of agreement or understanding is in place. The delivery arrangements must be clearly defined, including the academic and logistical responsibilities of each partner and the financial arrangements between the university and its partner. The awarding university must satisfy itself that the partner is able to discharge its responsibilities satisfactorily and will be responsible for the quality assurance of the programme.

2.7 Accreditation of Prior Learning

14. A process for Accreditation of Prior Learning (APL) that conforms to the guidelines below must be defined by each HEI provider. This must clearly define the minimum and maximum level of APL that will be awarded, the timing, costs and process, and align to statutory requirements for healthcare science. Good practice supports the view that such prior learning should only be used once, double counting is not recommended.

QAA ‘Higher education credit framework for England: guidance on academic credit arrangements in higher education in England’, August 2008

QAA ‘Guidelines on the accreditation of prior learning’, September 2004

HCPC ‘Standards of education and training’, September 2009
http://www.hpc-uk.org/aboutregistration/standards/sets/

2.8 Programme Delivery and Monitoring
15. The tender and subsequent MSC accreditation process will require an HEI to provide a detailed description of the content of each module and the teaching and learning and assessment strategy to demonstrate how the programme and module aims/learning outcomes will be met.
Section 3: The MSc Clinical Science Curriculum

3.1 Purpose

16. The purpose of the STP MSc curriculum is to clearly set out the expectations of graduates from the programme, including the academic skills, knowledge and understanding that each trainee will be expected to gain, develop and apply during work based training. Set within an integrated academic and work based programme the expectations of all MSc programmes should be read alongside the work based learning guides.

Additionally, the purpose is to signal the importance of providers being aware of the current structure, strategic direction and priorities of healthcare delivery in the UK, for example the NHS Constitution. The requirement to prioritise patients and their care and ensure that the patient and service provided by healthcare science is at the centre of all learning, assessment and work based practice is equally important.

3.2 Curriculum Development and Maintenance

17. Curriculum development began in 2010 and has been led by the Modernising Scientific Careers (MSC) team working with NHS and higher education colleagues and patients. Since 2012 the NSHCS has also contributed to curriculum development and maintenance via the professional leads and each of the NSHCS themed boards. Professional bodies have been represented in some curriculum working groups and have also been invited to provide feedback as the work developed, either directly or via the NSHCS themed boards.

All programmes have also been reviewed and approved by Health Education England via the Healthcare Science Professional Board Education and Training Working Group. External feedback from a review undertaken in 2012 by the Institute of Education has been incorporated into all programmes from 2013 onwards. All of the latest versions of the MSc Clinical Science programmes and work based learning guides can be found on the NHS Networks website by following the link: [http://www.networks.nhs.uk/nhs-networks/msc-framework-curricula](http://www.networks.nhs.uk/nhs-networks/msc-framework-curricula)

All MSC curricula will be subject to regular review, with all stakeholders given the opportunity to contribute to each review. This process is currently being set out in an MSC long-term curriculum maintenance plan.

18. STP MSc Clinical Science programmes leading to an academic award must be aligned to current NHS policy and strategy, and at the time of writing this guide should consider the recommendations of:

- *Strategy for UK Life Sciences (December 2011)*
HEIs should ensure they keep abreast of future strategic direction and policy.

3.3 Tender Process and Monitoring

19. Local Education and Training Boards are responsible for the commissioning of MSc Clinical Science programmes and the quality of each programme. The lead commissioner function for MSC programmes sits within the West Midlands.

3.4 MSC Accreditation

20. All MSc Clinical Science programmes must hold MSC Accreditation to confirm that commissioned MSc in Clinical Science programmes delivered by an HEI meet the requirements of the MSC Scientist Training Programme outlined in Modernising Scientific Careers: The UK Way Forward (DH, 2010). This accreditation process is currently the responsibility of the MSC Accreditation team, with advice given by the Health Education England Healthcare Science Professional Board (HEE HCSPB) and its Education and Training Working Group (HEE HCSPB ETWG).

3.5 Programme Delivery

21. HEIs are expected to ensure that all teaching, learning and assessment is up to date and informed by research to ensure that at graduation, Clinical Scientists meet the Framework for Higher Education Qualifications (FHEQ) descriptor at level 7 (http://www.qaa.ac.uk/). By undertaking a substantive research project bearing 60 credits, students should become aware of the major contribution the healthcare science workforce makes to research and innovation to benefit patients and the delivery of healthcare.
22. The key principles include:

- programmes must deliver the MSC learning outcomes and indicative content, which the HEE HCSPB Education and Training Working Group has advised meets the requirements of *Modernising Scientific Careers: The UK Way Forward*;
- wherever possible, delivery of the principles and knowledge underpinning practice should occur before the work based learning;
- programmes must meet current NHS education quality metrics and current Health and Care Professions Council (HCPC) Standards of Education and Training;
- the NSHCS, host departments, patients and the public should be involved in the design, implementation, delivery and review;
- assessment programmes must be fair, valid and reliable, and clearly articulated for all modules, and the timing and content should consider and complement the work based assessment programme;
- a robust student support and mentoring system must be in place and arrangements to support students in difficulty agreed with the NSHCS;
- a high-quality teaching and learning environment with appropriate resources and facilities to support teaching and research;
- teaching staff who are research active with a track record of undertaking high-quality research of national and international standing that is relevant to the practice of healthcare science and the NHS;
- evidence that each MSc programme meets the equivalent of the relevant HCPC Standards of Education and Training.

23. The Professional Practice and Good Scientific Practice underpin the MSc and work based programme. Key professional practice learning outcomes are included in the MSc programme and it is important that the MSc programme embeds the standards of professionalism set out in Good Scientific Practice in all aspects of the delivery and assessment of the programme. Trainees should be encouraged to develop a range of skills to support their professional life, and continuing professional development spanning communication, leadership, personal reflection, duty of care, duty of candour, critical reflection, giving and receiving feedback, career planning, commitment to lifelong learning.

HEIs should ensure that all staff involved in each MSc programme have read and are aware of the requirements of *Good Scientific Practice*, a copy of which can be found in the Appendices.

3.6 Academic Induction

24. It is expected that there will be a period of academic induction at the start of each MSc programme.

3.7 Teaching and Learning
25. It is expected that a blended learning approach will be adopted, based on a model of student-centred adult learning that balances and integrates face-to-face teaching, e-learning, etc., and considers the broader requirements of each STP. It is expected that a broad range of teaching and learning activities will be utilised, appropriate to the learning outcomes. Trainees should be enabled to gain the skills necessary to manage their own learning, and to exercise initiative and personal and professional responsibility. The learning strategy matrix and proformas outlined in ‘Liberating Learning’\textsuperscript{1} describe a range of activities that may be appropriate to this MSc programme; they are likely to include:

- Advanced library study
- Case study/discussions
- Debate
- Discussion forum
- Expert briefings
- Individual tutoring
- Interactive lectures
- Personal critical reflection and action planning
- Problem-based learning
- Role play
- Student-led and tutor-led seminars
- Skills teaching
- Simulation
- Self-assessment
- Self-directed learning activities
- Team projects
- Tutor-led small group learning

26. It is also expected that e-learning and m-learning\textsuperscript{2} opportunities will be available to enable students to be active participants in a range of learning activities. Work based learning will also contribute to the academic educational experience of the trainees, for example seminars, journal clubs, local, national and international scientific and education meetings.

All contributors to the MSc should have up-to-date knowledge of the requirements of the programme, current healthcare science and education practice.

\textsuperscript{2} JISC TechDis: see \url{http://www.jisctechdis.ac.uk/technologymatters/mobilelearning} for further information with respect to mobile (m) learning.
3.8 Interprofessional Learning

27. Opportunities to enable interprofessional and interdisciplinary learning, within and outside healthcare science, should be a fundamental part of each programme.

3.9 Patient and Public Involvement

28. The HEI programme team should have mechanisms in place to ensure that there is meaningful patient and public involvement in the design, delivery, development and quality assurance of each programme. It is expected that patients will be represented on course committees at all levels and contribute to teaching, learning and assessment.

Descriptions of MSc programmes need to make clear and explicit links to new models of service delivery, care and patient pathways. The delivery of high-quality, compassionate, patient-centred care should be an integral part of each degree programme, with the emphasis on the contribution of the healthcare science workforce to ensure trainees are aware that their actions have an impact on the patient and the patient's family. The responsibility of all staff in the NHS to maximise quality and productivity and efficiency and to continually strive to improve services should be stressed. Equally important is the ability of graduates from the STP to communicate with the general public with respect to healthcare science, leading to a better educated public that is encouraged to take responsibility for its own health and wellbeing and has a greater understanding of the role that science plays in society.
Section 4: Assessment

4.1 Purpose of Assessment

29. The purpose of assessment is to enable the trainee to demonstrate that they have the requisite knowledge, skills, attitudes and beliefs to work as a Clinical Scientist and, together with the successful graduation from the work based element of the STP, that they meet the HCPC standards of education and training, professional skills, conduct performance and ethics to provide reassurance to the public.

30. The MSc Clinical Science assessment programme should support assessment for learning, and in particular:

- help clarify what good performance is (goals, criteria, standards);
- encourage ‘time and effort’ on challenging learning tasks;
- deliver high-quality feedback information that helps learners to self-correct;
- encourage positive motivational beliefs and self-esteem;
- encourage interaction and dialogue around learning (peer and teacher–student);
- facilitate the development of self-assessment and reflection in learning;
- involve students in decision making about assessment policy and practice;
- support the development of learning communities;
- integrate and complement the work based assessment programme;
- help teachers adapt teaching to student needs.

31. The HEI must have in place a clear, overarching strategic and systematic approach to assessment that fits with the curriculum and delivers assessment methods that are valid, reliable/generalisable, feasible, fair, acceptable and defensible, and is led by assessment experts. The approach to the assessment of the MSc Clinical Science should also be cognisant of and complement the work based assessment programme.

32. The assessment programme should be designed to enable the trainee to obtain regular constructive feedback on progress and achievement. It should encourage critical reflection and action planning, identifying both strengths and areas for development and improvement.

33. The approach to assessment should include and be overseen by a central coordinating leadership group or assessment-focused group who oversee, advise and scrutinise assessment across modules and years in order to build a consistent approach to assessment across the whole programme, involving module/programme leaders as appropriate. The overall assessment strategy

---

3 Quality Assurance Agency Code of Practice.

should be documented in a clear and accessible manner with accountabilities clearly allocated. The strategy should also demonstrate how the approach is based on a sound understanding of the evidence base, academic literature and good practice in assessment.

4.2 Key areas that must be covered by the Assessment Strategy include:

- A clear statement of accountabilities, including the governance structure for assessment.
- The balance between formative and summative assessment.
- The assessment of each module, including the contribution of individual assessments and examinations within the module.
- Progression criteria.
- The range of valid, reliable and appropriate assessment techniques that will be utilised across the programme and for each module.
- The process for providing clear and timely information for students.
- How all examiners will be trained (including refresher training) and the guidelines that will be given.
- The mechanisms in place to ensure comparability of standards and to share good practice, including external examiners.
- How standard setting is undertaken.
- How student feedback will be given, including time lines.
- The arrangements for assessment of students with a disability.
- An assessment blueprint demonstrating the relationship between each assessment and the learning outcomes of the programme.
- Exemplar criteria and marking scheme, including critical reflective writing.
- The process of appointing external examiners.
- A defined role for external examiners that includes contributing to the review and development of assessment strategies and providing advice from an overarching perspective.
Section 5: Trainee Supervision, Support and Mentoring

34. The trainee supervision, support and mentoring systems will span the academic and work based elements of STP, and the relationship between the two systems must be clear to trainees, work based staff and HEI staff. The trainee supervision, support and mentoring system must be designed to encourage safe and effective practice, independent adult learning, appropriate professional conduct of the trainee and the safety of the patient. Those undertaking the role of supervisor or mentor must have relevant qualifications and experience and have undertaken appropriate and up-to-date training. The HEI will be expected to have an academic supervisory, support and mentoring scheme in place and to provide access to student support services.

Academic supervisor(s): Responsible, usually as part of a supervisory team, for guiding and assisting students during their period of academic study, including the research module.

Work based education supervisor: Responsible for monitoring, supporting and assessing the trainee on a day-to-day basis in their scientific, clinical and professional work and may take on the role of co-supervisor of the research project as part of the academic supervisory team.

5.1 Fitness to Practise

35. The HEI must have a clear policy with respect to Fitness to Practise, which must clearly articulate how staff and students are made aware of the policy and how the policy is implemented. Alongside this must be a clear policy on how student whistleblowers are supported. Breaches of professional practice and behaviour identified by the HEI or during HEI activities must be reported and investigated in accordance with this Fitness to Practise policy and accurate records maintained within the HEI. The NSCHCS should be informed of any issues with respect to fitness to practise and professional suitability.
Section 6: Progression, Annual Monitoring of Progress, Equality and Diversity, Curriculum Review and Updating

6.1 Progression

36. All trainees will usually be expected to complete the requirements for the MSc Clinical Science award within three years after initial registration (periods of suspension will not lead to an automatic extension of this period). This aligns with the duration of the STP and it is expected that successful STP graduates will be required to attain both an MSc in Clinical Science and certification of completion of STP work based training.

6.2 Annual Monitoring of Progress

37. The programme governance must include annual monitoring of progress that considers the outcome of the review of each module (including student and lay evaluation) and the handling and consideration of the external examiner's report. This process should enable the programme leaders to identify and propose changes to the programme in response to feedback.

6.3 Equality and Diversity

38. All programmes should reference and be able to demonstrate evidence of adherence to the Disability Discrimination Act 1995 (DDA) which was extended to education in September 2002, following amendments introduced by the Special Educational Needs and Disability Act (SENDA) 2001. Additionally evidence should be demonstrated to show adherence to the Disability Discrimination Act (2005) which includes the Disability Equality Duty and the QAA Code of Practice on Students with Disabilities should be available. All degree programmes should also include evidence of adherence to the 2010 Equality Act and any superseding legislation with respect to equality.

As part of this commitment to equality staff should be committed to inspiring and supporting all those who work, train and provide training in healthcare science to operate in a fair, open and honest manner. The approach taken is a comprehensive one and reflects all areas of diversity, recognising the value of each individual. This means that no one is treated less favourably than anybody else on the grounds of ethnic origin, nationality, age, disability, gender, sexual orientation, race or religion. This reflects not only the letter but also the spirit of equality legislation, taking into account current equality legislation and good practice.

Key legislation includes:

- Race Relations Act 1976 and the Race Relations Amendment Act (RRAA) 2000
- Disability Discrimination Act 1995 and subsequent amendments
• Human Rights Act 1998
• Employment and Equality (Sexual Orientation) Regulations 2003
• Employment and Equality (Religion or Belief) Regulations 2003
• Gender Recognition Act 2004
• Employment Equality (Age) Regulations 2011.

6.4 Curriculum Review and Updating

39. The review and updating of the doctoral level academic award curriculum will be part of the long-term MSC curriculum maintenance programme currently being developed.

If you have any feedback with respect to this programme please contact: msc.hee@nhs.net
Section 7: Relationships and Partnerships

7.1 National School of Healthcare Science

40. The NSHCS provides a national coordinating and oversight function to support trainees and host departments in the delivery of STP training. It is responsible for:

- national recruitment into STP, enabling a transparent and robust selection of the very best science graduates;
- providing national oversight of STP trainees throughout their training by managing and monitoring their progress through the Online Learning and Assessment Tool (OLAT), supporting trainees in difficulty as well as coordinating national structured assessments both during and at the end of STP training;
- evaluation of ongoing work based assessment outcomes through the OLAT, enabling the School to benchmark training programme delivery for early identification of programme issues that may need to be addressed and resolved, and reporting these as part of agreed MSC governance arrangements;
- liaising with each HEI’s MSc Clinical Science programme director to ensure the integration and coordination needed to deliver the academic and work based programmes that form the STP; liaising with MSC Strategic Health Authority (SHA) leads (and education and quality leads in the future arrangements) on local issues and problems and their resolution;
- working closely with workplace training departments and providing support as appropriate;
- organising national ‘Train the Trainer’ programmes to ensure common standards of delivery and content, and recommending ongoing training activities to support the continuing professional development of work based trainers.

41. Professional Leads in each of the scientific divisions within the NSHCS will provide help and support with respect to organising rotations and/or specialist training that might require national coordination. In order to optimise the educational benefit and value of OLAT and the e-learning Portfolio, Professional Leads will also work with and support training departments in its use.

The School can be contacted on the following email: nshcs@Westmidlands.nhs.uk and at www.nshcs.org.uk.

7.2 The Academy for Healthcare Science

41. The Academy for Healthcare Science (AHCS provides the professional voice for the healthcare science workforce. Its functions are to:

- act as a strong and coherent professional voice;
• be able to influence and inform a range of stakeholders on all matters relating to healthcare science and scientific services;
• act as the overarching body for professional issues related to education, training and development in the UK health system including the provisions of UK wide quality assurance across education and training arrangements;
• provide the infrastructure to support the professional regulation/registration of the healthcare science workforce including:
  o establishing a system of professional accreditation of education and training programmes for the regulation/registration of the healthcare science workforce;
  o setting the professional standards for the delivery of accredited registers as required by CHRE (to be renamed the Professional Standards Authority for Health and Social Care) to ensure consistency and coherence across all MSC programmes;
  o taking the central role in the sponsorship of the voluntary registers to achieve ‘accredited’ status as set out by CHRE (to be renamed the Professional Standards Authority for Health and Social Care);
  o becoming an HPC education provider for the statutory regulation of clinical scientists;
  o establishing a system for equivalence across the whole of the healthcare science workforce.

http://www.academyforhealthcarescience.co.uk/

The following sections of this MSc Curriculum provide an overview of the STP for the specialisms within this theme. This is followed by the Generic, Division and Themed Learning Outcomes and Indicative Content, together with the high-level work based learning outcomes.
Section 8: Professional Practice

Professional practice spans the whole of the three-year training programme, underpinning both work based training and the MSc in Clinical Science and is described in the document Good Scientific Practice. This document sets out the principles and values on which good practice undertaken by the Healthcare Science workforce is founded. Wherever possible teaching should be contextualised to patients and patient care recognising that the work of all members of the healthcare science workforce have an impact on patients and their care.

Good Scientific Practice sets out for the profession and the public the standards of behaviour and practice that must be achieved and maintained in the delivery of work activities, the provision of care and personal conduct.

Good Scientific Practice uses as a benchmark the Health Professions Council (HPC) Standards of Proficiency and Standards of Conduct, Performance and Ethics, but expresses these within the context of the specialities within Healthcare Science, recognising that three groups of the workforce, Biomedical Scientists, Clinical Scientists and Hearing Aid Dispensers are regulated by the HPC. The aim is that the standards are accessible to the profession and understandable by the public.

Good Scientific Practice represents standards and values that apply throughout an individual’s career in healthcare science at any level of practice. The standards will be contextualised by the role within Healthcare Science that an individual undertakes. This means that the standards must be interpreted based on the role that an individual performs. For example, in supervised roles where individuals work within defined procedures, rather than autonomously, some standards will need to be interpreted appropriately for the context of the specific role. There will, however, always be a requirement for an individual to work within the limits of their scope of practice and competence.

Students and trainees will be expected to be working towards meeting the expectations set out in this document. However, if an individual is undertaking further training and development following qualification from a professional training programme, he or she will be expected to be able to meet the standards in this document within their scope of practice.

The standards have been used to support curriculum development and will be used to underpin the process of judging individual equivalence, particularly for emerging specialisms.

The standards have been divided into five domains. The domains of Good Scientific Practice detailed in section 2 are:

1. Professional Practice
2. Scientific Practice
3. Clinical Practice
4. Research and development
5. Clinical Leadership
Further details including the content of each domain can be found in Appendix 3.

Within the MSc Clinical Sciences (Medical Physics) key outcomes for trainees are for all modules are shown below.

<table>
<thead>
<tr>
<th>Learning Outcomes: Associated Personal Qualities and Behaviours (Professionalism)</th>
</tr>
</thead>
<tbody>
<tr>
<td>On successful completion of this module the trainee will:</td>
</tr>
<tr>
<td>1. Present complex ideas in both oral and written formats at a level appropriate to the hearer.</td>
</tr>
<tr>
<td>2. Consistently operate within sphere of personal competence and level of authority.</td>
</tr>
<tr>
<td>3. Manage personal workload and objectives to achieve quality of care.</td>
</tr>
<tr>
<td>4. Actively seek accurate and validated information from all available sources.</td>
</tr>
<tr>
<td>5. Select and apply appropriate analysis or assessment techniques and tools.</td>
</tr>
<tr>
<td>6. Evaluate a wide range of data to assist with judgements and decision making.</td>
</tr>
<tr>
<td>7. Conduct a suitable range of diagnostic, investigative or monitoring procedures with due care for the safety of self and others.</td>
</tr>
<tr>
<td>8. Report problems and may take part in restorative action within quality control/assurance requirements to address threats of performance deterioration.</td>
</tr>
<tr>
<td>9. Work in partnership with colleagues, other professionals, patients and their carers to maximise patient care.</td>
</tr>
</tbody>
</table>
Section 9: MSc Clinical Science (Medical Physics)

9.1 Overview of STP in Medical Physics

The diagram below provides an overview of the STP each trainee in Medical Physics will follow.

Figure 1: Modernising Scientific Careers: Scientist Training Programme (STP): Diagrammatic representation of employment-based, pre-registration, three-year NHS-commissioned education and training programme

9.2 Medical Physics Route Map

The route map overleaf shows how the high-level framework has been interpreted for the MSc in Clinical Science (Medical Physics) for each of the four specialisms, namely:

i. Radiotherapy Physics
ii. Radiation Safety
iii. Imaging with Ionising Radiation
iv. Imaging with Non-Ionising Radiation
### MSc Clinical Science Route Map for Medical Physics

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to Specialist Medical Physics: underpinning knowledge for rotational work based training [40]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Radiotherapy Physics**
- Radiotherapy 1 [20]
- Research Project [30]
- Radiotherapy 2 [30]
- Research Project [30]

**OR**

**Radiation Safety**
- Radiation Safety 1 [20]
- Research Project [30]
- Radiation Safety 2 [30]
- Research Project [30]

**OR**

**Imaging with Ionising Radiation**
- Imaging with Ionising Radiation 1 [20]
- Research Project [30]
- Imaging with Ionising Radiation 2 [30]
- Research Project [30]

**OR**

**Imaging with Non-Ionising Radiation**
- Imaging with Non-Ionising Radiation 1 [20]
- Research Project [30]
- Imaging with Non-Ionising Radiation 2 [30]
- Research Project [30]

**Credits**

<table>
<thead>
<tr>
<th>Division/Theme</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generic</td>
<td>20</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Specialism</td>
<td>40</td>
<td>0</td>
<td>60</td>
</tr>
<tr>
<td>Total</td>
<td>60</td>
<td>60</td>
<td>60</td>
</tr>
</tbody>
</table>

Route map of MSc Clinical Science (Medical Physics) with specialisms in Radiotherapy Physics, Radiation Safety, Imaging with Ionising Radiation, Imaging with Non-Ionising Radiation. In Year 1, trainees begin by following the generic curriculum, which spans all divisions (blue), together with some division/theme-specific modules (yellow). In Year 2 and 3, trainees specialise (orange).
Section 10: Generic Modules

Generic Curriculum

The generic STP MSc Clinical Science curriculum followed by all trainees comprises three modules:

- Introduction to Healthcare Science, Professional Practice and Clinical Leadership: Year 1
- Research Methods: Year 2
- Research Project: Years 2 and 3

The generic STP work based programme generic curriculum modules are:

- Professional Practice: Years 1, 2 and 3
- Elective: following completion of the rotational training programme

These modules align to Good Scientific Practice (see Appendix).

Year 1: Generic Module
Introduction to Healthcare Science, Professional Practice and Clinical Leadership
[20 credits]

The overall aim of this introductory module is to provide all trainees with a broad knowledge and understanding of science and scientific knowledge, contextualised to the practice of healthcare science and the services provided by their healthcare science division/specialism. Central to this is the contribution of healthcare science to patient care, patient safety, service delivery, research and innovation, often at the cutting edge of science, for example genomics and bioinformatics. All members of the healthcare science workforce must understand the impact of their work on patients and patient care and remember that their work has a direct or indirect impact on patient care.

It is recognised that some of the learning within this module will not be at master’s level, as allowed for in university regulations, but achievement of each learning outcome provides the building blocks for the division- and specialism-specific learning to follow, ensuring a common starting point for all trainees. While some of the learning may be at a lower level, the application of that knowledge in the divisional and specialist modules will be at master’s level.

As an introductory module it is expected to provide an overview and reinforcement of key concepts with respect to the organisation, structure and function of the body, and important areas such as the psychosocial aspects of health and disease, clinical pharmacology and therapeutics, genomics and bioinformatics.

A major focus of this module is professional practice. This module will introduce and critically review the frameworks and academic literature
underpinning professional practice and enable trainees to gain the knowledge, skills, experience and tools to develop, improve and maintain high standards of professional practice at all times.

<table>
<thead>
<tr>
<th>Learning Outcomes: Knowledge and Understanding</th>
</tr>
</thead>
<tbody>
<tr>
<td>On successful completion of this module the trainee will:</td>
</tr>
</tbody>
</table>

**Scientific Basis of Healthcare Science**

1. Describe the cellular, tissue and systems responses to disease and discuss those body systems and processes relative to your division/specialism.
2. Explain the main principles and core concepts of clinical genetics and genomics and discuss in the context of patients referred to services provided by your division/specialism.
3. Explain the main principles and core concepts of the sociology of health and illness and discuss those relevant to patients and the role of your division/specialism.
4. Explain the basis of epidemiology, public health and health protection and discuss in relation to patients and the safety of patients referred to services provided by your division/specialism.
5. Explain the basic principles of clinical pharmacology and therapeutics and discuss in relation to patients and the safety of patients referred to services provided by your division/specialism.
6. Explain the basic principles of physics that underpin healthcare science and discuss in relation to patients and the safety of patients referred to services provided by your division/specialism.
7. Discuss and justify how bioinformatics, including large biological datasets, contributes to patient safety, patient care and the practice of healthcare science and defend the governance and ethical frameworks within which bioinformatics can be used.

**Professional Practice**

8. Discuss and appraise the ethical foundations of professionalism, including critical reflection, and how these relate to the clinical scientist, the patient, the practice of healthcare science and the wider healthcare environment.
9. Explain and critically evaluate the structures, processes and methodologies that underpin the quality of the service provided by the NHS and quality improvement initiatives to promote high-quality patient care and enhance patient safety, and discuss the quality mechanisms relevant to your division/specialism.
10. Explain the principles of effective written and verbal communication and feedback, considering the needs and dignity of patients, the public, health professionals and scientists.
11. Describe and evaluate the basic principles and structures underpinning history taking, clinical examination and clinical decision making and discuss their role in your division.

**Clinical Leadership**

12. Discuss, compare and contrast a range of leadership models, including
those that underpin current NHS Leadership and Competency Frameworks, and identify and critically evaluate how your personal values, principles and assumptions affect your personal leadership style.

13. Explain the current structure and management of health and social care systems and services at a national (UK-wide) and local level and the way in which the voice of patients and the public is embedded in all aspects of healthcare and healthcare education.

Learning Outcomes: Practical Skills

On successful completion of this module the trainee will:

1. Practise the skill of history taking.
2. Practise the skill of giving and receiving meaningful feedback.

Indicative Content

Review of the organisation, structure and function of the body
- Chemical, cellular and tissue level of organisation of the body
- Metabolism
- Function of blood as a tissue, blood cells (types and life times).
- Anatomy and physiology:
  - skin
  - skeletal system
  - respiratory system
    - ventilation
    - gas exchange
    - blood gas transport
  - heart, blood vessels and lymphatic system
- Central, peripheral and autonomic nervous system
- Vision, hearing and equilibrium
- GI tract, including digestion and absorption of food, the liver and liver function tests
- Renal system
- Endocrine system
- Electrolyte and acid-base balance
- Hormonal mechanisms and control
- Abdomen, pelvis and perineum, including male and female reproductive tract

Review of pathophysiology: cellular, tissue and systems responses to disease
- Review of the pathological processes underpinning common diseases:
  - cell death
  - inflammation
  - neoplasia
  - hypertrophy
  - hyperplasia
  - tissue response to injury and repair
Introduction to the main principles and core concepts of clinical genetics and genomics

- Meiosis and Mendelian inheritance
- Nucleic acid structure and function
- Chromosome structure and function
- Nomenclature used to describe the human genome
- Common genetic disorders
- Impact of genetic disorders on the patient and their families
- Genomic technology and role of the genome in the development and treatment of disease

Introduction to sociology of health and illness

- Factors affecting health and their contribution to inequalities in health between populations
- Basis of health protection, including principles of surveillance
- Patients' responses to illness and treatment, including the impact of psychological and social factors including culture, on health and health-related behaviour
- Health belief models
- Diversity of the patient experience
- Disability, including learning disabilities
- Potential health inequalities
- Self-care
- Impact of life-threatening and critical conditions
- Patient involvement in decisions regarding their healthcare

Introduction to epidemiology, public health and health protection

- Health and disease in population terms
- The importance of population factors in individual health/disease processes
- Data interpretation, including the variability of biological data and application of statistics
- Investigating disease, epidemiology and natural history, including mathematical modelling
- Role of local, national and international bodies associated with health protection
- Principles of surveillance, the characteristics of different surveillance systems and key current policies and programmes used to protect health
- Screening programmes, including design, strengths and weaknesses

Introduction to clinical pharmacology and therapeutics

- Overview of the basic principles of pharmacokinetics
- Overview of the basics of drug metabolism and excretion
- Basic mechanisms and clinical importance of drug interactions

Basic principles of physics underpinning common measurement techniques used in healthcare science

- Structure of matter (atomic and nuclear models)
- Radiation: nature and its measurement and radiation safety
- Physics and mathematics of image formation
• Basic electricity and magnetism as it relates to the measurement of physiological signals
• Viscous and inertial flow of simple liquids

Ethical foundations of professionalism and the patient at the centre of care
• Defining professionalism within health and healthcare science
• Characteristics (personal traits) that impact on professionalism and professional practice in the workplace
• Ethical, legal and governance requirements arising from working at the level of the Clinical Scientist
• Critical Reflective Practice
  o Evidence base
  o Reflection as a structure for learning
  o Frameworks that support critical reflective practice
  o Reflection to improve professional practice
  o Reflection as a model for developing deep learning
  o Reflection as a means of improving patient care, service delivery and scientific investigation

Introduction to quality, quality improvement
• Patient safety
• Definition of terms
• Quality management
• Quality control
• Quality assurance
• Quality improvement
• Quality methodologies
• Quality processes and procedures
• Clinical governance
• Current NHS quality management and improvement systems
• Quality assurance to protect patients and assure high-quality healthcare science services, and deliver safe and effective services

Introduction to history taking, clinical examination
• Importance of patient-centred care, treating patients with respect, honesty and compassion, maintaining patient dignity and confidentiality and putting the patient first
• Duty of candour and the importance of this in healthcare
• Informed consent
  o Principles, guidance and law with respect to informed consent
  o Introduction to the patient, including role of the Clinical Scientist
  o Explanation to the patient
• Structured models for presenting a patient history
• Process of patient-centred interviewing and the features of a good consultation
  o Initiating the session
  o Gathering information
  o Building the relationship
  o Explaining and planning
● Closing the session
  ● Link between the patient history and examination and development of clinical investigation and management plans
  ● Shared clinical decision making
  ● How information from a history and examination is used to develop clinical management plans

Introduction to communication skills
  ● Principles of effective communication, including:
    ○ written and electronic
    ○ verbal
    ○ non-verbal
  ● Importance of:
    ○ signposting
    ○ listening
    ○ paraphrasing
    ○ language
    ○ commonly used questioning techniques
    ○ non-verbal behaviour
    ○ ideas
    ○ beliefs
    ○ concerns
    ○ expectations
    ○ summarising
    ○ communication
  ● Range of question types that can be used in a communication
  ● Key features of effective patient interviews and information giving
  ● Adapting communication methods for people/groups/culture
  ● Feedback
    ○ The role of feedback in clinical education and continuing professional development
    ○ Feedback models
    ○ Characteristics of effective feedback

Introduction to leadership within the NHS
  ● Theories and models of leadership
  ● Concept of shared leadership
  ● Associated personal qualities and behaviours that promote shared leadership
  ● Overview of the NHS Leadership Framework and Clinical Leadership Competency

Introduction to the structure of the NHS
  ● Structure of the NHS across the four UK countries
    ○ Structure
    ○ Accountabilities
    ○ Funding arrangements
    ○ Working relationships
  ● NHS Constitution
    ○ The seven key principles that guide the NHS in all it does
- NHS Values
  - Respect and dignity
  - Commitment to quality of care
  - Compassion
  - Improving lives
  - Working together for patients
  - Everyone counts
- Quality improvement structures and processes within the NHS
- Patient safety and the requirement to protect patients from avoidable harm
- Patient focus
  - Shared decision making with patients
  - Access to information
  - Choice
  - Personalised care
  - Safeguarding patients

**Year 2: Generic Module**
**Research Methods**

[10 credits]

The overall aim of this module is to ensure that the trainee has the knowledge, skills and experience of the role of research, development and innovation in the NHS in improving patient care, including prevention, diagnostics, treatment and service delivery. On completion of this module and the research project, trainees should be able to generate ideas; assess, plan, conduct, evaluate, interpret and report research and innovation projects, which includes original research; and disseminate the findings and, where appropriate, the adoption of the findings. Trainees should also be able to use research to improve practice.

**Learning Outcomes: Knowledge and Understanding**

On successful completion of this module the trainee will:

1. Discuss and critically evaluate the context within which research, development, innovation and audit are undertaken to improve patient care, promote innovation and improve service delivery.
2. Describe, compare and contrast a range of research methods/approaches, including cohort studies, qualitative, quantitative, systematic review, sampling techniques and clinical trials.
3. Explain and justify current UK ethical and governance frameworks and processes spanning the conduct of human and animal research, innovation and audit.
4. Critically evaluate the literature/evidence base to identify a research question and create a new approach or technique to improve patient care or service delivery.
5. Discuss and justify the research, audit and innovation process from idea generation to dissemination/implementation, including patient/user involvement and intellectual property.
6. Describe and evaluate a range of data analysis techniques to ensure the validity, reliability and appropriateness to the research aim, design and conclusion.

7. Describe how clinical guidelines are produced and the concept of evidence-based practice, including the role of current statutory and advisory regulatory bodies.

8. Identify potential sources of research and innovation funding for healthcare science/Clinical Scientists.

---

**Learning Outcomes: Practical Skills**

On successful completion of this module the trainee will:

1. Undertake an evidence-based literature review, critically appraise the output, draw appropriate conclusions and report the findings, and where appropriate, use the findings to inform a research project.

2. Identify, discuss and critically evaluate a research, innovation or audit project that has resulted in an improvement in patient care, diagnostics or service delivery.

---

**Indicative Content**

**Research methods/approaches**
- Differentiation between audit and research
- Cohort studies
- Qualitative
- Quantitative
- Systematic review
- Meta-analysis
- Sampling techniques
- Clinical trials (pre-clinical to translational)
- Epidemiological studies
- Study design
- Hypothesis generation and testing

**Ethical and governance research frameworks**
- Good Clinical Practice (GCP)
- Human research
- Animal research
- Innovation
- Audit

**Research, audit and innovation process**
- Literature searching and referencing
- Innovation pathway (Invention, Evaluation, Adoption and Diffusion)
- Idea generation
- Patient/user involvement
- Peer/expert review
- Practical and financial criteria and constraints affecting research
- Dissemination/implementation
• Intellectual property
• Quality assurance
• Monitoring and reporting
• Archiving
• Roles and responsibilities of the research/innovation team

Data analysis techniques
• Data validity, reliability and appropriateness
• Application and interpretation of statistical techniques
• Power calculations
• Intention-to-treat analyses

Clinical guidelines
• Evidence-based practice
• Statutory and advisory regulatory bodies

Research and innovation funding
• Sources of funding including research councils and charities
• Grant applications
Section 11: Division/Theme-Specific Modules

This section covers the theme-specific module that will be studied by all trainees undertaking the Medical Physics programme.

**Division:** Physical Sciences and Biomedical Engineering  
**Theme:** Medical Physics  
**Year 1:** Introduction to Specialist Medical Physics  
[40 credits]

The overall aim of this module is to provide trainees with the knowledge that underpins the first four rotations of the Medical Physics STP and the common learning required within the division.

A high level description of the work based learning is included to provide MSc Clinical Science providers with information on how the academic and MSc elements of each STP programme integrate. The full Work Based Learning Guide can be found at:


**Year 1: Introduction to Specialist Medical Physics [40 credits in total]**  
Imaging with Non-Ionising Radiation (INIR)  
Imaging with IR (IIR)  
Radiation Safety Physics (RADS)  
Radiotherapy Physics (RP)

**Learning Outcomes: Knowledge and Understanding**

On successful completion of this module the trainee will:

1. Describe the legislation that applies to safe working within the radiation, workshop and clinical environments.
2. Explain the physical principles behind the interaction of radiation with matter.
3. Describe the basis of clinical measurement.
4. Discuss and evaluate the role of Medical Physics in innovation and service development.

**Indicative Content**

**Information and Communication Technology (ICT)**

- The range of general purpose computer software in common use, including spreadsheets, flat-file and structured databases, online reference and collaborative resources
- An understanding that computing applied clinically involves additional safeguards when ‘the computer acts as a clinical device’, including an understanding of the role of the Medicine and Healthcare products
Regulatory Agency (MHRA), the Food and Drugs Administration (FDA) and the International Electrotechnical Commission (IEC) and their role in CE Marking

- An introduction to the concept of the software life cycle and the tools and frameworks used to specify, develop, validate and verify clinical software
- The basic principles relating to Information and Communication Technology (ICT) security, including firewalls, virus protection, encryption, server access and data security
- Information Governance, including NHS security policies
- The need for data exchange standards and be aware of some of the common standards, e.g. Digital Imaging and Communications in Medicine (DICOM) and Healthcare Level 7 (HL7)
- The networking systems in common clinical use and be aware of the relevant local trust information technology policies
- The basic principles of applicable legislation and of local policies, including the Data Protection Act, Computer Misuse Act and Freedom of Information Act

**Clinical Measurement**

- The physiology of pressure, flow and electrophysiology
- The physical principles underpinning measurements of pressure, flow and electrophysiology
- Transducers for measuring pressure, flow and electrophysiology
- Calibration, traceability of standards
- Sources of error: random, systematic and human
- Sensitivity and specificity of measurement techniques
- Relationship to clinical pathology, data processing and interpretation

**Safety**

- Health and safety legislation specific to division
- Risk assessment techniques
- Chemical safety: COSHH, hazards, storage, use and disposal
- Electrical safety: medical equipment, leakage currents, fault conditions, isolation and circuit protection; biological/physiological response to electric shock; treatment of electric shock; equipment testing
- Mechanical safety: lifting gear; guards and operation of machine and hand tools, eye and ear protection; fumes, dusts, moving and handling
- Biological safety: pathological and normal specimens; blood and other tissues; equipment contamination, cleaning, cross-contamination; handling procedures and protocols
- Theatre safety: anaesthetic agents, explosion hazard, waste gas extraction, function checks, obstacles, sterility
- Workshop safety
- Personal Protective Equipment

**Innovation and Service Improvement**

- Role of Medical Physics and Clinical Engineering in innovation and service improvement
- Project management
• Process mapping
• Equipment life cycle
• Specification, procurement, installation and commissioning
• Critical review of protocols, techniques and equipment
• Health Technology Assessment
• Horizon scanning

**Introduction to Radiotherapy Physics**
• Malignant disease and role of radiotherapy
• Basic radiobiology
• Introduction to radiotherapy equipment (treatment machines and dosimetry equipment)
• Characteristics of clinical beams
• Target volume localisation: equipment and methods
• Principles of treatment planning
• Treatment verification
• Introduction to quality assurance, calibration, treatment accuracy and safety; standards
• Radiation protection specific to radiotherapy: local rules, protection measurements

**Introduction to Radiation Physics**
• X-rays, electrons (betas), neutrons, alpha and other particles
• Radioactivity units and relationships
• X-ray production
• Physical effects of radiation
• Interaction processes with matter
• Measurement and instrumentation
• Biological effects of ionising radiation
• Non-ionising radiations including ultraviolet (UV), radiofrequency (RF) and microwaves, lasers, infrared, magnetic fields and ultrasound
• Radiation safety: dose limits; national and international organisations and recommendations; legislation; principles of protection, safe practice, monitoring and reporting applied to:
  • ionising radiation
  • UV, microwave, RF and magnetic fields, lasers and ultrasound

**Introduction to Imaging with Ionising Radiation**
• The physics and mathematics of image formation with ionising radiation as it relates to:
  • the radiological image
  • computerised tomography (CT) scanning
  • nuclear medicine
  • positron emission tomography (PET)
• Introduction to image reconstruction techniques
• Introduction to image processing and analysis
• Image display characteristics
• Clinical application and a basic understanding of normal and pathological appearances within the image
• Introduction to image registration
• Quality assurance

**Introduction to Imaging with Non-Ionising Radiation**

- The physics and mathematics of image formation with ionising radiation as it relates to:
  - magnetic resonance imaging (MRI)
  - ultrasound
  - imaging with lasers
- Introduction to image reconstruction techniques
- Introduction to image processing and analysis
- Image display characteristics
- Clinical application and a basic understanding of normal and pathological appearances within the image
- Introduction to image registration
- Quality assurance

**Section 11.1: Rotational Work Based Modules for Medical Physics**

This section contains the work based learning outcomes for this Scientist Training Programme, further details can be found in the accompanying Work Based Learning Guides

<table>
<thead>
<tr>
<th>Imaging with Non-Ionising Radiation (INIR)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Learning Outcomes: Associated Work Based Learning</strong></td>
</tr>
<tr>
<td>High-level description of the work based learning that accompanies this academic module. Further details of the work based programme can be found in the Work Based Learning Guide, including the Clinical Experiential Learning, Competences and Applied Knowledge and Understanding.</td>
</tr>
</tbody>
</table>

On successful completion of this module the trainee will:

**Ultrasound**
1. Assist with the use of harmonic imaging, contrast agents and Doppler techniques to maximise the diagnostic potential of ultrasound imaging, including determining blood flow.
2. Perform routine quality control measurements on ultrasound scanners, including general, small parts and cardiac scanners.

**Magnetic Resonance Imaging**
3. Perform routine quality control measurements on a clinical magnetic resonance scanner.
4. Discuss a range of normal and pathological images obtained using simple pulse sequences, and evaluate the effect of contrast media.
### Non-Imaging Modalities
5. Perform measurements and record the output of a range of equipment, e.g. lasers, ultraviolet (UV) and physiotherapy ultrasound.
6. Perform the required safety and quality controls checks on a range of non-ionising, non-imaging equipment, for example lasers, UV and physiotherapy ultrasound.
7. Perform a risk assessment of a non-ionising radiation facility.

### Equipment Performance
8. Undertake performance testing on a range of non-ionising equipment.

### Emerging Modalities
9. Identify and critically appraise the mode of operation and scientific principles of a new and emerging technology, and the evidence base underpinning the technology.

---

### Imaging with IR (IIR)

#### Learning Outcomes: Associated Work Based Learning

High-level description of the work based learning that accompanies this academic module. Further details of the work based programme can be found in the Work Based Learning Guide, including the Clinical Experiential Learning, Competences and Applied Knowledge and Understanding.

On successful completion of this module the trainee will:

#### Radionuclide Imaging
1. Demonstrate safe practice when working with sources of ionising radiation, including X-ray equipment, sealed and unsealed radioactive material.

#### Non-Imaging Radionuclide Tests
2. Assist in routine patient investigations using uptake counters, gamma spectrometers, manual and automatic beta and gamma sample counters correctly and safely, and, where possible, other equipment such as whole body counters, demonstrating patient-centred, safe practice and the effect of equipment settings and counting geometry on measured count-rates.

#### Radiopharmacy
3. Perform a range of procedures in the radiopharmacy correctly and safely, including quality assurance tests of facilities, products, equipment and radionuclide calibrators.

#### Radiation Protection
4. Handle sealed and unsealed radioactive sources safely and use safe practice when working with X-ray equipment.

#### Diagnostic Radiology Equipment Performance
5. Operate radiographic and fluoroscopic equipment for the purpose of performance testing and undertake performance tests on a basic range of X-ray equipment.

#### Patient Dose Measurements
6. Make and collate patient dose measurements, calculating patient doses for a range of examinations, including the calculation of foetal dose.
Radiation Safety Physics (RADS)

Learning Outcomes: Associated Work Based Learning

High-level description of the work based learning that accompanies this academic module. Further details of the work based programme can be found in the Work Based Learning Guide, including the Clinical Experiential Learning, Competences and Applied Knowledge and Understanding.

On successful completion of this module the trainee will:

New Facilities
1. Produce a design specification for planned new facilities or services requiring a radiation risk assessment, which includes essential control features.

Facility Safety Assessment
2. Calibrate and test equipment that measures radiation and perform a safety assessment of a radiation facility.

Radiation Safety Audits
3. Undertake a simple audit of an area where radiation is used according to local standard operating procedures.

Optimisation
4. Use the results of patient dose audit to assess and interpret the optimisation of practices.
5. Participate in measurements of image quality and patient dose for the same practice.

Measure Radiation Levels
6. Select and use appropriate instruments and test equipment to measure and record levels and characteristics of radiation.

Contingency Plans
7. Assist in implementing safe and effective working practices in radiation areas, including response to radiation incidents and contingency planning.

Policy and Procedures
8. Critically appraise the content of local rules against legislative requirements for ionising and non-ionising radiation settings.

Radiotherapy Physics (RP)

Learning Outcomes: Associated Work Based Learning

High-level description of the work based learning that accompanies this academic module. Further details of the work based programme can be found in the Work Based Learning Guide, including the Clinical Experiential Learning, Competences and Applied Knowledge and Understanding.

On successful completion of this module the trainee will:

Radiation Protection applied to Radiotherapy
1. Assist with the safe handling and operation of small sealed sources.
2. Undertake a risk assessment and perform a radiation protection room survey.

**Dosimetry and Treatment Equipment**

3. Operate treatment equipment safely (under supervision), selecting and using relevant measurement devices, undertaking basic measurements on the treatment machines.

4. Assist with routine quality control on external beam radiotherapy equipment and evaluate the appropriateness of action/tolerance levels.

**Treatment Planning**

5. Assist with the treatment planning process from immobilisation to the start of treatment, and produce and critically appraise routine MV photon treatment plans.

6. Perform quality assurance checks on treatment planning systems.
## Section 12: MSc Specialist Modules for Imaging with Non-Ionising Radiation

<table>
<thead>
<tr>
<th>Year 3</th>
<th>Module Titles</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specialist</td>
<td>Imaging with Non-Ionising Radiation 2</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Research Project in Imaging with Non-Ionising Radiation</td>
<td>30</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year 2</th>
<th>Module Titles</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specialist</td>
<td>Research Methods</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Imaging with Non-Ionising Radiation 1</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Research Project in Imaging with Non-Ionising Radiation</td>
<td>30</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Module Titles</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Modules</td>
<td>Healthcare Science, Professional Practice and Clinical Leadership integrating science and professional practice</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Introduction to Specialist Medical Physics Underpinning knowledge for rotational elements and integrated professional practice</td>
<td>40</td>
</tr>
</tbody>
</table>

**Legend:**
- **Blue:** Generic Modules: Common to all divisions of healthcare science
- **Yellow:** Division/Theme-Specific Modules: Common to a division or theme
- **Orange:** Specialist Modules: Specific to a specialism
This module provides the trainee with the knowledge that underpins the specialist rotation in Imaging with Non-Ionising Radiation in the second year of the MSc.

**Learning Outcomes: Knowledge and Understanding**

On successful completion of this module the trainee will:

1. Discuss the physical processes behind image formation using non-ionising radiation.
2. Explain the normal and pathological appearances of images and identify common imaging artefacts.
3. Discuss the physical principles and operation of ultrasound and MRI.
4. Explain the factors that affect system performance.
5. Critically appraise the legislation and guidance that ensures safe working.

**Indicative Content**

**Fundamentals**
- Mathematical and physical principles behind the formation of the image
  - MRI
  - Ultrasound including Doppler ultrasound
  - Laser imaging
  - Image registration in multiplanar imaging, including MRI, CT, PET and single photon emission computed tomography (SPECT)
- The physics of electromagnetic and acoustic radiation interactions with matter
- The key parameters that define optimal image quality for a range of clinical/research applications

**Clinical**
- Normal and pathological appearances of MRI and ultrasound images
- Common imaging artefacts
- Results from analyses (e.g. qualitative, quantitative) and the context in which they were acquired

**Technical**
- Detailed understanding of the design principles and operation of MRI
  - Relaxation mechanisms
  - Pulse sequences and image generation
  - Instrumentation
  - The physics of MRI safety issues
• Detailed understanding of the design principles and operation of ultrasound
  o Linear and non-linear propagation
  o Generation and detection – transducers, piezoelectric effect
  o Interactions with tissue – diffraction, reflection, scatter, absorption
  o B-scanner principles – Time Gain Compensation, signal processing, image storage, array types
  o Resolution – focusing
  o Beam steering
  o Doppler imaging
• How to assess system performance and perform comparative evaluations
• Monitoring devices for RF, electric and magnetic fields
• Measurement of ultrasound beams and ultrasound power levels

Non-ionising Radiation
• Sources physical properties, interactions with matter, biological effects, measurement, applications and safety of:
  o UV
  o intense light sources
  o lasers
  o infrared
  o microwaves
  o RF
  o electric and magnetic fields
• The clinical measurements that use non-ionising radiation, for example:
  o red/infrared light to measure O₂ content in blood
  o infrared to measure microvascular circulation
  o UV to measure skin sensitivity
• The relevant guidelines, documents and standard operating procedures for safe practice with regard to the use of non-ionising radiation in the clinical environment
• The EM interactions between implanted devices and the MRI environment
• The safety issues and exposure limitations relevant to different patient groups
• Rationale behind safety standards

Division: Physical Sciences and Biomedical Engineering
Theme: Medical Physics
Specialism: Imaging with Non-Ionising Radiation
Years 2 and 3: Research Project in Imaging with Non-Ionising Radiation [60 credits]

The overall aim of this module, building on the Research Methods module, is for the trainee to undertake a research project that shows originality in the application of knowledge, together with a practical understanding of how established techniques of research and enquiry are used to create and interpret knowledge in a specialism of healthcare science. The research project may span scientific or clinical research, translational research,
operational and policy research, clinical education research, innovation, service development, service improvement, or supporting professional service users to meet the expected learning outcomes. Research projects should be designed to take into account the research training required by individual trainees and the needs of the department in which the research is to be conducted.

**Learning Outcomes: Knowledge and Understanding**

On successful completion of this module the trainee will:

1. Discuss the stages of the research and innovation process from conceptualisation to dissemination and, if appropriate, translation into practice.
2. Describe the purpose and importance of different kinds of research, including scientific or clinical research, translational research, operational and policy research, clinical education research, innovation, service development, service improvement and supporting professional service users, and relate these to the roles undertaken by Clinical Scientists in the trainee’s specialism.
3. Discuss and evaluate the use of reference manager systems.
4. Justify the rationale for research governance and ethical frameworks when undertaking research or innovation in the NHS.
5. Describe the process and requirements for publication in a peer-reviewed journal and the current system of grading research publications.

**Learning Outcomes: Practical Skills**

On successful completion of this module the trainee will:

1. Design, plan and undertake a research project to test a hypothesis from conception to completion/archiving in accordance with ethical and research governance regulations, drawing on expert advice where necessary and involving patients and service users.
2. Analyse the data using appropriate methods and statistical techniques, and interpret, critically discuss and draw conclusions from the data.
3. Prepare a written project that describes and critically evaluates the research project, clearly identifying the strengths and weaknesses.
4. Present a summary of the research project and outcome that conforms to the format of a typical scientific presentation at a national or international scientific meeting, responding to questions appropriately.
5. Prepare a summary of the research project suitable for non-specialist and lay audiences.

**Indicative Content**

- Critical evaluation of the literature/evidence base
- Reference management
- Identification of a research question
- Research ethics and regulatory requirements, including issues related to access and use of information
• Data protection and confidentiality guidelines
• Patient safety
• Patient consent
• Sources of funding/grants
• Peer review/expert advice
• Possible risks and balancing risk vs benefit
• Project management techniques and tools
• Roles and responsibilities of those involved in the research
• Monitoring and reporting
• Data analysis
• Data interpretation
• Criteria/metric for assessing and grading research data and publications in the scientific, NHS and HE sectors
• Range of formats and modes of presentation of data
• Requirements for publications submitted to scientific, education and similar journals
• Current conventions with respect to bibliography and referencing of information

Division: Physical Sciences and Biomedical Engineering
Theme: Medical Physics
Specialism: Imaging with Non-Ionising Radiation
Year 3:
Imaging with Non-Ionising Radiation 2
[30 credits]

This module provides the trainee with the knowledge that underpins the specialist rotation in Imaging with Non-Ionising Radiation in the third year of the MSc.

Learning Outcomes: Knowledge and Understanding

On successful completion of this module the trainee will:

1. Discuss and critically evaluate the use of non-ionising radiation in treatment.
2. Discuss appropriate image analysis/quantification techniques.
3. Participate in the commissioning and quality assurance of MRI and ultrasound equipment.
4. Explain biophotonic techniques and imaging using optical radiation.
5. Discuss and appraise the IT environment in which imaging equipment operates.

Indicative Content

Fundamentals

• MRI
  o specialist methods (e.g. magnetic resonance spectroscopy, perfusion MRI, diffusion MRI, functional MRI) and their clinical applications
  o contrast media
• hyper-polarised imaging
• factors that affect image quality
• development of pulse sequences
• magnetic resonance angiography

Ultrasound
• Doppler – continuous wave, pulsed, colour and power. The Doppler spectrum
• contrast media
• harmonic imaging
• factors that affect image quality

Clinical
• Results from analyses (e.g. qualitative, quantitative) and the context in which they were acquired for MRI and ultrasound imaging
• Limitations of applied acquisition and analysis protocols as this relates to interpretation
• Physiological and pathological processes giving rise to image findings
• The consequences of the result of the procedure to the patient’s overall clinical management, particularly in relation to radiotherapy and radiotherapy treatment planning

Image Display
• Hard copy and soft copy display systems
• External factors affecting image displays
• Quality assurance of image display systems
• Image perception

Treatments using Non-Ionising Radiation
• UV
• Photodynamic therapy
• Ultrasound, including HIFU and lithotripsy
• Calibration and dosimetry
• RF and microwave ablation

Biophotonics and Imaging using Optical Techniques
• Laser Doppler imaging
• Optical coherence tomography
• Raman spectroscopy
• Fourier transform infrared absorption spectroscopy

Technical
• The requirements of equipment for calibration/QA, both generally and specific to each application
• Appropriate methods for data reconstruction, pre-processing (e.g. registration, smoothing) and analysis (e.g. region of interest, curve generation)
• Gated and time sequence imaging
• The commissioning process for new equipment with reference to:
  • MRI
Section 12.1: Specialist Work Based Modules for Imaging with Non-Ionising Radiation

This section contains the work based learning outcomes for this Scientist Training Programmes in Medical Physics, further details can be found in the accompanying Work Based Learning Guides.

<table>
<thead>
<tr>
<th>Module 1 (INIR1)</th>
<th>Ultrasound Imaging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module 2 (INIR2)</td>
<td>Magnetic Resonance Imaging</td>
</tr>
<tr>
<td>Module 3 (INIR4)</td>
<td>Exposure Measurement</td>
</tr>
<tr>
<td>Module 4 (INIR5)</td>
<td>Risk, Safety and Bioeffects</td>
</tr>
<tr>
<td>Module 5 (INIR6)</td>
<td>Diagnostic Equipment Performance</td>
</tr>
<tr>
<td>Module 6 (INIR7)</td>
<td>Emerging Technology</td>
</tr>
<tr>
<td>Module 7 (INIR8)</td>
<td>Information and Communication Technology</td>
</tr>
</tbody>
</table>

Ultrasound Imaging (INIR1)

Learning Outcomes: Associated Work Based Learning

High-level description of the work based learning that accompanies this academic module. Further details of the work based programme can be found in the Work Based Learning Guide, including the Clinical Experiential Learning, Competences and Applied Knowledge and Understanding.

On successful completion of this module the trainee will:

1. Operate a range of ultrasound (US) imaging equipment for quality assurance purposes.
2. Advise on equipment choice and user-selectable options, including advanced functions such as harmonic, intracavity and elastography imaging.
3. Analyse images to extract quantitative information and increase diagnostic utility.
4. Provide a scientific contribution to the interpretation and reporting of images through explaining the scientific principles that underpin image acquisition.

**Magnetic Resonance Imaging (INIR2)**

**Learning Outcomes: Associated Work Based Learning**

High-level description of the work based learning that accompanies this academic module. Further details of the work based programme can be found in the Work Based Learning Guide, including the Clinical Experiential Learning, Competences and Applied Knowledge and Understanding.

On successful completion of this module the trainee will:

1. Explain the principles of the major pulse sequences in clinical use.
2. Optimise a range of magnetic resonance imaging (MRI) protocols.
3. Safely and effectively use MRI equipment to obtain images from test objects.
4. Use image analysis software to extract quantitative information from MR images/spectra.
5. Appraise the key issues for a range of advanced/specialist MR examinations in use at the training centre.

**Exposure Measurement (INIR4)**

**Learning Outcomes: Associated Work Based Learning**

High-level description of the work based learning that accompanies this academic module. Further details of the work based programme can be found in the Work Based Learning Guide, including the Clinical Experiential Learning, Competences and Applied Knowledge and Understanding.

On successful completion of this module the trainee will:

2. MR/US: design measurement schemes to reduce uncertainty.
3. Advise colleagues and other professionals on exposure levels and safe working practice.

**Risk, Safety and Bioeffects (INIR5)**

**Learning Outcomes: Associated Work Based Learning**

High-level description of the work based learning that accompanies this academic module. Further details of the work based programme can be found in the Work Based Learning Guide, including the Clinical Experiential Learning, Competences and Applied Knowledge and Understanding.
On successful completion of this module the trainee will:

1. Perform risk assessment of non-ionising radiation facilities.
2. Provide recommendations and advise on safety relating to use of non-ionising radiation facilities.

Diagnostic Equipment Performance (INIR6)

Learning Outcomes: Associated Work Based Learning

High-level description of the work based learning that accompanies this academic module. Further details of the work based programme can be found in the Work Based Learning Guide, including the Clinical Experiential Learning, Competences and Applied Knowledge and Understanding.

On successful completion of this module the trainee will:

1. Perform, evaluate and report on acceptance testing and routine quality control of a non-ionising imaging system; where possible on a range of equipment.
2. Investigate and report on poor performance of non-ionising equipment.
3. Assess and evaluate equipment performance and compare with the manufacturer’s specifications.

Emerging Technologies (INIR7)

Learning Outcomes: Associated Work Based Learning

High-level description of the work based learning that accompanies this academic module. Further details of the work based programme can be found in the Work Based Learning Guide, including the Clinical Experiential Learning, Competences and Applied Knowledge and Understanding.

On successful completion of this module the trainee will:

1. MR/US: appraise the key issues of an emerging technique/technology.
3. MR/US: apply safety and clinical governance criteria to the evaluation of an emerging technique/technology.
3. MR/US: design a study to evaluate the impact of the emerging technique/technology on the clinical practice at the training centre.

Information and Communication Technology (INIR8)

Learning Outcomes: Associated Work Based Learning
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>High-level description of the work based learning that accompanies this academic module. Further details of the work based programme can be found in the Work Based Learning Guide, including the Clinical Experiential Learning, Competences and Applied Knowledge and Understanding.</td>
<td></td>
</tr>
<tr>
<td>On successful completion of this module the trainee will:</td>
<td></td>
</tr>
<tr>
<td>1. MR/US: employ appropriate ICT skills in order to understand the structure of a DICOM image and consequently anonymisation of data sets for data transfer.</td>
<td></td>
</tr>
<tr>
<td>2. MR/US: employ appropriate ICT skills to develop an in-house software-based project; this could include pulse sequence development (if trained) or an image analysis task.</td>
<td></td>
</tr>
</tbody>
</table>
# Section 13: MSc Specialist Modules for Imaging with Ionising Radiation

<table>
<thead>
<tr>
<th>Year</th>
<th>Module Titles</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Year 3</strong></td>
<td></td>
</tr>
<tr>
<td>Specialist</td>
<td>Imaging with Ionising Radiation 2</td>
</tr>
<tr>
<td></td>
<td>Research Project in Imaging with Ionising Radiation</td>
</tr>
<tr>
<td></td>
<td>![30]</td>
</tr>
<tr>
<td><strong>Year 2</strong></td>
<td></td>
</tr>
<tr>
<td>Specialist</td>
<td>Research Methods</td>
</tr>
<tr>
<td></td>
<td>Imaging with Ionising Radiation 1</td>
</tr>
<tr>
<td></td>
<td>Research Project in Imaging with Ionising Radiation</td>
</tr>
<tr>
<td></td>
<td>![10] ![20] ![30]</td>
</tr>
<tr>
<td><strong>Year 1</strong></td>
<td></td>
</tr>
<tr>
<td>Core Modules</td>
<td>Healthcare Science, Professional Practice and Clinical Leadership</td>
</tr>
<tr>
<td></td>
<td>integrating science and professional practice</td>
</tr>
<tr>
<td></td>
<td>Introduction to Specialist Medical Physics</td>
</tr>
<tr>
<td></td>
<td>Underpinning knowledge for rotational elements and integrated professional practice</td>
</tr>
<tr>
<td></td>
<td>![20] ![40]</td>
</tr>
</tbody>
</table>

**Legend:**
- **Blue**: Generic Modules: Common to all divisions of Healthcare Science
- **Light Yellow**: Division/Theme-Specific Modules: Common to a division or theme
- **Orange**: Specialist Modules: Specific to a specialism
This module provides the trainee with the knowledge that underpins the specialist rotation in Imaging with Ionising Radiation in the second year of the MSc.

**Learning Outcomes: Knowledge and Understanding**

On successful completion of this module the trainee will:

1. Discuss the physical processes behind image formation in nuclear medicine and diagnostic radiology.
2. Describe the normal and pathological appearances of images and identify common imaging artefacts.
3. Discuss the physical principles and operation of radiographic and nuclear medicine equipment.
4. Explain and appraise the factors that affect system performance.
5. Critically appraise the legislation and guidance that ensures safe working in the radiation environment.

**Indicative Content**

**Fundamentals**

- Principles of tracer kinetic method, pharmacokinetics and the use of radiopharmaceuticals as physiological markers and therapeutic agents
- Mathematical and physical principles behind the formation of the image:
  - radiographic image
  - nuclear medicine
  - multiplanar imaging CT/SPECT/PET
  - Dual-energy X-ray absorptiometry (DEXA)
  - imaging with non-ionising radiation
- The physics of radiation interactions with matter in diagnostic radiology and nuclear medicine
- The key parameters that define optimal image quality for a range of clinical/research applications
- Radiation protection for diagnostic X-rays and nuclear medicine, including:
  - biological effects
  - protection quantity and units
  - risk factors and dose limits
  - risk-benefit, cost benefit analysis
  - As Low As Reasonably Achievable (ALARA), as low as reasonably practicable (ALARP)
  - radiation working areas
  - protection instrumentation
    - engineering controls
deal with radiation incidents and incident reporting
radiation risk and explanation/communication of risk to patients, staff and members of the public

Clinical
- Normal and pathological appearances of nuclear medicine and radiographic images
- Common imaging artefacts (pathological, patient-related, technical and system-related)
- Results from analyses (e.g. qualitative, quantitative) and the context in which they were acquired

Technical
- Design principles and operation of nuclear medicine imaging equipment
- Design principles and operation of radiographic imaging equipment
- Routine quality assurance, assess system performance and perform comparative evaluations
- Dosemeter and contamination monitors for use in diagnostic radiology and nuclear medicine

Legislation and Guidance
- Ionising Radiations Regulations 1999, Ionising Radiations (Medical Exposure) Regulations 2000
- Environmental Permitting Regulations 2010, High Activity Sealed Sources (HASS) Regulations 2006 and other relevant Health and Safety Regulations
- Ionising Radiation (Medical Exposure) Regulations 2000
- Other relevant legislation
- Awareness of other key documents (e.g. ARSAC/MARS, MHRA/GMP, GCP/GLP, etc.) national and local SOPs, policies and procedures

Division: Physical Sciences and Biomedical Engineering
Theme: Medical Physics
Specialism: Radiotherapy Physics
Years 2 and 3:
Research Project in Imaging with Ionising Radiation
[60 credits]

The overall aim of this module, building on the Research Methods module is for the trainee to undertake a research project that shows originality in the application of knowledge, together with a practical understanding of how established techniques of research and enquiry are used to create and interpret knowledge in a specialism of healthcare science. The research project may span scientific or clinical research, translational research, operational and policy research, clinical education research, innovation, service development, service improvement, or supporting professional service users to meet the expected learning outcomes. Research projects should be designed to take into account the research training required by individual
trainees and the needs of the department in which the research is to be conducted.

**Learning Outcomes: Knowledge and Understanding**

On successful completion of this module the trainee will:

1. Discuss the stages of the research and innovation process from conceptualisation to dissemination and, if appropriate translation, into practice.
2. Describe the purpose and importance of different kinds of research, including scientific or clinical research, translational research, operational and policy research, clinical education research, innovation, service development, service improvement and supporting professional service users, and relate these to the roles undertaken by Clinical Scientists in the trainee’s specialism.
3. Discuss and evaluate the use of reference manager systems.
4. Justify the rationale for research governance and ethical frameworks when undertaking research or innovation in the NHS.
5. Describe the process and requirements for publication in a peer-reviewed journal and the current system of grading research publications.

**Learning Outcomes: Practical Skills**

On successful completion of this module the trainee will:

1. Design, plan and undertake a research project to test a hypothesis from conception to completion/archiving in accordance with ethical and research governance regulations, drawing on expert advice where necessary and involving patients and service users.
2. Analyse the data using appropriate methods and statistical techniques and interpret, critically discuss and draw conclusions from the data.
3. Prepare a written project that describes and critically evaluates the research project, clearly identifying the strengths and weaknesses.
4. Present a summary of the research project and outcome that conforms to the format of a typical scientific presentation at a national or international scientific meeting, responding to questions appropriately.
5. Prepare a summary of the research project suitable for non-specialist and lay audiences.

**Indicative Content**

- Critical evaluation of the literature/evidence base
- Reference management
- Identification of a research question
- Research ethics and regulatory requirements, including issues related to access and use of information
- Data protection and confidentiality guidelines
- Patient safety
- Patient consent
- Sources of funding/grants
• Peer review/expert advice
• Possible risks and balancing risk vs benefit
• Project management techniques and tools
• Roles and responsibilities of those involved in the research
• Monitoring and reporting
• Data analysis
• Data interpretation
• Criteria/metric for assessing and grading research data and publications in the scientific, NHS and HE sectors
• Range of formats and modes of presentation of data
• Requirements for publications submitted to scientific, education and similar journals
• Current conventions in respect of bibliography and referencing of information

Division: Physical Sciences and Biomedical Engineering
Theme: Medical Physics
Specialism: Imaging with Ionising Radiation
Year 3:
Imaging with Ionising Radiation 2
[30 credits]

This module provides the trainee with the knowledge that underpins the specialist rotation in Imaging with Ionising Radiation in the third year of the MSc.

Learning Outcomes: Knowledge and Understanding

On successful completion of this module the trainee will:

1. Explain and evaluate the processes behind the safe production of radiopharmaceuticals.
2. Discuss and evaluate a range of non-imaging nuclear medicine studies.
3. Discuss appropriate image analysis/quantification techniques.
4. Design safe radiation environments that meet the requirements of legislation and guidance.
5. Describe the delivery of unsealed source therapy.
6. Discuss and critically appraise the commissioning and quality assurance of radiographic and nuclear medicine equipment.
7. Describe and critically appraise the IT environment in which radiographic and nuclear medicine equipment operates.

Indicative Content

Radiopharmacy Manufacture and Production
• Production of radiopharmaceuticals, including PET
• Principles and operation of cyclotrons and automated radiochemistry for PET
• Radiopharmaceutical practice
• Internal dosimetry of radiopharmaceuticals, including practical methods of calculating radiation dose to patients and staff in emergency situations
• Non-imaging nuclear medicine techniques

Clinical
• Results from analyses (e.g. qualitative, quantitative) and the context in which they were acquired for nuclear medicine and complex diagnostic radiology techniques
• Limitations of applied acquisition and analysis protocols as this relates to interpretation
• Physiological and pathological processes giving rise to image findings
• The consequences of the result of the procedure to the patient's overall clinical management, particularly in relation to radiotherapy and radiotherapy treatment planning

Image Display
• Hard copy and soft copy display systems
• External factors affecting image displays
• Quality assurance of image display systems
• Image perception

Radiation Protection Specific to Diagnostic Facilities
• Measurement and calculation of patient doses
• Optimisation
• Design of facilities
• Shielding calculations
• Cyclotrons and radionuclide production facilities
• Environmental monitoring
• Population exposures
• Radioactive source transport and waste disposal
• Accident procedures and emergency planning

Unsealed Source Treatments
• The scientific basis and radiobiology of the use of radioactive materials for radiotherapy
• Unsealed source treatments, including preparation, administration, protection arrangements and decontamination
• Uptake, planning and dosimetric calculations

Technical
• The requirements of equipment for calibration/QA, both generally and specific to each application
• Appropriate methods for data reconstruction, pre-processing (e.g. registration, smoothing) and analysis (e.g. region of interest, curve generation)
• Imaging techniques in radiotherapy (portal imaging, megavoltage imaging, cone beam CT and simulation
• Gated and time sequence imaging
• The commissioning process for new equipment with reference to:
  o gamma cameras, including SPECT/CT
  o PET/CT
  o diagnostic radiology equipment
  o the critical examination
• IT and networking
  o nuclear medicine workstations
  o image analysis software
  o PACS
  o specialist patient management systems, e.g. cardiology systems
  o networking and the network environment
  o system management, configuration control and software release
  o interoperability, DICOM RT, HL7 and messaging standards
  o links to hospital administration systems
  o legislative framework for IT, data protection
  o regulatory standards including IEC601 and the Medical Devices Directive as applied to software

Section 13.1: Specialist Work Based Modules for Imaging With Ionising Radiation

This section contains the work based learning outcomes for this Scientist Training Programme in Medical Physics, further details can be found in the accompanying Work Based Learning Guides.

<table>
<thead>
<tr>
<th>Module 1 (IIR1)</th>
<th>Radionuclide Imaging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module 2 (IIR2)</td>
<td>Non-Imaging Radionuclide Tests</td>
</tr>
<tr>
<td>Module 3 (IIR3)</td>
<td>Radionuclide Therapy</td>
</tr>
<tr>
<td>Module 4 (IIR4)</td>
<td>Radiopharmacy</td>
</tr>
<tr>
<td>Module 5 (IIR5)</td>
<td>Radiation Protection</td>
</tr>
<tr>
<td>Module 6 (IIR6)</td>
<td>Diagnostic Radiology: Equipment Performance</td>
</tr>
<tr>
<td>Module 7 (IIR7)</td>
<td>Diagnostic Radiology: Image Optimisation and Patient Dose Measurement</td>
</tr>
<tr>
<td>Module 8 (IIR8)</td>
<td>Information and Communication Technology</td>
</tr>
</tbody>
</table>

**Radionuclide Imaging (IIR1)**

**Learning Outcomes: Associated Work Based Learning**

High-level description of the work based learning that accompanies this academic module. Further details of the work based programme can be found in the Work Based Learning Guide, including the Clinical Experiential Learning, Competences and Applied Knowledge and Understanding.

On successful completion of this module the trainee will:
1. Perform and interpret measurements on imaging equipment, including gamma cameras, **single-photon emission computed tomography (SPECT/CT)** scanners and **positron emission tomography (PET)/computed tomography (CT)** scanners, advising on the acceptability of their clinical use in a range of contexts.

2. Advise on the acquisition and processing of clinical planar, SPECT and PET images.

3. Analyse images to extract quantitative information and increase diagnostic utility.

4. Contribute to the clinical interpretation and reporting of images.

**Non-Imaging Radionuclide Tests (IIR2)**

**Learning Outcomes: Associated Work Based Learning**

High-level description of the work based learning that accompanies this academic module. Further details of the work based programme can be found in the Work Based Learning Guide, including the Clinical Experiential Learning, Competences and Applied Knowledge and Understanding.

On successful completion of this module the trainee will:

1. Perform and interpret measurements on equipment for non-imaging diagnostic tests, for example uncollimated gamma cameras, intra-operative gamma probes, uptake counters, gamma spectrometers, manual and automatic beta and gamma sample counters, and whole body counters. This should include associated equipment such as balances, centrifuges and pipettes.

2. Ensure that all equipment used is calibrated and fit for purpose.

3. Advise on the acquisition and processing of data, including set-up and calibration of equipment.

4. Contribute to the analysis and clinical interpretation and reporting of results.

**Radionuclide Therapy (IIR3)**

**Learning Outcomes: Associated Work Based Learning**

High-level description of the work based learning that accompanies this academic module. Further details of the work based programme can be found in the Work Based Learning Guide, including the Clinical Experiential Learning, Competences and Applied Knowledge and Understanding.

On successful completion of this module the trainee will:

1. Advise on the choice of radiopharmaceutical for radionuclide therapy in terms of the physical properties of the radionuclide, the physiological properties of the radiopharmaceutical and the clinical context of the procedure.
2. Advise on and perform practical aspects of the administration of radionuclide therapy to patients.
3. Specify, and explain to the patient, the post-therapy behavioural restrictions placed on them.
4. Specify the facilities required for radionuclide therapy.
5. Implement and advise on the principles of management of radiation safety associated with radionuclide therapy administrations and patients.
6. Undertake practical radiation safety tasks required to deliver a service, including the effective communication of risk, decontamination procedures and radioactive waste management.
7. Specify and perform the radiation monitoring of inpatients to determine their point of release.
8. Implement the principles of internal radiation dosimetry, patient-specific dosimetry protocols and their requirements for data acquisition and analysis.

Radiopharmacy (IIR4)

Learning Outcomes: Associated Work Based Learning

High-level description of the work based learning that accompanies this academic module. Further details of the work based programme can be found in the Work Based Learning Guide, including the Clinical Experiential Learning, Competences and Applied Knowledge and Understanding.

On successful completion of this module the trainee will:

1. Obtain a detailed knowledge of the quality system used in radiopharmaceutical production, including production facilities and radiopharmaceutical quality control.
2. Advise on best practice in the use of a radionuclide calibrator.
3. Apply radiation safety practice and regulatory compliance in the context of a radiopharmacy.

Radiation Protection (IIR5)

Learning Outcomes: Associated Work Based Learning

High-level description of the work based learning that accompanies this academic module. Further details of the work based programme can be found in the Work Based Learning Guide, including the Clinical Experiential Learning, Competences and Applied Knowledge and Understanding.

On successful completion of this module the trainee will:

1. Understand the hierarchy of control measures available to ensure safe practice in a diagnostic imaging room and in the safe handling of sealed and unsealed radioactive sources.
2. Calculate estimated absorbed, equivalent and effective doses to patients, and effective doses to staff and members of the public for diagnostic X-ray and radionuclide procedures.
3. Specify the theoretical and practical requirement involved in room design for diagnostic imaging facilities.
4. Compare and contrast the radiation safety requirements for diagnostic X-ray imaging, nuclear medicine imaging and radionuclide therapy.
5. Advise patients, colleagues and other professionals on radiation safety issues.
6. Deal with radiation incidents.

Diagnostic Radiology: Equipment Performance (IIR6)

Learning Outcomes: Associated Work Based Learning

High-level description of the work based learning that accompanies this academic module. Further details of the work based programme can be found in the Work Based Learning Guide, including the Clinical Experiential Learning, Competences and Applied Knowledge and Understanding.

On successful completion of this module the trainee will:

1. Measure and record levels and characteristics of radiation.
2. Calibrate and test equipment that measures radiation.
3. Perform measurements appropriate to safety testing, commissioning and periodic routine testing of a wide range of diagnostic systems.
4. Devise an appropriate test schedule for safety testing, commissioning and routine testing for a diagnostic imaging system new to the trainee.
5. Devise and undertake the specification and evaluation of new diagnostic systems.

Diagnostic Radiology: Image Optimisation and Patient Dose Measurement (IIR7)

Learning Outcomes: Associated Work Based Learning

High-level description of the work based learning that accompanies this academic module. Further details of the work based programme can be found in the Work Based Learning Guide, including the Clinical Experiential Learning, Competences and Applied Knowledge and Understanding.

On successful completion of this module the trainee will:

1. Perform measurements to assess image quality in various types of equipment, to include computer radiography, digital radiography, CT and image intensifier systems.
2. Perform appropriate measurements and/or calculations to assess patient dose for a range of examinations, which must include examples from radiographic, fluoroscopic, CT and mammographic examinations.
3. Analyse patient dose measurements and, in the context of optimisation, draw conclusions.
4. Assess, by simulation and/or measurement, patient dose reduction interventions.
5. Calculate organ dose and effective dose, relate dose to risk and effectively communicate the risk.

**Information and Communication Technology (IIR8)**

**Learning Outcomes: Associated Work Based Learning**

High-level description of the work based learning that accompanies this academic module. Further details of the work based programme can be found in the Work Based Learning Guide, including the Clinical Experiential Learning, Competences and Applied Knowledge and Understanding.

On successful completion of this module the trainee will:

1. Comply with the information governance and operational management requirements for clinical systems.
2. Identify the ICT infrastructure requirements for a diagnostic imaging service, including networking, data storage and interconnectivity.
3. Develop, validate and verify novel image processing applications in diagnostic imaging.
## Section 14: MSc Specialist Modules for Radiation Safety Physics

<table>
<thead>
<tr>
<th>Year</th>
<th>Module Titles</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Year 3</strong></td>
<td>Radiation Safety 2</td>
<td>[30]</td>
</tr>
<tr>
<td>Specialist</td>
<td>Research Project in Radiation Safety Physics</td>
<td>[30]</td>
</tr>
<tr>
<td><strong>Year 2</strong></td>
<td>Research Methods</td>
<td>[10]</td>
</tr>
<tr>
<td>Specialist</td>
<td>Radiation Safety 1</td>
<td>[20]</td>
</tr>
<tr>
<td></td>
<td>Research Project in Radiation Safety Physics</td>
<td>[30]</td>
</tr>
<tr>
<td><strong>Year 1</strong></td>
<td>Healthcare Science, Professional Practice and Clinical Leadership integrating science and professional practice</td>
<td>[20]</td>
</tr>
<tr>
<td>Core Modules</td>
<td>Introduction to Specialist Medical Physics Underpinning knowledge for rotational elements and integrated professional practice</td>
<td>[40]</td>
</tr>
</tbody>
</table>

- **Generic Modules:** Common to all divisions of healthcare science
- **Division/Theme-Specific Modules:** Common to a division or theme
- **Specialist Modules:** Specific to a specialism
Learning Outcomes: Knowledge and Understanding

On successful completion of this module the trainee will:

1. Critically appraise the legislation and guidance that applies to ionising radiation safety.
2. Discuss the physical processes behind image formation in diagnostic radiology.
3. Explain the normal and pathological appearances of images and identify common imaging artefacts.
4. Discuss the physical principles and operation of radiographic equipment.
5. Explain the factors that affect system performance.
6. Explain the principles of operational radiation protection.

Indicative Content

Fundamentals

- Mathematical and physical principles behind the formation of the image:
  - radiographic images (film, CR, DR, fluoroscopy)
  - transaxial imaging CT
  - mammography
- The physics of radiation interactions with matter in diagnostic radiology
- The key parameters that define optimal image quality for a range of clinical/research applications

Legislation and Guidance

- Quantities and units (including dosimetry underlying regulatory quantities)
- Basis of radiation protection standards (e.g. epidemiology, linear hypothesis for stochastic effects, deterministic effects)
- International Commission on Radiological Protection (ICRP) principles:
  - justification
  - optimisation
  - dose limitation
- Practices and interventions (including natural radiation, especially radon)
- Legal and regulatory basis:
  - international recommendations/conventions
  - European Union legislation
  - Ionising Radiations Regulations 1999
  - Ionising Radiations (Medical Exposure) Regulations 2000
  - Approved Code of Practice and Guidance Notes
Environmental Permitting Regulations 2010, High Activity Sealed Sources (HASS) Regulations 2006 and other relevant Health and Safety Regulations. NaTsCo security requirements

Ionising Radiation (Medical Exposure) Regulations 2000, Amended 2006

The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2004

Exemption Orders

other relevant legislation

detailed knowledge and understanding of other key documents (ARSAC/MARS, MHRA/GMP, GCP/GLP, etc.), national and local SOPs, policies and procedures

competent authorities

Operational Radiation Protection

- Types of sources (sealed, unsealed, X-ray units, accelerators)
- Hazard and risk assessment (including environmental impact)
- Minimisation of risk
- Control of releases
- Monitoring: area, personal dosimetry (external, real time and internal), biological
- Critical dose concept/dose calculation for critical group
- Ergonomics (e.g. user-friendly design and layout of instrumentation)
- Operating rules and contingency planning
- Emergency procedures
- Remedial action/decontamination
- Dealing with radiation incidents and incident reporting
- Analysis of past incidents, including experience feedback
- Record keeping
- Security
- Accumulation of waste
- Wipe testing
- Instrumentation and limitations

Clinical

- The appearance of the radiographic image
- Common imaging artefacts
- Results from analyses (e.g. qualitative, quantitative) and the context in which they were acquired
- Radiation risk and communication of that risk to patients, staff and members of the public

Technical

- Design principles and operation of radiographic imaging equipment
- Assessment of system performance and perform comparative evaluations
- Quality assurance and quality control
- Dosemeters and contamination monitors, equipment for measuring patient dose
• Radiation protection for diagnostic X-rays, radiotherapy and nuclear medicine, including:
  o biological effects
  o protection quantity and units
  o risk factors and dose limits
  o risk-benefit, cost benefit analysis
  o ALARA, ALARP
  o radiation working areas
  o protection instrumentation
  o engineering control

**Division:** Physical Sciences and Biomedical Engineering  
**Theme:** Medical Physics  
**Specialism:** Radiation Safety Physics  
**Years 2 and 3:** Research Project in Radiation Safety Physics  
**[60 credits]**

The overall aim of this module, building on the Research Methods module, is for the trainee to undertake a research project that shows originality in the application of knowledge, together with a practical understanding of how established techniques of research and enquiry are used to create and interpret knowledge in a specialism of healthcare science. The research project may span scientific or clinical research, translational research, operational and policy research, clinical education research, innovation, service development, service improvement, or supporting professional service users to meet the expected learning outcomes. Research projects should be designed to take into account the research training required by individual trainees and the needs of the department in which the research is to be conducted.

**Learning Outcomes: Knowledge and Understanding**

On successful completion of this module the trainee will:

1. Discuss the stages of the research and innovation process from conceptualisation to dissemination and, if appropriate, translation into practice.
2. Describe the purpose and importance of different kinds of research, including scientific or clinical research, translational research, operational and policy research, clinical education research, innovation, service development, service improvement and supporting professional service users, and relate these to the roles undertaken by Clinical Scientists in the trainee’s specialism.
3. Discuss and evaluate the use of reference manager systems.
4. Justify the rationale for research governance and ethical frameworks when undertaking research or innovation in the NHS.
5. Describe the process and requirements for publication in a peer-reviewed journal and the current system of grading research publications.
Learning Outcomes: Practical Skills

On successful completion of this module the trainee will:

1. Design, plan and undertake a research project to test a hypothesis from conception to completion/archiving in accordance with ethical and research governance regulations, drawing on expert advice where necessary and involving patients and service users.
2. Analyse the data using appropriate methods and statistical techniques, and interpret, critically discuss and draw conclusions from the data.
3. Prepare a written project that describes and critically evaluates the research project, clearly identifying the strengths and weaknesses.
4. Present a summary of the research project and outcome that conforms to the format of a typical scientific presentation at a national or international scientific meeting, responding to questions appropriately.
5. Prepare a summary of the research project suitable for non-specialist and lay audiences.

Indicative Content
- Critical evaluation of the literature/evidence base
- Reference management
- Identification of a research question
- Research ethics and regulatory requirements, including issues related to access and use of information
- Data protection and confidentiality guidelines
- Patient safety
- Patient consent
- Sources of funding/grants
- Peer review/expert advice
- Possible risks and balancing risk vs benefit
- Project management techniques and tools
- Roles and responsibilities of those involved in the research
- Monitoring and reporting
- Data analysis
- Data interpretation
- Criteria/metric for assessing and grading research data and publications in the scientific, NHS and HE sectors
- Range of formats and modes of presentation of data
- Requirements for publications submitted to scientific, education and similar journals
- Current conventions with respect to bibliography and referencing of information

Division: Physical Sciences and Biomedical Engineering
Theme: Medical Physics
Specialism: Radiation Safety Physics
Year 3: Radiation Safety 2
[30 credits]
This module provides the trainee with the knowledge that underpins the specialist rotation in Radiation Safety in the third year of the MSc.

**Learning Outcomes: Knowledge and Understanding**

On successful completion of this module the trainee will:

1. Discuss the role of the radiation safety expert and the importance of safety culture.
2. Explain the physical principles and safe use of non-ionising radiations used in healthcare.
3. Design radiation facilities.
4. Undertake optimisation of radiographic techniques.
5. Discuss and evaluate the IT environment in radiation departments, including issues around interconnectivity of systems.
6. Explain image display systems and their optimisation.

**Section 14.1: Specialist Work Based Modules for Radiation Safety Physics**

This section contains the work based learning outcomes for this Scientist Training Programmes in Medical Physics, further details can be found in the accompanying Work Based Learning Guides.

<table>
<thead>
<tr>
<th>Module 1 (RADS1)</th>
<th>Risk Assessment and New Facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module 2 (RADS2)</td>
<td>Diagnostic Radiology: Equipment Performance</td>
</tr>
<tr>
<td>Module 3 (RADS3)</td>
<td>Patient Dose Assessment and Optimisation</td>
</tr>
<tr>
<td>Module 4 (RADS4)</td>
<td>Laser and Ultraviolet Equipment</td>
</tr>
<tr>
<td>Module 5 (RADS5)</td>
<td>Non-Ionising Sources: Radiation Risks, Safety and Bioeffects</td>
</tr>
<tr>
<td>Module 6 (RADS8)</td>
<td>Assess, Audit and Interpret Radiation Dose Monitoring</td>
</tr>
<tr>
<td>Module 7 (RADS7)</td>
<td>Radiation Governance Framework</td>
</tr>
<tr>
<td>Module 8 (RADS11)</td>
<td>Information and Communication Technology</td>
</tr>
</tbody>
</table>

**Risk Assessment and New Facilities (RADS1)**

**Learning Outcomes: Associated Work Based Learning**

High-level description of the work based learning that accompanies this academic module. Further details of the work based programme can be found in the Work Based Learning Guide, including the Clinical Experiential Learning, Competences and Applied Knowledge and Understanding.

On successful completion of this module the trainee will:
1. Assess risks associated with planned new facilities or services involving radiation.
2. Specify design features for new facilities or services involving the use of radiation.
3. Specify radiation protection and control features required for new facilities involving the use of radiation.
4. Develop local rules and contingency plans in conjunction with the radiation user for a new installation.

### Diagnostic Radiology: Equipment Performance (RADS2)

**Learning Outcomes: Associated Work Based Learning**

High-level description of the work based learning that accompanies this academic module. Further details of the work based programme can be found in the Work Based Learning Guide, including the Clinical Experiential Learning, Competences and Applied Knowledge and Understanding.

On successful completion of this module the trainee will:

1. Measure and record levels and characteristics of radiation.
2. Calibrate and test equipment that measures radiation.
3. Perform measurements appropriate to safety testing, commissioning and periodic routine testing of a wide range of diagnostic systems.
4. Devise an appropriate test schedule for safety testing, commissioning and routine testing for a diagnostic imaging system new to the trainee.
5. Devise and undertake the specification and evaluation of new diagnostic systems.

### Patient Dose Assessment and Optimisation (RADS3)

**Learning Outcomes: Associated Work Based Learning**

High-level description of the work based learning that accompanies this academic module. Further details of the work based programme can be found in the Work Based Learning Guide, including the Clinical Experiential Learning, Competences and Applied Knowledge and Understanding.

On successful completion of this module the trainee will:

1. Audit patient doses for a range of examinations.
2. Undertake an assessment of patient dose and image quality in a complex imaging system and propose optimisation strategies.
3. Perform appropriate measurements and/or calculations to assess patient dose for a range of examinations, which must include examples from radiographic, fluoroscopic, computed tomography and mammographic examinations.
4. Analyse patient dose measurements and, in the context of optimisation, draw conclusions.
5. Assess, by simulation and/or measurement, patient dose reduction interventions.
6. Calculate organ dose and effective dose, relate dose to risk and effectively communicate the risk.

---

**Laser and Ultraviolet Equipment (RADS4)**

**Learning Outcomes: Associated Work Based Learning**

High-level description of the work based learning that accompanies this academic module. Further details of the work based programme can be found in the Work Based Learning Guide, including the Clinical Experiential Learning, Competences and Applied Knowledge and Understanding.

On successful completion of this module the trainee will:

1. Identify an appropriate monitor that has a suitable sensitivity, range of use and in-date calibration.
2. Perform experiments to reduce uncertainty.
3. Provide recommendations on non-ionising radiation use based on measured output and published recommendations.
4. Interpret the readings of monitors and detectors.

---

**Non-Ionising Sources: Radiation Risks, Safety and Bioeffects (RADS5)**

**Learning Outcomes: Associated Work Based Learning**

High-level description of the work based learning that accompanies this academic module. Further details of the work based programme can be found in the Work Based Learning Guide, including the Clinical Experiential Learning, Competences and Applied Knowledge and Understanding.

On successful completion of this module the trainee will:

1. Undertake non-ionising radiation risk assessment, demonstrating an understanding of the control measures available to ensure safe practice.
2. Provide safety information to staff, patients and their carers.
3. Calculate estimated exposures to patients and staff.
4. Undertake a room risk assessment for a non-ionising radiation facility.
5. Explain modality-specific risks and the relevant exposure limits.

---

**Assess, Audit and Interpret Radiation Dose Monitoring (RADS8)**

**Learning Outcomes: Associated Work Based Learning**

High-level description of the work based learning that accompanies this academic module. Further details of the work based programme can be found
in the Work Based Learning Guide, including the Clinical Experiential Learning, Competences and Applied Knowledge and Understanding.

On successful completion of this module the trainee will:

1. Audit and interpret environmental radiation monitoring results.
2. Audit and interpret staff dosimetry and workplace monitoring results.
3. Undertake radiological impact assessments
4. Assess radiation doses to members of the public.

### Radiation Governance Framework (RADS7)

**Learning Outcomes: Associated Work Based Learning**

High-level description of the work based learning that accompanies this academic module. Further details of the work based programme can be found in the Work Based Learning Guide, including the Clinical Experiential Learning, Competences and Applied Knowledge and Understanding.

On successful completion of this module the trainee will:

1. Develop organisational policies for radiation protection.
2. Develop procedures for management and control of radioactive substances.
3. Develop procedures for control of equipment generating radiation and of the radiation emitted.
4. Audit areas where radiation is used.
5. Participate in the response to radiation incidents and emergencies.

### Information and Communication Technology (RADS11)

**Learning Outcomes: Associated Work Based Learning**

High-level description of the work based learning that accompanies this academic module. Further details of the work based programme can be found in the Work Based Learning Guide, including the Clinical Experiential Learning, Competences and Applied Knowledge and Understanding.

On successful completion of this module the trainee will:

1. Comply with the information governance and operational management requirements for clinical systems.
2. Identify the ICT infrastructure requirements for services using ionising radiation, including networking, data storage and interconnectivity.
3. Develop, validate and/or verify a novel radiation safety application.

**Indicative Content**

**Organisation of Radiation Protection**
• Role of qualified experts (e.g. medical physics expert, radiation protection advisor)
• Safety culture (importance of human behaviour)
• Communication skills (skills and ability to instil safety culture into others)
• Record keeping (sources, doses, unusual occurrences, etc.)
• Permits to work and other authorisations
• Designation of areas and classification of workers
• Quality control/auditing
• Dealing with contractors
• Cooperation between employers
• Patient-related issues; release of radioactive patients
• ALARP re patient safety
• Justification, optimisation, limits
• Overexposure of patients and staff
• Working safely within the range of radiation environments encountered in healthcare
• Practitioner, operator and referrer training and duties

Radioactive Materials
• Registration and authorisation of sealed and unsealed sources
• Releases to the environment
• Environmental impact assessment
• Best practical means
• Waste management:
  o principles of management
  o principles of disposal
• Transport

Non-Ionising Radiation
• Sources – physical properties, interactions with matter, biological effects, measurement, clinical applications and safety of:
  o UV
  o intense light sources
  o lasers
  o infrared
  o microwaves
  o RF
  o electric and magnetic fields
  o US
  o MRI
• Relevant guidelines, documents and standard operating procedures for safe practice with regard to the use of non-ionising radiation in the clinical environment
• Safety issues and exposure limitations relevant to different patient groups
• Rationale behind safety standards

Image Display
• Hard copy and soft copy display systems
• External factors affecting image displays
• Quality assurance of image display systems
• Image perception

Optimisation
• Measurement and calculation of patient doses
• Population exposures
• ALARP

Design of Facilities
• Design of facilities for radiotherapy, diagnostic radiology and nuclear medicine
• Shielding calculations, design features and engineering controls
• Cyclotrons and radionuclide production facilities

Technical
• The requirements of equipment for calibration/QA, both generally and specific to each application
• Appropriate methods for data reconstruction, pre-processing (e.g. registration, smoothing) and analysis (e.g. region of interest, curve generation)
• Gated and time sequence imaging
• The commissioning process for new equipment with reference to:
  o diagnostic radiology equipment
  o CT, including cone beam CT
  o mammography
  o radiotherapy/brachytherapy equipment
  o the critical examination
• IT and networking
  o image analysis software
  o PACS
  o specialist patient management systems, e.g. cardiology systems, radiology information systems
  o networking and the network environment
  o system management, configuration control and software release
  o interoperability, DICOM RT, HL7 and messaging standards
  o links to hospital administration systems
  o legislative framework for IT, data protection
  o regulatory standards including IEC601 and the Medical Devices Directive as applied to software
## Section 15: Specialist MSc Modules for Radiotherapy Physics

<table>
<thead>
<tr>
<th>Year 3</th>
<th>Specialist Practice</th>
<th>Module Titles</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Radiotherapy 2</td>
<td>[30]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Research Project in Radiotherapy Physics</td>
<td>[30]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year 2</th>
<th>Specialist Practice</th>
<th>Module Titles</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Research Methods</td>
<td>Radiotherapy 1</td>
<td>[20]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Research Project in Radiotherapy Physics</td>
<td>[30]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Core Modules</th>
<th>Module Titles</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Healthcare Science, Professional Practice and Clinical Leadership integrating science and professional practice</td>
<td>Introduction to Specialist Medical Physics Underpinning knowledge for rotational elements and integrated professional practice</td>
<td>[40]</td>
</tr>
</tbody>
</table>

**Legend:**
- **Blue** - Generic Modules: Common to all divisions of healthcare science
- **Yellow** - Division/Theme-Specific Modules: Common to a division or theme
- **Orange** - Specialist Modules: Specific to a specialism
This module provides the trainee with the knowledge that underpins the specialist rotation in Radiotherapy Physics in the second year of the MSc.

Learning Outcomes: Knowledge and Understanding

On successful completion of this module the trainee will:

1. Explain the radiobiological basis of radiotherapy.
2. Explain the patient pathway in radiotherapy and the associated risks.
3. Discuss the physics of radiotherapy treatment machines and dosimetry equipment.
4. Describe and evaluate the requirements for QA on radiotherapy equipment and undertake QA and dose measurements on radiotherapy equipment.
5. Explain and justify the quality framework in Radiotherapy Physics.
6. Undertake treatment planning on a basic range of clinical conditions.
7. Discuss the requirements for safe working in the radiotherapy environment.

Indicative Content

Fundamentals

• Radiobiology
• Radiation interactions with the patient at a wide range of photon and electron energies
• Dosimetry theory and methods in radiotherapy
• The relationship between measurements and dose
• Electron and photon codes of practice

Clinical

• The Radiotherapy Patient Pathway and associated dosimetry risks
• Dose limits to organs at risk
• Radiobiological models used in different tumour groups
• Knowledge of isodose distributions and patient-related corrections

Equipment

• The physics, operation and performance limitations of treatment simulators, CT simulators, linear accelerators, and superficial and orthovoltage units
• The physics, operation and performance limitations of dosimetry equipment
• The physics, operation and limitations of in-vivo dosimetry systems, EPIDs
• Characteristics of clinical beams
Treatment Planning
• Principles of treatment planning
• Target volume localisation: definitions and methods
• Beam modifiers

Radiation Protection
• Ionising Radiations Regulations 1999, Ionising Radiations Medical Exposure Regulations 2000 as applied to radiotherapy
• Environmental Permitting Regulations 2010, High Activity Sealed Sources (HASS) Regulations 2006 and other relevant legislation as applied to radiotherapy
• Ionising Radiation (Medical Exposure) Regulations 2000 as applied to radiotherapy
  o the roles of operator and practitioner in radiotherapy planning and dosimetry
  o concomitant doses
• Basic treatment room design and radiation protection

Quality Framework
• The role of quality assurance systems, e.g. ISO9000 in Radiotherapy Physics
• The basis of interdepartmental audit

Division: Physical Sciences and Biomedical Engineering
Theme: Medical Physics
Specialism: Radiotherapy Physics
Years 2 and 3: Research Project in Radiotherapy Physics [60 credits]

The overall aim of this module, building on the Research Methods module, is for the trainee to undertake a research project that shows originality in the application of knowledge, together with a practical understanding of how established techniques of research and enquiry are used to create and interpret knowledge in a specialism of healthcare science. The research project may span scientific or clinical research, translational research, operational and policy research, clinical education research, innovation, service development, service improvement, or supporting professional service users to meet the expected learning outcomes. Research projects should be designed to take into account the research training required by individual trainees and the needs of the department in which the research is to be conducted.

Learning Outcomes: Knowledge and Understanding
On successful completion of this module the trainee will:

1. Discuss the stages of the research and innovation process from conceptualisation to dissemination and, if appropriate, translation into
2. Describe the purpose and importance of different kinds of research, including scientific or clinical research, translational research, operational and policy research, clinical education research, innovation, service development, service improvement and supporting professional service users, and relate these to the roles undertaken by Clinical Scientists in the trainee’s specialism.

3. Discuss and evaluate the use of reference manager systems.

4. Justify the rationale for research governance and ethical frameworks when undertaking research or innovation in the NHS.

5. Describe the process and requirements for publication in a peer-reviewed journal and the current system of grading research publications.

**Learning Outcomes: Practical Skills**

On successful completion of this module the trainee will:

1. Design, plan and undertake a research project to test a hypothesis from conception to completion/archiving in accordance with ethical and research governance regulations, drawing on expert advice where necessary and involving patients and service users.

2. Analyse the data using appropriate methods and statistical techniques, and interpret, critically discuss and draw conclusions from the data.

3. Prepare a written project that describes and critically evaluates the research project, clearly identifying the strengths and weaknesses.

4. Present a summary of the research project and outcome that conforms to the format of a typical scientific presentation at a national or international scientific meeting, responding to questions appropriately.

5. Prepare a summary of the research project suitable for non-specialist and lay audiences.

**Indicative Content**

- Critical evaluation of the literature/evidence base
- Reference management
- Identification of a research question
- Research ethics and regulatory requirements, including issues related to access and use of information
- Data protection and confidentiality guidelines
- Patient safety
- Patient consent
- Sources of funding/grants
- Peer review/expert advice
- Possible risks and balancing risk vs benefit
- Project management techniques and tools
- Roles and responsibilities of those involved in the research
- Monitoring and reporting
- Data analysis
- Data interpretation
- Criteria/metric for assessing and grading research data and publications in the scientific, NHS and HE sectors
Learning Outcomes: Knowledge and Understanding

On successful completion of this module the trainee will:

1. Critically compare 3D dose calculation algorithms, their input requirements and the limitations of the methods employed.
2. Discuss how to acquire beam data for commissioning a treatment planning system.
3. Describe and evaluate a range of advanced treatment planning techniques.
4. Discuss and critically appraise brachytherapy techniques and treatment planning.
5. Describe a range of radiotherapy treatments using unsealed sources.
6. Critically evaluate the role of imaging in radiotherapy treatment planning and delivery.
7. Discuss and appraise the radiotherapy IT environment.

Indicative Content

Imaging
- The application, limitations and use of the following modalities in radiotherapy:
  - CT, including cone beam CT
  - MRI
  - PET/CT
  - SPECT/CT
  - Simulation
  - CT simulation
  - Verification imaging and imaging for IGRT
- Reconstruction methods and image registration

Clinical
- The harmful effects of radiotherapy
• The accuracy and precision of planning and dosimetry based on ICRU and RCR recommendations
• The commissioning process for new treatment techniques
• Advanced radiotherapy techniques, including:
  o intensity-modulated radiation therapy (IMRT)
  o IGRT
  o tomotherapy
  o 4D adaptive radiotherapy
  o proton beam therapy
  o emerging technologies
• Patient immobilisation and shielding
• Gating techniques

Brachytherapy and Unsealed Source Treatments
• The scientific basis and radiobiology of the use of radioactive implants and unsealed source treatments in radiotherapy
• After-loading and dosimetry equipment: application, quality assurance limitations and use
• Brachytherapy dose calculation algorithms, input requirements and limitations of the methods employed.
• Unsealed and sealed source treatments, including preparation, administration, protection arrangements and decontamination
• Record keeping for radioactive sources

Treatment Planning
• 3D dose algorithms, their limitations and use
• Beam data requirements for a treatment planning system
• Forward and inverse IMRT treatment planning
• Treatment plans for a range of complex conditions, including total body irradiation and total skin electron treatment

Technical
• The commissioning process for new equipment with reference to:
  o LINACs, orthovoltage and other treatment machines
  o treatment planning systems
  o imaging equipment
• Radiotherapy IT and networking:
  o virtual simulation
  o verification software
  o oncology patient management systems
  o networking and the network environment
  o system management, configuration control and software release
  o interoperability, DICOM RT, HL7 and messaging standards
  o links to hospital administration systems
  o legislative framework for IT, data protection
• Regulatory standards including IEC601 and the Medical Devices Directive as applied to software
Section 15.1: Specialist Work Based Modules for Radiotherapy Physics

This section contains the work based learning outcomes for this Scientist Training Programmes in Medical Physics, further details can be found in the accompanying Work Based Learning Guides.

<table>
<thead>
<tr>
<th>Module 1 (RP1)</th>
<th>Dosimetry and Treatment Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module 2 (RP2)</td>
<td>Treatment Planning</td>
</tr>
<tr>
<td>Module 3 (RP3)</td>
<td>Brachytherapy</td>
</tr>
<tr>
<td>Module 4 (RP4)</td>
<td>Computing Related to Radiotherapy</td>
</tr>
</tbody>
</table>

Dosimetry and Treatment Equipment (RP1)

Learning Outcomes: Associated Work Based Learning

High-level description of the work based learning that accompanies this academic module. Further details of the work based programme can be found in the Work Based Learning Guide, including the Clinical Experiential Learning, Competences and Applied Knowledge and Understanding.

On successful completion of this module the trainee will:

1. Perform required measurements to characterise a treatment beam.
2. Perform required measurements to establish that a treatment machine is suitable for clinical use.
3. Interpret results and instigate corrective action where required.
4. Apply the appropriate codes of practice.
5. Perform patient-specific quality assurance and in-vivo dosimetry, and analyse the results.

Treatment Planning (RP2)

Learning Outcomes: Associated Work Based Learning

High-level description of the work based learning that accompanies this academic module. Further details of the work based programme can be found in the Work Based Learning Guide, including the Clinical Experiential Learning, Competences and Applied Knowledge and Understanding.

On successful completion of this module the trainee will:

1. Plan all but the most complex cases.
2. Check calculations and standard plans.
3. Provide and analyse in-vivo dosimetry data.
4. Provide advice on treatment techniques.
5. Analyse effectiveness of treatment plan delivery.
6. Understand the appropriate use of treatment planning algorithms.
7. Quality assure the whole treatment planning process.

**Brachytherapy (RP3)**

**Learning Outcomes: Associated Work Based Learning**

High-level description of the work based learning that accompanies this academic module. Further details of the work based programme can be found in the Work Based Learning Guide, including the Clinical Experiential Learning, Competences and Applied Knowledge and Understanding.

On successful completion of this module the trainee will:

1. Act safely within the brachytherapy environment.
2. Perform routine quality assurance and safety tests on brachytherapy afterloading devices.
3. Create a dose distribution using a standard system for each of the intra-cavity and interstitial techniques, including image-guided techniques.
4. Perform an independent verification of treatment plans, including the dose distribution.
5. Provide advice on brachytherapy treatment techniques.

**Computing Related to Radiotherapy (RP4)**

**Learning Outcomes: Associated Work Based Learning**

High-level description of the work based learning that accompanies this academic module. Further details of the work based programme can be found in the Work Based Learning Guide, including the Clinical Experiential Learning, Competences and Applied Knowledge and Understanding.

On successful completion of this module the trainee will:

1. Use a variety of hardware configurations, operating systems and typical software applications.
2. Use contemporary planning, treatment management, delivery and dosimetry systems used in radiotherapy.
3. Participate in the specification, commissioning, validation, implementation and safe operation of contemporary radiotherapy equipment and software.
4. Participate in the safe execution of software upgrades or configuration changes within radiotherapy.
5. Use appropriate software for radiotherapy data processing.
6. Understand the governance, regulatory and data exchange standards that influence the procurement, maintenance and replacement of radiotherapy computer systems, including the anonymisation of patient data for clinical trials.
Appendix 1: Contributor List

Members of the STP MSc and Work Based Programme Physical Sciences and Biomedical Engineering: Medical Physics

Development of the STP curriculum for the MSc Clinical Sciences and Work Based Programme for Medical Physics has been coordinated by the Modernising Scientific Careers team and the National School of Healthcare Science working with NHS and Higher Education colleagues. The professionals who have contributed to the development of STP Programme since 2009 include:

<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catrin Abercrombie</td>
<td>Portsmouth Hospitals NHS Trust</td>
</tr>
<tr>
<td>Kathryn Adamson</td>
<td>Guy’s and St Thomas’ NHS Foundation Trust, London</td>
</tr>
<tr>
<td>Anna Barnes</td>
<td>University College London Hospitals NHS Foundation Trust</td>
</tr>
<tr>
<td>Andy Beavis</td>
<td>Hull and East Yorkshire Hospitals NHS Trust</td>
</tr>
<tr>
<td>Tony Bedford</td>
<td>Plymouth Hospitals Trust</td>
</tr>
<tr>
<td>Elizabeth Chaloner</td>
<td>King’s College Hospital, London</td>
</tr>
<tr>
<td>Iain Chambers</td>
<td>The James Cook University Hospital, Middlesbrough</td>
</tr>
<tr>
<td>Gillian Clarke</td>
<td>King’s College Hospital, London</td>
</tr>
<tr>
<td>Mary Cocker</td>
<td>Oxford University Hospitals NHS Trust</td>
</tr>
<tr>
<td>Andy Cousins</td>
<td>The Royal Wolverhampton Hospitals NHS Trust</td>
</tr>
<tr>
<td>Anne Davis</td>
<td>University College London Hospitals NHS Foundation Trust</td>
</tr>
<tr>
<td>Derek D’Souza</td>
<td>University College London Hospitals NHS Foundation Trust</td>
</tr>
<tr>
<td>Mike Dunn</td>
<td>University Hospitals of Leicester NHS Trust</td>
</tr>
<tr>
<td>Peter Dunn</td>
<td>Imperial College Healthcare NHS Trust, London</td>
</tr>
<tr>
<td>Stephen Evans</td>
<td>Northampton General Hospital</td>
</tr>
<tr>
<td>Will Evans</td>
<td>University Hospital of Wales, Cardiff</td>
</tr>
<tr>
<td>Jeremie Fromageau</td>
<td>Royal Marsden Hospital, London</td>
</tr>
<tr>
<td>Martin Graves</td>
<td>Cambridge University Hospitals NHS Foundation Trust</td>
</tr>
<tr>
<td>Claire Greaves</td>
<td>University Hospitals of Leicester NHS Trust</td>
</tr>
<tr>
<td>Julia Handley</td>
<td>The Christie NHS Foundation Trust, Manchester</td>
</tr>
<tr>
<td>Claire Hardiman</td>
<td>Mount Vernon Cancer Centre, E&amp;N Herts NHS Trust</td>
</tr>
<tr>
<td>Margaret Hills</td>
<td>Royal Berkshire Hospital, Reading</td>
</tr>
<tr>
<td>Paul Hinton</td>
<td>Royal Surrey County Hospital NHS Foundation Trust, Guildford</td>
</tr>
<tr>
<td>Mike Holubinka</td>
<td>Portsmouth Hospitals NHS Trust</td>
</tr>
<tr>
<td>Ian Honey</td>
<td>Guy’s and St Thomas’ NHS Trust, London</td>
</tr>
<tr>
<td>Andy Irwin</td>
<td>St George’s Healthcare NHS Trust, London</td>
</tr>
<tr>
<td>Mark Knight</td>
<td>Maidstone and Tunbridge Wells NHS Trust</td>
</tr>
<tr>
<td>Gill Lawrence</td>
<td>Freeman Hospital, Newcastle</td>
</tr>
<tr>
<td>Katherine Lymer</td>
<td>University of Dundee</td>
</tr>
<tr>
<td>Alison Mackie</td>
<td>University Hospital of North Durham</td>
</tr>
<tr>
<td>Name</td>
<td>Institution</td>
</tr>
<tr>
<td>-----------------------</td>
<td>------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Helen Mayles</td>
<td>The Clatterbridge Cancer Centre NHS Foundation Trust, Wirral</td>
</tr>
<tr>
<td>Mike Mayo</td>
<td>Plymouth Hospitals Trust</td>
</tr>
<tr>
<td>Donald McRobbie</td>
<td>Imperial College Healthcare NHS Trust, London</td>
</tr>
<tr>
<td>John Moody</td>
<td>University College London</td>
</tr>
<tr>
<td>Alexis Moore</td>
<td>Leeds Teaching Hospitals NHS Trust</td>
</tr>
<tr>
<td>Helen Morgan</td>
<td>Royal United Hospital, Bath</td>
</tr>
<tr>
<td>Seenivasan Naidu</td>
<td>Barking, Havering and Redbridge Hospitals NHS Trust</td>
</tr>
<tr>
<td>Ian Negus</td>
<td>University Hospitals Bristol NHS Foundation Trust</td>
</tr>
<tr>
<td>Kuldip Nijran</td>
<td>Imperial College Healthcare NHS Trust, London</td>
</tr>
<tr>
<td>Matilda Nyekiova</td>
<td>Royal Berkshire NHS Foundation Trust, Reading</td>
</tr>
<tr>
<td>Tony Palmer</td>
<td>Portsmouth Hospitals NHS Trust</td>
</tr>
<tr>
<td>Graham Petley</td>
<td>Southampton General Hospital</td>
</tr>
<tr>
<td>Carl Rowbottom</td>
<td>The Christie NHS Foundation Trust, Manchester</td>
</tr>
<tr>
<td>David Spendley</td>
<td>Brighton and Sussex University Hospitals NHS Trust</td>
</tr>
<tr>
<td>Malcolm Sperrin</td>
<td>Royal Berkshire NHS Foundation Trust, Reading</td>
</tr>
<tr>
<td>Lorna Sweetman</td>
<td>The Christie NHS Foundation Trust, Manchester</td>
</tr>
<tr>
<td>Simon Thomas</td>
<td>Addenbrooke’s Hospital, Cambridge</td>
</tr>
<tr>
<td>Andrew Tyler</td>
<td>Velindre Hospital, Cardiff</td>
</tr>
<tr>
<td>Alison Vinall</td>
<td>Norfolk &amp; Norwich University Hospitals NHS Foundation Trust</td>
</tr>
<tr>
<td>Wendy Waddington</td>
<td>University College London Hospitals NHS Foundation Trust</td>
</tr>
<tr>
<td>Bruce Walmsley</td>
<td>NHS London</td>
</tr>
<tr>
<td>Andrea Wynn-Jones</td>
<td>United Lincolnshire Hospitals</td>
</tr>
</tbody>
</table>

Professional bodies and societies were invited to review the curricula for Medical Physics and Clinical Engineering and their feedback has shaped the final publication:

- **IPEM**  [Institute of physics and Engineering in Medicine](#)
- **BMUS**  [British Medical Ultrasound Society](#)
- **BNMS**  [British Nuclear Medicine Society](#)
- **IHEE**  [Institute of Healthcare Engineering & Estate Management](#)
- **RESMG**  [Rehabilitation Engineering Services Management Group](#)

The National School of Healthcare Science Themed Board reviewed the MSc Clinical Science (Medical Physics) Curriculum on 7 January 2013.

**Modernising Scientific Careers Professional Advisor**
Dr Derek Pearson

**National School of Healthcare Science Professional Lead**
Dr Chris Gibson
Appendix 2: Programme Amendments

This section lists the programme amendments following first publication.

Amendments – May 2011

Page 3 Section 1.1 High level MSc Framework – title change to read HIGH LEVEL FRAMEWORK MSc IN CLINICAL SCIENCE

Page 58 Appendix 1 added

The rest of the content in the curriculum is unaltered.

The refreshed version is called MSc Medical Physics 2010-11 v2 on the footer.

Amendments – March 2013

These amendments apply to trainees commencing STP in the academic year 2013/14.

1. A generic introduction to all STP MSc Clinical Science programmes has been added.
2. In order to improve the alignment to QAA level 7 the word ‘understand’ has been replaced with an appropriate verb from Bloom’s Taxonomy for the Knowledge domain.
3. The generic module Healthcare Science has been renamed ‘Introduction to Healthcare Science, Professional Practice and Clinical Leadership’.
4. The generic modules Healthcare Science (which incorporates Professional Practice) and Research Methods have been revised and updated.
5. The Research Project has been revised and all students are expected to complete a single 60-credit research project spanning Years 2 and 3, see relevant section.
6. Good Scientific Practice (GSP) sets out for the healthcare science profession and the public the standards of behaviour and practice that must be achieved and maintained in the delivery of work activities, the provision of care and personal conduct. GSP has been added in the Appendices of each curricula and aspects of professionalism strengthened to reflect areas such as the need to ensure the shared nature of clinical decision making.
7. The learning outcomes related to ‘Personal Attitudes and Behaviours’ now appear in the Professional Practice section of this document but apply to all modules.
Learning outcomes amended:

2. Discuss and evaluate a range of non-imaging nuclear medicine studies.
5. Describe the delivery of unsealed source therapy.
6. Discuss and critically appraise the commissioning and quality assurance of radiographic and nuclear medicine equipment.

The new version is called STP MSc Medical Physics version 3.0 for 2013-14

For any queries regarding this change please email msc.hee@nhs.net
Appendix 3: Good Scientific Practice

Good Scientific Practice

Section 1: The purpose of this document

There are three key components to the Healthcare Science workforce in the UK:

1. Healthcare Science Associates and Assistants who perform a diverse range of task based roles with appropriate levels of supervision.

2. Healthcare Science Practitioners have a defined role in delivering and reporting quality assured investigations and interventions for patients, on samples or on equipment in a healthcare science specialty, for example Cardiac Physiology, Blood Sciences or Nuclear Medicine. They also provide direct patient care and more senior Healthcare Science Practitioners develop roles in specialist practice and management.

3. Healthcare Scientists are staff that have clinical and specialist expertise in a specific clinical discipline, underpinned by broader knowledge and experience within a healthcare science theme. Healthcare scientists undertake complex scientific and clinical roles, defining and choosing investigative and clinical options, and making key judgements about complex facts and clinical situations. Many work directly with patients. They are involved, often in lead roles, in innovation and improvement, research and development and education and training. Some pursue explicit joint academic career pathways, which combined clinical practice and academic activity in research, innovation and education.

This document sets out the principles and values on which good practice undertaken by the Healthcare Science workforce is founded.

*Good Scientific Practice* sets out for the profession and the public the standards of behaviour and practice that must be achieved and maintained in the delivery of work activities, the provision of care and personal conduct.

*Good Scientific Practice* uses as a benchmark the Health Professions Council (HPC) Standards of Proficiency and Standards of Conduct, Performance and Ethics, but expresses these within the context of the specialities within Healthcare Science, recognising that three groups of the workforce, Biomedical Scientists, Clinical Scientists and Hearing Aid Dispensers are regulated by the HPC. The aim is that the standards are accessible to the profession and understandable by the public.

*Good Scientific Practice* represents standards and values that apply throughout an individual’s career in healthcare science at any level of practice. The standards will be contextualised by the role within Healthcare Science.
that an individual undertakes. This means that the standards must be interpreted based on the role that an individual performs. For example, in supervised roles where individuals work within defined procedures, rather than autonomously, some standards will need to be interpreted appropriately for the context of the specific role. There will, however, always be a requirement for an individual to work within the limits of their scope of practice and competence.

Students and trainees will be expected to be working towards meeting the expectations set out in this document. However, if an individual is undertaking further training and development following qualification from a professional training programme, he or she will be expected to be able to meet the standards in this document within their scope of practice.

The standards have been used to support curriculum development and will be used to underpin the process of judging individual equivalence, particularly for emerging specialisms.

The standards have been divided into five domains. The domains of Good Scientific Practice detailed in section 2 are:

1. Professional Practice
2. Scientific Practice
3. Clinical Practice
4. Research and development
5. Clinical Leadership

**Section 2: The domains of Good Scientific Practice**

**Domain 1: Professional Practice**

All patients and service users are entitled to good standards of professional practice and probity from the Healthcare Science workforce including the observance of professional codes of conduct and ethics. In maintaining your fitness to practice as a part of the Healthcare Science workforce, you must:

1.1 **Professional Practice**
1.1.1 Make the patient your first concern
1.1.2 Exercise your professional duty of care
1.1.3 Work within the agreed scope of practice for lawful, safe and effective healthcare science
1.1.4 Keep your professional, scientific, technical knowledge and skills up to date
1.1.5 Engage fully in evidence based practice
1.1.6 Draw on appropriate skills and knowledge in order to make professional judgements
1.1.7 Work within the limits of your personal competence
1.1.8 Act without delay on concerns raised by patients or carers or if you have good reason to believe that you or a colleague may be putting people at risk

1.1.9 Never discriminate unfairly against patients, carers or colleagues

1.1.10 Treat each patient as an individual, respect their dignity and confidentiality and uphold the rights, values and autonomy of every service user, including their role in the diagnostic and therapeutic process and in maintaining health and well-being.

1.1.11 Respond constructively to the outcome of audit, appraisals and performance reviews, undertaking further training where necessary

1.2 Probity

1.2.1 Make sure that your conduct at all times justifies the trust of patients, carers and colleagues and maintains the public’s trust in the scientific profession

1.2.2 Inform the appropriate regulatory body without delay if, at any time, you have accepted a caution, been charged with or found guilty of a criminal offence, or if any finding has been made against you as a result of fitness to practice procedures, or if you are suspended from a scientific post, or if you have any restrictions placed on your scientific, clinical or technical practice

1.2.3 Be open, honest and act with integrity at all times, including but not limited to: writing reports, signing documents, providing information about your qualifications, experience, and position in the scientific community, and providing written and verbal information to any formal enquiry or litigation, including that relating to the limits of your scientific knowledge and experience

1.2.4 Take all reasonable steps to verify information in reports and documents, including research

1.2.5 Work within the Standards of Conduct, Performance and Ethics set by your profession

1.3 Working with colleagues

1.3.1 Work with other professionals, support staff, service users, carers and relatives in the ways that best serve patients’ interests

1.3.2 Work effectively as a member of a multi-disciplinary team

1.3.3 Consult and take advice from colleagues where appropriate

1.3.4 Be readily accessible when you are on duty

1.3.5 Respect the skills and contributions of your colleagues

1.3.6 Participate in regular reviews of team performance.

1.4 Training and developing others

1.4.1 Contribute to the education and training of colleagues

1.4.2 If you have responsibilities for teaching, develop the skills, attitudes and practices of a competent teacher

1.4.3 Ensure that junior colleagues and students are properly supervised
1.4.4 Support colleagues who have difficulties with performance, conduct or health
1.4.5 Share information with colleagues to protect patient safety
1.4.6 Provide work-based development for colleagues to enhance/improve skills and knowledge

Domain 2: Scientific Practice

As a part of the Healthcare Science workforce, you will keep your scientific and technical knowledge and skills up to date to effectively:

2.1 Scientific Practice

2.1.1 Develop investigative strategies/procedures/processes that take account of relevant clinical and other sources of information
2.1.2 Provide scientific advice to ensure the safe and effective delivery of services
2.1.3 Undertake scientific investigations using qualitative and quantitative methods to aid the screening, diagnosis, prognosis, monitoring and/or treatment of health and disorders appropriate to the discipline
2.1.4 Investigate and monitor disease processes and normal states
2.1.5 Provide clear reports using appropriate methods of analysing, summarising and displaying information
2.1.6 Critically evaluate data, draw conclusions from it, formulate actions and recommend further investigations where appropriate

2.2 Technical Practice

2.2.1 Provide technical advice to ensure the safe and effective delivery of services
2.2.2 Plan, take part in and act on the outcome of regular and systematic audit
2.2.3 Work within the principles and practice of instruments, equipment and methodology used in the relevant scope of practice
2.2.4 Demonstrate practical skills in the essentials of measurement, data generation and analysis
2.2.5 Assess and evaluate new technologies prior to their routine use
2.2.6 Identify and manage sources of risk in the workplace, including specimens, raw materials, clinical and special waste, equipment, radiation and electricity.
2.2.7 Apply principles of good practice in health and safety to all aspects of the workplace
2.2.8 Apply correct methods of disinfection, sterilisation and decontamination and deal with waste and spillages correctly.
2.2.9 Demonstrate appropriate level of skill in the use of information and communications technology

2.3 Quality
2.3.1 Set, maintain and apply quality standards, control and assurance techniques for interventions across all clinical, scientific and technological activities
2.3.2 Make judgements on the effectiveness of processes and procedures
2.3.3 Participate in quality assurance programmes
2.3.4 Maintain an effective audit trail and work towards continuous improvement

Domain 3: Clinical Practice

As a part of the Healthcare Science workforce, you will keep your clinical skills up to date and undertake the clinical duties appropriate to your role in order to effectively:

3.1 Clinical Practice

3.1.1 Ensure that you and the staff you supervise understand the need for and obtain relevant consent before undertaking any investigation, examination, provision of treatment, or involvement of patients and carers in teaching or research
3.1.2 Ensure that you and the staff you supervise maintain confidentiality of patient information and records in line with published guidance
3.1.3 Ensure that you and your staff understand the wider clinical consequences of decisions made on your actions or advice
3.1.4 Demonstrate expertise in the wider clinical situation that applies to patients who present in your discipline
3.1.5 Maintain up to date knowledge of the clinical evidence base that underpins the services that you provide and/or supervise and ensure that these services are in line with the best clinical evidence
3.1.6 Plan and determine the range of clinical/scientific investigations or products required to meet diagnostic, therapeutic, rehabilitative or treatment needs of patients, taking account of the complete clinical picture
3.1.7 Plan and agree investigative strategies and clinical protocols for the optimal diagnosis, monitoring and therapy of patients with a range of disorders
3.1.8 Ensure that detailed clinical assessments are undertaken and recorded using appropriate techniques and equipment and that the outcomes of these investigations are reviewed regularly with users of the service
3.1.9 Ensure the provision of expert interpretation of complex and or specialist data across your discipline in the context of clinical questions posed
3.1.10 Undertake and record a detailed clinical assessment using appropriate techniques and equipment
3.1.11 Provide specialised clinical investigation and/or analysis appropriate to your discipline
3.1.12 Provide interpretation of complex and/or specialist data in the context of the clinical question posed
3.1.13 Provide clinical advice based on results obtained, including a diagnostic or therapeutic opinion for further action to be taken by the individual directly responsible for the care of the patient

3.1.14 Provide expert clinical advice to stakeholders in order to optimise the efficiency and effectiveness of clinical investigation of individuals and groups of patients

3.1.15 Prioritise the delivery of investigations, services or treatment based on clinical need of patients

3.1.16 Represent your discipline in multidisciplinary clinical meetings to discuss patient outcomes and the appropriateness of services provided

3.1.17 Ensure that regular and systematic clinical audit is undertaken and be responsible for modifying services based on audit findings.

3.2 Investigation and reporting

3.2.1 Plan and conduct scientific, technical, diagnostic, monitoring, treatment and therapeutic procedures with professional skill and ensuring the safety of patients, the public and staff

3.2.2 Perform investigations and procedures/design products to assist with the management, diagnosis, treatment, rehabilitation or planning in relation to the range of patient conditions/equipment within a specialist scope of practice

3.2.3 Monitor and report on progress of patient conditions/use of technology and the need for further interventions.

3.2.4 Interpret and report on a range of investigations or procedures associated with the management of patient conditions/equipment

Domain 4: Research, Development and Innovation

As part of the Healthcare Science workforce, research, development and innovation are key to your role. It is essential in helping the NHS address the challenges of the ageing population, chronic disease, health inequalities and rising public expectations of the NHS. In your role, you will undertake the research, development and innovation appropriate to your role in order to effectively:

4.1 Research, Development and Innovation

4.1.1 Search and critically appraise scientific literature and other sources of information

4.1.2 Engage in evidence-based practice, participate in audit procedures and critically search for, appraise and identify innovative approaches to practice and delivery of healthcare

4.1.3 Apply a range of research methodologies and initiate and participate in collaborative research

4.1.4 Manage research and development within a governance framework

4.1.5 Develop, evaluate, validate and verify new scientific, technical, diagnostic, monitoring, treatment and therapeutic procedures and,
where indicated by the evidence, adapt and embed them in routine practice

4.1.6 Evaluate research and other available evidence to inform own practice in order to ensure that it remains at the leading edge of innovation.

4.1.7 Interpret data in the prevailing clinical context

4.1.8 Perform experimental work, produce and present results

4.1.9 Present data, research findings and innovative approaches to practice to peers in appropriate forms

4.1.10 Support the wider healthcare team in the spread and adoption of innovative technologies and practice

**Domain 5: Clinical Leadership**

All patients and service users have a right to expect that Healthcare Science services efficiently and effectively managed to meet service needs. As a leader in Healthcare Science, you will seek to effectively:

**5.1 Leadership**

5.1.1 Maintain responsibility when delegating healthcare activities and provide support as needed

5.1.2 Respect the skills and contributions of your colleagues

5.1.3 Protect patients from risk or harm presented by another person’s conduct, performance or health

5.1.4 Treat your colleagues fairly and with respect

5.1.5 Make suitable arrangements to ensure that roles and responsibilities are covered when you are absent, including handover at sufficient level of detail to competent colleagues

5.1.6 Ensure that patients, carers and colleagues understand the role and responsibilities of each member of the team

5.1.7 Ensure that systems are in place through which colleagues can raise concerns and take steps to act on those concerns if justified

5.1.8 Ensure regular reviews of team performance and take steps to develop and strengthen the team

5.1.9 Take steps to remedy any deficiencies in team performance

5.1.10 Refer patients to appropriate health professionals

5.1.11 Identify and take appropriate action to meet the development needs of those for whom you have management, supervision or training responsibilities

5.1.12 Act as an ambassador for the Healthcare Science community

*Good Scientific Practice AHCS V.2 Final*  
*September 2012*
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical experiential learning</td>
<td>The cyclical process linking concrete experience with abstract conceptualisation through reflection and planning.</td>
</tr>
<tr>
<td>Clinical experiential learning outcomes</td>
<td>The activities that the trainee will undertake to enable and facilitate their learning in the workplace.</td>
</tr>
<tr>
<td>Competence</td>
<td>The ability of an individual to perform a role consistently to required standards, combining knowledge, understanding, skills and behaviour.</td>
</tr>
<tr>
<td>Competence statements</td>
<td>Active and outcome-based statements that provide a further breakdown of the Learning Outcomes – reflecting what the trainee will be able to do in the workplace at the end of the programme. Each competence should be linked back to the numbered Learning Outcomes.</td>
</tr>
<tr>
<td>Component</td>
<td>An indication of the type of module within a learning guide, i.e. rotational, specialist, or elective.</td>
</tr>
<tr>
<td>Curricula</td>
<td>An outline of the expected educational outcomes across a subject area. The learning that is expected to take place during the Scientist Training Programme described in terms of knowledge, skills and attitudes.</td>
</tr>
<tr>
<td>Division</td>
<td>A high-level description of an area of practice within healthcare science. There are three divisions: Life Sciences, Physical Sciences and Biomedical Engineering, and Physiological Sciences.</td>
</tr>
<tr>
<td>Domains of learning</td>
<td>Cognitive (knowledge and intellectual skills), affective (feelings and attitudes), interpersonal (behaviour and relationships with others) and psychomotor (physical skills).</td>
</tr>
<tr>
<td>Feedback</td>
<td>Specific information about the comparison between a trainee’s observed performance and a standard, given with the intent of improving the trainee’s performance (van de Ridder JMM, Stokking KM, McGaghie WC and ten Cate OT. What is feedback in clinical education? <em>Medical Education</em> 2008: 42: 189–197).</td>
</tr>
<tr>
<td>Good Scientific Practice</td>
<td>Non-statutory guidance on the minimum requirements for good practice for the healthcare science workforce.</td>
</tr>
<tr>
<td>Host department</td>
<td>The department that is responsible for the three-year training programme and in which the training officer is based.</td>
</tr>
<tr>
<td>Job</td>
<td>A specific definition of the work activities, requirements and skills required to undertake work activities within a local context. This differs from a role – see below.</td>
</tr>
<tr>
<td>Key learning outcome</td>
<td>A defined learning outcome linked to relevant competence(s) within the workplace Learning Guide.</td>
</tr>
<tr>
<td>Knowledge and understanding</td>
<td>The knowledge and understanding that must be applied in the workplace to achieve the stated competence.</td>
</tr>
<tr>
<td>Learning framework</td>
<td>The specification for work based learning contained</td>
</tr>
<tr>
<td><strong>Learning module</strong></td>
<td>A distinct set of learning outcomes and competences that form part of a programme. Modules may be rotational, specialist, elective, or professional practice and can be combined to meet the needs of specific programmes.</td>
</tr>
<tr>
<td>---------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Learning outcome</strong></td>
<td>A high-level, outcome-based statement that describes what a trainee will be able to do at the end of the module.</td>
</tr>
<tr>
<td><strong>Mentoring</strong></td>
<td>Mentoring is a process in which a trainer (mentor) is responsible for overseeing the career and development of the trainee. The emphasis is therefore on the relationship (rather than the activity).</td>
</tr>
<tr>
<td><strong>Module aim</strong></td>
<td>The overall objective of a work based learning module – defining the intended learning achievements of the trainee. The aim works together with the ‘Scope’ statement to define the overall objectives and scope of the module.</td>
</tr>
<tr>
<td><strong>Module scope</strong></td>
<td>A statement within work based learning modules that defines the range/limits of the learning undertaken by the trainee in a module – patients/investigations/equipment/modalities etc.</td>
</tr>
<tr>
<td><strong>National Occupational Standards</strong></td>
<td>Nationally recognised standards of expected workplace performance and level of competence for a role. The standards are outcome based, defining what the role holder should be able to do, as well as what they must know and understand to demonstrate competent work performance. National Occupational Standards are supported by nationally agreed frameworks of expected attitudes, behaviour and skills.</td>
</tr>
<tr>
<td><strong>Practical skill</strong></td>
<td>A cognitive, psychomotor, physical, or communicative ability that supports performance of the required role.</td>
</tr>
<tr>
<td><strong>Programme</strong></td>
<td>The package of learning, teaching assessment and quality assurance leading to an award.</td>
</tr>
<tr>
<td><strong>Provider</strong></td>
<td>An organisation that delivers required training and learning activities to specified quality assurance requirements.</td>
</tr>
<tr>
<td><strong>Role</strong></td>
<td>A collection of functions undertaken in the workplace that represent the main broad areas of work for all similar workers at national level. The latter being defined specifically for a local context.</td>
</tr>
<tr>
<td><strong>Specialism</strong></td>
<td>A focused area of practice within a theme of healthcare science.</td>
</tr>
<tr>
<td><strong>Trainer</strong></td>
<td>A qualified individual who provides learning and development support for trainees.</td>
</tr>
<tr>
<td><strong>Theme</strong></td>
<td>A cluster of related specialisms within a division of healthcare science.</td>
</tr>
<tr>
<td><strong>Work based learning</strong></td>
<td>Learning that takes place in a real work setting and involves the application of academic learning to real work.</td>
</tr>
<tr>
<td><strong>Work performance</strong></td>
<td>The requirements of satisfactory and consistent demonstration of competence in specified functions for a work role.</td>
</tr>
<tr>
<td>----------------------</td>
<td>----------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Workplace</strong></td>
<td>A real work setting in which the trainee can apply learning.</td>
</tr>
</tbody>
</table>