National School of Healthcare Science

NHS
Health Education England

Modernising Scientific Careers
Practitioner Training Programme
BSc (Hons) Healthcare Science Curriculum
Medical Physics Technology 2016/17

Developing people for health and healthcare

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CONTENTS

SECTION 1: INTRODUCTION TO THE PROGRAMME

READERSHIP

The Practitioner Training Programme (PTP) is an integrated academic and work-based undergraduate BSc (Hons) degree which may be undertaken through an on-site academic programme or through an apprenticeship. This document provides the curriculum (both academic and work-based) for the PTP and will be of interest to:

- academic and administrative staff, including external examiners within Higher Education Institutions (HEIs) which are accountable for the delivery of the curriculum;
- employers who may wish to support apprentices or employees in undertaking the PTP degree programme;
- learners, host departments and managers of services that employ healthcare science (HCS) staff;
- work-based trainers, including all those involved in supervising, mentoring, co-ordinating, assessing and delivering PTP education and training;
- Health Education England (HEE) Local Education and Training Boards (LETBs) and all HCS education and training commissioning organisations in the UK;
- National School of Healthcare Science (NSHCS);
- Academy for Healthcare Science (AHCS);
- patients and the public.

A list of abbreviations and glossary of terms used is provided in the appendices.

Introduction to Modernising Scientific Careers (MSC) and the Practitioner Training Programme (PTP)

1.1 Healthcare Science and the MSC Education and Training Programme

1. The 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 HCS 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)[1] 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 Academy for Healthcare Science's (AHCS) Standards of Proficiency[2] and Standards of Education and Training[3] form the basis for all MSC training curricula that contextualise the Standards of Proficiency set down by the Health and Care Professions Council (HCPC) in a way that is accessible to the profession and the public.
3. The HCS workforce and services are grouped into four broad areas called divisions, namely: Life Sciences, Physical Sciences, Physiological Sciences and Clinical Bioinformatics. Within each division there are a number of HCS 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 seven PTP themes (groupings of specialisms within a HCS division), which define training across a total of 19 HCS specialisms.

1.2 Introduction to the Practitioner Training Programme (PTP)

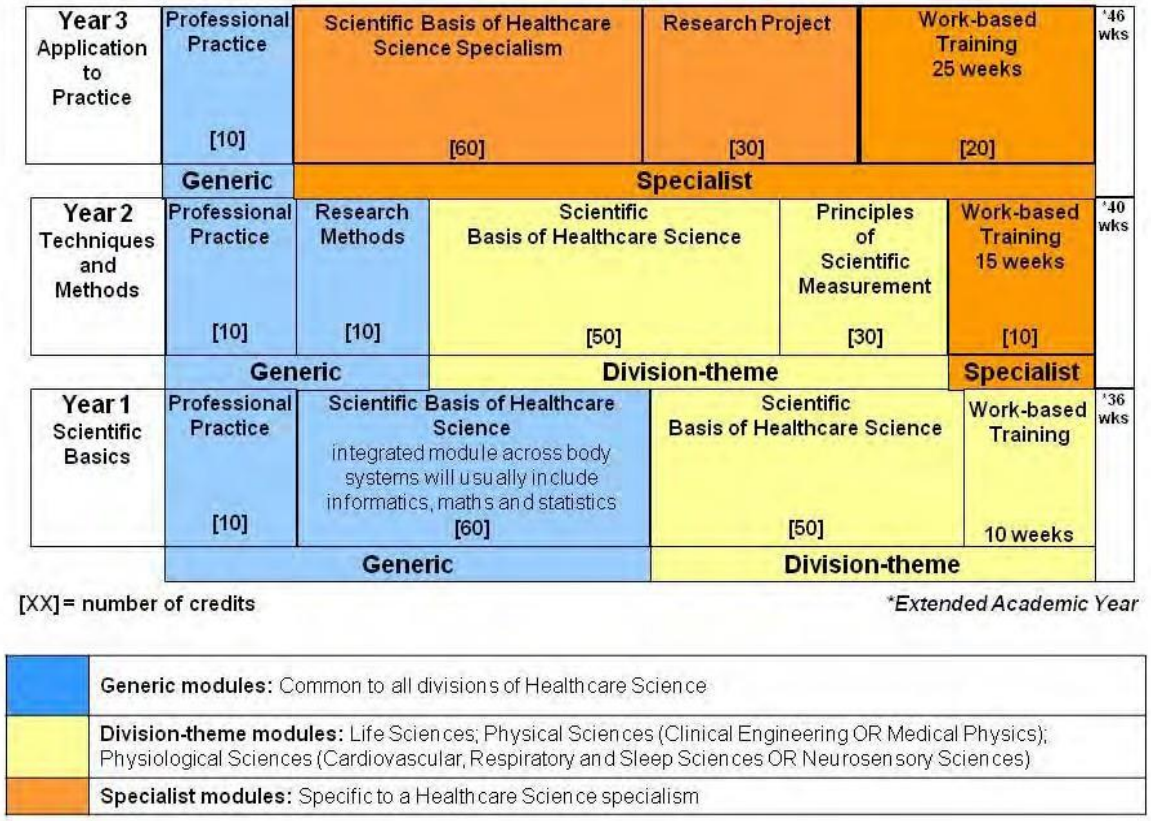
4. The HCS Practitioner Training Programme (HCS PTP) is a degree programme that has 2 routes of delivery:
   i. *On-site academic route:* an academic degree programme in which the learner[4] undertakes work-based placements but is not employed
   ii. *Apprenticeship route:* an in-service degree where the apprentice is employed whilst undertaking the PTP
5. The PTP typically will take a minimum of 3 years (but may be longer depending on the learner and the requirements of the employer and/or HEI to complete. It leads to a BSc Honours degree qualification that is contextualised for workplace occupational competency as a Healthcare Science Practitioner (HCSP) who provides HCS scientific and technical services within the HCS divisions and specialisms of Life Science, Physiological Science, or Physical Science.
6. The BSc (Hons) PTP is designed to provide the HCSP with a strong science-based, patient-centred education and training in a specialist area of HCS. The

[1] http://ahcs.flinthosts.co.uk/wordpress/wp-content/uploads/2013/09/AHCS-Good-Scientific-Practice.pdf
[2] http://www.ahcs.ac.uk/wordpress/wp-content/uploads/2014/07/AHCS_StandardsofProficiency.pdf
[3] http://www.ahcs.ac.uk/wordpress/wp-content/uploads/2014/08/AHCS_PTPStandardsOfEducationAndTraining.pdf
[4] the term *learner* is generally used to include both students undertaking the PTP through the on-site academic route and the apprenticeship route, except where reference to apprentices is specifically required.

overall aim of this HCSP education and training programme is to prepare the learner to fulfil the function of a HCSP working in a clinical HCS setting. The programme combines and integrates both academic and work-based learning and has a strong patient and technical scientific focus. Within the first year learners will experience of number of short placements or 'tasters' within the chosen PTP theme and gain some exposure to other aspects of the patient pathways, for example through clinics, patient education programmes, medical records and other area in which HCS contributes to patient care. This will give the learner a wide appreciation of the many related specialisms within HCS and a more holistic view of the areas that contribute to high-quality patient-centred care.

7. The diagram below depicts the broad framework and credit structure around which all PTP BSc (Hons) degree programmes in HCS are structured. The divisions within the MSC Programme (Life Sciences, Physical Sciences, Physiological Sciences and Clinical Bioinformatics)[5] have interpreted and adapted this framework to fit the range of HCS specialisms within the division/theme. Further refinement has been undertaken by each HEI to develop and deliver BSc (Hons) programmes that enable learners to meet the learning outcomes of the course. There is a strong generic programme that emphasises professional practice, research and the scientific basis of HCS.

High-level framework for the integrated BSc (Hons) in Healthcare Science



8. Once employed as a HCSP a range of career development options will be available, including structured in-post programmes of continuous personal and professional development (CPPD), provided through Accredited Scientific Practice programmes.[6]

[5] Although at the current time there is no PTP in Clinical Bioinformatics.
[6] http://hee.nhs.uk/2015/03/26/modernising-scientific-careers-accredited-scientific-practice-asp/

9. PTP degrees can be delivered either as an on-site academic programme with clinical placements, or through an apprenticeship[7], in which the learner is employed whilst the degree is undertaken. HEIs offering the degree apprenticeship must join the Skills Funding Agency's (SFA) Register of Apprenticeship Training Providers (RoATP)[8].
10. HEIs can choose to deliver the degree apprenticeship inclusive of the mandatory end-point synoptic assessment (EPA)[9] through an "integrated" degree, or may choose to only deliver the academic component of the apprenticeship and without including the EPA in its assessment programme – a "non-integrated" degree. Where employers choose the non-integrated degree for an apprentice, they will be required to ensure that the apprentice undertakes the EPA once the degree is obtained through an appropriately accredited Assessment Organisation (AO) that is on the SFA Register of Apprenticeship Assessment Organisations (RoAAO), in order that the apprenticeship is completed.[10] Whichever options are chosen, the PTP will develop the technical, scientific, interpersonal and behavioural skills and knowledge of learners so that they can operate effectively in HCS as a HCSP.

1.3 Practitioner Training Programme Outcomes

11. Graduates of the BSc (Hons) will possess the essential knowledge, skills, experience values, behaviours and attitudes required of a newly qualified HCSP. They will have the necessary expertise in applied scientific techniques underpinned by theoretical knowledge within a division or related specialism and will work in a range of healthcare settings. Many will work directly with patients but all HCSPs will work in roles that will have an impact on patient care and outcomes. Learning, therefore, must be in the context of the patient and patient-centred care.
12. On successful completion of the BSc (Hons) (academic and work-based learning outcomes) all graduates should be able to demonstrate the outcomes of the AHCS's Standards of Proficiency for HCSPs,[11] which will enable them to register on its Professional Standards Authority (PSA) accredited register. In addition, Life Science graduates should also be able to demonstrate the outcomes of the HCPC Standards of Proficiency for Biomedical Scientists, which will enable them to register with the HCPC as Biomedical Scientists. Degree programmes must align to the Quality Assurance Agency's (QAA)[12] level 6, but which will have been extended and contextualised to the NHS job role for HCSP.

13. The AHCS Standards of Proficiency cover three key areas:
    - professional autonomy and accountability;
    - skills required for practice as a HCS Practitioner
    - knowledge of healthcare science.
14. **Entry routes:** Entry into BSc (Hons) on-site academic HCS programmes is through the UCAS application process.[13] Increasingly, employers and patients are expected to be part of and contribute to the selection process, with HEIs

[7] Less commonly, some individuals will be employed by a trust and undertake the degree on a part-time basis.
[8] https://www.gov.uk/government/collections/register-of-apprenticeship-training-providers
[9] described more fully in Section 1.8
[10] Of significance, it should be noted that the employer will be responsible for the costs attached to the EPA. Employers and HEIs should be aware that the funding cap for this programme is fixed at £27,000. This may therefore require employers to fund the EPA outwith the apprenticeship levy and be an additional cost to the overall apprenticeship.
[11] http://www.ahcs.ac.uk/wordpress/wp-content/uploads/2014/07/AHCS_StandardsofProficiency.pdf
[12] http://www.qaa.ac.uk/en
[13] https://www.ucas.com

using values-based recruitment[14] as an underpinning principle of their selection processes. Those seeking to undertake the PTP through an apprenticeship will be competitively appointed by employers who will involve their local HEIs in the appointment process.

15. **Award titles and mode of delivery:** These degree programmes can be delivered either as on site academic programmes or as in-service apprenticeship programmes. The title of the degree programme should be consistent with current HCS terminology.[15] See http://www.nshcs.org.uk/for-trainees/accreditation/134-accreditation-for-heis for further details.
16. **Apprenticeship Standard:** where employers appoint apprentices to undertake the degree, the apprenticeship standard for HCSPs (Level 6)[16], the PTP degree and the End-point Assessment (EPA) demonstrating achievement of the standard must be achieved, either through an integrated or non-integrated degree.[17]
17. **Relevant Quality Assurance Agency (QAA) Code(s) of Practice:** HEIs must adhere to the current QAA Code of Practice for the Assurance of Academic Quality and Standards in Higher Education.
18. **Accreditation:** A BSc (Hons) HCS programme must hold accreditation from HEE's NSHCS to confirm that it meets the Standards of Accreditation for the HCS BSc (Hons),[18] reflecting the AHCS Standards of Education and Training and those of the HCPC[19], where appropriate.
19. **Accreditation of prior learning (APL):** A process of APL that conforms to the guidelines below must be defined by each HEI provider. This must clearly describe the minimum and maximum level of APL that will be awarded, the timing, costs and process, and align to statutory requirements for HCS. Good practice supports the view that such prior learning should only be used once; double counting is not recommended. This process will be of particular relevance for apprentices who have previously achieved the Level 4 Diploma in HCS.[20]
20. **Progression, compensation, condonation:** Should a clinical placement or the employer in the case of apprentices not deliver the environment/learning that supports a learner in achieving the required learning outcomes, the HEI and employer will need to support the learner/apprentice appropriately. While it is recognised that HEIs are likely to have a wide portfolio of degree programmes that fall under a single set of regulations (ordinances), the following conditions are specific requirements of the PTP BSc (Hons) degree programme accreditation process, irrespective of the HEI's own academic regulations:
    - all modules are mandatory;

[14] http://hee.nhs.uk/work-programmes/values-based-recruitment/

[15] In Scotland a 'full-time-equivalent' model is used to train clinical physiology practitioners who are NES employees, with their work-based learning being integral to the award. The programme timescale is identical to a full-time HEI learner (i.e. 4 years in Scotland).

[16] At the time of publication of the 2016 PTP curricula the Level 6 apprenticeship standard was awaiting publication. Once published it should be available via: https://www.gov.uk/government/collections/apprenticeship-standards#healthcare-standards (see Healthcare Science section)

[17] which will involve an AO for the EPA in the case of a non-integrated degree

[18] http://nshcs.org.uk/images/Accreditation/Proforma-BSc-accreditation-standards-July2014.pdf

[19] http://www.hpc-uk.org/aboutregistration/standards/sets/

[20] http://www.qaa.ac.uk/Publications/InformationAndGuidance/Pages/Higher-education-credit-framework-for-England-guidance-on-academic-credit-arrangements-in-higher-education-in-England-Augu.aspx http://www.qaa.ac.uk/Publications/InformationAndGuidance/Pages/Guidelines-on-the-accreditation-of-prior-learning-September-2004.aspx

- no condonation or compensation of marks between modules (although there is a measure of compensation within a module) or extended re-sits of modules marks is permitted;
- multiple assessment components in any single module cannot be aggregated to reach a final module mark;
- each assessment within a module should be mandatory and passed at the required level.

21. Where learners do not achieve the module requirements for progression they must follow a 'module retrieval plan', which supports them to recover the failed module(s) as soon as possible so that they can progress with minimum delay.
22. **Programme delivery and monitoring:** It is expected that all BSc (Hons) HCSP programmes should be an integral part of the faculty/school and that opportunities for interprofessional learning are maximised. There should be an appropriate balance between academic staff and visiting specialist staff to ensure teaching reflects current NHS practice, which must be evidenced as part of the programme accreditation by the NSHCS.

1.4 Purpose of the BSc (Hons) PTP Curriculum

23. There are three main purposes of this BSc (Hons) curriculum. It:
    i. clearly sets out the expectations of graduates from the programme, including the academic skills, knowledge and understanding, and attitudes and behaviours that each learner will be expected to gain, develop and apply during work-based training;
    ii. signals the importance to employers of the current structure, strategic direction and priorities of healthcare delivery in the UK, e.g. the *NHS Constitution* or equivalent frameworks across the UK, and the requirement to prioritise patients and their care, ensuring that the patient and service provided by HCS is at the centre of all learning, assessment and work-based practice;
    iii. introduces learning in relation to new scientific and technological developments as these become available.
24. **Curriculum development and maintenance:** The first BSc (Hons) curricula in HCS were published in 2010. Recently the NSHCS and the Council for HCS Education in Higher Education and its PTP Special Interest Group, professional bodies and other stakeholders have contributed to updating the scientific and professional content of the curriculum[21], resulting in this 2016 edition of the curricula. Led by the NSHCS, all MSC curricula will be subject to regular review, with all stakeholders given the opportunity to contribute to each review. Current and previous versions of the BSc (Hons) HCS programmes and work-based learning guides can be found on the NHS Networks website.[22]
25. BSc (Hons) HCS programmes leading to an academic award must be aligned to current NHS policy and strategy and equivalent policy documents for the devolved administrations and should be consistent with current professional body guidance. HEIs should ensure they keep abreast of future strategic direction and policy.

1.5 Programme Delivery

[21] including taking into account external feedback on the curricula undertaken by the Institute of Education (IOE)
[22] http://www.networks.nhs.uk/nhs-networks/msc-framework-curricula and https://www.nshcs.hee.nhs.uk/

26. **Programme delivery:** HEIs and employers are expected to ensure that all teaching, learning and assessment is up-to-date and informed by research to ensure that at graduation HCSPs meet the Framework for Higher Education Qualifications (FHEQ) descriptor at level 6. By undertaking a research project learners should become aware of the major contribution the HCS workforce makes to research and innovation to benefit patients, patient outcomes and the delivery of healthcare.
27. Although HEIs will deliver the programme described in this curriculum according to their local requirements, the key principles of programme delivery that underpin the NSHCS accreditation process[23] involve:
    - programmes must deliver all of the BSc (Hons) PTP learning outcomes (and will, de facto, deliver the outcomes required by the Level 6 HCSP apprenticeship standard which maps to the curricula) and indicative content, which the HEE Education and Training Scrutiny Group (ETSG) has advised meets the requirements of *Modernising Scientific Careers: The UK Way Forward* and the Academy for HCS's *Good Scientific Practice;*
    - wherever possible, delivering the principles and knowledge underpinning practice should occur before the work-based learning;
    - ensuring programmes meet current NHS education quality metrics and current AHCS and HCPC Standards of Education and Training;
    - ensuring that employer host departments, patients and the public are involved in the design, implementation, delivery and review;
    - the use of fair, valid, reliable, and clearly articulated assessment programmes for all modules, and the timing and content of which should consider and complement the work-based assessment programme;
    - the provision of a robust learner support and mentoring system, together with clearly defined arrangements to identify and support learners in difficulty (including the support services in place) clearly defined;
    - delivery of the programme within 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 potentially international standing that is relevant to the practice of HCS and the NHS.
28. Good Scientific Practice (GSP) underpins the PTP and the Level 6 HCSP apprenticeship standard and spans both the academic and work-based programmes. Key professional practice learning outcomes are included in the BSc (Hons) programme through its GSP syllabus, thus embedding the standards of professionalism set out in GSP in all aspects of the delivery and assessment of the programme. Learners should be encouraged to develop a range of skills to support their professional life and CPPD spanning communication, leadership, personal reflection, duty of care, duty of candour, critical reflection, giving and receiving feedback, career planning and commitment to lifelong learning, and show development and maturation in these areas through the degree programme.
29. HEIs should ensure that all staff involved in each BSc (Hons) programme have read and are aware of the requirements of *Good Scientific Practice* and the GSP syllabus in the PTP.
30. **Teaching and learning:** It is expected that a blended learning approach will be adopted, based on a model of learner-centred adult learning that balances and integrates face-to-face teaching, e-learning, etc., and considers the broader

[23] In Scotland NES is responsible for accreditation of PTP programmes.

requirements of each BSc (Hons) programme. It is anticipated that a broad range of teaching and learning activities will be utilised, appropriate to the learning outcomes. Learners 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'[24] describe a range of activities that may be appropriate to this BSc (Hons) programme. They are likely to include:

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

31. It is also expected that e-learning and, where possible, m-learning[25] opportunities will be available to enable to be active participants in a range of learning activities. Work-based learning will also contribute to the academic educational experience of the learner through, for example, seminars, journal clubs, local and national scientific and education meetings.
32. All academic and NHS staff leading or contributing to the BSc (Hons) programme should be appropriately qualified to teach and assess within the academic and/or work-based environment and have up-to-date knowledge of the requirements of the programme, GSP and the Standards of Proficiency for HCSPs. Further details can be found in the Accreditation Guidance from the NSHCS.[26]
33. **Interprofessional learning:** Opportunities to enable interprofessional and interdisciplinary learning, within and outside HCS, should be a fundamental part of each programme.
34. **Patient-centred care:** 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 HCS workforce to ensure that learners are aware that their actions have an impact on the patient and the patient's family. They should make clear and explicit links to new models of service delivery, care and patient pathways. The responsibility of all staff in the NHS to maximise quality, productivity and efficiency and to continually strive to improve services should be stressed. Equally important is the ability of graduates from the PTP to

[24] Liberating Learning, The Report of the Conference of Postgraduate Medical Deans' ad hoc Working Group on the Educational Implications of the European Union Working Time Directive and the subsequent European Working Time Regulations: November 2002 (revised 2009).
[25] JISC TechDis: see **http://www.jisctechdis.ac.uk/technologymatters/mobilelearning** for further information with respect to mobile (m) learning.
[26] http://www.nshcs.org.uk/for-trainees/accreditation/134-accreditation-for- heis

communicate with the general public with respect to HCS, leading to a better-educated public that is encouraged to take responsibility for its own health and wellbeing and have a greater understanding of the role that science plays in society.

35. **Patient and public involvement:** The HEI programme team must 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.
36. The participation of patients and the public in HCS in all aspects of education and training brings a number of benefits, including:
    - active, constructive lay involvement in the training of healthcare scientists;
    - assisting in the development, monitoring and evaluation of HCS training programmes and their outcomes;
    - operating as lay advisors to all professionals, academics, researchers and others involved in the teaching of healthcare scientist trainees (including the private and charity sector);
    - engaging with professionals, academics, researchers, patients/carers and the general public to promote education/publicity about the work and impact of healthcare scientists on the health of the community;
    - developing protocols and training opportunities that involve lay persons in the delivery, analysis and evaluation of training programmes;
    - initiating and supporting ideas/proposals/research questions about HCS and its impact on patients.

1.6 Introduction to Work-based Learning

37. The overall aim of the PTP is to prepare the learner to fulfil the function of a HCSP working in a clinical HCS setting. The programme combines and integrates both academic and work-based learning and has a strong patient and clinical focus. Within the first year it is expected that the experiential component will start broad with short 'tasters' across a theme, with some exposure to other aspects of patient pathways, for example a clinic, patient education programme, medical records, or other area of healthcare. This will give the learner a wide appreciation of the many specialisms and a more holistic view of the areas that contribute to high-quality care.
38. The work-based programme is divided into modules, all of which are focused on service need, patient/care and continuous service improvement. Each module follows a standard format. The aim and scope of each module is described followed by the:
    - **Learning Outcomes** – high-level descriptors of the required work-based achievements for the module;
    - **Clinical Experiential Learning** – the learning activities that will facilitate learning and achievement of the stated outcomes;
    - **Competences** – further outcome-based statements for each learning outcome;
    - **Knowledge and Understanding** - as applied to appropriate competences.
39. Both the curricula and the apprenticeship standard are based on GSP[27] and HCPC Standards[28], resulting in a direct relationship between the two, ensuring

[27] https://www.ahcs.ac.uk/wordpress/wp-content/uploads/2013/09/AHCS-Good-Scientific-Practice.pdf
[28] http://www.hcpc-uk.org/assets/documents/100004FDStandards_of_Proficiency_Biomedical_Scientists.pdf

that the curricula deliver the underpinning knowledge, skills and professionalism required by the standard. The learning outcomes of the curricula are clearly focused on employer and service requirements, reflecting patient care and clinical pathways and continuous improvement in a given area of HCS.

40. The work-based training for all learners has three components, which correspond to the academic programme, all of which are underpinned by the professional practice curriculum:
    - induction;
    - theme training;
    - specialist training.
41. It is anticipated that all learners will have an induction period in each employer/host department at the beginning of the apprenticeship and/or of each placement. The duration and timing of work-based placements will vary, depending on the HEI in which the learner studies.

1.7 Employing and Training Departments

42. The training and work environment is vital for successful training in the BSc and in this context includes each of the employers, training departments and other healthcare settings facilitating work-based training. The success of the training and the learner experience requires the commitment and enthusiasm from employers and those in the work environment to provide high quality, well-supervised training, underpinned by work-based formative assessment and a close working relationship with the HEI.
43. Training departments and employers should therefore ensure that they are fully familiar with the components of the BSc (Hons) programme, including the work-based training programme, including the required learning outcomes, competences and assessment processes, and have been trained by the HEI in each work-based assessment method. Additionally, the responsibilities for mentoring and supervision, whilst the learner is on placement should be clear, including access to HEI learner support services.
44. **Induction**: At the start of the training programme learners should be provided with an induction programme by employers and training units. Initial work-based induction should include an overview of the:
    - hospital/employer/healthcare setting and local policies, including health and safety, confidentiality, data protection, etc., relevant to the employment;
    - range of services provided by the department;
    - range of people who use the services provided by the department;
    - function, operation, and routine and corrective maintenance requirements of equipment appropriate to the section(s) of the department in which the trainee will be working;
    - host trust IT systems, including the library and knowledge service as required.
45. **Supervision**: At the core of successful work-based employer training is appropriate educational and clinical supervision, facilitation and feedback. It is recommended that each learner is allocated to a training officer[29] from within the host/employing department. Learners are advised to ensure that a planned schedule of meetings with their training officer is agreed early in training, commencing with a meeting during the first week.

[29] For the purposes of this document training officer has been used; however, the title may vary between departments and may be subject to a title change in England as part of developments for the whole of the professional healthcare workforce.

46. BSc educational and clinical supervision should promote learning, reflective practice and action planning. It will need to ensure that the learner becomes proficient in the specific skills and competences required by the curriculum, helping them to develop self-sufficiency and self-awareness in the ongoing acquisition of skills and knowledge. At every stage, patient safety must be paramount.
47. The first supervision meeting should be set up during the first week of the training programme. At the first meeting the training officer should ensure that the learner is following the agreed induction programme. It is recommended that the following areas should be explored and agreement reached at the first meeting with respect to the:
    - expectations of the training officer and learner;
    - responsibilities of the training officer and learner;
    - confidentiality;
    - boundaries between the training officer and learner;
    - frequency and duration of planned supervision meetings;
    - methods of communication and responsibility for arranging meetings;
    - level of support and arrangements for communications between meetings;
    - models of reflection and action planning;
    - record keeping;
    - content of the work-based training programme;
    - for apprentices, clarity between their employment responsibilities and their learning opportunities (i.e. formal training/learning time)
    - the approach to assessment;
    - sources of help and support.
48. The HEI and employers are responsible for ensuring that learners have access to training opportunities to enable the achievement of all the learning outcomes of the BSc (Hons) and where required, to meet the apprenticeship standard. In return learners are expected to take responsibility for:
    - ensuring that they fulfil their obligations to the HEI, to employers, to departments providing work base training and to patients (especially with regard to patient safety and confidentiality) as healthcare professionals;
    - engaging as active adult learners by initiating work-based assessments; contributing to learning activities; taking into account feedback received from their trainers and assessors; and giving considered and constructive feedback on their experience of their training.

1.8 Assessment

49. **Purpose of assessment:** The purpose of assessment is to enable the learner to demonstrate that they have the requisite knowledge, skills, values, behaviours and attitudes to work as a HCSP and meet standards of education and training, professional skills, conduct performance and ethics to provide reassurance to the public and the appropriate regulatory bodies. Given the integrated nature of this academic and work-based degree, each HEI's assessment programme must address both academic and work-based assessment (see Section 1.11 below) and must support assessment for learners undertaking the programme through an on-site academic programme or through an apprenticeship.
50. The full BSc (Hons) HCS assessment programme should support both assessment *for* and assessment *of* learning, and in particular:[30]

[30] Nicol DJ (2007) Principles of good assessment and feedback. REAP International Online Conference.

- 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–learner);
- facilitate the development of self-assessment and reflection in learning;
- involve learners 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 learner needs;
- for apprentices, facilitate and ensure readiness for the synoptic EPA.

51. 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 BSc (Hons) HCS should also be cognisant of and complement the work-based assessment programme, which is defined by the NSHCS and which is part of all NSHCS accredited BSc (Hons) programmes. In addition, where an integrated degree is offered, enabling those undertaking the degree through an apprenticeship route, the end-point assessment (EPA) must conform to Department for Education (DfE) requirements.[31]
52. The assessment programme should be designed to enable the learner to obtain regular and constructive feedback on progress and achievement. It should encourage critical reflection and action planning, identifying both strengths and areas for development and improvement.
53. The approach to assessment should include and be overseen by a central co-ordinating leadership group or assessment-focused group in the HEI. The role of this group is to 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 HEI's overall assessment strategy 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.
54. Key areas that are required for NSHCS accreditation and which must be covered by an HEI's Assessment Strategy include:
    - a clear statement of accountabilities, including the governance structure for assessment;
    - the balance between academic and work-based assessment;
    - the balance between formative and summative assessment;
    - clarity on the EPA programme for apprentices and preparation for it;
    - 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;

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www.reap.ac.uk/public/Papers/Principles_of_good_assessment_and_feedback.pdf (accessed 2.12.09).

[31] At the time of publication of the 2016 PTP curricula the Level 6 EPA was awaiting publication. Once published it should be available via: https://www.gov.uk/government/collections/apprenticeship-standards#healthcare-standards (see Healthcare Science section)

- the process for providing clear and timely information for learners;
- how all examiners will be selected and 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 opportunities for learner feedback will be maximised, including time lines and importance of developing learners-centred feedback;
- the arrangements for assessment of learners with a disability, which should be consistent with the ability to undertake this modified practice in the workplace setting;
- 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;
- the role and contribution of patients and the public to the assessment programme.

55. The on-programme assessment of the degree modules will include a range of formative and summative assessment approaches, for example essays, reports, completion of practical tasks and work-based projects as well as formal summative examinations as the degree progresses. In addition, a programme of formative work-based assessments will support progression through the degree, ensuring that for apprentices, there is adequate opportunity to practise scientific skills, and to gain feedback, as preparation for the EPA for apprentices.
56. For those undertaking the degree through an apprenticeship, the learner must achieve the award of the BSc (Hons) and pass the EPA. HEIs will be required to be on the SFA's RoATP and RoAAO. Where the EPA is not integrated as part of the degree programme, the EPA will be delivered following completion of the degree by an organisation on the RoAAO. In the event of failure to pass either the degree course or the EPA, completion of the apprenticeship cannot be achieved. Employers should be assured that HEIs have robust and well-established assessment and quality assurance processes, incorporating internal moderation and external examiners to ensure independence across the degree programme and consistency between HEIs and that these Honours degrees are all approved by the QAA.

1.9 On-programme (work-based) Assessment

57. **Formative assessment** is used to support learners in the workplace by ensuring regular, structured checks on developing competence. The formative assessment tools detailed in Table 1are used by all workplaces to capture evidence of the skills, knowledge, behaviours, attitudes and values required by the apprentice in the workplace, in their enactment of their practitioner role and in their interactions with colleagues, peers, patients and the public (where and as appropriate). Formative assessment helps to uncover performance issues or concerns and the HEI and employer will be able to support the learner and provide extra guidance where such issues might arise to ensure that the learner is fully supported in meeting the outcomes of the degree and the apprenticeship for those required to do so. The delivery of that support is likely to differ across HEIs and workplaces.

58. For apprentices, completion of the formative assessment programme is essential preparation for the synoptic EPA near the end of the programme that is designed to capture evidence of the apprentice's mastery of the skills, knowledge, behaviours and values defined in the standard (see section below for more detail). Table 1 also sets out the arrangements for the summative work based employer assessment competency log that encapsulates the performance of the HCSP learner in the demonstration of competences that have been achieved.
59. The high level learning outcomes and clinical experiential learning required in each of the areas of HCS are set out in the PTP curricula for HCSPs.[32] These detail the work-based learning outcomes that form an integral part of the degree programme for HCSPs should be used to guide the selection of formative assessments. The curricula also provide the templates for each of the work-based assessment tools to ensure assessment standardisation across the work-based programme (see appendices).
60. This formative work-based assessment programme should find a balance between what is realistic and achievable for employers and learners and what provides sufficient evidence of progress/competence. It is therefore recommended that learners, in consultation with their clinical supervisor, undertake work-based assessments as set out in the table below:

Recommended number of assessments per academic year

Year 1	**Year 2**	**Year 3**
2 DOPs 1 CBD Competence	4 DOPs 1 CPD 1 OCE Competence	4 DOPs 2 CBDs 2 OCEs Competence

[32] and in the Institute of Biomedical Science's (b) Registration Portfolio for those undertaking this degree programme

Table 1 Summary of On-Programme (work-based) formative assessment methods and the Employer based Competency Log[33]

Assessment tool	Direct Observation of Practical skills (DOPs)	Observed Clinical Event (OCE)	Case-based Discussion (CbD)	Work-based/employer based Competency Log
Purpose	Assessment of a practical skill or procedure, including, where relevant, interaction with a patient through direct observation. Learner and assessor feedback is generated, learning needs identified and an action plan agreed	Observation and assessment of a clinical encounter or interaction with colleagues with respect to an aspect of patient care. The format and approach is similar to DOPs but takes place with a patient present or when the learner is working with clinical colleagues	A clinical case is used as the basis for a discussion to assess the learners application of knowledge and understanding of an aspect of an activity they have been part of, e.g. professional practice, communication, leadership, science, the role of healthcare science in patient care	A record of attainment which demonstrates achievement of each work-based competence and clinical experiential learning (CEL) activity, reflecting the performance of the learner, including the demonstration of achievement of aspects of the apprenticeship standard where this is appropriate
Method	The assessor observes a practical activity and facilitates learner- centred feedback either during or immediately following the observation. The learner generates an action plan and agrees this with the assessor.	The assessor observes a clinical activity and facilitates learner-centred feedback either during or immediately following the observation. The learner generates an action plan and agrees this with the assessor.	A discussion between the learner and assessor with respect to any aspect of a case, including professional practice/*Good Scientific Practice*	An assessor reviews the evidence provided by the learner to support achievement of each competence and CEL. The expectation is that as the learner progresses the competency log will demonstrate an evidential base of achievement/progression.

[33] Whilst each individual assessment is formative review of the log as a whole forms part of the summative assessment of the degree and of the EPA.

1.10 Work-based/employer based Competency Log

61. All learners will also be required to provide evidence to demonstrate that they have successfully achieved the competences set out in the curriculum and for apprentices, those competences specifically reflected in the apprenticeship standard, through success in the EPA. The learner is expected to provide evidence to demonstrate achievement of each competence, which should then be reviewed and signed off by the trainer in the competency log. Learners will gain competence at their own pace, but in line with the overall delivery of the relevant modules. Each competence will link directly to a specific work-based learning outcome in the curriculum and some competences may be linked to more than one learning outcome. Successful completion of the curriculum and, for an apprentice the standard, cannot therefore be achieved until achievement of *all* work-based learning outcomes have been demonstrated.
62. On-going completion of a competency log (the high level requirements are set out in Table 1 above) is therefore essential for progression within the programme and as a requirement for achievement of the degree and completion of the apprenticeship. The expectation is that as the learner progresses the competency log will demonstrate an evidence base of their achievement. The achievement of each competence and a record of all on-programme work-based assessments must be recorded using a written log, or the HEI's own electronic system. For those in HCS programmes this should be presented within a Portfolio of Evidence that is accumulated by the learner to demonstrate learning, competence and insight into practice and professionalism.[34]

1.11 End Point Assessment for apprenticeships

63. All apprentices will have to pass the EPA that is designed as a final check on the apprentice's workplace competence and ability to integrate their learning across all elements of the PTP.
64. Where the EPA has been integrated into the degree programme, the degree obtained will provide verification that both the academic part of the standard and the required synoptic assessment have been met and graded. As described above, some HEIs may choose to deliver a non-integrated degree, which will not include the EPA. If an employer chooses to use such a non-integrated degree programme for an apprenticeship, then it will be required to ensure that the synoptic assessment described below is delivered by an appropriately accredited organisation that is on the SFA's RoAAO. In addition the employer will be responsible for the costs attached to the EPA which is delivered by the AO. Although a funding cap for this degree apprenticeship standard has not yet been allocated, employers and HEIs should be aware that if the full amount is used for the delivery of the degree programme, employers will be required to fund the EPA outwith the apprenticeship levy which will be an additional cost to the overall apprenticeship. For integrated degrees, HEIs are likely to have to pay a small fee to the AHCS to help support and maintain standardisation of the EPA

[34] For those learners studying to become healthcare science practitioners through biomedical science degrees, the IBMS Registration Portfolio provides the framework for education and training. This Portfolio enables biomedical science learners to demonstrate their fitness to practice through evidence of competence that can be independently verified against the HCPC Standards of Proficiency. This supports the biomedical science graduate in registering with the HCPC. A combined portfolio reflecting this Registration Portfolio and the HCS Portfolio of Evidence for those undertaking the PTP programme in the Life Sciences is currently under development.

assessment tools (Situational Judgment Test; Professional Discussion and Research evaluation templates).

65. The formative work-based assessment programme described above supports apprentices in acquiring and building the skills, knowledge, behaviours and values defined in the apprenticeship standard. Underpinned by the academic learning and summative assessment provided by the HEI, this will ensure that the learner is prepared and ready to understanding the synoptic assessment, demonstrating these.
66. All apprentices will therefore have to pass the EPA that is designed as a final check on the apprentice's workplace competence and ability to integrate their learning across all elements of the PTP. In integrated degrees, the EPA is delivered towards the end of the three-year programme; in non-integrated degrees, the EPA is undertaken after the degree is achieved and is administered by a registered AO.
67. The EPA is conducted with an independent assessor towards the end of the degree programme and takes approximately two hours. It consists of the following three components, each of which must be passed independently:
    i. one hour written Situational Judgment Test (SJT) set by the HEI;
    ii. face-to-face Professional Discussion, taking approximately 40 minutes, between the apprentice and the trained independent assessor (who has not been involved in the education or training of the apprentice) and based on questions arising from the assessor's scrutiny of the apprentice's portfolio of workplace-based assessments, experiences and critical reflection;
    iii. a presentation of up to 10 minutes to the assessor, in which the apprentice describes the research project undertaken as part of their degree programme. The presentation is followed by a 15 minute question and answer session with the independent assessor on issues raised by the research.

The link to the full version of the Level 6 HCSP Apprenticeship EPA was not available at the time of publication of the 2016 curricula but should be available via: https://www.gov.uk/government/collections/apprenticeship-standards#healthcare-standards

1.12 Learner Support and Mentoring

68. The learner supervision, support and mentoring systems will span the academic and work/employer-based elements of the programme, and the relationship between the two systems must be clear to learners, employers work-based staff and HEI staff. The learner supervision, support and mentoring system must be designed to encourage safe and effective practice, independent adult learning, appropriate professional conduct of the learner, the safety of the patient and quality assurance of all work activities of each learner. 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 learner support services.
69. **Fitness to practise:** The HEI must have a clear policy with respect to fitness to practice (FtP), which must clearly articulate how staff and learners are made aware of the policy and how the policy is implemented. The HEI's FtP policy should reflect and be aligned to the FtP policy of the AHCS and the HCPC (for

Life Sciences). Alongside this must be a clear policy on how learner 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 FtP policy and accurate records maintained within the HEI.

1.13 Annual Monitoring of Progress and Equality and Diversity

70. **Annual monitoring of progress:** All on-site academic learners will usually be expected to complete the requirements for the BSc (Hons) HCS award within three years after initial registration, in accordance with the regulations of each HEI. For those undertaking the degree through an apprenticeship, employers and the HEI should ensure that good progress is made, although through agreement between the employer, the apprentice and the HEI, the duration of the degree may take longer than 3 years.
71. Programme governance must include annual monitoring of progress that considers the outcome of the review of each module (including learner and patient 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.
72. **Equality and diversity:** HEE, the AHCS, HEI's, scientific professional bodies and employers are committed to the principle of equality and diversity in employment, membership, academic activities, assessment, examinations and training.
73. As part of this ethos these groups are committed to inspire and support all those who work, train and provide training in HCS 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 another on the grounds of ethnic origin, nationality, age, disability, gender, sexual orientation, race, or religion, in accordance with the Equality Act 2010[35]. This reflects not only the letter but also the spirit of equality legislation, taking into account current equality legislation and good practice.

1.14 Critical Reflection and Learning

74. **Critical reflection**: Critical reflection on progress and performance is an integral part of both the BSc and of being a professional. Learners should therefore be taught the theoretical models underpinning reflection and required to regularly critically reflect on their progress and performance, enabling them to develop skills in self-evaluation and action planning.
75. This should be used to support the learner as they learn from experiences gained in the workplace. Reflection should help the learner to understand and learn from work-based situations/experience, bridging the gap between theory and practice. Each learner should be taught about the underpinning evidence for the use of reflection and encouraged to reflect regularly on their progress and performance, developing their skills in self-assessment and action planning.
76. Learners should be encouraged to think about what they are doing as they do it (Reflection *in* Action) and retrospectively to reflect on practice (Reflection *on* Action). The reflective practitioner should describe and analyse experience,

[35] Equality Act 2010. http://www.legislation.gov.uk/ukpga/2010/15/contents

considering how the situation might have been handled differently and what other knowledge would have been helpful. When critically reflecting on an experience, learners should use a recognised model of reflection.

1.15 Relationships and Partnerships

77. **The National School of Healthcare Science:** The NSHCS is hosted by HEE, West Midlands Local Team. The NSHCS provides a national co-ordinating and oversight function to support the delivery of work-based training for HCS training and education programmes. With respect to the PTPs it is responsible for:
    - holding HEIs to account for the quality, integration, co-ordination and delivery of both the academic programme and work-based training through the accreditation process, ;
    - identification of programme issues that may need to be addressed and resolved and reporting these as part of agreed governance arrangements;
    - liaising with LETBs on local issues and problems and their resolution;
    - providing advice and support to accredited PTP programmes as necessary;
    - overarching review to ensure common standards of delivery and content and recommending ongoing training activities to support the CPD of work-based trainers.

    The School can be contacted at www.nshcs.org.uk

78. **The Academy for Healthcare Science:** The AHCS provides the professional voice for the HCS workforce and quality assurance of HCS training and education.[36] Included in 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 HCS and scientific services;
    - act as the overarching body for professional issues related to education, training and development in the UK health system, including the provision of UK-wide quality assurance across education and training arrangements[37];
    - provide the infrastructure to support the professional regulation/registration of the HCS workforce, including:
        - a system of professional accreditation of education and training programmes for the regulation/registration of the HCS workforce;
        - setting the professional standards for the delivery of accredited registers as required by the PSA's for Health and Social Care to ensure consistency and coherence across all HCS education and training programmes;
        - taking the central role in the sponsorship of the registers to achieve 'accredited' status as set out by the PSA;
        - being a HCPC education provider for the statutory regulation of Clinical Scientists;
        - offering a system for equivalence across the HCS workforce to enable those who can demonstrate evidence of training, experience and qualifications equivalent to the required outcomes of HCS training

[36] http://www.ahcs.ac.uk/wordpress/wp-content/uploads/2014/08/18th-Feb-2016-AHCSQA-Framework-pdf.pdf

[37] The Institute of Biomedical Science (IBMS) also has a role in approving laboratories for training and accrediting healthcare science degrees in the Life Sciences.

programmes to support entry on to the PSA accredited ACHS register www.academyforhealthcarescience.co.uk/

1.16 Programme Outcomes

79. On completion of the BSc (Hons) all graduates should be able to demonstrate the following outcomes that align to QAA level 6, extended and contextualised to the NHS job role for HCSP.

Professional Practice

i. Professional practice that meets the professional standards of conduct, performance and ethics defined by *Good Scientific Practice*[38] and is safe, lawful and effective, and within the scope of practice for the role undertaken, while maintaining fitness to practice.
ii. Personal qualities that encompass communication skills, self-management, self-awareness, acting with integrity and the ability to take some responsibility for self-directed learning, maintaining their own health and wellbeing, critical reflection and action planning to maintain and improve performance.
iii. 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.
iv. The ability to work, where appropriate, in partnership with other professionals, often as part of a multidisciplinary team (MDT), supporting staff, service users and their relatives and carers while maintaining confidentiality.
v. The ability to work with the public, service users, patients and their carers as partners in their care, embracing and valuing diversity.
vi. A range of transferable generic academic skills and capabilities to the exercise of initiative and personal responsibility, decision making in complex and unpredictable contexts spanning study skills, independent learning, reflective practice, communication, team working, research and leadership skills.
vii. A conceptual understanding that enables the learner to devise and sustain arguments and/or to solve problems, using ideas and techniques, some of which are at the forefront of a specialism of HCS.
viii. The ability to apply problem-solving skills, evaluate evidence, arguments and assumptions, to reach sound judgements and to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.

Scientific and Clinical Practice

ix. An understanding of a complex body of knowledge, some of it at the current boundaries of an academic discipline, and the ability to apply the scientific principles, method and knowledge to HCS.
x. The ability to apply scientific method and approaches to analytical techniques, HCS research, development and innovation.
xi. The ability to perform technical investigations/skills and technical reporting of quality assured tests, investigations and interventions on

[38] and the HCPC in the Life Sciences

patients/samples safely and skillfully, adhering to applicable legislation and in compliance with local, national and international guidelines.

xii. The ability to provide therapeutic interventions, some of which may be specialist, in a number of specialisms.

xiii. A systematic understanding of key aspects of their field of study, including acquisition of coherent and detailed knowledge, at least some of which is at, or informed by, the forefront of defined aspects of HCS.

xiv. High-quality clinical and scientific practice that applies core scientific knowledge, skills and experience in a healthcare setting, places the patient/public at the centre of care, prioritising patient safety and dignity and reflecting NHS/health service values and the NHS Constitution.

Research, Development and Innovation

xv. An appreciation of the uncertainty, ambiguity and limits of knowledge, the ability to manage their own learning, and to make use of scholarly reviews and primary sources (for example refereed research articles and/or original materials appropriate to HCS).

xvi. To apply the methods and techniques that they have learned to review, consolidate, extend and apply their knowledge and understanding, and to initiate and carry out projects.

xvii. An understanding of the strengths, weaknesses and opportunities for further development of healthcare and HCS 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.

Clinical Leadership

xviii. Scientific and clinical leadership appropriate to the HSCP job role based on the continual advancement of their knowledge, skills and understanding through the independent learning required for CPPD.

1.17 Transferable Skills

80. It is expected that all BSc (Hons) HCS programmes will meet the descriptors for a higher education qualification at level 6 (Bachelor's degree with honours) outlined by the Framework for Higher Education Qualifications in England, Wales and Northern Ireland (FHEQ) and the Scottish Credit and Qualifications Framework (SCQF) Level 10. On graduation all will have gained a range of transferable generic academic skills and capabilities, including study skills, independent learning, problem solving, reflective practice, communication skills, team working, research, innovation and leadership skills. These transferable skills should be embedded in the curriculum developed by each HEI. For those undertaking the apprenticeship programme, employers will be further assured that apprentices have gained the transferable skills required, given the successful completion of the EPA as part of or in addition to the degree programme.

SECTION 2: BSc(Hons) IN MEDICAL PHYSICS TECHNOLOGY

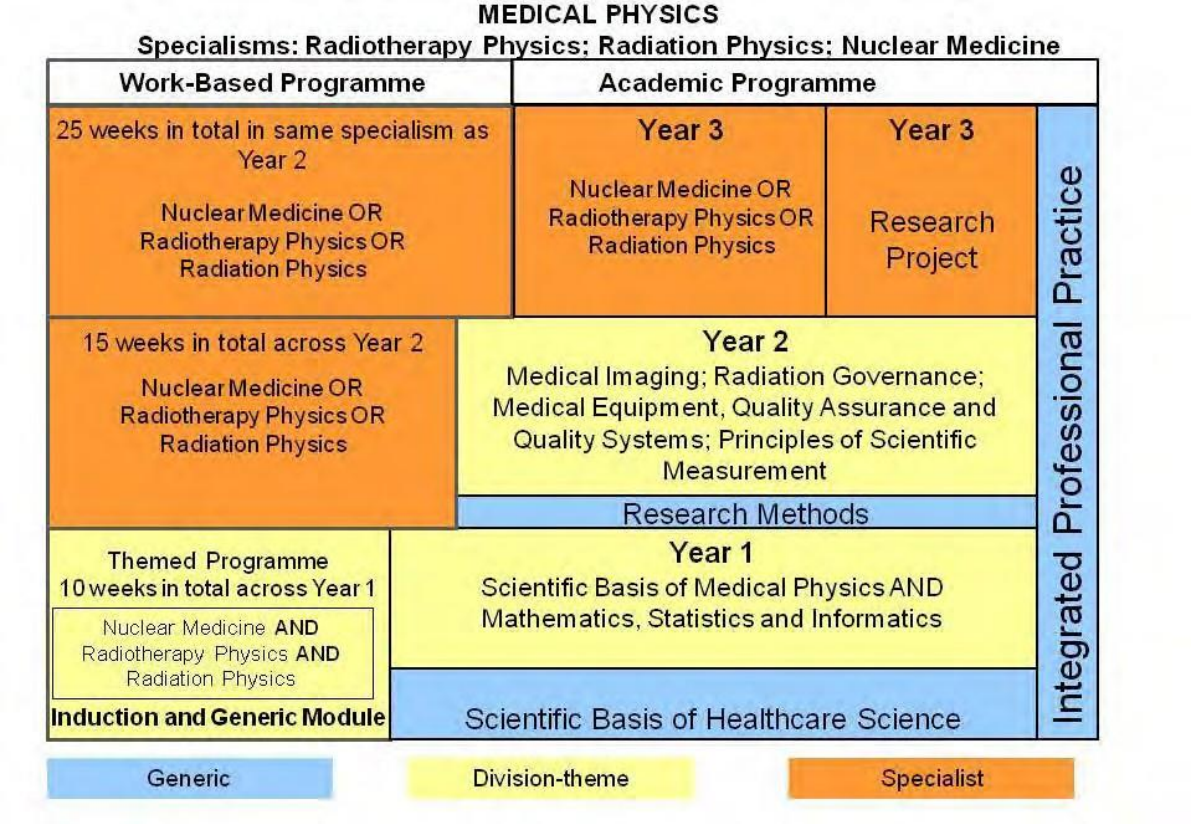
2.1 Details of the PTP Curriculum in Medical Physics Technology

The BSc (Hons) in Healthcare Science for the Practitioner Training Programme will begin with an induction programme provided by the academic provider. All HCS students will then complete a generic introductory module entitled ‘Scientific Basis of Healthcare Science’ and will begin to develop their knowledge and understanding of professional practice. Later in Year 1 they will study ‘Mathematics, Statistics and Informatics’ followed by the ‘Scientific Basis of Medical Physics Technology’. During Year 1 students will undertake 10 weeks of work-based learning across all three specialisms of Medical Physics Technology.

In Year 2, the students will continue to develop their learning in areas that are common across Medical Physics Technology, namely ‘Medical Imaging’, ‘Radiation Governance’, ‘Medical Equipment, Quality Assurance and Quality Systems’ and ‘Principles of Scientific Measurement’. They will also continue to build on their professional practice and complete the generic ‘Research Methods’ module. Year 3 is a specialist year where students will continue to build their professional practice, specialist practice and their research skills, including completing a research project in their chosen specialism. During Years 2 and 3 there will be a further 40 weeks of work-based learning. The emphasis will be developing and building knowledge and skills as they move through the programme, consistently demonstrating the requisite attitudes, behaviours and skills.

The diagram overleaf summarises the training programme for Medical Physics Technology.

Modernising Scientific Careers: Practitioner Training Programme (PTP): Diagrammatic representation of the full-time, three-year, pre-registration, integrated academic and work-based BSc (Hons) in Healthcare Science



This programme can be delivered part time through employment
Note: The 10-week work-based experience in Year 1 does not require equal time to spent in each specialism. However, the students should become acquainted with the breadth of Medical Physics Technology by the end of the first year

2.2 List of Modules

Year	Module Title	Credits
1	Professional Practice	10
1	Scientific Basis of Healthcare Science – integrated module across body systems	60
1	Mathematics, Statistics and Informatics	10
1	Scientific Basis of Medical Physics	40
2	Professional Practice	10
2	Research Methods	10
2	Medical Imaging	30
2	Radiation Governance	15
2	Medical Equipment, Quality Assurance and Quality Systems	15
2	Principles of Scientific Measurement	30
	NUCLEAR MEDICINE	
2	Work-based training	10
3	Professional Practice	10
3	Physics and Instrumentation	30
3	Clinical Indication, Pathology and Patient Care	30
3	Research Project in Nuclear Medicine	30
3	Work-based training	20
	RADIATION PHYSICS	
2	Work-based training	10
3	Professional Practice	10
3	Framework for Radiation Governance and Risk Management	30
3	Practice of Radiation Physics	30
3	Research Project in Radiation Physics	30
3	Work-based training	20
	RADIOTHERAPY PHYSICS	
2	Work-based training	10
3	Professional Practice	10
3	Cancer, Radiobiology and Clinical Radiotherapy Physics	30
3	Practice of Radiotherapy Physics	30
3	Research Project in Radiotherapy Physics	30
3	Work-based training	20

SECTION 3: GENERIC GOOD SCIENTIFIC PRACTICE SYLLABUS

Introduction

The Academy for Healthcare Science (AHCS) has set out the principles, values and the standards of behaviour and practice for the HCS workforce in the document *Good Scientific Practice* (GSP). These standards and values must be achieved and maintained in the delivery of work activities, the provision of care and personal conduct. In addition, the AHCS holds a Professional Standards Authority accredited register for Healthcare Science Practitioners (HCSPs) not covered by statutory regulation.[39] The Health and Care Professions Council (HCPC) sets out the Standards of Proficiency, which must be achieved for statutory registration as a Biomedical Scientist on completion of the Life Sciences Practitioner Training Programme (PTP).

Key professional practice learning outcomes are included in the BSc (Hons) programme through its GSP syllabus, thus embedding the standards of professionalism set out in GSP in all aspects of the delivery and assessment of the programme. The GSP syllabus is a common component of all PTP curricula and must be followed throughout the whole training period, with engagement at the appropriate level, depending on the stage of training.

The syllabus is divided into five domains. These align with the five domains of *Good Scientific Practice* (GSP):

- Domain 1: Professional Practice
- Domain 2: Scientific Practice
- Domain 3: Clinical Practice
- Domain 4: Research, Development and Innovation
- Domain 5: Clinical Leadership

Each domain contains an overall learning objective, which is described by a number of competence statements. These are presented as:

- knowledge to be acquired and applied;
- practical skills to be demonstrated;
- attitudes and behaviours to be consistently displayed.

As students progress through the three-year programme they are expected to critically reflect on their performance as they build on and extend the depth and complexity of the knowledge, skills and experience (spiral learning) that underpins professional practice as a HCSP.

[39] Practitioners who have completed an HCPC-approved PTP course in Life Sciences are eligible to apply for Statutory Regulation as Biomedical Scientists.

Domain 1: Professional Practice

Topic	Professional Practice	GSP reference
Learning objective	By the end of the course the student will be able to practise as an autonomous professional, usually within the context of the MDT, applying their knowledge appropriately, exercising their own professional judgement practising within the legal and ethical boundaries of the role of a HCSP and critically reflecting on, and developing their professional practice.	
High-level learning outcome(s)	By the end of the course, the student will be able to: • Demonstrate verbally, in written form and in practice, the knowledge and understanding of the professional requirements of a HCSP in the provision of patient-centred care and healthcare service(s) as described in GSP.	
Knowledge	By the end of the course students will know, comprehend and apply their knowledge, and will be able to: 1. Discuss the standards of proficiency of the AHCS and the HCPC and the role of regulation for healthcare professions. 2. Explain the importance of placing the patient at the centre of care and consider services from a user's point of view. 3. Explain the importance of keeping professional knowledge and skills up to date, working within the limits of personal competence. 4. Analyse the ethical, legal and governance requirements arising from working as a HCSP across a range of situations. 5. Summarise and evaluate the evidence to support the high levels of probity required when working at the level of HCSP. 6. Justify the importance of personal health and wellbeing in order to ensure that personal performance and judgement are not affected by their own health. 7. Analyse NHS organisation, policy, values and practice as it affects the provision of healthcare, healthcare science and the patients and populations it serves. 8. Discuss theories of teaching and learning to underpin the role of the HCS workforce in education as a learner, teacher, or trainer, according to the best contemporary clinical and educational standards. 9. Explain a range of strategies to ensure that the voice of patients and the public is embedded in all aspects of healthcare, healthcare science and healthcare science education in the academic and work-based setting. 10. Understand the need, where appropriate, to hold indemnity insurance.	1.1.1 1.1.4 1.1.5 1.1.6 1.1.7 1.2 1.2.5 1.4.1 1.4.2 2.3.2
Technical	By the end of the course, the student will be expected to apply in practice a range of professional,	

Topic	Professional Practice	GSP reference
procedures and clinical skills	technical and clinical skills and critically reflect on and develop their performance, working within the Standards of Proficiency set by the AHCS and for Biomedical Scientists, the HCPC. They will be able to: 1. Work within their agreed scope of practice. 2. Apply their understanding of professional practice with conduct that places the patient at the centre of care in a manner that promotes patient wellbeing and self-care in all academic and work-based activities. 3. Apply their understanding of the role and importance of continuing personal and professional development (CPPD) to ensure that their professional knowledge and skills are kept up to date. 4. Respond to the ethical, legal and governance requirements arising from working at the level of a HCSP, applying and accruing knowledge and evidence. 5. Work in a manner that demonstrates probity in every aspect of professional practice at all times. 6. Make appropriate judgements to ensure they limit their work or stop practising if their performance or judgement is affected by their health and raise any concerns about the performance of colleagues with their supervisor. 7. Maintain records accurately, comprehensively and comprehensibly in accordance with applicable legislation, protocols and guidelines. 8. Raise concerns through appropriate channels if they have evidence to believe that the practice or judgements of colleagues are impaired and are a matter of concern in relation to patient safety. 9. Work in accordance with relevant current NHS policy, guidelines and practice.	1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.6 1.1.7 1.1.8 1.1.10 1.2.2 2.2.3 2.2.6 2.2.7 2.3.2 3.2.2 4.1.2
Attitudes, values and behaviours	By the end of the course, the student will be expected to demonstrate the attitudes, values and behaviours of a HCSP and will be able to: 1. Apply evidence-based personal and team professional practice that places the patient at the centre of care. 2. Apply knowledge, experience and critical reflection to identify personal development needs using a range of tools, and develop and update action plans to ensure that they keep skills and knowledge up to date. 3. Display a professional commitment to ethical practice, consistently operating within national and local ethical, legal and governance requirements. 4. Apply the principles of GSP and its professional standards, performing to the highest standards of personal behaviour in all aspects of professional practice.	1.1.1– 1.1.10 1.2 1.3.1 2.2.3 2.2.6 2.2.7 2.2.8 4.1.2 4.1.6

Topic	Professional Practice	GSP reference
	5. Consistently operate in accordance with relevant current NHS policy and practice. 6. Operate consistently within a sphere of personal capability and level of authority, managing personal workload and objectives to achieve quality of care.	

Domain 2: Scientific Practice

Topic	Scientific Practice	GSP reference
Learning objective	By the end of the course, the student will establish and maintain a safe environment in which healthcare science is delivered, drawing on the knowledge, skills, attitudes and behaviours required for safe and effective practice. They will be able to deliver high-quality scientific services in a safe and secure working environment. They will also be able to reflect on their performance or situations and record their action plans as they continually evaluate, review and improve their practice.	
High-level learning outcome(s)	By the end of the course, the student will be able to: • Explain and apply the knowledge, skills, values and behaviours required of a HCSP in the delivery of high-quality, evidence-based and patient-centred services in a safe and secure working environment to which they effectively contribute.	
Knowledge	By the end of the course, the student will know, comprehend and apply the key concepts of the knowledge base relevant to healthcare science and will be able to: 1. Describe information and communication technologies (ICT) appropriate to the HCS specialism. 2. Explain the principles and practice of quality control (QC), external quality assessment and quality management as applied to relevant areas of healthcare science. 3. Explain the role of audit and the audit cycle and how it is used as a tool to facilitate continuous quality improvement. 4. Discuss and justify relevant health and safety legislation and guidance for the workplace.	1.4.5 2.2.2 2.2.7 2.2.9 2.3.1–2.3.4 3.1.17 3.2.1 4.1.2
Technical procedures and clinical skills	By the end of the course, the student will be expected to apply in practice a range of professional, technical and clinical skills and critically reflect on and develop their performance, working within the Standards of Proficiency set by the AHCS and for Biomedical Scientists, the HCPC. They will be able to: 1. Apply evidence-based practice, both current and new/emerging, in determining the use of scientific investigations and methods. 2. Apply the appropriate HCS knowledge and skills required for safe and effective practice. 3. Perform a range of routine technical and clinical skills relevant to the HCS division and theme in which they are training. 4. Master the use of ICT in relevant areas of healthcare science. 5. Apply and maintain quality standards and related QC, assessment and management techniques to	1.1.5 1.4.5 2.1.2 2.1.3 2.2.2 2.2.3 2.2.4 2.2.6 2.2.7 2.2.8

Topic	Scientific Practice	GSP reference
	assure the validity of scientific and technical investigations routinely and assure the quality of personal practice. 6. Participate in scientific and technical audit to determine that investigations and methods are fit for purpose. 7. Practise and promote the importance of health and safety standards in the workplace, prioritising patient safety and the safety of all those working in or accessing the specialism, and identify actions that will improve health and safety, including reducing the risk of infection.	2.2.9 2.3 3.1.5 3.2.1 4.1.2 4.1.6
Attitudes, values and behaviours	By the end of the course, the student will be able to: 1. Consistently practise in accordance with the values described in *Good Scientific Practice* and the NHS Constitution to ensure high-level, safe, effective and compassionate patient-centred care.	1.1.1–1.1.11 1.2

Domain 3: Clinical Practice

Topic	Clinical Practice	GSP reference
Learning objective	By the end of the course, the student will be able to deliver high-quality, effective and safe technical clinical services, performing a range of clinical and/or laboratory skills consistent with the required roles, responsibilities and values of a HCSP within their scope of practice.	
High-level learning outcome(s)	By the end of the course, the student will be able to: • Explain and demonstrate the need for and the ability to deliver high-quality technical and clinical services in the investigation and management of patients as part of a MDT. • Apply and demonstrate those skills, attitudes, values and behaviours, in a variety of settings and with regard to a variety of political, social, technical, economic, organisational and professional contexts, required of a HCSP delivering consistently high-quality technical and clinical services that are targeted to meet the needs of the individual and group needs of patients.	
Knowledge	By the end of the course, the student will know, comprehend and apply their knowledge and be able to: 1. Describe the pathophysiology of common diseases that result in a referral to HCS services in a specific area of practice. 2. Evaluate the contribution of the MDT to patient care, patient safety and quality outcomes, and consider barriers to effective MDT working. 3. Describe the key roles of the healthcare professions that contribute to the MDT in your area of practice. 4. Discuss your role within the MDT and evaluate the clinical effectiveness of the team, reflecting and suggesting as appropriate areas for improvement. 5. Describe typical behaviours of team members and evaluate the clinical effectiveness of the team and suggest areas for improvement as appropriate. 6. Discuss and evaluate the principles and practice of clinical audit as a tool to evaluate the effectiveness of services.	1.1.4 1.1.5 1.3.2 1.3.6 2.2.2 2.3.4 4.1.2 4.1.10
Technical procedures and clinical skills	By the end of the course, the student will be expected to apply in practice a range of professional, technical and clinical skills and critically reflect on and develop their performance, working within the Standards of Proficiency set by the AHCS and for Biomedical Scientists, the HCPC. They will be able to: 1. Deliver high-quality technical clinical procedures in the investigation and management of patients. 2. Apply in practice consistently high standards in the technical skills required in the investigation and	1.3.2 1.3.6 2.1.3 2.1.4 2.1.5 2.1.6

Topic	Clinical Practice	GSP reference
	management of patients and critically reflect on their performance. 3. Assist and, where appropriate, perform a range of equipment management skills, e.g. preventative maintenance, fault finding and calibration. 4. Attend and, if appropriate, actively participate in MDT meetings. 5. Assist in the design, data collection, data analysis and reporting within the clinical audit cycle.	2.2.1–2.2.4 2.2.6–2.2.9 4.1.10
Attitudes, values and behaviours	By the end of the course, the student would be expected to demonstrate the attitudes and behaviours necessary for the role of a HCSP and will be able to: 1. Commit to the provision of high standards of technical clinical services, taking account of the political, social, technical, economic, organisational and professional environment, and act as a positive role model. 2. Promote the importance of active participation of HCSPs in MDT meetings. 3. Advocate clinical audit as a tool to evaluate and optimise clinical services and communicate ideas and aspirations.	1.1.4 1.1.5 1.1.6 1.1.11 1.2.5 1.3.2 2.3 4.1.10

Domain 4: Research, Development and Innovation

Topic	Research, Development and Innovation	GSP reference
Learning objective	By the end of the course, the student will be able to justify the need for evidence-based practice, audit and innovation to support the development and improvement of patient services and patient safety, and will demonstrate the necessary knowledge, skills, attitudes, values and behaviours in relation to research, development and innovation in the pursuit of improved patient safety and care.	
High-level learning outcome(s)	By the end of the course, the student will be able to: • Explain the need for evidence-based practice, audit and innovation, within appropriate governance and ethical frameworks, in the delivery, development and improvement of patient-centred services. • Undertake or participate in personal or collaborative research, audit, development (professional or service) and innovation, applying the knowledge, skills, attitudes, values and behaviours required of a HCSP.	
Knowledge	By the end of the course, the student will know, comprehend and apply their knowledge and be able to: 1. Know the principles and applications of scientific enquiry, including the evaluation of treatment efficacy, the research process and research methodologies. 2. Know the value of research to the critical evaluation of practice research. 3. Describe and justify how and why research and development is undertaken within governance and ethical frameworks. 4. Explain ways in which the individual HCSP can support the wider healthcare team in the spread and adoption of innovative technologies and practice.	1.1.5 4.1.1 4.1.2 4.1.3 4.1.6 4.1.7 4.1.8 4.1.9 4.1.10
Technical procedures and clinical skills and procedures	By the end of the course, the student will be expected to apply in practice a range of professional, technical and clinical skills and critically reflect on and develop their performance, working within the Standards of Proficiency set by the AHCS and for Biomedical Scientists, the HCPC. They will be able to: 1. Apply research methods and techniques to initiate and complete a research project, development or innovation project. 2. Evaluate research and other evidence to inform own practice.	4.1.3 4.1.6 4.1.8 4.1.9
Attitudes, values and behaviours	By the end of the course, the student would be expected to demonstrate the attitudes and behaviours necessary for the role of a HCSP and will: 1. Work with appropriate research and development governance, legal and ethical frameworks. 2. Promote the need for evidence-based practice to support the provision of high-quality care.	1.1.4 1.1.5 4.1.1 4.1.2

Topic	Research, Development and Innovation	GSP reference
	3. Be flexible and adaptable to the introduction of new scientific, technical, diagnostic, monitoring, treatment and therapeutic procedures into routine practice. 4. Keep up to date as part of a commitment to CPPD.	4.1.4 4.1.6

Domain 5: Clinical Leadership

Topic	Clinical Leadership	GSP reference
Learning objective	The NHS Leadership Academy states that: '*The Healthcare Leadership Model is to help those who work in health and care to become better leaders. It is useful for everyone – whether you have formal leadership responsibility or not, if you work in a clinical or other service setting, and if you work with a team of five people or 5,000.'* By the end of this course the student should therefore begin to develop an understanding of the key concepts of leadership; the skills, qualities and abilities of effective leaders and how their personal qualities affects the experiences of patients and service users, the organisation, the quality of care provided, and the reputation of the organisation itself. They will be introduced to assessment tools to measure their personal qualities and critically reflect on performance to identify their own personal qualities, including values, principles and assumptions, developing action plans to adapt personal behaviour as necessary.	
High-level learning outcome(s)	By the end of the course, the student will: • Understand the principles underpinning the current NHS clinical leadership frameworks[40] and the associated personal qualities and the impact of personal qualities on the culture and climate within which the student, their colleagues and teams work.	
Knowledge	By the end of the course, the student will know, comprehend and apply their knowledge and be able to: 1. Explain the difference between leadership and management. 2. Discuss the skills, qualities and abilities of effective leaders. 3. Describe the impact of personal qualities on the culture and climate the student, their colleagues and teams work in. 4. Discuss how what the student does and how they behave affects the experiences of patients/service users, the organisation, the quality of care provided, and the reputation of the organisation itself.	5.1.1–5.1.6 5.1.10 5.1.12
Technical procedures and clinical skills	By the end of the course, the student will be expected to apply in practice a range of professional, technical and clinical skills and critically reflect on and develop their performance, working within the Standards of Proficiency set by the AHCS and for Biomedical Scientists, the HCPC. They will be able to: 1. Identify and develop skills in listening, observing and using feedback. 2. Identify conflict style and develop skills in negotiating and mediating conflicts.	
Attitudes,	By the end of the course, the student would be expected to demonstrate the personal qualities that	1.3.1

[40] http://www.leadershipacademy.nhs.uk/wp-content/uploads/dlm_uploads/2014/10/NHSLeadership-LeadershipModel-colour.pdf

Topic	Clinical Leadership	GSP reference
values and behaviours	underpin the practice of a HCSP, namely self-awareness, e.g. self-confidence; self-control; self-knowledge; personal reflection; resilience and determination. Students should be aware of their strengths and limitations in these areas and how these will have a direct effect on how they behave and interact with others. Students will be expected to critically reflect on performance to identify their own personal qualities, including values, principles and assumptions, developing action plans to adapt personal behaviour as necessary.	1.3.2 1.3.3 1.3.4 1.3.5 1.3.6

SECTION 4: GENERIC PROFESSIONAL, SCIENTIFIC AND TECHNICAL MODULES

This section covers the three generic modules that will be studied by all students undertaking an MSC accredited BSc (Hons) Healthcare Science integrated degree.

- Years 1 – 3: Professional Practice [10 credits per year developing learning at Level 4, Level 5 and Level 6]
- Year 1: Scientific Basis of Healthcare Science [60 credits]: Level 4
- Year 2: Research Methods [10 credits]: Level 5
- Year 3 Research Project [30 credits]: Level 6

GM(i): Professional Practice (Years 1, 2 and 3)

Topic	Professional Practice [10 credits per year]	GSP reference
Learning objective	The overall aim of this module is to ensure that the student has the underpinning knowledge, understanding and skills, and consistently demonstrates the values, attitudes and behaviours to perform a range of technical and clinical skills working within the Standards of Proficiency set by the AHCS and for Biomedical Scientists, the HCPC. Professional practice should be embedded in every aspect of the three-year programme to enable the student to develop and build their professional practice as they progress through the programme. In line with the concept of a spiral curriculum, students will encounter the same subject in different parts of the curriculum, but across the three-year programme the complexity will increase and the student will reinforce previous learning, gradually increasing their knowledge, skills and confidence.	
Knowledge	On successful completion of this programme the student will: **Professional practice** 1. Describe the values and principles that underpin the shared UK NHS and Social Care services culture, including the HEE five key workforce characteristics and the NHS Constitution, especially the values relating to compassion, transparency, candour, openness and leadership.[41,42] 2. Describe the role of the HCSP and how HCSPs contribute to the delivery of high-quality healthcare. 3. Explain the importance of placing the patient at the centre of care and discuss how this translates into practice. 4. Discuss the impact of culture, equality and diversity on practice. 5. Discuss how HCS services can work in partnership with patients and service users to ensure the views of patients are central to delivering, develop and maintaining high-quality, safe services. **Legal and ethical boundaries of practice** 6. Analyse the ethical, legal and governance requirements arising from working at the level of a HCSP across a range of situations. 7. Discuss the principles, guidance and law with respect to medical ethics, patient confidentiality (the limits of the concept of confidentiality), informed consent, equality and diversity,	1.1 1.2 1.3 2.3.4 4.1.1 5.1.2 5.1.4

[41] Investing in People – Workforce Plan for England.
[42] Maps to Francis Report, Recommendation 2 – also to The Speaking Up Charter.

Topic	Professional Practice [10 credits per year]	GSP reference
	safeguarding, use of chaperones. 8. Summarise the procedures to follow if cautioned, charged with a criminal offence, suspended, or have restrictions placed on personal scientific, clinical or professional practice. 9. Justify the importance of personal health and wellbeing to ensure personal performance and judgement is not affected by their own health. **Patient safety and quality** 10. Explain the importance of protecting patients from risk or harm presented by another person's conduct, performance or health, and what to do when concerns are identified or raised. 11. Discuss how to how to share information appropriately with patients, carers, colleagues and other services to support the quality of care. 12. Explain the common causes of error and understand the critical incident reporting process, recognising the importance of promoting a no-blame culture. 13. Explain approaches to procedures for identifying and reporting critical incidents and receiving and responding to complaints. 14. Explain current national and local policy issues as they affect the service provided by HCSPs and the HCS workforce. 15. Discuss your role in healthcare science and its contribution to the delivery of high-quality healthcare. 16. Explain why it is important that the HCS workforce takes reasonable care of health and safety at work for themselves, members of their team and others. **Communication skills** 17. Explain the principles that underpin effective verbal and written communication within your role, including those who do not have English as a first language and communication with people with sensory and cognitive impairments. **Leadership** 18. Explain the concept of shared leadership and the associated personal qualities and behaviours that promote shared leadership and apply this knowledge within the work-base. **Continuing personal and professional development** 19. Explain the importance of keeping professional knowledge and skills up to date and working within the limits of their personal competence.	

Topic	Professional Practice [10 credits per year]	GSP reference
	20. Justify the rationale for engaging in CPPD and critical reflective practice, and evaluate methods for recording, learning, developing and evaluating action plans.	
Technical skills and procedures	By the end of the course, the student will be expected to apply in practice a range of professional, technical and clinical skills and critically reflect on and develop their performance, working within the Standards of Proficiency set by the AHCS and for Biomedical Scientists, the HCPC.	1.1 1.2 1.3

GM(ii): Scientific Basis of Healthcare Science (Year 1)

Topic	Scientific Basis of Healthcare Science [60 credits]	GSP reference
Learning objective	The overall aim of this introductory module is to provide all students with a broad knowledge and understanding of clinical science and scientific knowledge, contextualised to the practice of healthcare science and the services provided by their HCS 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, personalised medicine and clinical bioinformatics. All members of the HCS 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. As an introductory module it will 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, personalised/precision medicine and clinical bioinformatics. 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 students. This module is designed to provide students with broad scientific knowledge to underpin their future practice to provide the foundations for study in any area of healthcare science.	
Knowledge	On successful completion of this module the student will: 1. Describe the structural, chemical, cellular and tissue organisation of the body and explain the cellular, tissue and systems responses to diseases. 2. Explain the structure and function of all body systems and the effects of common diseases. 3. Explain the principles and core concepts of clinical genetics, genomics and personalised/precision medicine and discuss in the context of patients referred to HCS services. 4. Explain the basis of epidemiology, public health, health prevention and health protection and discuss in relation to the role of the public health function and HCS services. 5. Explain the principles of clinical pharmacology and therapeutics and discuss in relation to patients referred to HCS services. 6. Explain the principles and core concepts of the sociology of health and illness and discuss those relevant to patients typically referred to HCS services. 7. Explain the basic principles of physics and clinical engineering that underpin HCS and discuss in relation to patients referred to HCS services.	1.1.4 1.1.5 1.1.6 2.1.6

Topic	Scientific Basis of Healthcare Science [60 credits]	GSP reference
	8. Explain the principles of clinical bioinformatics and health informatics and discuss their impact on healthcare, health and HCS services. 9. Explain a range of mathematical and statistical techniques that underpin the practice of healthcare science. 10. Keep up to date with developments in healthcare and healthcare science, identifying new and innovative scientific and technical developments and their application in healthcare science.	
Technical skills and procedures	By the end of this module the student will be expected to apply in practice a range of technical and clinical skills and critically reflect on and develop their performance, working within the Standards of Proficiency set by the AHCS and for Biomedical Scientists, the HCPC. Students will be expected to apply and develop their knowledge as they progress through the programme in their academic and work-based learning. They will also be expected to develop a range of study skills, including time management, organisational skills, using the library, search engines, self-directed learning, critical analysis and avoiding plagiarism.	1.1.4 1.1.5 1.1.6 2.2.4

GM(iii): Research Methods (Year 2)

Topic	Research Methods [10 credits]	GSP reference
Learning objective	The overall aim of this module is to ensure that the student has the knowledge, skills and experience of the place 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, students 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. Students will extend their knowledge and application of mathematics, statistics and data presentation techniques gained in Year 1. This module will provide the underpinning knowledge to support the final year research project.	
Knowledge	On successful completion of this module the student will: 1. Explain and justify the process and importance of research, innovation and audit to the NHS and healthcare science. 2. Explain the current UK ethical, legal and governance frameworks within which human and animal research can be conducted. 3. Explain the principles of evidence-based medicine; literature and systematic review; and the development of clinical guidelines. 4. Describe a range of study designs and discuss the appropriate use of each method. 5. Describe and justify the use of statistical techniques to analyse data and a range of dissemination methods to share research findings.	4.1.1 4.1.7

GM(iv): Research Project (Year 3)

Topic	Research Project [30 credits]	GSP reference
Learning objective	The overall aim of this module, building on the Research Methods module, is for the student to apply the methods and techniques that they have learned to review, consolidate, extend and apply their knowledge and understanding as they initiate and complete a research project. 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. Research projects should be designed to take into account the current research programmes of the academic and/or work-based departments in which the research is to be conducted.	
Knowledge	By the end of this module the student will: 1. Discuss the range of research undertaken in health and healthcare science and how these are applied in the specialism in which the student is based. 2. Describe the ethical and governance approval processes required to undertake the planned research project.	1.1.4 1.1.5 4.1.1 4.1.2
Technical skills and procedures	On successful completion of this module and working within legal and ethical frameworks the student will be able to: 1. Work with a supervisor to 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 project report that describes and critically evaluates the research project, clearly identifying the strengths and weaknesses. 4. Present a summary of the research project, responding to questions appropriately. 5. Prepare a summary of the research project suitable for non-specialist and lay audiences.	4.1.1 4.1.2 4.1.3 4.1.6 4.1.8 4.1.9
Technical skills and procedures	On successful completion of this module and working within legal and ethical frameworks the student will be able to: 1. Undertake an evidence-based literature review, critically appraise the output, draw appropriate conclusions and prepare a written report the findings, and where appropriate, use the findings to	2.1.6 2.2.4 4.1.1 4.1.2 4.1.7

Topic	Research Project [30 credits]	GSP reference
	inform the third-year research project. 2. Present the outcome of the literature review to a non-scientific and scientific audience.	4.1.9

SECTION 5: DIVISION-THEME SCIENTIFIC AND TECHNICAL SYLLABUS

5.1 Attitudes, Behaviours and Values

The student will be expected to critically reflect on their professional practice and consistently demonstrate the professional attributes and insights required of a HCSP.

The following learning outcomes should be achieved, as appropriate to the modules within the Medical Physics Technology syllabus:

- Work within the Standards of Conduct, Performance and Ethics set by the AHCS in *Good Scientific Practice*
- Show respect and behave in accordance with *Good Scientific Practice*
- Treat patients, carers and their families with respect, kindness and compassion, putting them at their ease.
- Show understanding of the patient's anxiety and be sympathetic and kind, respecting and understanding individuals' beliefs and ways of coping with illness.
- Appreciate the empathy and sensitivity needed when dealing with the patient experience of long-term conditions and terminal illness.
- Appreciate the impact of medical physics services on the patient pathway and outcome.
- Appreciate the emotional and psychological impact the patient, relatives and carers might experience when undergoing investigations, diagnosis and treatment.
- Act in a calm, controlled and reassuring manner.
- Behave in a professional manner in matters of attendance and appearance.
- Recognise the limits of professional competence, seeking help and support and referring to colleagues appropriately.
- Maintain confidentiality of patient information and data.
- Value social diversity and its relationship to service provision in healthcare.
- Work effectively within a MDT, developing and maintaining professional relationships.
- Develop a balance between reflective practice and active exploration in personal learning and take responsibility for personal learning.
- Develop, maintain and improve personal knowledge and skills and engage in evidence based practice.
- Consistently work safely, demonstrating being precise and paying attention to detail.
- Communicate effectively within the healthcare environment and clinical team, adapting communication to meet varying needs and overcoming barriers to understanding.
- Communicate scientific and engineering information at a level appropriate to the audience, including the public.

- Use correct terminology appropriate to healthcare, healthcare science, Medical Physics Technology and the specialist areas where work placements are undertaken.
- Listen and extract relevant information.
- Encourage feedback from the public, patients and staff, welcome it and use it to improve services.
- Establish and influence the culture of health and safety in the workplace.
- Recognise, where necessary, the urgency of a situation and seek help and advice.
- Show a positive attitude to lifelong learning and professional development.
- Bring the highest levels of knowledge and skill at times of basic human need when care and compassion are what matters most.

The PTP syllabus for Medical Physics Technology follows.

5.2 Division-theme Modules

This section covers the six division-theme modules that will be studied by all students undertaking the Medical Physics Technology PTP:

MP(i): Mathematics, Statistics and Informatics (Year 1)
MP(ii): Scientific Basis of Medical Physics (Year 1)
MP(iii): Medical Imaging (Year 2)
MP(iv): Radiation Governance (Year 2)
MP(v): Medical Equipment, Quality Assurance and Quality Systems (Year 2)
MP(vi): Principles of Scientific Measurement (Year 2)

Year 1
MP(i): Mathematics, Statistics and Informatics
[10 credits]

Topic	Mathematics, Statistics and Informatics [10 credits]	GSP reference
Learning objective	The overall aim of this module is to ensure that the student has the underpinning knowledge of mathematics, statistics and informatics required for their role	
Knowledge	By the end of this module the student will be able to: 1. Explain the need to apply the appropriate mathematical and statistical tools for tasks they are required to perform within the clinical environment. *2.* Explain the need for data security and confidentiality within their clinical environment. *3.* Discuss the essential issues associated with computing technologies and their management as appropriate to either Clinical Engineering, Medical Physics or Clinical Photography.	2.1.2 2.1.5 3.1.6 3.1.9
Technical skills	By the end of this module, the student will be expected to apply in the academic setting a range of technical skills and critically reflect on and develop their performance, working within the Standards of Proficiency set by the AHCS, and will be able to: 1. Analyse and interpret data within a work-based context. 2. Manipulate, analyse and present technical and clinical information appropriately, using spreadsheets, databases and presentation software. 3. Solve problems by applying appropriate mathematical and statistical techniques to clinical data, e.g. algebra, trigonometry, exponential, graphs and linear relationships. 4. Use data securely, respecting confidentiality and maintaining consent in the use of data. 5. Present data appropriately and communicate effectively.	2.2.1 2.2.9 4.1.9

Year 1
MP(ii): Scientific Basis of Medical Physics
[40 credits]

Topic	Scientific Basis of Medical Physics, including work-based training [40 credits]	GSP reference
Learning objective	The overall aim of this module is to ensure that the student understands the breadth of the application of science within Medical Physics Technology, the underpinning radiation physics and is able to work safely within the medical physics environment within a hospital. The overall aim of the work-based placements within Year 1 is to provide the student with a broad appreciation of the range of work undertaken within healthcare science. Students will begin the process of the development of the skills and attitudes relevant to the HCSP, building on learning in the academic environment, including practical sessions, clinical skills sessions, reflection on development, etc. Additionally it should help students learn in the context of practice and real-life experience and have a motivational element as they work towards a career in the NHS. This module will provide a foundation from which the student will build their knowledge, skills, experience and attitudes throughout the three-year programme of study and transfer these skills to employment in healthcare science. It is expected that this period of initial work-based training will provide the opportunity to begin to integrate and embed many of the professional practice learning outcomes and enable the student to practise safely in the workplace.	
Knowledge	By the end of this module, with reference to each form of radiation (ionising, ultraviolet [UV], radio frequency [RF] and microwaves, lasers, infrared, magnetic fields), the student will be able to: 1. Describe and explain, using the correct scientific terminology, the basic laws that underpin electricity and magnetism. 2. Describe and explain, using the correct scientific terminology, the sources of radiation and their physical properties, demonstrating an understanding of the underlying basic physics. 3. Describe and explain the interactions of radiation with matter. 4. Describe and explain the basic equipment and clinical applications of each type of radiation. 5. Describe and explain the biological effects and measurement of each type of radiation. 6. Describe and explain the possible health effects and safety of each type of radiation. 7. Describe the procedures and need for evaluation of adverse incidents and the potential impact of adverse incidents on patients, carers and healthcare professionals. 8. Know and discuss basic radiation protection principles and the basic application of legislation within	1.1.4 2.1.1 2.1.2 2.2.6 2.2.9 5.1.4

Topic	Scientific Basis of Medical Physics, including work-based training [40 credits]	GSP reference
	the workplace. 9. Describe the role of a Medical Physics Technology HCSP within their specific practice environment, the patient pathway and within the wider context of healthcare.	
Technical and clinical skills	By the end of this module, the student will be expected to apply in practice a range of technical and clinical skills and critically reflect on and develop their performance, working within the Standards of Proficiency set by the AHCS and will be able to: 1. Perform a range of generic skills, including infection control, basic life support, communication and team working, adhering to health and safety regulations, and behaving in a professional manner in accordance with *Good Scientific Practice*. 2. Practise the highest standards of person-centred care, treating every person with compassion, dignity and respect. 3. Demonstrate safe working practice within an ionising radiation environment. 4. Observe and assist with some examples of standard technical and clinical procedures in nuclear medicine, radiation safety and radiotherapy physics. 5. Observe and assist with contamination and radiation dose measurements. 6. Observe and assist with the production of a radiotherapy treatment plan and the production of an immobilisation device. 7. Communicate effectively within the healthcare environment and clinical team, adapting communication to meet varying needs and overcoming barriers to understanding.	1.1.1 1.1.3 1.1.7 1.2.5 2.1.3 2.2.3 2.2.4 2.2.7 2.2.9 5.1.2 5.1.4

Year 2
MP(iii): Medical Imaging
[30 credits]

Topic	Medical Imaging [30 credits]	GSP reference
Learning objective	The overall aim of this module is to ensure that the student understands the principles of medical image formation, the operation, role, clinical applications and health effects of different imaging modalities and discuss the advantages and disadvantages of each.	
Knowledge	By the end of this module, for each imaging modality, the student will be able to: 1. Describe and explain the principles of image formation, acquisition and manipulation including image registration, reconstruction, display, storage and sharing. 2. Describe and explain the principles of operation and application in the patient pathway of a range of ionising radiation and non-ionising radiation imaging modalities and appraise the choice of imaging technique. 3. Appraise the risks and benefits of each modality including the health effects of radiation. 4. Describe and explain the QA framework for each modality. *5.* Describe and explain the legislative framework surrounding the use of each modality.	2.1.1 2.1.2 2.1.5 2.2.1 2.2.9 3.1.6 3.1.9
Technical skills	**The Year 2 and 3 work-based learning outcomes can be found in:** For Nuclear Medicine in module MPNM(ii): Clinical Indication, Pathology and Patient Care For Radiation Physics in module MPRP(ii): Practice of Radiation Physics For Radiotherapy Physics in module MPRT(ii): Practice of Radiotherapy Physics	

Year 2
MP(iv): Radiation Governance
[15 credits]

Topic	Radiation Governance [15 credits]	GSP reference
Learning objective	The overall aim of this module is to ensure that the student understands and can work safely within the legislative and policy framework around the safe use of ionising and non-ionising radiation in a healthcare environment.	
Knowledge	By the end of this module for each type of radiation the student will be able to: 1. Describe and explain the principles of radiation protection, relevant policy and legislation, and dose limitation. 2. Discuss and evaluate the governance framework within the workplace to demonstrate legislative compliance. 3. Describe the different types of personal and environmental dose monitors and explain how they are used in the healthcare environment. 4. Explain the factors affecting the design of radiation facilities. 5. Apply basic problem solving skills and knowledge to analyse a range of clinical and technical scenarios.	2.1.5 2.2.9 2.3.3 3.2.4 5.1.2
Technical and clinical skills	**The Year 2 and 3 work-based learning outcomes can be found in:** For Nuclear Medicine in module MPNM(ii): Clinical Indication, Pathology and Patient Care For Radiation Physics in module MPRP(ii): Practice of Radiation Physics For Radiotherapy Physics in module MPRT(ii): Practice of Radiotherapy Physics	

Year 2
MP(v): Medical Equipment, Quality Assurance and Quality Systems
[15 credits]

Topic	Medical Equipment, Quality Assurance and Quality Systems [15 credits]	GSP reference
Learning objective	On successful completion of this module the student will know and understand the principles that underpin the operation, QA and quality systems of medical equipment commonly encountered in medical physics and its importance in the maintenance of patient safety.	
Knowledge	By the end of this module the student will be able to: 1. Describe each stage of the medical equipment life cycle and management and how this is implemented within healthcare, with reference to legislation, guidance and standards. 2. Explain the operation and principles of radiation-emitting equipment. 3. Explain the role of quality systems and their place in the safe delivery of modern healthcare. 4. Describe and understand QA tests commonly performed on medical equipment and systems encountered in medical physics and their impact on patient safety. 5. Explain the importance of control of infection and decontamination of medical equipment. 6. Know the processes and regulations relating to the decommissioning and disposal of medical devices.	2.1.5 2.1.6 2.2.9 2.3.3 2.3.4
Technical and clinical skills	**The Year 2 and 3 work-based learning outcomes can be found in:** For Nuclear Medicine in module MPNM(ii): Clinical Indication, Pathology and Patient Care For Radiation Physics in module MPRP(ii): Practice of Radiation Physics For Radiotherapy Physics in module MPRT(ii): Practice of Radiotherapy Physics	

Year 2
MP(vi): Principles of Scientific Measurement
[30 credits]

Topic	Principles of Scientific Measurement [30 credits]	GSP reference
Learning objective	The overall aim of this module is to ensure that the student understands the principles of scientific measurement, including calibration, errors and precision, particularly as it relates to the measurement of ionising radiation and non-ionising (including ultrasound) radiation. In addition, the student will understand the measurement of physiological signals relating to gating systems used in Medical Physics Technology.	
Knowledge	By the end of this module the student will: 1. Describe and explain the principles of scientific measurement, including calibration, errors and precision. 2. Describe basic analogue and digital electronics. 3. Explain the components of an instrumentation system, describe the components of a generalised instrument system and have knowledge of range of system parameters. 4. Discuss different radiation detector systems, the appropriate choice of detector and counting statistics. 5. Describe and explain common techniques for the measurement of physiological signals and their impact on patient safety and comfort. 6. Describe and explain the physiological signals used in cardiac and respiratory gating.	2.1.1 2.1.5 2.2.6 2.2.9 3.2.2
Technical and clinical skills	**The Year 2 and 3 work-based learning outcomes can be found in:** For Nuclear Medicine in module MPNM (ii): Clinical Indication, Pathology and Patient Care For Radiation Physics in module MPRP(ii): Practice of Radiation Physics For Radiotherapy Physics in module MPRT(ii): Practice of Radiotherapy Physics, Pathology and Patient Care	

SECTION 6: NUCLEAR MEDICINE SPECIALIST TECHNICAL AND SCIENTIFIC MODULES

6.1 Specialist Modules for Nuclear Medicine

Interpretation of the high-level framework: Medical Physics Technology specialising in Nuclear Medicine

	Module Titles						
Year 3 Application to Practice	Professional Practice [10]	Physics and Instrumentation [30]	Clinical Indication, Pathology and Patient Care [30]		Research Project [30]	Work-based training 25 weeks [20]	
Year 2 Technologies and Methodologies	Professional Practice [10]	Research Methods [10]	Medical Imaging [30]	Radiation Governance [15]	Medical Equipment , Quality Assurance and Quality Systems [15]	Principles of Scientific Measurement [30]	Work-based training 15 weeks [10]
Year 1 Scientific Basics	Professional Practice [10]	Scientific Basis of Healthcare Science [60]		Mathematics, Statistics and Informatics [10]	Scientific Basis of Medical Physics, including work-based training 10 weeks [40]		

[XX] = Number of credits

Generic modules: Common to all divisions of Healthcare Science

Division-theme modules: Shared by a group of specialisms, usually within a Healthcare Science division

Specialist modules: Specific to a specialism

Year 3
MPNM(i): Physics and Instrumentation
[30 credits]

Topic	Physics and Instrumentation [30 credits]	GSP reference
Learning objective	The overall aim of this module is to ensure that the student has an understanding of instrumentation and procedures carried out in the nuclear medicine department and understands the physical processes that underpin them.	
Knowledge	By the end of this module the student will: 1. Critically evaluate imaging systems used in nuclear medicine, their performance, uses and applications, QC procedures and their role in the patient pathway. 2. Describe and explain radiation dosimetry as applicable to nuclear medicine practice 3. Explain and critically evaluate the procedures, radiation protection and legislative issues surrounding the administration of radioactive materials with adult and paediatric patients, with particular regard to patient safety and dignity. 4. Explain the principles of radionuclide production, with reference to the different methods of production. 5. Critically appraise the problems associated with the assay of radioactive material and the principles of such measurements. 6. Describe the design or refurbishment of a nuclear medicine department.	2.1.1 2.1.3 2.1.5 2.1.6 2.2.6 2.3.2 3.2.2
Technical and clinical skills	**The Year 2 and 3 work-based learning outcomes can be found in module MP(ii): Clinical Indication, Pathology and Patient Care**	

Year 3
MPNM(ii): Clinical Indication, Pathology and Patient Care
[30 credits] plus work-based learning [30 credits]

Topic	Clinical Indication, Pathology and Patient Care [30 credits] including work-based learning [30 credits]	GSP reference
Learning objective	The overall aim of this module is to ensure that the student has the underpinning knowledge to allow them to carry out a range of nuclear medicine investigations.	
Knowledge	By the end of this module the student will: 1. Explain the anatomy and physiology relating to the practice of nuclear medicine. 2. Critically discuss the problems associated with the care of patients undergoing nuclear medicine investigations or treatments. 3. Explain and critically evaluate the procedures, radiation protection and legislative issues surrounding the administration of radioactive materials with adult and paediatric patients. 4. Appraise a range of radiopharmacy techniques, including generators, isotope properties and blood-labelling techniques. 5. Describe and critically analyse the role of nuclear medicine in the diagnosis of disease, with reference to a range of different body systems. 6. Discuss and evaluate radiopharmaceuticals in terms of radionuclide chemistry, biological behaviour and factors affecting product quality. 7. Critically review and evaluate applications of nuclear medicine in terms of diagnosis and therapy for a range of body systems with due reference to patient care needs.	2.1.1 2.1.3 2.1.5 2.1.6 2.2.6 2.3.2 3.2.2
Technical and clinical skills	By the end of this module, the student will be expected to apply in practice a range of technical and clinical skills and critically reflect on and develop their performance, working within the Standards of Proficiency set by the AHCS, and will be able to: **Safe working and equipment management in the nuclear medicine environment** 1. Work safely within the legislative and policy framework around the safe use of ionising radiation within a hospital environment. 2. Observe and assist in the procurement of equipment, accessories, or consumables. 3. Observe and perform the risk assessment of equipment.[43] 4. Perform the cleaning of a range of equipment, applying cleaning and/or decontamination processes.	1.1.1 1.1.3 1.1.7 1.2.5 1.3.2 1.4.5 2.1.4 2.1.5 2.2.4

[43] *Note: When performing a risk assessment all risk elements must be considered.*

Topic	Clinical Indication, Pathology and Patient Care [30 credits] including work-based learning [30 credits]	GSP reference
	5. Assist and perform a range of fault reporting and first-line user maintenance procedures. 6. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*. **Diagnostic imaging and therapy in nuclear medicine** 1. Set up, optimise and operate imaging equipment safely so as to be able to produce the highest-quality results for interpretation across a range of nuclear medicine investigations. 2. Perform all aspects of the preparation required, including providing relevant information and guidance to the patient/carer. 3. Perform a range of acquisition and recording techniques used when carrying out diagnostic imaging procedures. 4. Perform a range of nuclear medicine therapy procedures used in the clinical treatment pathway of patients. 5. Perform tracer methodology procedures in nuclear medicine investigations. 6. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*. **Radiopharmaceuticals** 1. Administer radiopharmaceuticals while observing all safety, control of infection and radiation protection governance requirements. 2. Work in a radiopharmacy safely and within the legislative and statutory framework to prepare and dispense radiopharmaceuticals for use in the diagnosis or treatment of patients. 3. Apply QC procedures within the radiopharmacy to establish and maintain a safe environment that meets all legislative and medicine inspectorate requirements. 4. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*. **Safe working with radioactivity in the clinical environment** 1. Use a dose calibrator in the preparation and measurement of radioactivity. 2. Perform in-vitro procedures in nuclear medicine. 3. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*.	2.2.6 2.2.8 2.2.9 2.3.3 2.3.4 3.1.5 3.1.7 3.2.1 3.2.2 3.2.3 3.2.4 5.1.2 5.1.4 5.1.12

SECTION 7: RADIATION PHYSICS TECHNICAL AND SCIENTIFIC SPECIALIST MODULES

7.1 Specialist Modules for Radiation Physics

Interpretation of the high-level framework for Medical Physics Technology specialising in Radiation Physics

<table>
<tr><th></th><th colspan="8">Module Titles</th></tr>
<tr><td>Year 3
Application to Practice</td><td>Professional Practice
[10]</td><td colspan="2">Framework for Radiation Governance and Risk Management
[30]</td><td colspan="2">Practice of Radiation Physics
[30]</td><td>Research Project
[30]</td><td colspan="2">Work-based training
25 weeks
[20]</td></tr>
<tr><td>Year 2
Technologies and Methodologies</td><td>Professional Practice
[10]</td><td>Research Methods
[10]</td><td>Medical Imaging
[30]</td><td>Radiation Governance
[15]</td><td>Medical Equipment, Quality Assurance and Quality Systems
[15]</td><td colspan="2">Principles of Scientific Measurement
[30]</td><td>Work-based training
15 weeks
[10]</td></tr>
<tr><td>Year 1
Scientific Basics</td><td>Professional Practice
[10]</td><td colspan="3">Scientific Basis of Healthcare Science
[60]</td><td>Mathematics, Statistics and Informatics
[10]</td><td colspan="3">Scientific Basis of Medical Physics, including work-based training
10 weeks
[40]</td></tr>
</table>

[XX] = Number of credits

Generic modules: Common to all divisions of Healthcare Science

Division-theme modules: Shared by a group of specialisms, usually within a Healthcare Science division

Specialist modules: Specific to a specialism

Year 3
MPRP(i): Framework of Radiation Governance and Risk Management
[30 credits]

Topic	Framework of Radiation Governance and Risk Management [30 credits]	GSP reference
Learning objective	The overall aim of this module is to ensure that the student has an understanding of the main sources of ionising and non-ionising radiation encountered in the clinical environment, the legislative and organisational framework surrounding their use, and the principles of risk assessment and risk management.	
Knowledge	By the end of this module the student will: 1. Explain the main clinical sources of ionising and non-ionising radiation and their interaction with human tissue. 2. Evaluate the organisational arrangements for radiation protection and the role of quality management, with particular regard for patient safety. 3. Critically review and evaluate legislation and codes of practice associated with the control of ionising and non-ionising radiation. 4. Describe and evaluate risk assessment and emergency procedures of all clinical diagnostic X-ray and non-ionising radiation sources and their role in ensuring patient safety and comfort. 5. Appraise the safe use of radioactive materials in the clinical environment.	2.1.1 2.1.3 2.1.5 2.1.6 2.2.6 2.3.2 3.2.2
Technical and clinical skills	**The Year 2 and 3 work-based learning outcomes can be found in module MPRP(ii): Practice of Radiation Physics.**	

Year 3
MPRP(ii): Practice of Radiation Physics
[30 credits] plus work-based learning [30 credits]

Topic	Practice of Radiation Physics [30 credits] including work-based learning [30 credits]	GSP reference
Learning objective	The overall aim of this module is to ensure that the student has an understanding of the performance testing of a wide range of equipment, understanding the measurement of patient doses and dose optimisation and audit.	
Knowledge	By the end of this module the student will: 1. Explain the principles and methods of performance testing of a range of diagnostic X-ray and non-ionising equipment and their role in ensuring patient and staff safety. 2. Describe dosimetric methods and critically analyse dose reduction options and the risk benefit to patients. 3. Critically appraise room design and shielding calculations. 4. Explain the principles and methods of radiation surveys, and evaluate methods and options for improvement and dealing with radiation incidents and emergencies. 5. Explain the principles supporting the selection of appropriate radiation for equipment testing and dosimetry measurements, including calibration and type testing.	2.1.1 2.1.3 2.1.5 2.1.6 2.2.6 2.3.2 3.2.2
Technical and clinical skills	By the end of this module the student will be expected to apply in practice a range of technical and clinical skills and critically reflect on and develop their performance, working within the Standards of Proficiency set by the AHCS and will be able to: **Equipment management in radiation physics** 1. Observe and assist with calibration of a range of diagnostic X-ray and non-ionising equipment. 2. Perform routine QA tests on a range of equipment that produce both diagnostic X-rays and non-ionising radiations. 3. Assist with commissioning tests on a range of equipment that utilise both diagnostic X-ray and non-ionising radiations. 4. Assist with critical examinations on diagnostic X-ray equipment installations.* 5. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*. **Equipment and installations include, for example, static and mobile diagnostic X-ray, static and mobile fluoroscopy, dental plus associated equipment such as automatic exposure control (AEC), computed tomography (CT) scanners, dose area product (DAP) meters, imaging systems, etc.*	1.1.1 1.1.3 1.1.7 1.2.5 1.3.2 1.4.5 2.1.4 2.1.5 2.2.4 2.2.6 2.2.8 2.2.9 2.3.3 2.3.4

Topic	Practice of Radiation Physics [30 credits] including work-based learning [30 credits]	GSP reference
	Radiation measurement 6. Measure and record levels of radiation, including dose rate, contamination checks, output measurements. 7. Calibrate a range of radiation measuring devices, including contamination monitors, dose rate meters, electronic personal dosimeters, radiographer QA meters and dosimeters. 8. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*. **Radiation transport and dosimetry** 9. Safely use and transport radioactive sources. 10. Perform a range of tasks in the personal dosimetry service, including issuing of dosimeters to users and the processing and reporting of results of returned dosimeters. 11. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*. **Radiation protection** 12. Assist in patient dosimetry procedures for both diagnostic X-ray and non-ionising applications. 13. Perform radiation surveys for ionising and non-ionising installations. 14. Perform a radiation risk assessment for ionising and non-ionising radiation installations. 15. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*.	3.1.5 3.1.7 3.2.1 3.2.2 3.2.3 3.2.4 5.1.2 5.1.4 5.1.12

SECTION 8: RADIOTHERAPY PHYSICS TECHNICAL AND SCIENTIFIC SPECIALIST MODULES

8.1 Specialist Modules for Radiotherapy Physics

Interpretation of the high-level framework Medical Physics Technology specialising in Radiotherapy Physics

<table>
<tr><th></th><th colspan="8">Module Titles</th></tr>
<tr><td>Year 3
Application to Practice</td><td>Professional Practice
[10]</td><td colspan="2">Cancer, Radiobiology and Clinical Radiotherapy Physics
[30]</td><td colspan="2">Practice of Radiotherapy Physics
[30]</td><td>Research Project
[30]</td><td colspan="2">Work-based training
25 weeks
[20]</td></tr>
<tr><td>Year 2
Technologies and Methodologies</td><td>Professional Practice
[10]</td><td>Research Methods
[10]</td><td colspan="2">Medical Imaging
[30]</td><td>Radiation Governance
[15]</td><td>Medical Equipment and Quality Assurance and Quality Systems
[15]</td><td>Principles of Scientific Measurement
[30]</td><td>Work-based training
15 weeks
[10]</td></tr>
<tr><td>Year 1
Scientific Basics</td><td>Professional Practice
[10]</td><td colspan="4">Scientific Basis of Healthcare Science
[60]</td><td>Mathematics, Statistics and Informatics
[10]</td><td colspan="2">Scientific Basis of Medical Physics, including work-based training
10 weeks
[40]</td></tr>
</table>

[XX] = Number of credits

Generic modules: Common to all divisions of Healthcare Science

Division-theme modules: Shared by a group of specialisms, usually within a Healthcare Science division

Specialist modules: Specific to a specialism

Year 3
MPRT(i): Cancer, Radiobiology and Clinical Radiotherapy Physics
[30 credits]

Topic	Cancer, Radiobiology and Clinical Radiotherapy Physics [30 credits]	GSP reference
Learning objective	The overall aim of this module is to ensure that the student has an understanding of the treatment planning process and the physics that underpins it, and appreciates its place within the clinical context of radiotherapy.	
Knowledge	By the end of this module the student will: 1. Examine the role of radiotherapy in the cancer pathway and critically review tumour pathology of some common tumour sites. 2. Describe and critically evaluate the principles of radiobiology applied to external beam radiotherapy. 3. Compare and contrast the range of treatment planning techniques available, and critically appraise the choice of physical parameters required when preparing treatment plans. 4. Discuss the requirements relating to patient care in the mould room and specify and appraise factors, principles and constraints that affect treatment regimens and treatment planning. 5. Explain target volumes as defined in current national and international standards. 6. Define dose prescriptions and reporting as per current national and international standards.	2.1.1 2.1.3 2.1.5 2.1.6 2.2.6 2.3.2 3.2.2
Technical and clinical skills	**The Year 2 and 3 work-based learning outcomes can be found in module MPRT(ii): Practice of Radiotherapy Physics.**	

Year 3
MPRT(ii): Practice of Radiotherapy Physics
[30 credits] plus work-based learning [30 credits]

Topic	Practice of Radiotherapy Physics [30 credits] including work-based learning [30 credits]	GSP reference
Learning objective	The overall aim of this module is to ensure that the student understands the basis of radiotherapy equipment, dose measurement, calibration and QA, and how they affect patient treatment. The student should also have an appreciation of accidents in radiotherapy and the processes in place to mitigate risk.	
Knowledge	By the end of this module the student will: 1. Evaluate treatment planning, radiation dose measurement and calculation in radiotherapy, applying skills of analysis and judgement. 2. Evaluate radiotherapy equipment and associated QC procedures and systems. 3. Discuss the requirements relating to the application of medical imaging to radiotherapy and appraise the choice of imaging technique. 4. Critically appraise the principles relating to the calculation of dose distributions within patients. 5. Compare and contrast radiotherapy equipment, the beams produced, their characteristics and how they are analysed. 6. Explain the principles of radiation protection in radiotherapy. 7. Specify the principles supporting the selection of a medical device that will ensure it is fit for purpose, including the ability to develop and evaluate basic specifications to meet user and service requirements.	2.1.1 2.1.3 2.1.5 2.1.6 2.2.6 2.3.2 3.2.2
Technical and clinical skills	By the end of this module the student will be expected to apply in practice a range of technical and clinical skills and critically reflect on and develop their performance, working within the Standards of Proficiency set by the AHCS and will be able to: **Introduction to radiotherapy physics** 1. Perform routine tasks and/or situations in radiotherapy physics, including treatment planning, dose measurement, QA, calibration and operation of equipment, and patient interventions. 2. Undertake a radiation risk assessment for the use of a radiotherapy machine. 3. Undertake a radiation dose survey for a radiotherapy installation. 4. Use a wide range of dosimeters for a variety of dose measurements types in accordance with established procedures.	1.1.1 1.1.3 1.1.7 1.2.5 1.3.2 1.4.5 2.1.4 2.1.5 2.2.4 2.2.6

Topic	Practice of Radiotherapy Physics [30 credits] including work-based learning [30 credits]	GSP reference
	5. Apply a professional approach to all activities undertaken within the radiotherapy department, adhering to appropriate standards of professional practice as defined in *Good Scientific Practice*. **Dose planning, virtual stimulation and image guidance** 1. Produce a range of radiotherapy dose treatment plans using imaging data, defined treatment parameters, dose calculations and simulation processes to assist in the safest and most effective treatment being delivered to the patient. 2. Use image guidance to check and modify treatment plans following local protocols. 3. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*. **Mould room** 1. Make safe and appropriate immobilisation devices for patients, considering the individual needs of each patient, in accordance with local protocols. 2. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*. **Brachytherapy** 1. Participate in the preparation and delivery of brachytherapy treatment procedures. 2. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*. **Quality control of radiotherapy** 1. Perform QC procedures for radiotherapy systems, including orthovoltage treatment units, megavoltage units and other radiotherapy treatment units (e.g. high-dose rate brachytherapy, tomotherapy units). *2.* Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*	2.2.8 2.2.9 2.3.3 2.3.4 3.1.5 3.1.7 3.2.1 3.2.2 3.2.3 3.2.4 5.1.2 5.1.4 5.1.12

SECTION 9: INDICATIVE CONTENT: KNOWLEDGE

9.1 Generic Professional Practice, Technical and Scientific Modules

GM(i): Professional Practice

Indicative Content

KNOWLEDGE

Professional Practice

- The role of regulation
- Regulation of the HCS workforce by the AHCS and HCPC
- NHS Constitution
- HEE five key workforce characteristics
- Values relating to compassion, transparency, candour, openness and leadership
- Current national NHS policies and practice, including policy relevant to the area of practice
- How service delivery aligns to current NHS policy and practice
- The HCS workforce:
  - structure into four divisions and specialisms within each division
  - education and training programmes
  - leadership of the healthcare science profession (e.g. the role of the Chief Scientific Officer)
  - Modernising Scientific Careers (MSC)
  - the contribution of the HCS workforce to health and healthcare services
- The role of the HCSP
- Patient–professional partnerships, with the patient at the centre of care
- Patient and carer perspectives and the diversity of the patient experience
- Use of chaperones
- Current safeguarding regulations relevant to practice as a HCSP
- Culture, equality and diversity and how this can affect practice
- Disability, including learning disabilities
- Mental health
- Patient wellbeing and self-care, including how to support self-care
- How to work in partnership with patients and service users to ensure that the views of patients are central to delivering, developing and maintaining high-quality, safe services
- The role of patient support groups

- The importance of the patient voice in education and training for the HCS workforce, including the structures within each BSc programme to promote the patient voice

Legal and Ethical Boundaries of Practice

- Sharing of information and advice between peers in order to encourage a consistent approach to the implementation of NHS policy
- Ethical, legal and governance requirements arising from working at the level of HCSP
- Principles, guidance and law with respect to medical ethics
- Principles, guidance and law with respect to patient confidentiality
- Principles, guidance and law with respect to informed consent and how to gain informed consent
- The limits of the concept of confidentiality
- The importance of introducing yourself and explaining your role to every patient
- Principles, guidance and law with respect to equality and diversity
- Principles, guidance and law with respect to safeguarding, including the use of chaperones
- The procedures to follow if cautioned, charged with a criminal offence, suspended, or have restrictions placed on personal scientific, clinical or professional practice
- The importance of personal health and wellbeing to ensure personal performance and judgement is not affected by their own health
- Information governance and be aware of the safe and effective use of health and social care information
- The need to manage records and all other information in accordance with applicable legislation, protocols and guidelines

Patient Safety and Quality

- NHS Constitution
- The wider context of safety in the NHS, including the culture of an organisation
- How effective communication underpins high-quality and safe patient services/patient care, including shared decision making
- The role of national organisations, e.g. NHS England; NHS Improving Quality
- Definition of terms:
  - Quality management
  - QC
  - QA
  - Quality improvement

    - Quality methodologies
    - Quality processes and procedures
- Principles of Quality Management Systems (QMS):
    - Quality management; QA; QC
    - The role of the United Kingdom Accreditation Service
    - Current HCS accreditation programmes, e.g. Improving Quality in Physiology Sciences;
- British, European and international standards that govern and affect pathology laboratory practice
- Safety – prioritisation of patient safety in practice
- Safety – team working and patient safety
- Safety – equipment management
- Calibration, action levels
- Infection control
- Equipment life cycle, including specification, procurement commissioning, preventative maintenance, fault finding and repair, calibration, safety testing and decommissioning for equipment relevant to the specialism
- Strategies to improve patient safety
- Critical incident reporting, review and action
- 'Never' events and strategies to reduce them
- Improving quality of life
- Improving quality of the patient experience of healthcare
- Processes for the distribution of documentation, e.g. Department of Health (DH), Central Alerting System (CAS), Medical Device Alerts (MDA)
- Quality, risk and audit
- Regulatory frameworks such as EU directives and Medicines and Healthcare products Regulatory Agency (MHRA) requirements
- Standard operating procedures, guidelines and protocols
- The contribution to the delivery of high-quality healthcare of the:
    - HCS workforce
    - HCS student
    - HCSP
- Why it is important to monitor and evaluate the quality of practice and the value of contributing to the generation of data for QA and improvement programmes

Communication Skills

- Principles of effective verbal communication
- Principles of effective written communication
- Communication with those who do not have English as a first language
- Communication with people with sensory and cognitive impairments
- When and how to adapt communication methods
- Communication with patients across the age spectrum
- Use of patient leaflets and other appropriate media methods to engage with patients, donors and carers and the public

Leadership
- The concept of leadership and its application to practice
- The NHS Leadership Framework
- Leadership within the NHS, healthcare science, HCS teams and the multiprofessional team

Teaching and Learning
Students should be introduced to key theories of teaching and learning, including teaching and learning practical skills to begin to support their personal development and provide a base for their future career.

Continuing Personal and Professional Development (CPPD)
- The role and importance of CPPD to ensure that their professional knowledge and skills are being kept up to date

ATTITUDES, BEHAVIOURS AND SKILLS

Professional Practice
- Develop and maintain appropriate professional and patient–professional relationships in practice
- Treat patients with compassion and promoting patient wellbeing and self-care
- Work with colleagues, patients and carers in a respectful and non-discriminatory manner
- Provide safe, high-quality care at all times and in all settings
- Consistently bring the highest levels of knowledge and skill at times of basic human need when care and compassion are what matters most
- Create and justify open and non-discriminatory professional working relationships with colleagues, using critical reflection to review personal behaviour and responses to challenging issues
- Develop and maintain appropriate coping mechanisms for a range of potential issues, including stress, and seek help if appropriate and evaluate the impact of an intervention

- Support and contribute to a culture in which innovation and developments are identified, discussed, evaluated and potentially introduced to improve service delivery
- Recognise and exploit learning opportunities in the workplace
- Act in accordance with the principles and practice of patient-centred care, regularly reflecting on their personal practice and revising judgements and changing behaviour in the light of new evidence
- Practise as an autonomous professional, applying knowledge appropriately and exercising their own professional judgement within their scope of practice and with support from the team
- Promote professional attitudes and values at all times
- Recognise the need to be truthful and to admit to and learn from errors
- Seek advice in the event of ethical dilemmas, including disclosure and confidentiality
- Accept and comply with the requirements for professional regulation

Legal and Ethical Boundaries of Practice

- Consistently operate in accordance with relevant current NHS policy and practice and recognise the limits of their own competence and scope of practice in order to make safe, informed and reasonable decisions about their practice
- Respond to the ethical, legal and governance requirements arising from working at the level of a HCSP, applying accrued knowledge and evidence
- Recognise the factors influencing ethical decision making, including religion, personal and moral beliefs, cultural practices, and make informed decisions, taking these into account
- Share information in accordance with the regulations, encouraging such behaviour in other members of the healthcare team and taking action where breaches of the guidelines may occur
- Ensure confidentiality is maintained, e.g. removal of patient names where appropriate, reviewing and analysing published literature, and considering the impact of such measures on the clinical service
- Recognise the problems posed by disclosure without consent of the patient, in the public interest
- Ensure patients, relatives and carers are aware of the need for appropriate information distribution within members of the immediate healthcare team
- Use appropriate methods of ethical reasoning to justify a decision where complex and conflicting issues are involved, calling on the support of others where needed
- Act in a manner that demonstrates probity in all aspects of professional practice
- Act in accordance with GSP at all times so that their conduct justifies the trust of patients and colleagues and maintains public trust in healthcare science
- Ensure that personal practice is always provided in line with the legal framework, acting with integrity at all times

- Apply appropriately the principles, guidance and laws regarding medical ethics and confidentiality and demonstrate the ability to gain informed consent
- Complete any/all documentation honestly and accurately and sign appropriately
- Apply honesty and accuracy about personal qualifications, experience and position in the scientific community
- Act honestly with respect to written and verbal information provided to any formal or legal enquiry, including recognition of the limits of scientific knowledge and experience
- Keep records in accordance with current best practice requirements, including accuracy of information recording within patient records and the framework that underpins data security practice in the NHS

Patient Safety and Quality

- Respond in an open, constructive and timely manner to critical incidents or complaints about their own or team performance, influencing the response, and using self-reflection to review personal behaviour and response to challenging issues
- Take appropriate action if it is suspected that they or a colleague may not be fit to practise, always putting patient safety at the forefront of practice
- Practise within the Standards of Proficiency set by the AHCS and for Biomedical Scientists, the HCPC
- Make appropriate judgements to ensure one limits work or stops practising if performance or judgement is affected by their health
- Recognise when personal health takes priority over work pressures, seeking appropriate advice and support, and taking appropriate action
- Co-operate with employers to ensure compliance with health and safety requirements

Leadership

- Recognise the importance of leading by example in setting high standards of personal behaviour, and in acting with openness, candour, fairness and integrity, listening and respecting the views of others

Continuing Personal and Professional Development (CPPD)

- Contribute to a culture that values CPPD in recognising strengths and identifying areas for improvement and supporting others to do the same
- Continue to develop their own learning and reflective practice by maintaining personal records of CPPD, providing evidence of critical reflection, including action planning, with respect to technical and clinical practice and professional development in a form suitable for audit by a professional body or regulator, and demonstrate continuing fitness to practise

- Apply knowledge, experience and critical reflection to identify personal development needs using a range of tools, and develop and update action plans
- Act as a self-motivated professional HCSP, being willing to learn from self-reflection and others, responding positively to constructive and meaningful feedback
- Record critically reflective notes demonstrating how participation in CPPD has contributed to learning and led to improvements in personal and service performance
- Monitor their own performance by a variety of methods
- Respond constructively to feedback and provide feedback when asked to support personal development and the development of others
- Prioritise and organise academic and work-based tasks in order to optimise their own work and the work of the department

Communication Skills

- Effective verbal communication
- Effective written communication
- Frameworks underpinning communication
- Adapting communication skills
- Giving and receiving feedback, including feedback frameworks

Teaching and Learning

- Introduction to how people learn
- Teaching and learning practical skills
- Transforming experience into knowledge and skills by reflection and action and linking this to the skills of feedback (see above) and work-based learning

GM(ii): Scientific Basis of Healthcare Science (Year 1)

Students should be introduced to every subject area described by each learning outcome and associated indicative content to provide a broad foundation of scientific and HCS knowledge on which to build their knowledge, skills and professional practice. Following the broad overview learning should then being developed in the context of individual BSc (Hons) Healthcare Science programme, providing the flexibility to study specific areas in more depth.

1. Introduction to the organisation of the human body

- Structural

- Chemical
- Cellular
- Tissue
- Skin
- Cellular, tissue and systems responses to disease:
  - cell death
  - inflammation
  - neoplasia, e.g. carcinoma
  - hypertrophy
  - hyperplasia
  - tissue responses to injury and repair
- How the body changes from birth to old age

2. Introduction to the structure and function of body systems: embryology, anatomy, physiology, pathology

- Embryology
- Skeletal system
- Nervous system:
  - spinal cord and spinal nerves
  - brain and cranial nerves
  - sensory and motor systems
- Endocrine system
- Vision, hearing and equilibrium
- Cardiovascular system, including blood and blood vessels
- Respiratory system
- Lymphatic system
- Immune system
- Gastrointestinal tract, including digestion and absorption of food, nutrition, the liver and liver function tests
- Renal system
- Electrolyte and acid-base balance
- Hormonal mechanisms and control
- Metabolism
- Reproductive system
- Abdomen, pelvis and perineum

- Histology and cytology
- Microbiology, including infection control
- Treatment regimens, including antibiotics and antibiotic resistance
- Virology
- Biochemistry
- Haematology
- Immunology and histocompatibility

3. Introduction to clinical genetics, genomics and personalised medicine

- 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
- The role of genomic counselling

4. Introduction to epidemiology and public health

- Local, national and international role of the public health function, e.g. Public Health England and related UK organisations
- Infectious disease services
- International partnership working for control of infection
- Principles of epidemiology
- Basis of health protection:
  - principles of surveillance
  - infectious disease control and emergency planning
- Screening:
  - screening programmes: purpose, design, outcomes
  - screening programmes: typical screening programmes in healthcare science
- Using epidemiological data to plan health services
- Factors affecting the health of the population
- Strategies and methods to improve health

- Factors affecting health and their contribution to inequalities in health between populations
- Changes in population demographics, including ageing

5. Introduction to clinical pharmacology and therapeutics

- Difference between pharmacology, clinical pharmacology, therapeutics and prescribing and medicine management
- Principles of pharmacology, pharmacokinetics and therapeutics:
  - drug names
  - classifications
  - definitions of terms and basic mechanisms
- Role of the pharmacist in primary and secondary care

6. Sociology of health and illness

- Patients' responses to illness and treatment:
  - the impact of psychological and social factors, including culture, age, ethnicity, gender, socioeconomic status and spiritual or religious beliefs, on health and health-related behaviour
- Health belief models
- Diversity of the patient experience
- Disability, including learning disabilities
- Mental health
- Potential health inequalities
- Self-care
- Impact of life-threatening and critical conditions
- Patient involvement in decisions regarding their healthcare

This topic area should include the underpinning theoretical foundations and models, e.g. Health Belief Model, World Health Organization (WHO) model of activity limitation (disability)

7. Introduction to medical physics and clinical engineering

- Structure of matter (atomic and nuclear models)
- Radiation: nature and its measurement and radiation safety
- Radiation dosimeters – personal dosimetry
- Basic physics and mathematics of image formation
- Imaging Techniques
  - Ultrasound
  - Magnetic Resonance Imaging (MRI)

    - Computerised Tomography (CT)
    - Positron Emission Computed Tomography (PET)
    - Single Photon Emission Computed Tomography (SPECT)
- Basic electricity and magnetism as it relates to the measurement of physiological signals
- Viscous and inertial flow of simple liquids
- Use of radiotherapy

8. Introduction to clinical bioinformatics and health informatics

Clinical bioinformatics brings together the disciplines of computer science, mathematics, statistics and physics/engineering to influence, analyse and inform clinical and biological practice, so helping to maintain patient safety and the integrity and security of data. Students should be introduced to the three specialisms of clinical bioinformatics within healthcare science (genomics; health informatics science and physical sciences) in the context of: (i) innovation, translation and interpretation of complex genomic data, optimising the benefits this brings to patient care, including personalised medicine; (ii) the development and adoption of technology solutions and biomedically motivated methods for the collection, management, movement, analysis and use of health information in line with government legislation to improve the quality and safety of healthcare practice and delivery; and (iii) devices that may have therapeutic, diagnostic, or patient monitoring functions and they generate ever-increasing amounts of data that contribute to patient management.

Teaching should be tailored to the student group using examples relevant to health and healthcare science.

- Contribution of clinical bioinformatics genomics, health informatics sciences and physical sciences to:
    - patient safety
    - patient care
    - health care
    - healthcare science
- Governance and ethical frameworks
- Storage and sharing of images, DICOM
- PACS
- Clinical information systems and applications
- Clinical information systems and applications, e.g. HL7
- Database management
- Direct patient access to test results

9. Introduction to mathematical and statistical techniques

- Data interpretation, including the variability of biological data and application of statistics
- Generation of reference ranges and their limitations

10. Introduction to innovation in health and healthcare science

- Identifying, reading and evaluating the literature
- Innovation in the NHS
- Using innovation to improve services
- Scientific and technical developments and their application in healthcare sconce
- The role of the HCS workforce in innovation

GM(iii): Research Methods (Year 2)

1. Research, innovation and audit

- Process and importance of research, innovation and audit to the NHS and healthcare science
- Role of healthcare science in research, innovation and audit
- NHS Research and Innovation Strategy
- Difference between research, audit and service improvement
- User/patient involvement
- Peer review
- Role of statutory, advisory regulatory bodies and funding bodies, including:
  - National Institute for Health and Care Excellence (NICE)
  - National Institute for Health Research (NIHR)
- Evidence-based practice
- Clinical guideline development
- QA frameworks:
  - quality improvement
  - patient care
  - patient safety
  - improved treatments
- The role of the HCS workforce in undertaking research and innovation and applying findings
- Use of research and audit to interpret and apply new knowledge in the NHS and healthcare science

2. Current ethical and legal frameworks

- Good Clinical Practice (GCP)
- Health and safety
- Risk assessment
- Human research
- Animal research
- Innovation
- Audit
- Ethical frameworks, including informed consent
- Legal frameworks
- Confidentiality
- Archiving
- Research governance framework for health and social care research
- Data Protection Act
- Intellectual property regulations
- Informed consent
- Roles and responsibilities of the research team

3. Principles of literature searching

- Evidence-based practice
- Principles of a literature search
- Process of literature searching
- Critical review of literature
- Systematic review
- Publication impact factor
- Reference manager systems

4. Introduction to study design

- Cohort studies
- Qualitative
- Quantitative
- Case control
- Systematic review
- Meta-analysis

- Sampling techniques
- Clinical trials (pre-clinical to translational)
- Epidemiological studies
- Hypothesis generation and testing
- Clinical trials

5. Data analysis, statistical techniques and dissemination

- Data validity, reliability and appropriateness
- Application and interpretation of statistical techniques:
  - parametric
  - non-parametric
- Power calculations/sample size
- Methods to disseminate research output
- Impact factor
- Scientific poster design
- Writing for scientific journals
- Writing scientific abstracts
- Preparing research presentations for time-limited scientific meetings

GM(iv): Research Project (Year 3)

1. Research in health and healthcare science, including:

- Scientific or clinical research
- Translational research
- Operational and policy research
- Clinical education research
- Innovation, service development
- Service improvement
- Supporting professional service users

2. Ethical and governance approval process

- The student must know the ethical approval and governance process required to undertake the proposed project including initial approval; monitoring; reporting; data storage and archiving

9.2 Medical Physics Technology

Year 1

MP (i): Mathematics, Statistics and Informatics

Mathematics and statistics

- *Numerical representation and scientific calculator use*: standard form, negative numbers, percentages, accuracy and precision, conversion of units of measure
- *Algebra*: review of basic concepts
- *Graphs*: linear and non-linear graphs in the x-y plane, plotting a graph of the function, solving equations using graphs, solving simultaneous equations graphically
- *Logarithmic expressions*: indices, laws of indices, laws of logs, combinations of logs, natural logs and base 10 logs, solving equations with logarithms, properties and graph of ln and log function
- *Angles and trigonometry*: degrees, radians, trigonometry ratios (sine, cosine, tangent), solving trigonometric equations, maxima and minima, graphs and waves generated by trigonometry
- *Exponential functions*: exponential expressions, exponential function and its graph, solving equations involving exponential terms using a graphical method
- Determinants, matrices and vectors
- *Differentiation*: gradient function, rules for differentiation, higher derivatives, maximums, minimums, points of inflection, differentiation of sums, differentiation of differences
- *Advanced differentiation*: products, quotients, exponential functions, logarithmic functions, function of a function
- *Indefinite integration*: indefinite integration, some rules for indefinite integration, constant of integration
- *Definite integration*: areas under curves, areas bounded by lines and curves, finding areas where some or all lie below the x-axis
- *Types of data*: discrete and continuous data
- *Summarising data graphically*: dot plot, stem and leaf, box and whisker, grouped frequency distribution, histogram, cumulative frequency distribution, cumulative frequency polygon, bar chart, one and two
- *Summarising data numerically*: mean, median, mode, samples, when to use various averages, standard deviation, error, inter quartile range, box and whisker plots, variance, range, measures of skewness
- *Normal distribution*: mean, standard deviation, areas under the curve, standard normal transformation, solution of problems

- *Simple probability, samples and population distributions*: reasons for sampling sample size, random sampling, biased sampling, quota sampling, systematic sampling and stratified sampling, relationship to normal distribution, primary and secondary data

Informatics

- Informatics and clinical practice
- Basics of databases:
  - create a database
  - understand the basic principles of database
  - interrogate and produce reports
  - evaluate and amend the database
- Interpreting and presenting data using spreadsheet software
- Presentation software:
  - create a short presentation
  - apply appropriate techniques and slides for presentation
  - evaluate and amend the presentation

Essential issues associated with computing technologies and their management in clinical engineering

- Networking of medical devices
- Effective system management
- Patient safety and confidentiality

Year 1

MP(ii): Scientific Basis of Medical Physics, including work-based training

Medical Physics and patient pathway

The role of Medical Physics in:

- Diagnostics
- Therapeutics
- The equipment life cycle
- Innovation and service development

Atomic structure and radioactive decay

- Atomic and nuclear structure, mass number, atomic number, isotopes
- Mechanisms of radioactive decay

- Alpha, beta and gamma radiation
- Half-life, mean life, physical half-life
- Decay schemes and energy level diagrams
- The units of activity
- Specific activity, radioactive concentration

Production of X-rays
- General principles
- Electromagnetic spectrum
- Production of X-rays (low to megavoltage)
- X-ray tubes
- Linear accelerators

Interactions of radiation with matter
- Radiation quality – Half Value Layer (HVL) and Tenth Value Layer (TVL), Quality Index
- Attenuation, absorption and scatter (photo-electric, Compton scatter and pair-production)
- Exponential attenuation of monoenergetic photons
- Electrons scatter and bremsstrahlung
- Ionisation and excitation
- Electron range and energy
- Inverse square law
- Filters and filtration
- Effects of electron and photon energy, absorber density and atomic number tissue equivalent materials

Introduction to ionising radiation equipment in Medical Physics
- Radiation detectors
- Gamma camera and single-photon emission computed tomography (SPECT)
- Basic diagnostic X-ray equipment
- Computed tomography (CT)
- SPECT-CT
- Positron emission tomography (PET) and PET/CT
- Linear accelerator
- Orthovoltage (kV) radiotherapy unit

- Radiotherapy treatment planning system (TPS)
- Brachytherapy after-loaders
- Cyclotron

Introduction to the basic science and the role of the HCSP in radiotherapy

- Mould Room
- Treatment planning
- QA and QC
- Dosimetry
- Brachytherapy

Introduction to the basic science and the role of the HCSP in nuclear medicine

- Radiopharmacy
- Scanning
- Radionuclide therapy

Introduction the basic science and the role of the HCSP in radiation protection

- Room surveys
- QA and QC
- Environmental monitoring
- Personnel monitoring
- Sealed sources
- Unsealed sources

Basic ionising radiation protection

- International and national legislation, guidance, standards and recommendations
- Hospital organisation of radiological protection: radiation safety policy, local rules
- Designation of areas
- Classification of persons
- Roles and responsibilities of staff, including duty holders
- As Low as Reasonable Practicable (ALARP)
- Basic principles of dose limitation: time, distance, shielding
- Radiation protection of public and staff
- Radiation protection of patients

- Transportation of radioactive materials
- Administration of radionuclides
- High activity materials
- Disposal of radioactive materials
- Personnel and environmental dose monitoring

Year 1
Work-based training (10 weeks)

- Observe the work of a range of healthcare science departments, technologies and procedures
- Observe the process for handling work requests from the receipt of the request to completion
- Observe the patient journey from admission to discharge
- Patient-centred care that is respectful of and responsive to individual patient preferences, needs and values, and ensuring that patient values guide all clinical decisions
- Gain an understanding of the skills required to work safely in the clinical/laboratory/workshop/radiation environment
- Record keeping, data protection, confidentiality
- Gain an appreciation of how the NHS is structured
- Team working and the role of MDT meetings
- Meaning and role of professionalism and professions in healthcare
- Roles of different professional grouping in healthcare science
- Human and social diversity and its implications for relationships, behaviours and service provision in healthcare
- Types of effective communication in the context of healthcare
- Barriers to effective communication and strategies to overcome them
- Interpersonal skills related to dealing with patients, carers and healthcare professionals
- The skills needed to work as part of a team
- Management and evaluation of adverse incidents
- Data management (paper and electronic)
- Infection control
- Basic life support
- Reflective practice and its application

Year 2

MP(iii): Medical Imaging

Introduction to image formation, acquisition, manipulation, analysis, storage and sharing

- Theory of image formation, including reconstruction from projections
- Display, manipulation and analysis of images
- Image registration and fusion
- Image storage, sharing files and formats:
  - PACS
  - DICOM
  - HL7

Principles of operation

- Formation of the X-ray image, fluoroscopy, computed radiography, digital radiography (CR/DR), CT scanners, electronic portal imaging devices, cone beam CT (CBCT)
- Ultrasound:
  - basic physics
  - transducers
  - formation of the ultrasound image, harmonic imaging
  - artefacts
  - Doppler
- Nuclear medicine:
  - construction of the gamma camera
  - static imaging
  - dynamic imaging
  - SPECT-CT
  - image quality
  - artefacts, noise sensitivity and quantification
  - PET-CT
  - PET-MR
- Magnetic resonance imaging (MRI)
  - basic physics
  - formation of the image
  - image sequences
  - image quality and artefacts
  - PET-MR

Clinical applications (including hybrid imaging)

- Choice of modality for common clinical scenarios
- Common clinical applications of each modality
- Planning and delivery of radiotherapy:
  - CBCT and other image guided radiotherapy (IGRT) devices
  - CT for treatment planning
  - PET-CT for treatment planning
  - uses and limitations of MR in radiotherapy, and the use of 4D CT
  - MR for treatment planning
- Mammography:
  - breast screening
- Future directions in imaging
- Gating techniques and 4D CT imaging (cardiac and respiratory)
- The possible risks and health effects of each modality (risk benefit ratios)
- Overview of QA and testing
- Radiation protection of patients and diagnostic reference levels

Year 2

MP(iv): Radiation Governance

Clinical sources of radiation

- Ionising and non-ionising radiation sources and hazards
- Radiation protection international and national legislation, guidance, standards and recommendations
- Net positive benefit, dose limits
- Basic radiobiology
- Stochastic and deterministic effects
- Principles of designation of areas
- Principles of classification of persons
- Roles and responsibilities of staff and duty holders
- External audit standards
- Registration, safe custody, transport, use and disposal of radioactive sources
- Contingency plans, including radiation emergencies
- Notification of radiation accidents and incidents

- Biological and effective half-life
- Record keeping

Dose monitoring

Personnel and environmental dose monitoring

- Operation of a personal monitoring service and approved dosimetry service
- Film and thermoluminescent dosimeter (TLD), optically stimulated luminance (OSL) monitoring, real-time dosimeters, e.g. Electronic Personal Dosimeter (EPD)
- Instrument calibration
- Internal dosimetry:
  - whole body, extremities, eyes, thyroid
- Patient dosimetry
- In-vivo dosimetry in radiotherapy, e.g. diodes, TLD, transit dosimetry

Principles of radiation dose limitation (including factors affecting the design of radiation facilities)

- Risk assessment
- Controls:
  - room and equipment
  - interlocks
  - warning signs
  - emergency stop buttons
- Calculation of shielding requirements
- Environmental radiation surveys
- Radiation protection in the administration of radioactive substances
- Decontamination of radionuclide spills
- Contamination monitoring isotope calibrators
- Contamination monitors, wipe tests
- Waste management – biological and radioactive hazards:
  - discharge of radioactive patient
  - death of a radioactive patient
- Radioactive source security, e.g. high-activity sources

Year 2

MP(v): Medical Equipment, Quality Assurance and Quality Systems
With reference to commonly used equipment and systems in radiation physics, nuclear medicine and radiotherapy and their role in maintaining patient safety.

Operation and principles of non-imaging equipment in Medical Physics (not covered in Medical Imaging)

- Radiation detectors
- Linear accelerator
- Orthovoltage (kV) radiotherapy unit
- Radiotherapy TPS
- Brachytherapy after-loaders
- Cyclotron

Basic quality systems

- International and national legislation, guidance, standards and recommendations:
  - general requirements and rationale
  - overview of errors and learning
  - control of documentation
  - record keeping
  - responsibility, authority and communication
  - incident reporting
  - protocols and processes
  - identification and traceability
  - audit
- Record keeping:
  - equipment information
  - maintenance and repair records
  - QC and QA records
- Risk assessments and risk-based analysis
- Basic acceptance and safety testing:
  - stages of acceptance
  - visual inspections
  - electrical safety testing
  - mechanical safety tests
  - appropriate test equipment

- functional testing
- purpose of measurements
- performing measurements
- assessing results
- safety test records
- acceptance test records

Quality assurance

For a range of commonly performed QA tests:

- Best practice protocols
- Test equipment
- Action limits
- Frequency

Basic planned preventative maintenance

- Repair and post-repair QC requirements
- Process of handover to and from clinical use
- Factors affecting decisions on maintenance activity including:
  - urgency
  - time
  - impact on services and the availability of other equipment
- Calibration and QA:
  - calibration procedures
  - measurement principles
  - action levels and tolerances
  - frequency
  - appropriate calibration equipment
  - primary standards and national system
  - calibration of instruments against secondary standards
  - checking instruments for consistency, comparison and accuracy
  - reliability, repeatability, validity, limitations

Decontamination and waste management

- Infection control
- Biological decontamination techniques

- Radioactive decontamination
- Decontamination records
- Disinfection, sterilisation and cleaning:
  - specialist advice
- Special waste, clinical waste, radioactive waste, waste electrical and electronic equipment (WEEE):
  - disabling equipment
  - removal and disposal of data
- Data storage
- Incident investigation and reports:
  - adverse events
  - critical events
  - risk-based analysis

Year 2
MP(vi): Principles of Scientific Measurement
to include ionising and non-ionising (including ultrasound) fields

Principles of scientific measurement

- Fundamental and derived measurements and data
- Components of an instrumentation system, matching, source and internal impedance, fault finding
- System parameters (gain, linearity, accuracy, precision, error, resolution, hysteresis, sensitivity, bandwidth, frequency response and damping, time constant, noise, signal to noise)
- Power supplies and isolation
- Types of signal
- Choice of transducers and detectors
- Signal capture and process
- Image manipulation, e.g. monitor calibration, windowing and filtering
- Equipment sensitivity and uncertainty
- Sources of error
- Estimation and addition of uncertainties
- Random and systematic error
- Sample size

- Physiological test sensitivity and specificity
- Calibration and traceability:
  - medical equipment
  - measuring devices

Radiation detectors

- For each detector system:
  - principles
  - construction
  - limitations
  - associated equipment
  - common clinical applications in radiation physics, nuclear medicine and radiotherapy
- Detector systems:
  - ionisation chambers (Farmer, pinpoint, parallel plate, thimble)
  - detector arrays for dosimetry.
  - Geiger tubes
  - sodium iodide and other scintillators
  - liquid scintillation detection
  - solid state detectors, e.g. diodes, amorphous silicon (a-Si)
  - optical detectors, e.g. Cerenkov imaging
  - TLDs
  - photographic film
  - gel dosimeters
  - alanine
  - OSL
  - chemical detectors, e.g. gafchromic film

Physiological signals

- Physiological basis of signals
- Methods of measurement
- Signal processing and extraction
- Use of physiological signals in Medical Physics, e.g. respiratory and cardiac gating
- Introduction to ECG (Electrocardiogram) in clinical practice

9.3 Specialist: Nuclear Medicine

Year 3

MPNM(i): Physics and Instrumentation

- Performance, application, risk assessment and QC procedures for of each of the following imaging systems used in nuclear medicine:
  - gamma camera
  - SPECT
  - SPECT-CT
  - PET
  - PET-CT
  - PET-MR
- Dosimetry of unsealed and sealed radionuclide sources
- Review of practical administration of radioactivity and specific radiation protection and risk considerations:
  - inpatients
  - pregnant and breastfeeding patients
  - paediatrics
  - comforters and carers
  - nursing staff on wards with therapy patients
  - staff and public
- Principles of radionuclide production
  - carrier-free radionuclides
  - radionuclide generator systems: growth and decay curves, elution profiles
  - generator elution
  - kit reconstitution
  - aseptic techniques
  - drawing up
  - available generator systems and their construction
  - cyclotron and reactors and their role in radionuclide production
- Basic mathematical methods as applied to nuclear medicine:
  - counting statistics, precision of net sample counts
  - radioactive decay and decay calculations
  - isotope dilution methods

    - clearance techniques, exponential analysis
- The assay of radioactivity:
    - problems associated with assay
    - background and shielding
    - counting loss associated with dead time and its correction
    - efficiency and the optimisation of counting conditions, dual isotope counting
    - geometry of the detecting system
    - assay of radioactive samples
    - radionuclide identification
    - quantification of uptake, relative and absolute
    - use of standards, background and phantoms
    - whole body monitors
- Department design or refurbishment:
    - services
    - equipment
    - room design
    - clinical workload
    - patient pathways

MPNM (ii): Clinical Indication, Pathology and Patient Care
All of the content in this module should consider both adult and paediatric applications.

- Review, with reference to the planning and interpretation of radionuclide tests and therapy:
    - anatomy and physiology
    - immunology
    - infection
        - acute, chronic, pus, abscess, differential diagnosis between abscess, cyst and tumour
    - neoplastic disease
        - tumours, primary and secondary (metastases), benign and malignant tumours, assessing the extent of malignant involvement
- Review of radiobiological effects of ionising radiation
- Radiopharmaceuticals used in nuclear medicine:
    - the design and operation of the radiopharmacy

    - Good Manufacturing Practice
    - the types of preparation
    - sterilisation techniques
    - maintaining and monitoring the pharmaceutical environment
    - waste disposal
- Radiochemistry and QC:
    - the chemistry of commonly used radionuclides
    - radiochemical techniques
    - production of radiopharmaceuticals
    - labelling of blood products
    - selection of appropriate radiopharmaceutical
- Techniques requiring the Assay of Radioactive Samples In Vitro Non-imaging

The clinical application of nuclear medicine

Assessment of appropriateness of commonly requested tests or procedures, for all the body systems listed below, which should include an understanding of:

- The radiopharmaceutical used, activity administered and route of administration, half-life, energy
- The preparation of the patient
- The views and samples that must be obtained, dynamic protocols, static protocols, SPECT, SPECT-CT, PET-CT, PET-MR:
    - the use of any special data handling techniques or display mode
    - any special features of the study
    - possible artefacts
    - setting up the equipment – energy windows, collimation, etc.
    - the clinical context in which radionuclide tests may be of value and the influence of the test results on patient management
    - the radiation dose to the patient and the risks and benefits of the particular radionuclide test to a particular patient
    - new developments in nuclear medicine, and the changing role of nuclear medicine in the diagnosis and treatment of disease and the relevant imaging modalities used in reaching a diagnosis

All the above should be applied to the following body systems:

- Skeletal system
- Central nervous system

- Endocrine system
- Cardiovascular system
- Respiratory system
- Urinary system
- Gastrointestinal system
- Hemopoietic and lymphatic system
- Reproductive system
- Oncological applications
- Infection and inflammatory imaging

Therapeutic applications of radionuclides in nuclear medicine

- Dosimetry in molecular radiotherapy.
- Radionuclide therapy in thyroid carcinoma
- Radionuclide therapy in benign thyroid disease
- Radionuclide therapy in neuroendocrine tumours
- Radionuclide therapy in hepatocellular carcinoma
- Radioimmunotherapy in lymphoma and other blood disorders
- Radionuclide therapy of refractory metastatic bone pain
- Radiosynovectomy
- Future developments in therapeutic nuclear medicine applications
- Nursing implications for patients undergoing radionuclide metabolic therapy

9.4 Specialist Radiation Physics

MPRP(i): Framework of Radiation Governance and Risk Management

- Review of the main clinical sources of diagnostic kV ionising and non-ionising radiation and their interaction with human tissue:
  - external and internal radiation
  - non-ionising radiation interactions
  - risks of exposure to ionising and non-ionising radiation
- Review of the organisation of radiation protection in hospitals
- Review and application of the general principles of radiation protection and international and national legislation, guidance, codes of practice, standards and recommendations

- International Commission on Radiological Protection (ICRP) recommendations and rationale
- Current regulations and recommendations relating to:
  - radiation protection of staff and the public
  - comforters and carers
  - environmental protection
  - the administration of radioactive substances
  - transportation of dangerous goods
  - Health and Safety at Work
  - electromagnetic fields (EMF), mobile phones, MRI
  - lasers, UV and intense light sources (ILS)
  - ultrasound
  - enforcement and prosecution

Quality systems

- Accreditation of calibration laboratories; National Physical Laboratory (NPL), United Kingdom Accreditation Service (UKAS)

Risk assessment, risk management and emergency procedures

- Diagnostic X-ray installations
- Radiotherapy using radioactive materials
- Diagnostic use of radioactive materials
- Ultrasound
- MRI
- Lasers, UV and ILS

Use of radioactive materials

- Contamination monitors, wipe tests
- Instrument types, range of probes
- Survey meters
- Isotope calibrators
- Calibration of above instruments

MPRP(ii): Practice of Radiation Physics
Equipment performance testing: quality assurance, calibration and dosimetry
To include critical examination of diagnostic:

- X-ray tubes and generators (conventional, CT, dental, mammography)
- Ultrasound – diagnostic and therapeutic
- MRI
- Lasers, UV and ILS
- Dose measurement devices
- Record keeping

Patient dosimetry in diagnostic X-ray

- Factors affecting patient dose
- Patient dose measurements
- Patient dose surveys
- Diagnostic reference levels
- Optimisation and image quality

Patient doses in UV therapy

- Factors affecting patient dose
- Patient dose measurements
- Patient dose surveys

Room design

- Shielding calculations
- Design features
- Engineering controls

Survey procedures

- Measurements of machines, barriers, including appropriate choice of measuring device:
  - diagnostic X-ray departments
  - dental X-ray rooms and clinics
  - wards, operating theatres, etc.
  - radiotherapy rooms
  - brachytherapy
  - nuclear medicine
  - lasers, UV and ILS

Procedures for dealing with emergency situations

- Procedure for radioactive patients leaving hospital:
  - patient dose rate
  - removal of temporary implants
  - information card with travel dates, work dates, and personal contact dates
- Death of radioactive patients
  - removal of implants
  - informing pathologists, etc., of precautions for post-mortems
  - dose levels for embalming, burial and cremation

9.5 Specialist Radiotherapy Physics

Year 3

MPRT(i): Cancer, Radiobiology and Clinical Radiotherapy Physics

All of the below should be considered for photon and charged particle therapy. Intensity-modulated radiotherapy (IMRT) should be considered to include both fixed beam and dynamic arc therapy.

Clinical evaluation including application of medical imaging to radiotherapy

- Referral pathways, including national pathway guidelines
- Clinical evaluation – pathology, staging, investigations
- Therapy options, including new technologies
- Aim of radiotherapy – radical, adjuvant, palliation
- Follow-up
- Imaging, including the choice and appraisal of different techniques:
  - multiplanar sectional anatomy from CT and MRI
  - functional imaging –PET and SPECT

Radiobiology related to radiotherapy

Linear energy transfer and radiobiological effect

- Cell survival curves – shape, cell kill, chromosomes and cell division
- Dose response relationship
- Radiosensitivity
- Tumour systems
- Dose – time relationship
- Radiation pathology – acute and late effects

- Radiation carcinogenesis
- Radiobiological models – linear quadratic
- Biological effective dose

Tumour pathology

- Anatomy, pathology, lymphatic drainage and associated critical structures:
  - head and neck
  - central nervous system
  - pituitary
  - thorax
  - breast
  - abdomen
  - pelvis
- Hodgkin's disease
- Leukaemia
- Extremities
- Metastases

Treatment planning considerations

- Prescribed dose
- Target delineation
- Treatment techniques (site specific)
- Typical tissue heterogeneities
- Beam weighting
- Guidelines for field arrangement
- Field matching
- Energy

Positioning and immobilisation

- Back pointers
- Patient positioning equipment
- Patient care in the mould room
- Immobilisation (site specific)
- Motion management, e.g. deep inspiration breath hold (DIBH), gating

- Dosimetric effects of equipment

Localisation

- CT localisation:
  - inhomogeneities
  - surface contours and organs at risk
- Use of other imaging and image fusion (MRI, PET-CT)
- Data transfer

Dose planning and display

- Treatment planning algorithms, including pencil beam, collapsed cone and Monte Carlo
- International Commission on Radiological Units & Measurements (ICRU) recommendations
- Planning target volume – margins
- Computer planning:
  - 3-dimensional and 4-dimensional plans
  - beam's eye view
- Plan evaluation:
  - isodose distributions
  - dose volume histograms
- Conformal planning
- Optimisation, including inverse planning techniques and IMRT
- Forward planned segmented field techniques

Beam modification

- Collimation – beam matching
- Beam shaping and shielding
- Bolus and compensators
- Wedges: mechanical, dynamic, virtual

Dose calculations

- Dose distribution computation
- Organs at risk (critical organs and dose constraints
- Dose prescription
- Phantom scatter factors:

    - back scatter factor
    - peak scatter factor
- Head scatter
- Radiation output
- Computation of treatment time/set dose
- Effect of inhomogeneities

Verification

- Positional accuracy and tolerances
- Dosimetric accuracy – patient dose monitoring
- Record and verify systems
- Image guided radiotherapy (IGRT)
- Adaptive radiotherapy

Brachytherapy preparation and planning for temporary and permanent implants

- Key clinical applications
- Guidance and recommendations
- Sources – nuclide, structure, identification
- After-loading equipment
- Calculation algorithms
- Units of measurement
- Source calibration
- Calculation of dose distributions

Year 3

MPRT(ii): Practice of Radiotherapy Physics

External beam radiation treatment equipment

- Construction and principles of operation of very low energy, low energy, medium energy X-ray equipment
- Linear accelerator
- Photon beam generation
- Electron beam generation
- Cobalt teletherapy and gamma knife
- Tomotherapy

- Stereotactic equipment for stereotactic ablative radiotherapy (SABR) and stereotactic radiosurgery (SRS)
- Proton therapy equipment
- Operation and controls of treatment equipment
- Imaging equipment (see MPRP(i) and MP(iii))

Dose distribution

- Central axis depth dose, tissue maximum ratio, tissue phantom ratio (TPR)
- Irregular fields – equivalent square – sector integration
- Off-axis dose – dose in shielded regions – scatter, primary beam hardening
- Isodose curves
- Beam quality, source size, source surface distance, source collimator distance, beam flatness, flattening filters, field size, penumbra, oblique incidence, tissue heterogeneity
- Summation of isodose curves
- Large field treatment techniques, e.g. total body irradiation (TBI) and total skin electron irradiation (TSEI)
- Effect of change in radiation beam energy

Dose measurement

- Kerma and absorbed dose
- Selection of appropriate dosimeter
- Absolute dose measurement
- Relative dose measurement
- Beam data acquisition
- Small field dosimetry
- Patient dosimetry – diodes, thermoluminescent dosimeters (TLD), electronic portal imaging devices
- Electron dosimetry
- Phantoms

Electron beams

- Depth dose characteristics
- Isodose curve characteristics
- Oblique incidence
- Beam shaping

Superficial and Orthovoltage Radiotherapy (SXT and DXT) dosimetry

- Back scatter factors
- Lead cut-outs
- Applicators
- Eyeshields (internal and external)

Proton dosimetry
- Bragg peak
- Stopping power
- Moderators

Radiation protection
- Structural shielding (SXT/CT, Linacs, brachytherapy rooms, protons)
- Measures for reducing radiation dose to staff during brachytherapy
- Source handling and storage
- Procedures for radioactive patients leaving hospital
- Death of radioactive patients – removal of implants:
  - informing pathologists, etc., of precautions for post-mortems
  - dose levels for embalming, burial and cremation

Quality control and quality assurance
- Example accidents in radiotherapy
- Guidance for avoidance of accidents in radiotherapy
- Reporting accidents in radiotherapy
- QC of external beam radiotherapy equipment
- QC of CT simulator
- QC of CT and MRI
- QC for brachytherapy equipment and systems
- QC for treatment planning systems
- Treatment plan and radiotherapy prescription calculation checks
- QC of dosimetry systems

SECTION 10: WORK-BASED SYLLABUS

This section describes the Learning Framework for the **Generic and Themed Component** of work-based learning covering the Learning Outcomes, Clinical Experiential Learning, Competence, and Applied Knowledge and Understanding.

10.1 Generic Work-based Modules

MODULE	Generic Introduction to Work-based Learning	Component	Generic Year 1
AIM	The aim of this module is to introduce the student to the workplace and enable them to apply and contextualise the knowledge and skills they have gained in the module 'Scientific Basis of Healthcare Science' and the Year 1 modules in each HCS theme. Students will be expected to perform some routine skills and develop and build their professional practice in accordance with *Good Scientific Practice*.		
SCOPE	On completion of this module the student will be able to perform basic life support and infection control techniques and use effective communication skills in the context of patient-centred care and recognise the role of the specialism in patient care. They will also be expected to adhere to health and safety procedures and work safely in the workplace, adhering to the trust procedures and governance, including patient confidentiality and the Data Protection Act.		

LEARNING OUTCOMES

On successful completion of this module the student will:

1. Perform a range of generic skills, including infection control, basic life support, communication and team working, adhering to health and safety regulations, and behaving in a professional manner in accordance with *Good Scientific Practice*.

CLINICAL EXPERIENTIAL LEARNING

The clinical experiential learning for this module is:

- Observe how staff in the workplace communicate with patients and reflect on the importance of effective communication in the workplace with respect to patient-centred compassionate care.
- Shadow a qualified HCSP and discuss the role of the practitioner in Medical Physics and their contribution to healthcare and multiprofessional teams.

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
1	Control infection risks in accordance with departmental protocols, always washing hands in accordance with the six-stage hand-washing technique when necessary.	• Protocols and requirements for hygiene and infection control related to the relevant range of investigations, including preparation, conduct and completion of investigation. • Protocol for hand washing and how effective hand washing contributes to control of infection and local trust requirements.
1	Perform basic life support in accordance with current Resuscitation Council (UK) guidelines.	• Current Resuscitation Council (UK) guidelines.
1	Use effective communication skills within the healthcare environment.	• The principles of effective communication, including written and electronic, verbal and non-verbal. • The importance of introducing yourself and your role as a student HCSP as part of the process of introduction and consent. • Patient-centred care and the importance of informed consent and involving patients in decisions about their healthcare. • Importance of ensuring the patient is aware of the role of the member of the HCS workforce. • The way effective communication can assist in identifying problems accurately, increase patient satisfaction, enhance treatment adherence, and reduce patient distress and anxiety. • The importance of some key ideas, for example signposting, listening, language, non-verbal behaviour, ideas, beliefs, concerns, expectations and summarising in communication.
1	Adheres to safe working practice in the workplace.	• The relevant health and safety regulations specific to the workplace and investigations undertaken, the potential hazards and risks and the actions to be taken to minimise these.
1	Work professionally in the workplace at all times.	• *Good Scientific Practice*.

DIVISION	Physical Sciences
THEME	**Medical Physics**
SPECIALISM	Nuclear Medicine
SPECIALISM	Radiation Physics
SPECIALISM	Radiotherapy Physics

This programme can be delivered part-time through employment
Note: The 10 week work-based experience in Year 1 does not require equal time to be spent in each specialism. However, the students should become acquainted with the breadth of medical physics technology by the end of the first year

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10.2 Introduction to Medical Physics

MODULE	Introduction to Medical Physics	Component	Year 1 Theme
AIM	This module will provide a foundation from which students will build their knowledge, skills, experience and attitudes throughout the three-year programme of study and enable them to transfer these skills to employment in healthcare science. It is expected that this period of initial work-based training will provide the opportunity to apply their learning from the modules 'Mathematics, Statistics and Informatics' and 'Scientific Basis of Medical Physics', begin to integrate and embed many of the professional practice learning outcomes, and enable students to practise safely in the workplace.		
SCOPE	This module will enable students to begin to gain skills and experience of Medical Physics by observing, assisting and performing under direct supervision, some basic routine procedures while working in accordance with local rules and safety regulations. On completion of this module the student will be able to perform some basic medical physics procedures under direct supervision. Students will also apply knowledge and develop and build their professional practice safely.		

LEARNING OUTCOMES

On successful completion of this module, in routine adult patients, the student will:

1. Practise the highest standards of person-centred care, treating every person with compassion, dignity and respect.
2. Demonstrate safe working practice within an ionising radiation environment.
3. Observe and assist with some examples of standard technical and clinical procedures in nuclear medicine, radiation safety and radiotherapy physics.
4. Observe and assist with contamination and radiation dose measurements.
5. Observe and assist with the production of a radiotherapy treatment plan and the production of an immobilisation device.
6. Communicate effectively within the healthcare environment and clinical team, adapting communication to meet varying needs and overcoming barriers to understanding.

CLINICAL EXPERIENTIAL LEARNING

The clinical experiential learning for this module is:

- Observe the care pathway of a patient referred to the department requiring a nuclear medicine scan, from the referral through to the communication of the results to the patient, reflect on the process and identify any potential improvements that could be made with respect to the patient journey.
- Observe and assist with a diagnostic X-ray QA process and reflect on the process and the impact of the results on the patient pathway.
- Attend a multidisciplinary or department meeting and reflect on the way the MDT contributes to the care of patients referred to the department.
- Observe the work of the radiotherapy department, including patient treatment, and discuss the role of the medical physics team in providing high-quality patient care.

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
1, 2, 3	Control infection risks in accordance with departmental protocols.	• Protocols and requirements for hygiene and infection control related to the clinical measurements, including preparation, conduct and completion of investigation. • Protocol for hand washing and how effective hand washing contributes to control of infection.
1, 2, 3	Use effective communication skills within the healthcare environment.	• The principles of effective communication, including written and electronic, verbal and non-verbal. • The way effective communication can assist in identifying problems accurately, increase patient satisfaction, enhance treatment adherence and reduce patient distress and anxiety. • The importance of some key ideas, for example signposting, listening, language, non-verbal behaviour, ideas, beliefs, concerns, expectations and summarising in communication.
1, 2, 3	Adhere to safe working practice in the workplace.	• The relevant health and safety regulations specific to the workplace and investigations undertaken, the potential hazards and risks, and the actions to be taken to minimise these.
1, 2, 3	Work professionally in the workplace at all times.	• *Good Scientific Practice*.
4	Assist in the preparation of nuclear medicine equipment prior to a scanning procedure.	**Medical Physics and patient pathway** The role of Medical Physics in: • diagnostics; • therapeutics; • the equipment life cycle; • innovation and service development. **Atomic structure and radioactive decay** • Atomic and nuclear structure, mass number, atomic number, isotopes. • Mechanisms of radioactive decay.
4	Observe and assist in routine nuclear medicine scans.	

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
4	Observe and assist in measuring the performance characteristics of an X- ray tube.	• Alpha, beta and gamma radiation. • Half-life, mean life, physical half-life. • Decay schemes and energy level diagrams. • The units of activity. • Specific activity, radioactive concentration. **Production of X-rays** • General principles. • Electromagnetic spectrum. • Production of X-rays (low to megavoltage). • X-ray tubes. • Linear accelerators. **Interactions of radiation with matter** • Radiation quality – half value layer (HVL) and tenth value layer (TVL), quality index. • Attenuation, absorption and scatter (photo-electric, Compton scatter and pair-production). • Exponential attenuation of monoenergetic photons. • Electrons scatter and bremsstrahlung. • Ionisation and excitation. • Electron range and energy. • Inverse square law. • Filters and filtration. • Effects of electron and photon energy, absorber density and atomic number. • Tissue equivalent materials. **Introduction to ionising radiation equipment in Medical Physics**
5	Perform basic contamination monitoring.	
5	Perform basic radiation dose measurements.	
6	Observe and assist in the production of a radiotherapy treatment plan.	

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
6	Observe and assist in the production of an immobilisation device.	Radiation detectors. • Gamma camera and SPECT. • Basic diagnostic X-ray equipment. • CT. • SPECT-CT. • PET and PET/CT. • Linear accelerator. • Orthovoltage (kV) radiotherapy unit. • Radiotherapy treatment planning system (TPS). • Brachytherapy after-loaders. • Cyclotron. **Introduction to the basic science and the role of the HCSP in radiotherapy** • Mould room. • Treatment planning. • QA and QC. • Dosimetry. • Brachytherapy. **Introduction to the basic science and the role of the HCSP in nuclear medicine** • Radiopharmacy. • Scanning. • Radionuclide therapy. **Introduction the basic science and the role of the HCSP in radiation protection** • Room surveys. • QA and QC. • Environmental monitoring. • Personnel monitoring.

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
		• Sealed sources. • Unsealed sources. **Basic ionising radiation protection** • International and national legislation, guidance, standards and recommendations. • Hospital organisation of radiological protection: radiation safety policy, local rules. • Designation of areas. • Classification of persons. • Roles and responsibilities of staff, including duty holders. • ALARP. • Basic principles of dose limitation: time, distance, shielding. • Radiation protection of public and staff. • Radiation protection of patients. • Transportation of radioactive materials. • Administration of radionuclides. • High activity materials. • Disposal of radioactive materials. • Personnel and environmental dose monitoring.
1, 2, 3, 7	Reflect on your practice during this period of work-based training and generate a reflective diary that demonstrates how you take responsibility for your learning and utilise the skills required of an independent learner.	• Personal values, principles and assumptions, emotions and prejudices, understanding how these may influence personal judgement and behaviour. • The role of critical reflection and reflective practice and the methods of reflection that can be used to maintain or improve knowledge, skills and attitudes. • How CPD can improve personal performance.

SECTION 11: WORK-BASED SYLLABUS: NUCLEAR MEDICINE

This section describes the Learning Framework for the **Specialist Component** of work-based learning covering the Learning Outcomes, Clinical Experiential Learning, Competence, and Applied Knowledge and Understanding.

DIVISION	Physical Sciences
THEME	Medical Physics
SPECIALISM	**Nuclear Medicine**

MODULE	Safe Working and Equipment Management in the Nuclear Medicine Environment	COMPONENT	Specialist Years 2 and 3
AIM	The aim of this module is to ensure the student is able to work safely in the nuclear medicine environment with the emphasis on health and safety and the equipment life cycle. Students will be expected to perform risk assessments and operate the equipment inventory system. During this specialist work-based module students will be able to apply their learning from the generic, division-theme, and specialist academic modules.		
SCOPE	On completion of this module the student will be able to work safely in the nuclear medicine environment. They should be able to perform a range of risk assessments and tasks within the equipment life cycle, including cleaning, decontamination, fault reporting and first-line user maintenance. They will be expected to build their professional practice and use critical reflection to review and improve their performance in the workplace and develop skills to promote CPD.		

LEARNING OUTCOMES

On successful completion of this module the student will:

1. Work safely within the legislative and policy framework around the safe use of ionising radiation within a hospital environment.
2. Observe and assist in the procurement of equipment, accessories, or consumables.
3. Observe and perform the risk assessment of equipment.*
4. Perform the cleaning of a range of equipment, applying cleaning and/or decontamination processes.
5. Assist and perform a range of fault reporting and first-line user maintenance procedures.
6. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*.

**Note: When performing a risk assessment all risk elements must be considered.*

CLINICAL EXPERIENTIAL LEARNING

The clinical experiential learning for this module is:

- Produce a professional portfolio that cumulatively records/provides evidence of: skills, knowledge and understanding, ability to use reflective practice, and personal and professional development.

All of these experiences should be recorded in your e-portfolio.

The following section details the competence and knowledge and understanding each student must gain. Each competence is linked to the relevant learning outcomes and students must demonstrate achievement of each competence for each linked learning outcome.

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
1	Complete all generic health and safety and mandatory training contextualised to the work placement and work according to the department's local rules, procedures and protocols.	• Local health and safety policy covering work-based activities and safe working. • Generic health and safety risks and the steps that are in place or need to be put in place to mitigate these risks. • Fire escape routes, location of alarms and extinguishers, hand washing facilities, etc. **Clinical sources of radiation** • Ionising and non-ionising radiation sources and hazards. • Radiation protection international and national legislation, guidance, standards and recommendations. • Net positive benefit, dose limits. • Basic radiobiology. • Stochastic and deterministic effects. • Principles of designation of areas. • Principles of classification of persons. • Roles and responsibilities of staff and duty holders. • External audit standards. • Registration, safe custody, transport, use and disposal of radioactive sources. • Contingency plans, including radiation emergencies. • Notification of radiation accidents and incidents. • Biological and effective half-life. • Record keeping.

1	Undertake a radiation risk assessment in the clinical environment.	**Principles of radiation dose limitation (including factors affecting the design of radiation facilities)**
		• Risk assessment.
		• Controls:
		  ○ room and equipment;
		  ○ interlocks;

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
		○ warning signs; ○ emergency stop buttons. • Calculation of shielding requirements. • Environmental radiation surveys. • Radiation protection in the administration of radioactive substances. • Decontamination of radionuclide spills. • Contamination monitoring isotope calibrators. • Contamination monitors, wipe tests. • Waste management-biological and radioactive hazards: ○ discharge of radioactive patient; ○ death of a radioactive patient. • Radioactive source security, e.g. high-activity sources.
1	Prepare and tidy areas where radioactive materials are handled or used so as to ensure present no unexpected risk.	• Health and safety guidelines. • Standard operating procedure (SOP).
1	Use gloves, shielding, distance and speed to reduce exposure and contamination.	• Radiation protection for nuclear medicine. • Health and safety guidelines. • SOP.
1	Use equipment used to contain spillage.	• Radiation protection in the administration of radioactive substances. • Decontamination of radionuclide spills. • Contamination monitoring isotope calibrators. • Contamination monitors, wipe tests. • Waste management – biological and radioactive hazards.
1	Document a radiation incident.	• Health and safety guidelines. • Hospital organisation of radiological protection: radiation safety policy, local rules. • Legislative framework for the external reporting of radiation incidents. • Environmental permitting, safe custody, transport, use and disposal of

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
		radioactive sources. • Contingency plans, including radiation emergencies. • Notification of radiation accidents and incidents.
1	Select and check the meters for dose measurement and contamination monitoring by checking the power supply and background levels.	• Radiation detectors and detection systems. • How to identify the survey meters used in the department, and be aware of which meter to use for which application. • SOP.
1	Perform reference source checks and understand the need for reporting deviations from the norm.	• Radiation detectors and detection systems. • Instrument calibration. • Handling of radioactive materials. • SOP. • National legislation, European directives, and national and international recommendations on radiation safety.
1	Perform and document personal and environmental monitoring for radioactive contamination in accordance with local protocol.	• Radiation detectors and detection systems. • Instrument calibration. • Personal dose monitoring. • Environmental radiation surveys. • Contamination monitoring protocols. • Health and safety guidelines. • SOPs.
1	Apply local protocols for the disposal of radioactive waste, including: • segregation and labelling of different types of radioactive waste; • estimation of storage activity; • estimation of disposal activity; • record keeping.	• Health and safety guidelines. • SOPs for radioactive materials for: ○ acceptance; ○ storage; ○ handling; ○ waste disposal; ○ labelling.

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
1	Package and label radioactive materials for transport in accordance with local procedures.	• Requirements for labelling and transporting radioactive materials. • Health and safety guidelines. • SOP.
1	Assist in giving instructions to other personnel and patients, to include: • doses given and hazards to patients; • hazards arising from patients to staff/family/carers; • appropriate care to be given following a nuclear medicine procedure; • instructions for pregnant or breastfeeding patients.	• Health and safety guidelines. • SOP. • Radiation doses and dose rates encountered by staff, family and carers from nuclear medicine procedures. • Procedures for pregnant or breastfeeding staff to minimise radiation dose. • Procedures for nursing staff following nuclear medicine procedures, including patient transfer to another hospital. • Information for patients, family and carers following nuclear medicine procedures.
2	Assist in the procurement of equipment, accessories or consumables.	• Specification and evaluation of equipment, accessories, or consumables. • Procurement procedures and regulations. • How to complete documentation, including requisitions and the relevant order codes. • Authorisation procedures. • Procedure for processing equipment orders.
2	Perform visual inspection of equipment prior to use to ensure it is safe to use.	• The actions to be taken in the event of equipment or packaging being damaged.
3	Perform risk assessments on equipment and its use.	• Theory of risk assessment using current statutory and professional guidance. • The kind of risk assessments that are performed, where they are kept and how to access them. • The types of symbols, meaning and the implications these may have on any further action:

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
		○ equipment classifications; ○ electrical symbols; ○ biological hazards; ○ chemical hazards. • Control of Substances Hazardous to Health (COSHH) assessment and comment on application in the workplace.
4	Clean equipment, applying cleaning and/or decontamination processes on a range of equipment of equipment.	• The cleaning and/or decontamination processes for a range of equipment within the specialist area. • SOP.
5	Assist in reporting faults on a range of equipment used in the department and perform user maintenance.	• Common equipment faults encountered in the department. • SOP relating to user maintenance. • How to obtain local or manufacturer assistance in maintenance or repair.
6	Work within the context of the departmental quality management system, particularly in relation to: • internal audit; • preventative and corrective actions.	• Quality management systems, including ISO9000, Good Manufacturing Practice and MHRA and Environment Agency requirements. • Internal auditing. • Preventive and corrective actions.
6	Work within their own knowledge, skills, ability and responsibility, being able and willing to seek assistance when it is necessary, complying with relevant guidance and laws, to include those relating to: • your scope of practice; • probity; • fitness to practice; • maintaining your own health.	• Principles, guidance and law with respect to: ○ *Good Scientific Practice*; ○ probity; ○ fitness to practise. • The importance of maintaining your own health.

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING

6	Follow data protection policy and local procedures to maintain data records and confidentiality.	• Principles, guidance and law with respect to:
		  ○ confidentiality;
		  ○ information governance;
		  ○ informed consent;
		  ○ probity;
		  ○ fitness to practise.
		• The importance of maintaining your own health.

6	Maintain a professional and courteous attitude at all times.	• *Good Scientific Practice*.
6	Follow the dress and behaviour code, applying any additional requirements when entering/working in controlled areas or areas of restricted access.	• *Good Scientific Practice*. • Local requirements for dress and behaviour in specific areas of work placement.
6	Work constructively and effectively as a member of a MDT.	• The underpinning principles of effective teamwork and working within and across professional boundaries.
6	Reflect on your practice and generate a reflective diary that demonstrates how you take responsibility for your learning and utilise the skills required of an independent learner, and your commitment to your CPD.	• Personal values, principles and assumptions, emotions and prejudices, understanding how these may influence personal judgement and behaviour. • The role of critical reflection and reflective practice and the methods of reflection that can be used to maintain or improve knowledge, skills and attitudes. • How continuous personal development can improve personal performance.

MODULE	Diagnostic Imaging and Therapy in Nuclear Medicine	COMPONENT	Specialist Years 2 and 3
AIM	The aim of this module is to introduce the student to diagnostic imaging in nuclear medicine from the setting up, optimisation and operation of equipment, while performing a range of nuclear medicine diagnostic and therapy procedures. During this specialist work-based module students will be able to apply their learning from the generic, division-theme, and specialist academic modules, and develop their patient-centred skills.		
SCOPE	On completion of this module the student will be able to safely perform a range of routine diagnostic imaging and therapy procedures in accordance with SOPs. They will be expected to build their professional practice and use critical reflection to review and improve their performance in the workplace and develop skills to promote CPD.		

LEARNING OUTCOMES

On successful completion of this module the student will:

1. Set up, optimise and operate imaging equipment safely so as to be able to produce the highest quality results for interpretation across a range of nuclear medicine investigations.
2. Perform all aspects of the preparation required, including providing relevant information and guidance to the patient/carer.
3. Perform a range of acquisition and recording techniques used when carrying out diagnostic imaging procedures.
4. Perform a range of nuclear medicine therapy procedures used in the clinical treatment pathway of patients.
5. Perform tracer methodology procedures in nuclear medicine investigations.
6. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*.

CLINICAL EXPERIENTIAL LEARNING

The clinical experiential learning for this module is:

- Observe the care pathway for a patient referred to nuclear medicine for a diagnostic and therapeutic procedure and, with permission, talk to each patient to gain a patient perspective of the service provided by the nuclear medicine department and reflect on your learning from this.
- Observe and describe a range of common nuclear medicine scans, undertake analysis of the results and discuss with your training officer how the clinical scans contribute to the diagnosis and management of patients.
- Produce a professional portfolio which cumulatively records/provides evidence of: skills, knowledge and understanding, ability to use reflective practice, and personal and professional development.

All of these experiences should be recorded in your e-portfolio.

The following section details the competence and knowledge and understanding each student must gain. Each competence is linked to the relevant learning outcomes and students must demonstrate achievement of each competence for each linked learning outcome.

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING

1	Perform basic operating features of the imaging equipment and its accessories, e.g. bed operation, gantry movement, collimators, positioning controls, emergency stop, etc.	• Nuclear properties of radionuclides used in nuclear medicine: atomic weight, number, half-life, mode of decay, principal emissions.
		• Imaging systems in nuclear medicine:
		○ construction of the gamma camera;
		○ static imaging;
		○ dynamic imaging;
		  ○ SPECT-CT;
		○ image quality;
		○ artefacts, noise sensitivity and quantification;
		  ○ PET-CT;
		  ○ PET-MR.
		• Commissioning and quality control.
		• Future detector systems – flat panel and solid state detectors.
		Introduction to image formation, acquisition, manipulation, analysis, storage and sharing
		• Theory of image formation, including reconstruction from projections.
		• Display, manipulation and analysis of images.
		• Image registration and fusion.
		• Image storage, sharing files and formats.
		• PACS.
		• DICOM.
		• HL7.

1	Operate the acquisition control and information processing system.	
1	Use a suitable phantom and acquisition mode, operate equipment gamma camera to investigate the effect of: • collimator selection; • photo peak; • counts/time statistics; • positioning and orientation; • attenuation; • dual energy acquisition; • image manipulation and presentation.	
1	Perform daily, weekly and monthly QC on a gamma camera using an appropriate source and standardised parameters, and be aware of action thresholds. To include the following: • uniformity; • centre of rotation; • linearity; • spatial resolution;	

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
	• sensitivity; • X-ray CT components.	
1	Perform commissioning tests on a gamma camera system.	
1	Interpret results of QC and commissioning tests, recognising normal appearances and normal ranges, common artefacts and the possible causes of abnormal appearances.	• Performance, application, risk assessment and QC procedures for of each of the following imaging systems used in nuclear medicine: ○ gamma camera; ○ SPECT; ○ SPECT-CT; ○ PET; ○ PET-CT; ○ PET-MR. **Quality assurance** For a range of commonly performed QA tests: • best practice protocols; • test equipment; • action limits; • frequency.
2	Assist in scheduling appointments with regard to: • session arrangements; • radiopharmaceutical availability; • equipment and room availability; • staff availability; • patient transport arrangements; • pre-medication.	• Legislative framework: ○ Ionising Radiations (Medical Exposure) Regulations 2000 (IRMER); ○ Medicines (Administration or Radioactive Substances) Regulations 1987 (MARS); ○ Administration of Radioactive Substances Advisory Committee (ARSAC). • How to identify the roles of operator, practitioner and referrer. • How to identify criteria acceptable for delegated authority for the authorisation of referrals. • Local authorisation guidelines and procedures. • How to identify when practitioner justification is required.

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
		• Patient confidentiality regulations.
1, 2, 3, 4, 5	Control infection risks in accordance with departmental protocols when performing nuclear medicine investigations.	• Protocols and requirements for hygiene and infection control related to the relevant range of investigations, including preparation, conduct and completion of investigation. • Safe handling of radioactive materials used in nuclear medicine. • Protocol for hand washing and how effective hand washing contributes to control of infection and local trust requirements.
1, 2, 3, 4, 5	Minimise risks and hazards in compliance with health and safety policies when performing nuclear medicine investigations.	• The relevant health and safety legislation specific to nuclear medicine, including the Ionising Radiation Regulations 1999, the Local Rules, the potential hazards and risks, and the actions to be taken to minimise these.
1, 2, 3, 4, 5	Use effective communication skills within the nuclear medicine environment adapting communication style and language to meet the needs of the listener.	• The principles of effective communication, including written and electronic, verbal and non-verbal. • The way effective communication can assist in identifying problems accurately, increase patient satisfaction, enhance treatment adherence and reduce patient distress and anxiety. • The importance of some key ideas, for example signposting, listening, language, non-verbal behaviour, ideas, beliefs, concerns, expectations and summarising in communication.
2, 3, 4, 5	Obtain a suitably completed request form, greet the patient and check patient ID for nuclear medicine investigations.	• Referral routes for cardiac diagnostic investigations. • Requirements for correct completion of request forms and how to validate. • The importance of checking and confirming the patient identity and the implications of not doing so.
2, 3, 4, 5	Gain informed consent for each investigation.	• The importance of introducing yourself and your role as a student HCSP as part of the process of introduction and consent. • The importance of explaining the procedure for each investigation to the patient and gaining informed consent. • The importance of explaining your role within the HCS workforce to the patient.

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
		• The relevant procedures and requirements for patient conformance. • Clinical indications and contraindications for each investigation. • Principles, guidance and law with respect to informed consent. • Investigations for which written consent is obtained. • Procedures to follow with women of childbearing age, pregnant women and breastfeeding mothers.

2, 3, 4, 5	Prepare patients for nuclear medicine investigations/therapy, explaining the procedure to the patient/carer, answering questions using appropriate language and interpreters.	• SOPs, including how to:
		  ○ check patient's identity according to local procedures;
		  ○ confirm patient consent according to local protocol;
		  ○ confirm justification and authorisation for procedures;
		  ○ check study is appropriate to clinical history provided and the study has been justified under local procedures;
		  ○ check there are no contraindications to proceeding routinely;
		  ○ check relevant patient preparation has been undertaken;
		  ○ check for possible pregnancy or breastfeeding in women of reproductive capacity.
		• Local procedures for identifying non-standard occurrences during the procedure.

2, 3, 4, 5	Treat patients referred to nuclear medicine in a way that respects their dignity, rights, privacy and confidentiality while undertaking nuclear medicine investigations.	• The rights of the patient with regard to consent for treatment and confidentiality of consultation and medical records. • Key factors influencing dignity, rights, privacy and confidentiality, including age, gender, culture and beliefs. • Correct positioning of the patient ensuring comfort, co-operation and optimal investigation results. • The impact of incorrect positioning or non-co-operation on investigation results.
2, 3, 4, 5	Keep clear and accurate documentation that meets or exceeds the requirements in place through protocols, procedures,	• SOPs.

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
	guidance, local rules and legislation.	
2, 3, 5	Work within skills and abilities to be sure the patient is not placed at undue risk or injury with due regard to patient's medical condition.	• The potential hazards and risks and the actions to be taken to minimise these. • Nursing and emergency procedures, including: ○ basic adult life support/paediatric life support; ○ managing the diabetic patient; ○ identification of the deteriorating patient and action to follow. • *Good Scientific Practice*.
3	Select equipment and use relevant SOP for appropriate data acquisition.	• SOPs and the importance of: ○ patient preparation; ○ reason for the examination; ○ presenting pathology; ○ radiopharmaceutical administered; ○ mode of uptake; ○ dose administered and the Administration of Radioactive Substances Advisory Committee (ARSCA) limit; ○ protocol used/views acquired; ○ supporting documentation. • Normal and abnormal appearances. • Review, with reference to the planning and interpretation of radionuclide tests and therapy: ○ anatomy and physiology; ○ immunology; ○ infection: ▪ acute, chronic, pus, abscess, differential diagnosis between abscess, cyst and tumour; ○ neoplastic disease: ▪ tumours, primary and secondary (metastases), benign and malignant tumours, assessing the extent of malignant involvement.
3	Perform a wide range of imaging procedures according to local SOPs.	
3	Perform basic routine processing and analysis according to protocols, e.g. static studies, dynamic studies, SPECT and gated studies.	

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
		Assessment of appropriateness of commonly requested tests or procedures, for all the body systems listed below, which should include an understanding of: • The radiopharmaceutical used, activity administered and route of administration, half-life, energy. • The preparation of the patient. • The views and samples that must be obtained, dynamic protocols, static protocols, SPECT, SPECT-CT, PET-CT, PET-MR. • The use of any special data handling techniques or display mode. • Any special features of the study. • Possible artefacts. • Setting up the equipment – energy windows, collimation, etc. • The clinical context in which radionuclide tests may be of value and the influence of the test results on patient management. • The radiation dose to the patient and the risks and benefits of the particular radionuclide test to a particular patient. • New developments in nuclear medicine, and the changing role of nuclear medicine in the diagnosis and treatment of disease and the relevant imaging modalities used in reaching a diagnosis. All the above should be applied to the following body systems: • skeletal system; • central nervous system; • endocrine system; • cardiovascular system; • respiratory system; • urinary system; • gastrointestinal system; • hemopoietic and lymphatic system; • reproductive system;

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
		• oncological applications; • infection and inflammatory imaging.
3	Perform complex processing to include myocardial perfusion imaging and filter choice for SPECT.	• The application of nuclear medicine in diagnosis in PET/CT, SPECT/CT and PET-MR. • Myocardial perfusion imaging. • Image and data analysis and display. • Image reconstruction, including filter choice for SPECT. • Image registration. • SOPs.
3	Observe and assist in the acquisition and recording of hybrid imaging, e.g. SPECT/CT, PET/CT and PET-MR.	
4	Observe and assist in the administration of therapy, to include at least one of the following: • ^{131}I for benign and malignant disease of the thyroid gland; • ^{90}Y; • ^{131}I-MIBG for treatment of adrenal tumours; • ^{89}Sr for the treatment of bone metastases.	• Therapeutic applications of radionuclides in nuclear medicine: ○ dosimetry in molecular radiotherapy; ○ radionuclide therapy in thyroid carcinoma; ○ radionuclide therapy in benign thyroid disease; ○ radionuclide therapy in neuroendocrine tumours; ○ radionuclide therapy in hepatocellular carcinoma; ○ radioimmunotherapy in lymphoma and other blood disorders; ○ radionuclide therapy of refractory metastatic bone pain; ○ radiosynovectomy; ○ future developments in therapeutic nuclear medicine applications; ○ nursing implications for patients undergoing radionuclide metabolic therapy. • The differences between radiopharmaceutical administered, mode of uptake and radiation emissions, and the impact this may make on the patient. • How to identify the practitioner with the specific ARSAC certificate. • SOPs and the importance of: ○ patient preparation, including the need to stop other drug therapy before the therapy is given; ○ reason for the therapy;
4	For each type of therapy procedure observed identify the protocol to be used and confirm appropriate authorisation and justification.	
4	For each type of therapy procedure observed assist in the patient preparation, including pre-administration checks including medication.	

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
4	For each type of therapy procedure observed, assist in delivering specific patient and patient carer information, including radiation protection and instructions following administration.	○ presenting pathology; ○ radiopharmaceutical administered; ○ administration and mode of uptake; ○ dose administered and the ARSCA limit; ○ requirement for inpatient stay and safe dose rates for patient discharge; ○ patient information on discharge; ○ contamination monitoring of facilities; ○ decontamination of facilities; ○ storage and disposal of radioactive waste and contaminated items; ○ documentation. • Medical emergencies after the administration of radionuclide therapy. • Safe levels of radioactivity for discharge, post mortem and burial or cremation.
4	Assist in the monitoring and decontamination of facilities used and the disposal of waste according to protocol, and monitoring procedures for each type of therapy procedure.	
5	Assist and perform white cell labelling using either ^{99m}Tc or ^{111}In.	• Labelling blood products. • SOP.
6	Assist with a clinical audit, including appropriate statistical analysis.	• The process of undertaking clinical audit, including approval, governance, design, data collection, analysis, dissemination.
6	Maintain a professional and courteous attitude at all times.	• *Good Scientific Practice*.
6	Follow the dress and behaviour code, applying any additional requirements when entering/working in controlled areas or areas of restricted access.	• *Good Scientific Practice*. • Local requirements for dress and behaviour in specific areas of work placement.
6	Work constructively and effectively as a member of a MDT.	• The underpinning principles of effective teamwork and working within and across professional boundaries.
6	Reflect on your practice and generate a reflective diary that demonstrates how you take responsibility for your learning and	• Personal values, principles and assumptions, emotions and prejudices, understanding how these may influence personal judgement and behaviour. • The role of critical reflection and reflective practice and the methods of

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
	utilise the skills required of an independent learner, and your commitment to your CPD.	reflection that can be used to maintain or improve knowledge, skills and attitudes. • How continuous personal development can improve personal performance.

MODULE	Radiopharmaceuticals	COMPONENT	Specialist Years 2 and 3
AIM	The aim of this module is to introduce the student to working in the radiopharmacy, the administration of radiopharmaceuticals and QC. The student will be able to perform a range of tasks to support the process and will be able to apply their learning from the generic, division-theme, and specialist academic modules.		
SCOPE	On completion of this module the student will be able to safely administer radiopharmaceuticals, work in a radiopharmacy and apply QC procedures. They will be expected to build their professional practice and use critical reflection to review and improve their performance in the workplace and develop skills to promote CPD.		

LEARNING OUTCOMES

On successful completion of this module the student will:

1. Administer radiopharmaceuticals while observing all safety, control of infection and radiation protection governance requirements.
2. Work in a radiopharmacy safely and within the legislative and statutory framework to prepare and dispense radiopharmaceuticals for use in the diagnosis or treatment of patients.
3. Apply QC procedures within the radiopharmacy to establish and maintain a safe environment that meets all legislative and medicine inspectorate requirements.
4. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*.

CLINICAL EXPERIENTIAL LEARNING

The clinical experiential learning for this module is:

- Observe the routine production of radiopharmaceuticals and participate in routine quality assurance procedures within the radiopharmacy, and describe the role of the radiopharmacy in patient care.
- Produce a professional portfolio that cumulatively records/provides evidence of: skills, knowledge and understanding, ability to use reflective practice, and personal and professional development.

All of these experiences should be recorded in your e-portfolio.

The following section details the competence and knowledge and understanding each student must gain. Each competence is linked to the relevant learning outcomes and students must demonstrate achievement of each competence for each linked learning outcome.

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
1	Complete accredited training and perform venous sampling.	• Health and safety guidelines. • SOPs. • Correct procedures for responding to and reporting adverse reactions or extravasation.
1	Complete accredited training and administer intravenous (IV) radiopharmaceuticals.	• Radiopharmaceuticals used in nuclear medicine. • The need for administration of adjunct drugs. • Adjunct drugs regularly used in nuclear medicine and their usual mode of administration. • Patient group directions: o how they work; o who they relate to.
1	Observe and assist with the operation of: • a syringe pump; • a giving set.	• The principles of operation of a syringe pump. • Health and safety guidelines. • SOPs.
1	Complete relevant training to administer radiopharmaceuticals and adjunct drugs via the following routes: • oral; • aerosol; • IV.	• For in-vivo non-imaging techniques in common use, knowledge of: o the radiopharmaceutical used, activity administered and route of administration, half-life, beta energy. • Health and safety guidelines. • SOPs.
1	Confirm and calculate patient's dosage (relevant activity of radioactive material or medical dosage of pharmaceutical product).	• Dosimetry of unsealed radionuclide sources. • Principles of radionuclide production: o carrier-free radionuclides; o radionuclide generator systems: growth and decay curves, elution profiles; o available generator systems and their construction; o cyclotron and reactor production, general principles.
1	Select a suitable site/route for administration, and if difficulties were to occur, know when, how and	

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING

	where to get support.	• Nuclear properties of radionuclides used in nuclear medicine:
		  ○ atomic weight, number, half-life, mode of decay, principal emissions.
		• For radionuclide tests in common use this should include knowledge of:
		  ○ the radiopharmaceutical used, activity administered and route of administration, half-life, beta energy;
		  ○ the preparation of the patient.

1	Keep clear and accurate documentation that meets or exceeds the requirements in place through protocols, procedures, guidance, local rules and legislation.	• Requirements for documentation. • *Good Scientific Practice*. • SOPs.
2	Check and confirm that the air handling unit work stations/isolators are working within specification.	• Radiopharmaceuticals used in nuclear medicine. • The design and operation of the radiopharmacy. • Good Manufacturing Practice. • The types of preparation. • Sterilisation techniques. • Maintaining and monitoring the pharmaceutical environment. • Waste disposal. • Action levels. • Identification of the classification of rooms and the classification of rooms and the air handling unit. • The different types of preparation with respect to open and closed procedures.
2	Check the environmental integrity (room and cabinet pressures) and be aware of the action levels.	
2	Complete operator tests.	• Good Manufacturing Practice. • Maintaining and monitoring the pharmaceutical environment. • Operator tests for radiopharmacy.
2	Elute a ^{99m}Tc generator to include: • elution procedure;	• Radiochemistry and QC: ○ the chemistry of commonly used radionuclides;

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
	• carrying out the procedure for molybdenum breakthrough; • first-line quality control; • measure activity of eluate.	○ radiochemical techniques; ○ production of radiopharmaceuticals; ○ labelling of blood products; ○ selection of appropriate radiopharmaceutical. • The assay of radioactivity: ○ problems associated with assay; ○ background and shielding; ○ counting loss associated with dead time and its correction; ○ efficiency and the optimisation of counting conditions, dual isotope counting; ○ geometry of the detecting system; ○ assay of radioactive samples; ○ radionuclide identification; ○ quantification of uptake, relative and absolute; ○ use of standards, background and phantoms; ○ whole body monitors.
2	Calculate the required volume of individual patient doses based on the required activity and the time of injection.	• Adjustments needed to account for patient factors, e.g. paediatrics and patient's weight.
2	Reconstitute a range of commercial kits in accordance with written procedure, being aware of the different production techniques involved.	• Radiochemistry and QC: ○ the chemistry of commonly used radionuclides; ○ radiochemical techniques; ○ production of radiopharmaceuticals; ○ labelling of blood products; ○ selection of appropriate radiopharmaceutical.
2	Measure activity of reconstituted kits.	• The assay of radioactivity: ○ problems associated with assay; ○ background and shielding;

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
		○ counting loss associated with dead time and its correction; ○ efficiency and the optimisation of counting conditions, dual isotope counting; ○ geometry of the detecting system; ○ assay of radioactive samples; ○ radionuclide identification; ○ quantification of uptake, relative and absolute; ○ use of standards, background and phantoms; ○ whole body monitors.
2	Complete the documentation for the receipt of both active and non-active products.	• The procedure for use of unlicensed products and the roles of those involved. • How to identify and the procedures to be followed when there are failures of equipment, products, or QC tests. • How to identify the procedures to be followed in the event of a recall of products, e.g. quality control failure, manufacturer recall.
2	Keep clear and accurate documentation that meets or exceeds the requirements in place through protocols, procedures, guidance, local rules and legislation.	• The procedures in case of failures of equipment, products, or QC tests.
2	Perform radioactive contamination monitoring.	• Radiation detectors and detection systems. • Instrument calibration. • Personal dose monitoring. • Environmental radiation surveys. • Contamination monitoring protocols. • Health and safety guidelines.
2	Perform the procedures for use of unlicensed products, to include products that are purchased as finished products, prepared from	• The procedure for use of unlicensed products and the roles of those involved. • Good Manufacturing Practice.

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
	unlicensed kits, or prepared according to in-house formulae.	• Radiochemistry and QC: ○ the chemistry of commonly used radionuclides; ○ radiochemical techniques; ○ production of radiopharmaceuticals; ○ labelling of blood products; ○ selection of appropriate radiopharmaceutical. • SOPs. • Documentation requirements.
3	Perform first-line quality control, to include: • inspection for particles; • expected activity; • pH; • radionuclide concentration; • radiochemical purity.	
3	Perform radiochemical purity (RCP) for a range of radiopharmaceuticals.	
3	Assist in the environmental testing of the radiopharmacy, to include: • settle plate testing; • particle counting; • contact plates; • observation and recording of room pressures, fridge temperatures, etc.	
3	Perform the procedures for release/failure of product.	
3	Complete documentation regarding the results of quality control carried out in the radiopharmacy.	
4	Work within their own knowledge, skills, ability and responsibility, being able and willing to seek assistance when it is necessary, complying with relevant guidance and laws, to include those relating to:	• Principles, guidance and law with respect to: ○ *Good Scientific Practice*; ○ probity; ○ fitness to practise. • The importance of maintaining your own health.

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
	• your scope of practice; • probity; • fitness to practice; • maintaining your own health.	
4	Maintain a professional and courteous attitude at all times.	• *Good Scientific Practice*.
4	Follow the dress and behaviour code, applying any additional requirements when entering/working in controlled areas or areas of restricted access.	• *Good Scientific Practice*. • Local requirements for dress and behaviour in specific areas of work placement.
4	Work constructively and effectively as a member of a MDT.	• The underpinning principles of effective teamwork and working within and across professional boundaries.
4	Reflect on your practice and generate a reflective diary that demonstrates how you take responsibility for your learning and utilise the skills required of an independent learner, and your commitment to your CPD.	• Personal values, principles and assumptions, emotions and prejudices, understanding how these may influence personal judgement and behaviour. • The role of critical reflection and reflective practice and the methods of reflection that can be used to maintain or improve knowledge, skills and attitudes. • How continuous personal development can improve personal performance.

MODULE	Safe Working with Radioactivity in the Clinical Environment	COMPONENT	Specialist Years 2 and 3
AIM	The aim of this module is for the student to apply knowledge and gain work-based skills and experience with respect to health and safety and QC when working with radioactivity. During this specialist work-based module students will be able to apply their learning from the generic, division-theme, and specialist academic modules.		
SCOPE	On completion of this module the student will be able to use a dose calibrator to prepare and measure radioactivity, perform in-vitro procedures, and work safely within legislative and policy frameworks. They will be expected to build their professional practice and use critical reflection to review and improve their performance in the workplace and develop skills to promote CPD.		

LEARNING OUTCOMES

On successful completion of this module the student will:

1. Use a dose calibrator in the preparation and measurement of radioactivity.
2. Perform in-vitro procedures in nuclear medicine.
3. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*.

CLINICAL EXPERIENTIAL LEARNING

The clinical experiential learning for this module is:

- Illustrate the planned preventative maintenance arrangements for a medical device on the medical device information system, e.g. in-house maintained, on external service contract, loan devices, etc., and select one device to follow this process through.
- Produce a professional portfolio that cumulatively records/provides evidence of: skills, knowledge and understanding, ability to use reflective practice, and personal and professional development.

All of these experiences should be recorded in your e-portfolio.

The following section details the competence and knowledge and understanding each student must gain. Each competence is linked to the relevant learning outcomes and students must demonstrate achievement of each competence for each linked learning outcome.

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
1	Use the dose calibrator to measure the activity of radiopharmaceuticals.	• The construction, operation and characteristics of the dose calibrator and gamma counter. • The assay of radioactivity: ○ the problems associated with assay; ○ background and shielding; ○ counting loss associated with dead time and its correction; ○ efficiency and the optimisation of counting conditions, dual isotope counting; ○ the geometry of the detecting system; ○ the assay of radioactive samples; ○ detection systems; ○ QC; ○ radionuclide identification. • Radiation protection for nuclear medicine. • Radiopharmaceuticals used in nuclear medicine: ○ *Good Manufacturing Practice*; ○ the types of preparation; ○ sterilisation techniques; ○ the operation of the radiopharmacy; ○ waste disposal. • Radiochemistry and QC: ○ the chemistry of commonly used radionuclides; ○ radiochemical techniques; ○ production of radiopharmaceuticals; ○ labelling of blood products; ○ selection of appropriate radiopharmaceutical.
1	Measure the changes in readings of activity when a radioactive sample is positioned at different depths.	
1	Measure changes in readings of activity when samples are in different volumes.	
1	Measure the linearity over the range of activities used in practice.	
1	Demonstrate readings obtained from the same activity in different containers, e.g. syringe, bottle and vial.	
1	Perform QC in accordance with local procedures and be aware of the procedure for reporting any deviations.	
2	Perform or confirm routine QC procedures on monitoring or measuring equipment.	
2	Use preventative measures when dealing with potential microbiological or radiation hazards.	
2	Pipette a series of samples, weighing the sample each time and calculate the accuracy of pipetting.	
2	Prepare samples for counting in an	

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
	auto gamma counter.	
2	Operate auto gamma counter in accordance with pre-defined protocol to produce a single energy spectrum.	
2	Count a mixture of two radionuclides. Calculate cross-channel contribution to demonstrate the need for cross-channel correction in a sample of more than one radionuclide.	
2	Prepare a standard stock solution according to a written protocol.	
2	Process data produced by an auto gamma counter in accordance with pre-defined protocol.	
2	Assist and perform red cell volume determination, including: • labelling blood cells; • preparation of injection; • assisting with the injection and taking of the blood samples; • preparation of standards and samples for counting; • assaying the activity of the samples; • calculation of the red cell volume.	• Basic mathematical methods as applied to nuclear medicine ○ counting statistics, precision of net sample counts; ○ radioactive decay and decay calculations; ○ isotope dilution methods; ○ clearance techniques, exponential analysis. • For in-vivo non-imaging techniques in common use, knowledge of: ○ the radiopharmaceutical used, activity administered and route of administration, half-life, beta energy; ○ the preparation of the patient; ○ sample taking; ○ preparation of samples; ○ normal ranges. • The assay of radioactivity: ○ problems associated with assay;
2	Perform a glomerular filtration rate (GFR) determination, to include: • preparation of injection;	

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
	• assisting with the administration of the radiopharmaceutical and taking of blood samples; • preparation of standards and samples for counting; • assaying activity of samples; • calculation of results.	○ background and shielding; ○ counting loss associated with dead time and its correction; ○ efficiency and the optimisation of counting conditions, dual isotope counting; ○ geometry of the detecting system; ○ assay of radioactive samples; ○ radionuclide identification; ○ quantification of uptake, relative and absolute; ○ use of standards, background and phantoms; ○ whole body monitors. • Labelling blood products. • SOP.
2	Safely dispose of all waste materials, clean the area and monitor for radioactive after in-vitro testing.	• Protocol for waste disposal or radioactive waste.
3	Maintain a professional and courteous attitude at all times.	• *Good Scientific Practice*.
3	Follow the dress and behaviour code, applying any additional requirements when entering/working in controlled areas or areas of restricted access.	• *Good Scientific Practice*. • Local requirements for dress and behaviour in specific areas of work placement.
3	Work constructively and effectively as a member of a MDT.	• The underpinning principles of effective teamwork and working within and across professional boundaries.
3	Reflect on your practice and generate a reflective diary that demonstrates how you take responsibility for your learning and utilise the skills required of an	• Personal values, principles and assumptions, emotions and prejudices, understanding how these may influence personal judgement and behaviour. • The role of critical reflection and reflective practice and the methods of reflection that can be used to maintain or improve knowledge, skills and

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
	independent learner, and your commitment to your CPD.	attitudes. • How continuous personal development can improve personal performance.

SECTION 12: WORK-BASED SYLLABUS: RADIATION PHYSICS

This section describes the Learning Framework for the **Specialist Component** of work-based learning covering the Learning Outcomes, Clinical Experiential Learning, Competence, and Applied Knowledge and Understanding.

DIVISION	Physical Sciences
THEME	Medical Physics
SPECIALISM	**Radiation Physics**

MODULE	Equipment Management in Radiation Physics	COMPONENT	Specialist Years 2 and 3
AIM	The aim of this module is to ensure the student is able to work safely in the radiation physics environment. During this specialist work-based module students will be able to apply their learning from the generic, division-theme, and specialist academic modules.		
SCOPE	On completion of this module the student will be able to perform equipment life-cycle procedures, routine quality assurance and commissioning tests on a range of equipment, including static and mobile diagnostic X-ray, static and mobile fluoroscopy, dental plus associated equipment such as automatic exposure control (AEC), dose area product (DAP) meters and imaging systems. They will be expected to build their professional practice and use critical reflection to review and improve their performance in the workplace and develop skills to promote CPD.		

LEARNING OUTCOMES

On successful completion of this module the student will:

1. Observe and assist with calibration of a range of equipment life-cycle procedures diagnostic X-ray and non-ionising equipment.
2. Perform routine QA tests on a range of equipment that produce both diagnostic X-rays and non-ionising radiations.
3. Assist with commissioning tests on a range of equipment that utilise both diagnostic X-ray and non-ionising radiations.
4. Assist with critical examinations on diagnostic X-ray equipment installations.*
5. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*.

**Equipment and installations include, for example, static and mobile diagnostic X-ray, static and mobile fluoroscopy, dental plus associated equipment such as AEC, CT scanners, DAP meters, imaging systems, etc.*

CLINICAL EXPERIENTIAL LEARNING

The clinical experiential learning for this module is:

- Observe the work undertaken in a range of clinical areas where radiation is used, for example X-ray, cardiac catheterisation and imaging, and discuss the role of radiation physics.
- Produce a professional portfolio that cumulatively records/provides evidence of: skills, knowledge and understanding, ability to use reflective practice, and personal and professional development.

All of these experiences should be recorded in your e-portfolio.

The following section details the competence and knowledge and understanding each student must gain. Each competence is linked to the relevant learning outcomes and students must demonstrate achievement of each competence for each linked learning outcome.

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
1	Assist in the procurement of equipment, accessories, or consumables.	• How to critically appraise equipment, accessories, or consumables as to whether they are fit for purpose.

1	Perform visual inspection of equipment prior to use to ensure it is safe to use.	• Performance testing of equipment:
		  ○ X-ray tubes and generators (conventional, CT, dental, mammography).
		• Practical use and applications of instruments:
		  ○ primary standards and national system;
		  ○ calibration of instruments against secondary standards;
		  ○ checking instruments for consistency, comparison and accuracy;
		  ○ storage.

1	Perform risk assessments on equipment and its use.	• Theory of risk assessment using current statutory and professional guidance.
1	Operate the equipment inventory system (written or electronic) in order to save or retrieve equipment information.	• How to identify equipment inventory information such as serial numbers, model numbers, etc.

1	Perform user maintenance on a range of equipment used in the medical physics department.	• Practical use and applications of instruments:
		  ○ primary standards and national system;
		  ○ calibration of instruments against secondary standards;
		  ○ checking instruments for consistency, comparison and accuracy;
		  ○ storage.
		• The maintenance requirements of a range of equipment used in the department.
		• The procedure to obtain local or manufacturer assistance in maintenance or repair.

2	Perform routine quality assurance tests on **general radiography**	• Production of X-rays:

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
	equipment: kilovoltage (kV), exposure time, focal spot size, HVL, filtration, light field alignment, X-ray field – bucky alignment, tube voltage, tube linearity, tube repeatability, tube output.	○ general principles; ○ electromagnetic spectrum; ○ production of X-rays (low to megavoltage); ○ filters. • Interactions of radiation with matter: ○ radiation quality – HVL and TVL; ○ attenuation, absorption and scatter (photo-electric, Compton scatter and pair-production); ○ exponential attenuation of monoenergetic photons; ○ electrons scatter and bremsstrahlung; ○ ionisation and excitation; ○ electron range and energy; ○ inverse square law; ○ filters and filtration; ○ effects of electron and photon energy, absorber density and atomic number; ○ tissue equivalent materials. • Radiation protection: ○ national and international legislation and recommendations; ○ legislative requirements for critical examination, commissioning and QC; ○ controlled and supervised areas, classified persons; ○ roles and responsibilities of staff, including radiation protection advisor (RPA), radiation protection supervisor (RPS); ○ hospital organisation of radiological protection, radiation safety policy, local rules. • Dosimetry: ○ instrument types, range of probes; ○ survey meters;
2	Perform routine quality assurance tests on **intra-oral dental equipment**: kilovoltage (kV), X-ray beam alignment, HVL, filtration, tube voltage, tube linearity, tube repeatability, timer accuracy, measurement/estimation of patient skin dose.	
2	Perform routine quality assurance tests on **orthopantomogram (OPG):** kilovoltage (kV), X-ray beam alignment, HVL, filtration, tube voltage, tube linearity, tube repeatability, timer accuracy, dose width product.	
2	Perform routine quality assurance tests on **fluoroscopy:** kilovoltage (kV), input dose (all field sizes and programmes), patient entrance skin dose rate, maximum skin dose, threshold contrast, image size and collimation, spatial resolution, X-ray beam-image intensifier alignment.	
2	Perform routine quality assurance	

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
	tests on **DAP meter**: calibration accuracy, change in calibration with variation of: (i) tube voltage, (ii) field size.	○ ionisation chambers, Geiger counters, scintillation counters, dose and dose rate meters; ○ diagnostic X-ray quality assurance instruments for tube output and kilovoltage (kV). • Performance testing of equipment: ○ X-ray tubes and generators (conventional, CT, dental, mammography); ○ associated equipment (DAP, AEC, CR, CCR). • Practical use and applications of instruments: ○ primary standards and national system; ○ calibration of instruments against secondary standards; ○ checking instruments for consistency, comparison and accuracy; ○ storage. • Appropriate equipment and documentation for tests. • Appropriate room handover procedures on both arrival and departure. • Procedure for operating test equipment being used and identifying common equipment faults. • Procedure for operating the equipment under test and identifying all control functions. • Procedure for performing all tests required to complete the assessment (see below for equipment specific lists). • How to identify equipment failing to meet remedial or suspension levels or having radiation safety implications. • Procedure for assisting with assessments of image quality associated with the test. • How to record all measurements made during the test accurately and produce a report for the equipment. • Basic statistical techniques to deal with parametric and non-
2	Perform routine quality assurance tests on **AEC**: image receptor dose, repeatability, variation with: (i) patient thickness, (ii) tube voltage, consistency between chambers.	
2	Perform routine quality assurance tests on **computed radiography (CR) reader**: calibration of exposure indicator, system transfer process, system linearity, dark noise, non-uniformity, erasure efficiency, threshold contrast, spatial resolution, scaling errors.	

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
		parametric data • *Summarising data graphically*: dot plot, stem and leaf, box and whisker, grouped frequency distribution, histogram, cumulative frequency distribution, cumulative frequency polygon, bar chart, one and two. • *Summarising data numerically*: mean, median, mode, samples, when to use various averages, standard deviation, error, interquartile range, box and whisker plots, variance, range, measures of skewness. • *Normal distribution*: mean, standard deviation, areas under the curve, standard normal transformation, solution of problems. • How to report results to an appropriate individual and comment on any issues highlighted by the report.
2	Perform routine quality assurance tests on **direct digital radiography (DDR)**: accuracy of detector dose indicator, dark noise, image uniformity, detector indicator reproducibility, system linearity, system transfer property, threshold contrast, scaling errors, spatial resolution, blurring and stitching artefacts.	**Principles of operation** • Formation of the X-ray image, fluoroscopy, computed radiography, digital radiography (CR/DR), CT scanners, EPID, CBCT. • Basic acceptance and safety testing: ○ stages of acceptance; ○ visual inspections; ○ electrical safety testing; ○ mechanical safety tests; ○ appropriate test equipment; ○ functional testing; ○ purpose of measurements; ○ performing measurements; ○ assessing results; ○ safety test records; ○ acceptance test records. **Quality Assurance**
3	Assist with commissioning tests on **general radiography equipment**: kilovoltage (kV), exposure time, focal spot size, HVL, filtration, light field alignment, X-ray field – bucky alignment, tube voltage, tube linearity, tube repeatability, tube	

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
	output.	For a range of commonly performed QA tests: • Best practice protocols. • Test equipment. • Action limits. • Frequency. **Basic planned preventative maintenance** • Repair and post-repair QC requirements. • Process of handover to and from clinical use. • Factors affecting decisions on maintenance activity, including: ○ urgency ○ time ○ impact on services and the availability of other equipment. • Calibration and QA: ○ calibration procedures; ○ measurement principles; ○ action levels and tolerance; ○ frequency; ○ appropriate calibration equipment; ○ primary standards and national system; ○ calibration of instruments against secondary standards; ○ checking instruments for consistency, comparison and accuracy; ○ reliability, repeatability, validity, limitations. **Quality systems** • Accreditation of calibration laboratories; (NPL), (UKAS). **Equipment performance testing: quality assurance, calibration and dosimetry** • To include critical examination of diagnostic X-ray tubes and generators (conventional, CT, dental, mammography). • Dose measurement devices.
3	Assist with commissioning tests on **intra-oral dental**: kilovoltage (kV), X-ray beam alignment, HVL, filtration, tube voltage, tube linearity, tube repeatability, timer accuracy, measurement/estimation of patient skin dose.	
3	Assist with commissioning tests on **orthopantomogram (OPG)**: kilovoltage (kV), X-ray beam alignment, HVL, filtration, tube voltage, tube linearity, tube repeatability, timer accuracy, dose width product.	
3	Assist with commissioning tests on **fluoroscopy**: kilovoltage (kV), input dose (all field sizes and programs), patient entrance skin dose rate, maximum skin dose, threshold contrast, image size and collimation, spatial resolution, X-ray beam-image intensifier alignment.	
3	Assist with commissioning tests on **DAP meter**: calibration accuracy, change in calibration with variation of: (i) tube voltage, (ii) field size.	
3	Assist with commissioning tests on **AEC**: image receptor dose, repeatability, variation with: (i)	

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
	patient thickness (ii) tube voltage, consistency between chambers.	• Record keeping.
3	Assist with commissioning tests on **CR reader**: calibration of exposure indicator, system transfer process, system linearity, dark noise, non-uniformity, erasure efficiency, threshold contrast, spatial resolution, scaling errors.	
3	Assist with commissioning tests on **DDR**: accuracy of detector dose indicator, dark noise, image uniformity, detector indicator reproducibility, system linearity, system transfer property, threshold contrast, scaling errors, spatial resolution, blurring and stitching artefacts.	**Principles of operation** • Formation of the X-ray image, fluoroscopy, CR/DR, CT scanners, EPID, CBCT. • Basic acceptance and safety testing: ○ stages of acceptance; ○ visual Inspections; ○ electrical safety testing; ○ mechanical safety tests; ○ appropriate test equipment; ○ functional testing; ○ purpose of measurements; ○ performing measurements; ○ assessing results; ○ safety test records; ○ acceptance test records. **Quality assurance** For a range of commonly performed QA tests: • Best practice protocols. • Test equipment. • Action limits.
4	Assist with critical examinations on diagnostic X-ray equipment installations.	

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING

		• Frequency.
		
		Basic planned preventative maintenance
		• Repair and post-repair QC requirements.
		• Process of handover to and from clinical use.
		• Factors affecting decisions on maintenance activity, including:
		  ○ urgency;
		  ○ time;
		  ○ impact on services and the availability of other equipment.
		• Calibration and QA:
		  ○ calibration procedures;
		  ○ measurement principles;
		  ○ action levels and tolerances;
		  ○ frequency;
		  ○ appropriate calibration equipment;
		  ○ primary standards and national system;
		  ○ calibration of instruments against secondary standards;
		  ○ checking instruments for consistency, comparison and accuracy;
		  ○ reliability, repeatability, validity, limitations.
		
		Quality systems
		• Accreditation of calibration laboratories; (NPL), (UKAS)
		
		Equipment performance testing: quality assurance, calibration and dosimetry
		• To include critical examination of diagnostic X-ray tubes and generators (conventional, CT, dental, mammography).
		• Dose measurement devices.
		• Record keeping.

5	Communicate effectively with equipment user and scientific staff in the event of radiation equipment-	• Effective communication skills, including listening, describing, explaining. • The local and national regulatory incident identification and

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
	related incidents.	escalation process.
5	Work within their own knowledge, skills, ability and responsibility, being able and willing to seek assistance when it is necessary, complying with relevant guidance and laws, to include those relating to: • your scope of practice; • probity; • fitness to practice; • maintaining your own health.	• Principles, guidance and law with respect to: ○ *Good Scientific Practice*; ○ probity; ○ fitness to practise. • The importance of maintaining your own health.
5	Follow data protection policy and local procedures to maintain data records and confidentiality.	• Principles, guidance and law with respect to: ○ Confidentiality; ○ information governance; ○ informed consent; ○ probity; ○ fitness to practise. • The importance of maintaining your own health.
5	Maintain a professional and courteous attitude at all times.	• *Good Scientific Practice*.
5	Follow the dress and behaviour code, applying any additional requirements when entering/working in controlled areas or areas of restricted access.	• *Good Scientific Practice*. • Local requirements for dress and behaviour in specific areas of work placement.
5	Work constructively and effectively as a member of a MDT.	• The underpinning principles of effective teamwork and working within and across professional boundaries.
54	Reflect on your practice and generate a reflective diary that demonstrates how you take	• Personal values, principles and assumptions, emotions and prejudices, understanding how these may influence personal judgement and behaviour.

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
	responsibility for your learning and utilise the skills required of an independent learner, and your commitment to your CPD.	• The role of critical reflection and reflective practice and the methods of reflection that can be used to maintain or improve knowledge, skills and attitudes. • How continuous personal development can improve personal performance.

MODULE	Radiation Measurement	COMPONENT	Specialist Years 2 and 3
AIM	The aim of this module is to enable the student to apply their knowledge and gain skills working with radiation and radiation devices, including the calibration of a range of radiation measuring devices. During this specialist work-based module students will be able to apply their learning from the generic, division-theme, and specialist academic modules.		
SCOPE	On completion of this module the student will be able to measure and record levels of radiation and calibrate a range of radiation measuring devices, including contamination monitors, dose rate meters, electronic personal dosimeters, radiographer quality assurance meters, dosimeters. They will be expected to build their professional practice and use critical reflection to review and improve their performance in the workplace and develop skills to promote CPD.		

LEARNING OUTCOMES

On successful completion of this module the student will:

1. Measure and record levels of radiation, including dose rate, contamination checks, output measurements.
2. Calibrate a range of radiation measuring devices, including contamination monitors, dose rate meters, electronic personal dosimeters, radiographer quality assurance meters, dosimeters.
3. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*.

CLINICAL EXPERIENTIAL LEARNING

The clinical experiential learning for this module is:

- Observe the work of radiographers and health professionals in other areas using radiation and discuss with them the role of the radiation protection service, reflecting on how this will influence your future practice as a HCSP in radiation safety.
- Produce a professional portfolio that cumulatively records/provides evidence of: skills, knowledge and understanding, ability to use reflective practice, and personal and professional development.

All of these experiences should be recorded in your e-portfolio.

The following section details the competence and knowledge and understanding each student must gain. Each competence is linked to the relevant learning outcomes and students must demonstrate achievement of each competence for each linked learning outcome.

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
1	Select appropriate device for the type of radiation to be measured, ensuring selected equipment is in working order and within calibration.	• Principles of scientific measurement: ○ fundamental and derived measurements; ○ types of signal; ○ choice of transducers; ○ signal capture and process; ○ display; ○ errors of measurement, precision; ○ calibration. • Radiation detectors; for each detector system: ○ principles; ○ construction; ○ uses; ○ limitations; ○ associated equipment. • Dosimetry: ○ personal monitoring equipment, e.g. film badge, TLD, OSL, electrometer, pocket alarm, record keeping; ○ contamination monitors, wipe tests; ○ instrument types, range of probes; ○ survey meters; ○ ionisation chambers, Geiger counters, scintillation counters, dose and dose rate meters; ○ isotope calibrators; ○ diagnostic X-ray QA instruments for tube output and kilovoltage (kV). • Practical use and applications of instruments: ○ primary standards and national system; ○ calibration of instruments against secondary standards; ○ checking instruments for consistency, comparison and accuracy; ○ storage.
1	Perform the full range of measurements required, e.g. dose rate, contamination checks, output measurements.	
1, 2	Record the results accurately and in the correct format.	
1, 2	Produce results and make them available to the appropriate person within specified timescales.	

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
2	Perform the calibration of contamination monitor, recording the measurements/observations necessary to complete the equipment calibration. Take advice and make appropriate adjustments to test protocol where equipment under test prevents standard procedure being used.	• SOP. • Type of device to be tested and select the documentation and equipment appropriate to the test. • Where calibration is performed away from base, how to check that location provided for tests is appropriate. • Selection of the appropriate radiation source(s) for the calibration. • How to use the source(s) in an appropriate manner, following all procedures put in place to satisfy legislation. • How to identify equipment that, despite passing calibration, may appear to be failing. • How to accurately record all measurements made during the test and produce a report for the equipment. • How to report results to an appropriate individual and comment on any issues highlighted by the report.
2	Calculate equipment calibration factors, identify equipment failing to pass calibration and take appropriate action for contamination monitor recording.	
2	Perform the calibration of dose rate meters, recording the measurements/observations necessary to complete the equipment calibration, taking advice and making appropriate adjustments to test protocol where equipment under test prevents standard procedure being used.	
2	Calculate equipment calibration factors, identify equipment failing to pass calibration and take	

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
	appropriate action for dose rate meters	
2	Perform the calibration of electronic personal dosimeters, recording the measurements/observations necessary to complete the equipment calibration, taking advice and making appropriate adjustments to test protocol where equipment under test prevents standard procedure being used.	
2	Calculate equipment calibration factors, identify equipment failing to pass calibration and take appropriate action for electronic personal dosimeters.	
2	Perform the calibration of radiographer quality assurance meters, recording the measurements/observations necessary to complete the equipment calibration, taking advice and making appropriate adjustments to test protocol where equipment under test prevents standard procedure being used.	
	Calculate equipment calibration factors, identify equipment failing to pass calibration and take	• Principles of scientific measurement: ○ fundamental and derived measurements;

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
	appropriate action for radiographer quality assurance meters.	○ types of signal; ○ choice of transducers; ○ signal capture and process; ○ display; ○ errors of measurement, precision; ○ calibration. • Radiation detectors; for each detector system: ○ principles; ○ construction; ○ uses; ○ limitations; ○ associated equipment. • Dosimetry: ○ personal monitoring equipment, e.g. film badge, TLD, OSL, electrometer, pocket alarm, record keeping; ○ contamination monitors, wipe tests; ○ instrument types, range of probes; ○ survey meters; ○ ionisation chambers, Geiger counters, scintillation counters, dose and dose rate meters; ○ isotope calibrators; ○ diagnostic X-ray QA instruments for tube output and kilovoltage (kV). • Practical use and applications of instruments: ○ primary standards and national system; ○ calibration of instruments against secondary standards; ○ checking instruments for consistency, comparison and accuracy; ○ storage. • SOP. • Type of device to be tested and select the documentation and equipment appropriate to the test.
2	Perform the calibration of dosimeters, recording the measurements/observations necessary to complete the equipment calibration, taking advice and making appropriate adjustments to test protocol where equipment under test prevents standard procedure being used.	
2	Calculate equipment calibration factors, identify equipment failing to pass calibration and take appropriate action for dosimeters.	
2	Where appropriate, assist with or observe adjustments made to equipment to facilitate a pass.	

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
		• Where calibration is performed away from base, how to check that location provided for tests is appropriate. • Selection of the appropriate radiation source(s) for the calibration. • How to use the source(s) in an appropriate manner, following all procedures put in place to satisfy legislation. • How to identify equipment that, despite passing calibration, may appear to be failing. • How to accurately record all measurements made during the test and produce a report for the equipment. • How to report results to an appropriate individual and comment on any issues highlighted by the report.
2	Produce a written report for each item of equipment.	• Principles, guidance and law with respect to: ○ *Good Scientific Practice*; ○ probity; ○ fitness to practise. • The importance of maintaining your own health.
3	Maintain a professional and courteous attitude at all times.	• *Good Scientific Practice*.
3	Follow the dress and behaviour code, applying any additional requirements when entering/working in controlled areas or areas of restricted access.	• *Good Scientific Practice*. • Local requirements for dress and behaviour in specific areas of work placement.
3	Work constructively and effectively as a member of a MDT.	• The underpinning principles of effective teamwork and working within and across professional boundaries.
3	Reflect on your practice and generate a reflective diary that demonstrates how you take responsibility for your learning and	• Personal values, principles and assumptions, emotions and prejudices, understanding how these may influence personal judgement and behaviour. • The role of critical reflection and reflective practice and the methods of

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
	utilise the skills required of an independent learner, and your commitment to your CPD.	reflection that can be used to maintain or improve knowledge, skills and attitudes. • How continuous personal development can improve personal performance.

MODULE	Radiation Transport and Dosimetry	COMPONENT	Specialist Years 2 and 3
AIM	The aim of this module is to introduce the student to the safe use and transport of radioactive sources and enable them to perform a range of tasks in the personal dosimetry service. During this specialist work-based module students will be able to apply their learning from the generic, division-theme, and specialist academic modules.		
SCOPE	On completion of this module the student will be able to undertake the procurement process from the initial definition of the user specification to the acceptance and installation procedures. They should also have the opportunity to assist senior staff in the installation, commissioning and introduction of radiation equipment into service. They will be expected to build their professional practice and use critical reflection to review and improve their performance in the workplace and develop skills to promote CPD.		

LEARNING OUTCOMES

On successful completion of this module the student will:

1. Safely use and transport radioactive sources.
2. Perform a range of tasks in the personal dosimetry service, including issuing of dosimeters to users and the processing and reporting of results of returned dosimeters.
3. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*.

CLINICAL EXPERIENTIAL LEARNING

The clinical experiential learning for this module is:

- Produce a professional portfolio that cumulatively records/provides evidence of: skills, knowledge and understanding, ability to use reflective practice, and personal and professional development.

All of these experiences should be recorded in your e-portfolio.

The following section details the competence and knowledge and understanding each student must gain. Each competence is linked to the relevant learning outcomes and students must demonstrate achievement of each competence for each linked learning outcome.

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
1	Perform all checks required prior to removal of source(s) from base, completing all required paperwork prior to transport of source(s).	• Contingency plans. • Radiation protection. • Local rules and procedures with regard to all relevant radiation protection legislation applied to use of sealed sources, i.e. prior risk assessment. • High Activity Sealed Source regulations and their use in the department. • Local security plans. • Procedure to ensure that any source(s) not immediately returned to base are stored in an appropriate location. • What action should be taken when it is suspected that a source is lost or damaged. • Procedure for source leak testing. • Record keeping for leak testing and source security.
1	Transport source(s) in a manner that satisfies legislatory requirements.	
1	Perform source leak tests.	
1	Review the results of leak tests and identify any results that may indicate potential source damage, taking appropriate action where leak tests indicate potential damage.	
1	Follow all procedures put in place to ensure the security of sources.	
1	Perform contamination checks following use of unsealed sources.	• Contamination monitors, wipe tests. • Instrument types, range of probes. • Calibration of equipment. • Procedures for contamination monitoring. • Local rules and contingency plans for spillage. • Appropriate action to be taken in the event that contamination is detected. • Record keeping for contamination monitoring.
1	Assist in the maintenance of contamination check records.	

2	Provide personal dosimetry services to a range of users.	• Interaction of radiation with matter.
		• Biological effects of radiation.
		• Risks and health effects.
		• Dosimetry:
		  ○ personal monitoring equipment, e.g. film badge, TLD, OSL, electrometer, pocket alarm, record keeping;
		  ○ calibration of the above;

2	Assist with the issue of dosimeters to users and the processing and reporting of results of returned dosimeters.	
2	Provide basic advice to users on the outcome of personal dosimetry.	

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
2	Assist in the production of routine reports and other documentation for users.	○ approved dosimetry services; ○ legislative framework for personal dosimetry. • Action to be taken when assessed doses exceed pre-set action levels or give other cause for concern.
2	Assist with the record keeping associated with personal dosimetry.	
3	Maintain a professional and courteous attitude at all times.	• *Good Scientific Practice*.
3	Follow the dress and behaviour code, applying any additional requirements when entering/working in controlled areas or areas of restricted access.	• *Good Scientific Practice*. • Local requirements for dress and behaviour in specific areas of work placement.
3	Work constructively and effectively as a member of a MDT.	• The underpinning principles of effective teamwork and working within and across professional boundaries.
3	Reflect on your practice and generate a reflective diary that demonstrates how you take responsibility for your learning and utilise the skills required of an independent learner, and your commitment to your CPD.	• Personal values, principles and assumptions, emotions and prejudices, understanding how these may influence personal judgement and behaviour. • The role of critical reflection and reflective practice and the methods of reflection that can be used to maintain or improve knowledge, skills and attitudes. • How continuous personal development can improve personal performance.

MODULE	Radiation Protection	COMPONENT	Specialist Years 2 and 3
AIM	The aim of this module is for the student to apply knowledge and gain the work-based skills and experience in radiation protection. During this specialist work-based module students will be able to apply their learning from the generic, division-theme, and specialist academic modules.		
SCOPE	On completion of this module the student will be able to assist in patient dosimetry procedures for ionising and non-ionising applications, and perform radiation surveys and radiation risk assessments. They will be expected to build their professional practice and use critical reflection to review and improve their performance in the workplace and develop skills to promote CPD.		

LEARNING OUTCOMES

On successful completion of this module the student will:

1. Assist in patient dosimetry procedures for both ionising and non-ionising applications.
2. Perform radiation surveys for ionising and non-ionising installations.
3. Perform a radiation risk assessment for ionising and non-ionising radiation installations
4. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*.

CLINICAL EXPERIENTIAL LEARNING

The clinical experiential learning for this module is:

- Observe the use of equipment output measurements to calculate patient dose following actual, suspected, or simulated incidents.
- Observe the methods used in the assessment of patient dose in UV therapy.
- Observe the methods used to assess patient dose in radiotherapy and nuclear medicine.
- Produce a professional portfolio that cumulatively records/provides evidence of: skills, knowledge and understanding, ability to use reflective practice, and personal and professional development.

All of these experiences should be recorded in your e-portfolio.

The following section details the competence and knowledge and understanding each student must gain. Each competence is linked to the relevant learning outcomes and students must demonstrate achievement of each competence for each linked learning outcome.

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
1	Assist with the processing of DAP data to generate local diagnostic reference levels (DRL) or where DAP data are not collated locally, use national data to identify diagnostic reference levels for different examinations.	• Interaction of radiation with matter. • Biological effects of radiation. • Risks and health effects. • Operation of dose area product meters. • Patient doses in diagnostic X-ray. • Factors affecting patient dose. • Patient dose measurements. • Patient dose surveys. • Diagnostic reference levels. • Optimisation and image quality. • Patient dosimetry in CT and complex interventional procedures. • How to identify records that would not be included for the purpose of generating diagnostic reference levels. • How to accurately record all measurements made during the test and produce a report for the equipment. • How to report results to an appropriate individual and comment on any issues highlighted by the report.
1	Assist with patient dose surveys using methods other than DAP readings to gather data.	
1	Use patient dosimetry assessments and/or equipment QA results to identify areas where optimisation of processes and/or equipment settings may be required.	

2	Assist with radiation surveys for a range of installations, e.g. diagnostic X-ray, dental, radiotherapy, brachytherapy, nuclear medicine, laser, UV and ILS.	• Shielding calculations, design features and engineering controls.
		• Survey procedures:
		  ○ diagnostic X-ray departments;
		  ○ dental X-ray rooms and clinics;
		  ○ wards, operating theatres, etc.;
		  ○ radiotherapy rooms;
		  ○ brachytherapy;
		  ○ nuclear medicine;
		  ○ lasers, UV and ILS.
		• SOP, including:
		  ○ how to select appropriate equipment and documentation for assessments;

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
		○ appropriate handover procedures on both arrival and departure; ○ how to operate test equipment used and identify common equipment faults; ○ identification of any radiation safety implications.
2	Assist with radiation surveys for temporary installations (e.g. wards, operating theatres), including with all tests/observations/calculations required to complete the survey.	• Shielding calculations, design features and engineering controls • Survey procedures: ○ diagnostic X-ray departments ○ dental X-ray rooms and clinics; ○ wards, operating theatres, etc.; ○ radiotherapy rooms; ○ brachytherapy; ○ nuclear medicine; ○ lasers, UV and ILS. • SOP, including: ○ how to select appropriate equipment and documentation for assessments; ○ appropriate handover procedures on both arrival and departure; ○ how to operate test equipment used and identify common equipment faults; ○ identification of any radiation safety implications.
2	Accurately record all measurements/observations during the survey and produce a report.	
2	Report results to an appropriate individual and comment on any issues highlighted by the report. Make recommendations on methods for improvement.	
2	Assist with the routine testing of protective equipment used in diagnostic X-ray, including with all tests/observations/calculations required to complete the survey.	• Protective equipment used in diagnostic X-ray departments, including lead aprons, thyroid collars, eye shields. • SOP, including: ○ how to select appropriate equipment and documentation for assessments; ○ how to operate test equipment used and identify common equipment faults; ○ identification of any radiation safety implications; ○ procedures to follow if equipment fails tests;
2	Record all measurements/observations during the survey accurately and	

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
	produce a report	○ how to record all measurements made during the test accurately and produce a report for the equipment; ○ how to report results to an appropriate individual and comment on any issues highlighted by the report. • Controlled and supervised areas, classified persons. • Legislative requirements for environmental monitoring. • Choice of dosimeters. • Choice of location for dosimeters. • How to review the measurements and produce a report for the survey. • How to report results to an appropriate individual and comment on any issues highlighted by the report. • Principles of risk assessment. • Shielding calculations, design features and engineering controls. • Radiation dose levels within and adjacent to the facilities. • Legislative framework. • How to record a risk assessment and comment on any issues highlighted by the report. • Controlled and supervised areas, classified persons. • Legislative requirements for environmental monitoring. • Choice of dosimeters. • Choice of location for dosimeters. • How to review the measurements and produce a report for the survey. • How to report results to an appropriate individual and comment on any issues highlighted by the report.
2	Report results to an appropriate individual and comment on any issues highlighted by the report. Make recommendations on methods for improvement.	
2	Assist with environmental monitoring surveys using dosimeters or survey meters and comment on the advantages/disadvantages of each method, including with all tests/observations/calculations required to complete the survey.	
2	Accurately record all measurements/observations during the survey and produce a report.	
2	Report results to an appropriate individual and comment on any issues highlighted by the report. Make recommendations on methods for improvement.	
3	Perform radiation risk assessment for ionising and non-ionising radiation facilities.	• Principles of risk assessment • Shielding calculations, design features and engineering controls. • Radiation dose levels within and adjacent to the facilities.

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
		• Legislative framework. • How to record a risk assessment and comment on any issues highlighted by the report.
4	Maintain a professional and courteous attitude at all times.	• *Good Scientific Practice*.
4	Follow the dress and behaviour code, applying any additional requirements when entering/working in controlled areas or areas of restricted access.	• *Good Scientific Practice*. • Local requirements for dress and behaviour in specific areas of work placement.
4	Work constructively and effectively as a member of a MDT.	• The underpinning principles of effective teamwork and working within and across professional boundaries.
4	Reflect on your practice and generate a reflective diary that demonstrates how you take responsibility for your learning and utilise the skills required of an independent learner, and your commitment to your CPD.	• Personal values, principles and assumptions, emotions and prejudices, understanding how these may influence personal judgement and behaviour. • The role of critical reflection and reflective practice and the methods of reflection that can be used to maintain or improve knowledge, skills and attitudes. • How continuous personal development can improve personal performance.

SECTION 13: WORK-BASED SYLLABUS: RADIOTHERAPY PHYSICS

This section describes the Learning Framework for the **Specialist Component** of work-based learning covering the Learning Outcomes, Clinical Experiential Learning, Competence, and Applied Knowledge and Understanding.

DIVISION	Physical Sciences
THEME	Medical Physics
SPECIALISM	**Radiotherapy Physics**

MODULE	Introduction to Radiotherapy Physics	COMPONENT	Specialist Years 2 and 3
AIM	The aim of this module is to ensure the student is able to work safely and professionally in the radiotherapy environment. During this specialist work-based module students will be able to apply their learning from the generic, division-theme, and specialist academic modules, and develop their patient-centred skills.		
SCOPE	On completion of this module the student will be able to perform equipment life-cycle procedures and use a range of dosimeters. They will be expected to build their professional practice and use critical reflection to review and improve their performance in the workplace and develop skills to promote CPD.		

LEARNING OUTCOMES

On successful completion of this module the student will:

1. Perform routine tasks and/or situations in radiotherapy physics, including treatment planning, dose measurement, quality assurance, calibration and operation of equipment, and patient interventions.
2. Undertake a radiation risk assessment for the use of a radiotherapy machine.
3. Undertake a radiation dose survey for a radiotherapy installation.
4. Use a wide range of dosimeters for a variety of dose measurements types in accordance with established procedures.
5. Apply a professional approach to all activities undertaken within the radiotherapy department, adhering to appropriate standards of professional practice as defined in *Good Scientific Practice*.

CLINICAL EXPERIENTIAL LEARNING

The clinical experiential learning for this module is:

- Participate in the working of the radiotherapy quality management system, including undertaking internal audit.
- Participate in radiation protection procedures, including risk assessment and radiation dose surveys.
- Produce a professional portfolio that cumulatively records/provides evidence of: skills, knowledge and understanding, ability to use reflective practice, and personal and professional development.

All of these experiences should be recorded in your e-portfolio.

The following section details the competence and knowledge and understanding each student must gain. Each competence is linked to the relevant learning outcomes and students must demonstrate achievement of each competence for each linked learning outcome.

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
5	Practise safely and to the highest professional standards.	• *Good Scientific Practice.*

1, 2, 3, 4, 5	Work in accordance with all data protection requirements when creating, storing and maintaining valid patient records.	• *Good Scientific Practice.*
		• Principles, guidance and law with respect to:
		  ○ confidentiality;
		  ○ information governance;
		  ○ informed consent;
		  ○ probity;
		  ○ fitness to practise.
		• The importance of maintaining your own health.

1, 4	Use computer systems, treatment planning systems, verification systems and network systems within the radiotherapy department.	• *Good Scientific Practice*.
		• Principles, guidance and law with respect to:
		  ○ confidentiality;
		  ○ information governance.
		• Informatics:
		  ○ informatics and clinical practice;
		  ○ clinical coding and terminology;
		  ○ clinical information systems and applications;
		  ○ healthcare computer systems;
		  ○ database management;
		  ○ data protection, Caldicott, information governance;
		  ○ networking and messaging standards, e.g. DICOM, HL7;
		  ○ computer planning.

1, 4	Work within the legislative frameworks, radiology protection, health and safety standards and clinical governance.	• *Good Scientific Practice*. • Legislative frameworks, radiology protection, health and safety standards and clinical governance. • Controlled and supervised areas, classified persons. • Roles and responsibilities of staff, including RPA, RPS. • Hospital organisation of radiological protection, radiation safety policy,

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
		local rules. • Personnel and environmental dose monitoring. • Local rules.
1, 4	Work within the QA systems as applied to radiotherapy and audit.	• Cancer peer review standards. • Quality management standards. • ISO9001:2008. • Quality systems. • General requirements. • Control of documentation. • Control of records. • Responsibility, authority and communication. • Planning of activities and resources. • Protocols and processes. • Identification and traceability. • Analysis and improvement, audit.
1, 4	Work within the rules relating to health and safety, including manual handling.	• *Good Scientific Practice*. • Health and safety within the radiotherapy environment. • Manual handling techniques.
5	Use effective communication skills within the radiotherapy environment, adapting communication style and language to meet the needs of the listener.	• The principles of effective communication, including written and electronic, verbal and non-verbal. • The way effective communication can assist in identifying problems accurately, increase patient satisfaction, enhance treatment adherence, and reduce patient distress and anxiety. • The importance of some key ideas, for example signposting, listening, language, non-verbal behaviour, ideas, beliefs, concerns, expectations and summarising in communication.
5	Maintain a professional and courteous attitude at all times.	• *Good Scientific Practice*.

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
5	Follow the dress and behaviour code, applying any additional requirements when entering/working in controlled areas or areas of restricted access.	• *Good Scientific Practice*. • Local requirements for dress and behaviour in specific areas of work placement.
5	Work constructively and effectively as a member of a MDT.	• The underpinning principles of effective teamwork and working within and across professional boundaries.
5	Reflect on your practice and generate a reflective diary that demonstrates how you take responsibility for your learning and utilise the skills required of an independent learner, and your commitment to your CPD.	• Personal values, principles and assumptions, emotions and prejudices, understanding how these may influence personal judgement and behaviour. • The role of critical reflection and reflective practice and the methods of reflection that can be used to maintain or improve knowledge, skills and attitudes. • How continuous personal development can improve personal performance.
2	Undertake a radiation risk assessment in the clinical environment.	• Radiation risks encountered in the workplace and the steps in place or need to be put in place to mitigate these risks. • Principles of radiation dose limitation (including factors affecting the design of radiation facilities). • Risk assessment. • Controls: ○ room and equipment; ○ interlocks; ○ warning signs; ○ emergency stop buttons. • Calculation of shielding requirements. • Environmental radiation surveys.
1, 4	Perform the calibration of dose rate meters, recording the measurements/observations	• Dosimetry: ○ instrument types, range of probes; ○ survey meters;

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
	necessary to complete the equipment calibration, taking advice and making appropriate adjustments to test protocol where equipment under test prevents standard procedure being used.	○ ionisation chambers, Geiger counters, scintillation counters, dose and dose rate meters. • Practical use and applications of instruments: ○ primary standards and national system; ○ calibration of instruments against secondary standards; ○ checking instruments for consistency, comparison and accuracy; ○ storage. • Standard operating procedure (SOP). • Type of device to be tested and select the documentation and equipment appropriate to the test. • Where calibration is performed away from base, how to check that location provided for tests is appropriate. • Selection of the appropriate radiation source(s) for the calibration. • How to use the source(s) in an appropriate manner, following all procedures put in place to satisfy legislation. • How to identify equipment that, despite passing calibration, may appear to be failing. • How to record all measurements made during the test accurately and produce a report for the equipment. • How to report results to an appropriate individual and comment on any issues highlighted by the report.
3	Undertake a radiation survey of a linear accelerator bunker and document the outcome.	• Principles of radiation dose limitation (including factors affecting the design of radiation facilities). • Controls: ○ room and equipment; ○ interlocks; ○ warning signs; ○ emergency stop buttons. • Calculation of shielding requirements. • Environmental radiation surveys.

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
2	Assist in the procurement of equipment, accessories, or consumables.	• Specification and evaluation of equipment, accessories, or consumables. • Procurement procedures and regulations. • How to complete documentation, including requisitions and the relevant order codes. • Authorisation procedures. • Procedure for processing equipment orders.
2	Perform visual inspection of equipment prior to use to ensure it is safe to use.	• The actions to be taken in the event of equipment or packaging being damaged.

3	Perform risk assessments on equipment and its use.	• Theory of risk assessment using current statutory and professional guidance.
		• The kind of risk assessments are performed, where they are kept and how to access them.
		• The types of symbols, meaning and the implications these may have on any further action:
		  ○ equipment classifications;
		  ○ electrical symbols;
		  ○ biological hazards.
		• Chemical hazards.
		• COSHH assessment and comment on application in the workplace.

4	Clean equipment, applying cleaning and/or decontamination processes on a range of equipment of equipment.	• The cleaning and/or decontamination processes for a range of equipment within the specialist area. • SOP.
1	Assist in reporting and recording faults on a range of equipment used in the department and perform user maintenance.	• Common equipment faults encountered in the department. • SOPs relating to user maintenance. • How to obtain local or manufacturer assistance in maintenance or repair.

MODULE	Dose Planning, Virtual Stimulation and Image Guidance	COMPONENT	Specialist Years 2 and 3
AIM	The aim of this module is to enable the student to produce treatment plans and use image guidance to check and modify treatment plans. During this specialist work-based module students will be able to apply their learning from the generic, division-theme, and specialist academic modules.		
SCOPE	On completion of this module the student will be able to produce a range of radiotherapy treatment plans to assist in safe and effective radiotherapy treatment and use image guidance to check and modify treatments plans as necessary. They will be expected to build their professional practice and use critical reflection to review and improve their performance in the workplace and develop skills to promote CPD.		

LEARNING OUTCOMES

On successful completion of this module the student will:

1. Produce a range of radiotherapy dose treatment plans using imaging data, defined treatment parameters, dose calculations and simulation processes to assist in the safest and most effective treatment being delivered to the patient.
2. Use image guidance to check and modify treatment plans following local protocols.
3. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*.

CLINICAL EXPERIENTIAL LEARNING

The clinical experiential learning for this module is:

- Follow a patient through the complete pathway of radiotherapy treatment and discuss the experience of the patient, reflecting on your learning and how it will influence your future practice.
- Participate in planning team meetings and report on the process and outcomes in terms of the contribution of this process to improvements and innovation in service delivery and the impact on improved patient treatment.
- Produce a professional portfolio that cumulatively records/provides evidence of: skills, knowledge and understanding, ability to use reflective practice, and personal and professional development.

All of these experiences should be recorded in your e-portfolio.

The following section details the competence and knowledge and understanding each student must gain. Each competence is linked to the relevant learning outcomes and students must demonstrate achievement of each competence for each linked learning outcome.

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING

1	Manually add opposed fields dose distribution.	• Clinical evaluation, including application of medical imaging to radiotherapy:
		  ○ referral pathways, including national pathway guidelines;
		  ○ how the legislation and guidance particular to treatment planning, e.g. data protection, patient confidentiality, and Ionising Radiation (Medical Exposures) Regulations 2000 fit in with local practice;
		  ○ clinical evaluation – pathology, staging, investigations;
		  ○ therapy options, including new technologies;
		  ○ aim of radiotherapy – radical, adjuvant, palliation;
		  ○ follow-up;
		  ○ imaging:
		  • multiplanar sectional anatomy from CT and MRI;
		  • functional imaging –PET and SPECT.
		• Radiobiology related to radiotherapy:
		  ○ linear energy transfer and radiobiological effect;
		  ○ cell survival curves – shape, cell kill, chromosomes and cell division;
		  ○ dose–response relationship;
		  ○ radiosensitivity;
		  ○ tumour systems;
		  ○ dose–time relationship;
		  ○ radiation pathology – acute and late effects;
		  ○ radiation carcinogenesis;
		  ○ radiobiological models – linear quadratic.
		• Tumour pathology:
		  ○ anatomy, pathology, lymphatic drainage and associated critical structures:
		  • head and neck
		  • central nervous system
		  • pituitary
		  • thorax

1	Calculate monitor units from the treatment prescription for the opposed field's distribution.	
1	Use the department's treatment planning system.	
1	Produce and critically evaluate an opposed field pelvis plan, including sparing organ at risk following local protocols.	
1	Produce and critically evaluate a multifield treatment plan for a bladder or prostate patient, including sparing organ at risk following local protocols.	
1	Produce and critically evaluate an opposed fields plan for a larynx, including sparing organ at risk following local protocols.	
1	Produce and critically evaluate a breast/chest wall plan, including sparing organ at risk following local protocols.	
1	Check planning target volume margins against clinical protocols as per diagnosis.	
1	Define treatment field parameters for simple treatment techniques using virtual simulation software, including	

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
	the appropriate isocentre.	• breast • abdomen • pelvis ○ Hodgkin's disease; ○ leukaemia; ○ extremities; ○ metastases. • Treatment planning considerations: ○ prescribed dose; ○ target delineation; ○ treatment techniques (site specific); ○ typical tissue heterogeneities; ○ international, national and local guidelines in treatment planning. • Localisation: ○ surface contouring; ○ use of orthogonal radiographs and shift radiographs; ○ CT localisation: • inhomogeneities • surface contours and organs at risk ○ use of imaging and image fusion; ○ data transfer; ○ planning target volume – margins; ○ organs at risk (critical organs and dose constraints). • Dose planning and display: ○ treatment planning algorithms, including pencil beam, collapsed cone and Monte Carlo; ○ dose distribution computation; ○ computer planning: • 2D, 3D and 4D plans • comparison of CT and non-CT plans
1	Solve problems in a logical and systematic way, seeking advice from senior colleagues.	
2	Confirm treatment fields using multileaf collimators, etc.	
2	Check, under supervision, verification images against planning digitally reconstructed radiographs following local protocols.	
2	Produce digitally reconstructed radiographs encompassing relevant anatomy to assist the image matching process.	
2	Apply the limitations of cone beam soft tissue matching analysis.	

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
		• beam's eye view ○ plan evaluation: • isodose distributions • dose volume histograms ○ conformal planning; ○ optimisation, including inverse planning techniques and IMRT; ○ forward-planned segmented field techniques. • Justify departmental localisation tolerances. • The appropriate use of different fiducial markers for a number of treatment sites: ○ the criteria required for rescanning, replanning and reimaging patients in according to local protocols or tolerances. • Beam modification: ○ collimation – asymmetric jaws; ○ beam shaping and shielding; ○ bolus and compensators; ○ wedges: mechanical, dynamic, virtual. • Dose calculations: ○ dose prescription; ○ phantom scatter factors: • back scatter factor • peak scatter factor ○ head scatter; ○ radiation output; ○ computation of treatment time/set dose; ○ effect of inhomogeneities.
3	Maintain a professional and courteous attitude at all times.	• *Good Scientific Practice*.
3	Follow the dress and behaviour code, applying any additional	• *Good Scientific Practice*. • Local requirements for dress and behaviour in specific areas of work

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
	requirements when entering/working in controlled areas or areas of restricted access.	placement.
3	Work constructively and effectively as a member of a MDT.	• The underpinning principles of effective teamwork and working within and across professional boundaries.
3	Reflect on your practice and generate a reflective diary that demonstrates how you take responsibility for your learning and utilise the skills required of an independent learner, and your commitment to your CPD.	• Personal values, principles and assumptions, emotions and prejudices, understanding how these may influence personal judgement and behaviour. • The role of critical reflection and reflective practice and the methods of reflection that can be used to maintain or improve knowledge, skills and attitudes. • How continuous personal development can improve personal performance.

MODULE	Mould Room	COMPONENT	Specialist Year3 2 and 3
AIM	The aim of this module is to introduce the student to the mould room and make a range of immobilisation devices, appreciating the concerns and needs of the patient, and developing and building their professional practice and patient-centred care.		
SCOPE	On completion of this module the student will be able to make a range of immobilisation devices for patients undergoing radiotherapy treatment. Students will be expected to build their professional practice and use critical reflection to review and improve their performance in the workplace and develop skills to promote CPD.		

LEARNING OUTCOMES

On successful completion of this module the student will:

1. Make safe and appropriate immobilisation devices for patients, considering the individual needs of each patient, in accordance with local protocols.
2. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*.

CLINICAL EXPERIENTIAL LEARNING

The clinical experiential learning for this module is:

- Follow patients through the localisation and immobilisation process.
- Produce a professional portfolio that cumulatively records/provides evidence of: skills, knowledge and understanding, ability to use reflective practice, and personal and professional development.

All of these experiences should be recorded in your e-portfolio.

The following section details the competence and knowledge and understanding each student must gain. Each competence is linked to the relevant learning outcomes and students must demonstrate achievement of each competence for each linked learning outcome.

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
1	Prepare the clinical area for the procedure.	• Health and safety practice when performing mould room procedures.
1	Obtain a suitably completed request form, greet the patient, and check patient ID and recent clinical history.	• Requirements for correct completion of request forms and how to validate. • How to communicate with patients in a way that respects their dignity, rights, privacy and confidentiality. • The importance of checking patient identity. • The importance of explaining the procedure to the patient and gaining consent. • How to take and record a patient history and key information required.
1	Gain informed consent for each investigation.	• The importance of introducing yourself and your role as a student HCSP as part of the process of introduction and consent. • The importance of explaining the procedure for each investigation to the patient and gaining informed consent. • The relevant procedures and requirements for patient conformance. • Clinical indications and contraindications for each investigation. • Principles, guidance and law with respect to informed consent.
1	Treat patients in a way that respects their dignity, rights, privacy and confidentiality.	• The rights of the patient with regard to consent for treatment and confidentiality of consultation and medical records. • Key factors influencing dignity, rights, privacy and confidentiality, including age, gender, culture and beliefs. • Correct positioning of the patient to ensure comfort, co-operation and optimal investigation results. • The impact of incorrect positioning or non-co-operation on investigation results.
1	Prepare the patient according to the radiotherapy request form, explaining the process and answering questions.	• Safe operation of workshop equipment used in the mould room. • Quality Standards • Choice of material. Advantages and disadvantages of thermoplastic

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING

1	Complete the necessary documentation for set-up reproduction.	materials compared to traditional immobilisation techniques.
		• Positioning and immobilisation:
		  ○ isocentric mounting;
		  ○ front and back pointers;
		  ○ patient positioning;
		  ○ patient care in the mould room;
		  ○ immobilisation (site specific).
		• Image verification.
		• Lead cut-outs.
		• Applicators.
		• Eyeshields (internal and external).

1	Use hand and machine tools safely and effectively during procedures associated with the mould room.	
1	Position patient appropriate to the procedure and take relevant measurements and impressions.	
1	Manufacture immobilisation devices to meet the specification required to deliver treatment.	
1	Select appropriate thickness of lead shielding.	
1	Produce a lead mask or cut-out that meets the department's quality standard.	
1	Produce a tissue equivalent substance (bolus) to meet the treatment specification requirements.	

2	Work within their own knowledge, skills, ability and responsibility, being able and willing to seek assistance when it is necessary, complying with relevant guidance and laws, to include those relating to:
	• your scope of practice;
	• probity;
	• fitness to practice;
		• Principles, guidance and law with respect to:
		  ○ *Good Scientific Practice*;
		  ○ probity;
		  ○ fitness to practise.
		• The importance of maintaining your own health.

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
	• maintaining your own health.	

2	Follow data protection policy and local procedures to maintain data records and confidentiality.	• Principles, guidance and law with respect to:
		  ○ confidentiality;
		  ○ information governance;
		  ○ informed consent;
		  ○ probity;
		  ○ fitness to practise.
		• The importance of maintaining your own health.

2	Maintain a professional and courteous attitude at all times.	• *Good Scientific Practice*.
2	Follow the dress and behaviour code, applying any additional requirements when entering/working in controlled areas or areas of restricted access.	• *Good Scientific Practice*. • Local requirements for dress and behaviour in specific areas of work placement.
2	Work constructively and effectively as a member of a MDT.	• The underpinning principles of effective teamwork and working within and across professional boundaries.
2	Reflect on your practice and generate a reflective diary that demonstrates how you take responsibility for your learning and utilise the skills required of an independent learner, and your commitment to your CPD.	• Personal values, principles and assumptions, emotions and prejudices, understanding how these may influence personal judgement and behaviour. • The role of critical reflection and reflective practice and the methods of reflection that can be used to maintain or improve knowledge, skills and attitudes. • How continuous personal development can improve personal performance.

MODULE 4	Brachytherapy	COMPONENT	Specialist Years 2 and 3
AIM	The aim of this module is for the student to apply knowledge and gain skills and experience of the preparation for and delivery of brachytherapy treatment procedures. During this specialist work-based module students will be able to apply their learning from the generic, division-theme, and specialist academic modules, and develop their patient-centred skills.		
SCOPE	On completion of this module the student will be able to produce brachytherapy plans and deliver them, ensuring the quality assurance of the procedures. They will be expected to build their professional practice and use critical reflection to review and improve their performance in the workplace and develop skills to promote CPD.		

LEARNING OUTCOMES

On successful completion of this module the student will:

1. Participate in the preparation and delivery of brachytherapy treatment procedures.
2. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*.

CLINICAL EXPERIENTIAL LEARNING

The clinical experiential learning for this module is:

- Follow a patient through the brachytherapy treatment pathway and discuss the patient experience and the learning from this that you will apply in your work as a HCSP.
- Produce a professional portfolio that cumulatively records/provides evidence of: skills, knowledge and understanding, ability to use reflective practice, and personal and professional development.

All of these experiences should be recorded in your e-portfolio.

The following section details the competence and knowledge and understanding each student must gain. Each competence is linked to the relevant learning outcomes and students must demonstrate achievement of each competence for each linked learning outcome.

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING

1	Check and calculate the activity of sealed sources.	• Brachytherapy preparation and planning:
		  ○ the principles of brachytherapy and observation of the procedure;
		  ○ sources – nuclide, structure, identification;
		  ○ afterloading equipment;
		  ○ units of measurement;
		  ○ source calibration;
		  ○ calculation of dose distributions;
		  ○ the volume coverage and treatment plan analysis;
		  ○ brachytherapy treatment planning, including treatment effectiveness;
		  ○ the size and clinical relevance of uncertainties;
		  ○ standard system rules;
		  ○ image-guided techniques in brachytherapy planning;
		  ○ benefits of using other algorithms (cf. TG43).
		• Planning algorithms.
		• SOPs for cleaning and disinfection.
		• Quality control for brachytherapy equipment and systems.
		• Radiation protection:
		  ○ structural shielding;
		  ○ measures for reducing radiation dose to staff during brachytherapy;
		  ○ source handling and storage;
		  ○ death of radioactive patients – removal of implants.

1	Perform standard sealed source calculations using the department's planning programmes (e.g. standard high dose rate brachytherapy insertion).	
1	Clean and sterilise applicators after use in accordance with departmental rules.	
1	Produce brachytherapy treatment plans.	
1	Perform routine QC of any brachytherapy equipment.	
2	Maintain a professional and courteous attitude at all times.	• *Good Scientific Practice*.
2	Follow the dress and behaviour code, applying any additional requirements when entering/working in controlled areas or areas of restricted access.	• *Good Scientific Practice*. • Local requirements for dress and behaviour in specific areas of work placement.
2	Work constructively and effectively as a member of a MDT.	• The underpinning principles of effective teamwork and working within and across professional boundaries.

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
2	Reflect on your practice and generate a reflective diary that demonstrates how you take responsibility for your learning and utilise the skills required of an independent learner, and your commitment to your CPD.	• Personal values, principles and assumptions, emotions and prejudices, understanding how these may influence personal judgement and behaviour. • The role of critical reflection and reflective practice and the methods of reflection that can be used to maintain or improve knowledge, skills and attitudes. • How continuous personal development can improve personal performance.

MODULE	Quality Control of Radiotherapy	COMPONENT	Specialist Years 2 and 3
AIM	The aim of this module is for the student to perform a range of QC procedures for radiotherapy systems. During this specialist work-based module students will be able to apply their learning from the generic, division-theme, and specialist academic modules, including professional practice.		
SCOPE	On completion of this module the student will be able to perform a range of QC procedures and build their professional practice and use critical reflection to review and improve their performance in the workplace and develop skills to promote CPD.		

LEARNING OUTCOMES

On successful completion of this module the student will:

1. Perform QC procedures for radiotherapy systems, including orthovoltage treatment units, megavoltage units and other radiotherapy treatment units (e.g. high dose rate brachytherapy, tomotherapy units).
2. Adhere to appropriate standards of professional practice as defined in *Good Scientific Practice*.

CLINICAL EXPERIENTIAL LEARNING

The clinical experiential learning for this module is:

- Produce a professional portfolio that cumulatively records/provides evidence of: skills, knowledge and understanding, ability to use reflective practice, and personal and professional development.

All of these experiences should be recorded in your e-portfolio.

The following section details the competence and knowledge and understanding each student must gain. Each competence is linked to the relevant learning outcomes and students must demonstrate achievement of each competence for each linked learning outcome.

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING

1	Perform routine QC programme of orthovoltage treatment units.	• Relevant current guidelines.
		• Evaluation of risk.
		• External beam radiation treatment equipment:
		  ○ construction and principles of operation of very low energy, low energy, medium energy X-ray equipment;
		  ○ linear accelerator;
		  ○ photon beam generation;
		  ○ electron beam generation;
		  ○ cobalt teletherapy;
		  ○ cyclotron;
		  ○ operation and controls of treatment equipment.
		• Imaging equipment used in radiotherapy:
		  ○ CT scanners;
		  ○ MRI;
		  ○ CBCT.
		• Dose distribution:
		  ○ photon interactions with respect to radiotherapy;
		  ○ central axis depth dose;
		  ○ irregular fields – equivalent square – sector integration;
		  ○ off-axis dose – dose in shielded regions – scatter, primary beam hardening;
		  ○ isodose curves;
		  ○ beam quality, source size, source surface distance, source collimator distance, beam flatness, flattening filters, field size, penumbra, oblique incidence, tissue heterogeneity;
		  ○ summation of isodose curves;
		  ○ beam weighting;
		  ○ guidelines for field arrangements;
		  ○ large field treatment techniques;
		  ○ field matching asymmetric collimators;

1	Perform, under supervision, routine QC programme of megavoltage units.	
1	Complete radiation dosimetry checks on linear accelerator (photons and electrons).	
1	Perform, under supervision, QC procedures for other radiotherapy treatment units (e.g. high dose rate brachytherapy, tomotherapy units)	
1	Perform routine strontium testing of therapy level dosimeters.	
1	Perform routine output measurements of treatment units (orthovoltage – in air measurements, megavoltage X-ray and electron measurements).	
1	Perform, under supervision, routine QC programme of CT and simulators.	
1	Perform, under supervision, routine QC programme of treatment planning systems.	

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
		○ effect of change in radiation beam energy. • Dose measurement: ○ kerma and absorbed dose; ○ selection of appropriate dosimeter; ○ absolute dose measurement; ○ relative dose measurement; ○ beam data acquisition; ○ patient dosimetry – diodes, TLD, EPID; ○ electron dosimetry; ○ phantoms. • Electron beams: ○ depth dose characteristics; ○ isodose curve characteristics; ○ oblique incidence; ○ beam shaping. • QC and quality QA: ○ quality systems. ○ treatment machine QC programme – logic, method and frequency; ○ QC of external beam radiotherapy equipment; ○ QC of radiotherapy simulator; ○ QC of CT and MRI; ○ QC for treatment planning systems; ○ treatment plan and radiotherapy prescription calculation checks; ○ QC of dosimetry systems.
2	Maintain a professional and courteous attitude at all times.	• *Good Scientific Practice*.
2	Follow the dress and behaviour code, applying any additional requirements when entering/working in controlled areas or areas of	• *Good Scientific Practice*. • Local requirements for dress and behaviour in specific areas of work placement.

KEY LEARNING OUTCOMES	COMPETENCES	KNOWLEDGE AND UNDERSTANDING
	restricted access.	
2	Work constructively and effectively as a member of a MDT.	• The underpinning principles of effective teamwork and working within and across professional boundaries.
2	Reflect on your practice and generate a reflective diary that demonstrates how you take responsibility for your learning utilise the skills required of an independent learner and your commitment to your CPD.	• Personal values, principles and assumptions, emotions and prejudices, understanding how these may influence personal judgement and behaviour. • The role of critical reflection and reflective practice and the methods of reflection that can be used to maintain or improve knowledge, skills and attitudes. • How continuous personal development can improve personal performance.

SECTION 14: APPENDICES

Appendix 1: Contributor List

The BSc (Hons) curriculum for Medical Physics Technology has been co-ordinated by the Modernising Scientific Careers (MSC) team working with professional colleagues in Medical Physics and within each of the three specialisms of Medical Physics in this programme.

Medical Physics Technology curriculum working group since first publication:
To 2015

Diane Allen	Leicester Royal Infirmary
Allyson Butcher	The Royal Surrey Country Hospital NHS Trust
Barbara Dawson	Rotherham Hospital
Claire Greaves	University Hospitals of Leicester
Colin Martin	North Glasgow Hospitals NHS Trust
Michaela Moore	Newcastle Hospitals NHS Foundation Trust
Carl Rowbottom	Centre for Imaging Sciences, University of Manchester
Christine Taylor	Sheffield Teaching Hospitals
Stuart MacDonald Wilson	Leeds Teaching Hospital

The BSc curriculum for Medical Physics Technology has also been circulated to the following professional bodies and societies for their comments and contributions:

BNMS	British Nuclear Medicine Society
IPEM	Institute of Physics and Engineering in Medicine
NRIG	National Radiotherapy Implementation Group
SCoR	The Society and College of Radiographers
VRCT	Voluntary Register of Clinical Technologists

2015 Revision

Claire Hardiman	Lead Editor; Mount Vernon Cancer Centre and National School of Healthcare Science
Diane Allen	University Hospitals Coventry and Warwickshire (IPEM)
Peter Colley	Hull and East Yorkshire Hospitals (IPEM)
Barbara Dawson	The Rotherham NHS Foundation Trust (IPEM)
Anita Fenton	University Hospitals of North Midlands NHS Trust (IPEM)
Glenn Guthrie	Sunderland Royal Hospital
Peter Harding	Leicester Royal Infirmary (IPEM)
Mark Hardy	The Christie NHS FT
Dean Harris	University of Cumbria
Peter Langston	University Hospitals Birmingham NHS FT (IPEM)
Richard Lawson	Central Manchester University Hospitals
Chris Mayes	The Royal Liverpool and Broadgreen University Hospitals NHS Trust
John Moody	Public Health England
Faye Morton	Swansea University
Peter Philips	Cumbria University
Dareyoush Rassi	Swansea University
Andrew Tyler	Velindre Cancer Centre
Chris Wigham	Swansea University
Heather Williams	Central Manchester University Hospitals

In addition to the professionals detailed above 23 patient groups, 54 professional bodies/groups and 26 PTP accredited Higher Education Institutions were alerted to the opportunity to feedback on the proposed revisions to the scientific content between December 2015 and February 2016.

Appendix 2: BSc (Hons) Healthcare Science Amendments

March 2016

Generic changes

The BSc (Hons) curriculum has been amended and is now presented in a single document which includes both the BSc syllabus and the work-based Learning Guide.

The Introduction (Section 1) has been updated and amended to reflect the totality of the curriculum and apprenticeships. A background to the Modernising Scientific Career (MSC) programme has been added and the importance of *Good Scientific Practice* (GSP) in setting the standards of practice in healthcare science has been emphasised. There has been additional information and emphasis in areas such as: entry routes, progression, patient and public involvement, accreditation through the National School of Healthcare Science, programme delivery and monitoring, student support and mentoring and clarity about a number of issues around programme delivery.

Key professional practice learning outcomes have been added through the GSP syllabus (Section 3), which embeds the standards of professionalism set out in GSP in all aspects of the delivery and assessment of the programme. The GSP syllabus is a common component of all PTP curricula and must be followed throughout the whole training period, with engagement at the appropriate level, depending on the stage of training.

The Professional, Scientific and Technical modules (Section 4) have been revised.

Theme-specific modules

High-level overview of changes made to the curriculum.

Where recommendations were made regarding the update of content to align with current and future service delivery these have been incorporated

Year 1 Module: MP(i): Mathematics, Statistics and Informatics has been renamed and content modified to reflect required knowledge. This module is shared with Clinical Bioengineering.

Year 2 Module: MP(v): Medical Equipment, Quality Assurance and Quality Systems has been renamed to place emphasis on equipment and includes more radiotherapy equipment and QA, than in the previous version.

April 2017

The recommended number of assessments per year on p.19 was clarified and a table added to illustrate this. The new version of the curriculum is PTP Medical Physics Version 1.01 2016.

For any queries regarding this change please email: nshcs@wm.hee.nhs.uk

Appendix 3: Abbreviations

Generic abbreviations

AHCS	Academy for Healthcare Science
AO	Assessment Organisation
APL	Accreditation of Prior Learning
BSc	Bachelor of Science
CAS	Central Alerting System
CBD	Case Based Discussion
CEL	Clinical Experiential Learning
COSHH	Control of Substances Hazardous to Health
CPD	Continuing Professional Development
CPPD	Continuing Personal and Professional Development
CSO	Chief Scientific Officer
CT	Computer Tomography
DH	Department of Health
DICOM	Digital Image and Communications in Medicine
DfE	Department for Education
DOPs	Direct Observation of Practical skills
EPA	End-point Assessment
ETSG	Education and Training Scrutiny Group
ETWG	Education and Training Working Group
EU	European Union
FHEQ	Framework for Higher Education Qualifications
FtP	Fitness to Practise (FtP)
GCP	Good Clinical Practice
GM	Generic Module (Professional, Scientific and Technical)
GSP	Good Scientific Practice
HCPC	Health and Care Professions Council
HCS	Healthcare Science
HCSP	Healthcare Science Practitioner
HEE	Health Education England

HEI	Higher Education Institutions
HL7	Health Level 7
IBMS	Institute of Biomedical Science
ICT	Information and Communication Technologies
IOE	Institute of Education
IT	Information Technology
LETB	Local Education and Training Board
MDA	Medical Device Alerts
MDT	Multidisciplinary Team
MHRA	Medicines and Healthcare products Regulatory Agency
MRI	Magnetic Resonance Imaging
MSC	Modernising Scientific Careers
NES	NHS Education for Scotland
NICE	National Institute for Health and Care Excellence
NIHR	National Institute for Health Research
NHS	National Health Service
NSHCS	National School of Healthcare Science
OCE	Observed Clinical Event
OLAT	Online Assessment Tool
PACS	Picture Archiving and Communications Systems
PSA	Professional Standards Authority
PTP	Practitioner Training Programme
QA	Quality Assurance
QAA	Quality Assurance Agency
QC	Quality Control
QMS	Quality Management System
RoAAO	Register of Apprenticeship Assessment Organisations
RoATP	Register of Apprenticeship Training Providers
SCQF	Scottish Credit and Qualifications Framework
SFA	Skill Funding Agency
SJT	Situational Judgement Test
SPECT	Single Photon Emission Computed Tomography
UCAS	The Universities and Colleges Admissions Service

UK	United Kingdom

Programme specific abbreviations (Medical Physics Technology)

AEC	Automatic Exposure Control
ALARP	As Low as Reasonable Practicable
ARSAC	Administration of Radioactive Substances Advisory Committee
a-SI	Amorphous Silicon
CBCT	Cone Beam Computed Tomography
COSHH	Control of Substances Hazardous to Health
CR	Computed Radiography
DAP	Dose Area Product
DDR	Direct Digital Radiography
DIBH	Deep Inspiration Breath Hold
DR	Digital Radiography
DRL	Diagnostic Reference Levels
EMF	Electromagnetic Fields
EPD	Electronic Personal Dosimeter
HVL	Half Value Layer
ICRP	International Commission on Radiological Protection
IGRT	Image Guided Radiotherapy
ILS	Intense Light Sources
IMRT	Intensity-modulated Radiotherapy
MP	Medical Physics
MPNM	Medical Physics: Nuclear Medicine
MPRP	Medical Physics: Radiation Physics
MPRT	Medical Physics: Radiotherapy Physics
MR	Magnetic Resonance
NPL	National Physical Laboratory
OSL	Optically Stimulated Luminance
PET-CT	Positron Emission Tomography – Computed Tomography
PET-MR	Positron Emission Tomography – Magnetic Resonance
SABR	Stereotactic ablative radiotherapy

SRS	Stereotactic radiosurgery
TBI	Total Body Irradiation
TLD	Thermo Luminescent Dosimeter
TPR	Tissue Phantom Ratio
TSEI	Total Skin Electron Irradiation
TSR	Tissue Maximum Ratio
TPS	Treatment Planning System
TVL	Tenth Value Layer
UKAS	United Kingdom Accreditation Service
UV	Ultraviolet
WEEE	Waste Electrical and Electronic Equipment
4D	Four dimensional
2D	Two dimensional
3D	Three dimensional

Appendix 4: Glossary

Term	Definition
Clinical experiential learning	The cyclical process linking concrete experience with abstract conceptualisation through reflection and planning.
Clinical experiential learning outcomes	The activities that the student will undertake to enable and facilitate their learning in the workplace.
Competence	The ability of an individual to perform a role consistently to required standards, combining knowledge, understanding, skills, attitudes, behaviour and values.
Competence statements	Active and outcome-based statements that provide a further breakdown of the work-based Learning Outcomes – reflecting what the student 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.
Component	An indication of the type of module within the curriculum, i.e. Generic, Theme or Specialist.
Curricula	An outline of the expected educational outcomes across a subject area. The learning that is expected to take place during the Practitioner Training Programme described in terms of knowledge, skills, attitudes, behaviours and values.
Division	A high-level description of an area of practice within healthcare science. There are four divisions: Life Sciences, Physical Sciences, Physiological Sciences and Clinical Bioinformatics.
Domains of learning	Cognitive (knowledge and intellectual skills), affective (feelings and attitudes), interpersonal (behaviour and relationships with others) and psychomotor (physical skills).
Feedback	Specific information about the comparison between a student's observed performance and a standard, given with the intent of improving the student's performance (van de Ridder JMM, Stokking KM, McGaghie WC and ten Cate OT. What is feedback in clinical education? *Medical Education* 2008: 42: 189–197).
Good Scientific Practice	Non-statutory guidance on the minimum requirements for good practice for the healthcare science workforce.
Job	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.
Key learning outcome	A defined learning outcome linked to relevant competence(s) within the work-based Learning Framework.
Learning framework	The specification for work-based learning contained within the work-based syllabus.
Learning outcome	A high-level, outcome-based statement that describes what a student will be able to do at the end of the module.

Term	Definition
Mentoring	Mentoring is *a process in which a trainer (mentor) is responsible for overseeing the career and development of the student.* The emphasis is therefore on the relationship (rather than the activity).
Module aim	The overall objective of a module – defining the intended learning achievements of the student. The aim works together with the 'Scope' statement to define the overall objectives and scope of the module.
Module scope	A statement within a module that defines the range/limits of the learning undertaken by the student in a module – patients/investigations/equipment/modalities, etc.
National Occupational Standards	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 to 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, behaviours and skills.
Practical skill	A cognitive, psychomotor, physical, or communicative ability that supports performance of the required role.
Programme	The package of learning, teaching assessment and quality assurance leading to an award.
Provider	An organisation that delivers required training and learning activities to specified quality assurance requirements.
Role	A collection of functions undertaken in the workplace that represent the main broad areas of work for all similar workers at national level. A role differs from a job, the latter being defined specifically for a local context.
Specialism	A focused area of practice within a division of healthcare science.
Trainer	A qualified individual who provides learning and development support for students.
Theme	A group of related specialisms usually within a division of healthcare science.
Work-based learning	Learning that takes place in a real work setting and involves the application of academic learning to real work activities.
Work performance	The requirements of satisfactory and consistent demonstration of competence in specified functions for a work role.
Workplace	A real work setting in which the student can apply learning.

Appendix 5: Assessment Proformas

A5.1: Direct Observation of Practical/Procedural Skills Template

Student identification data			
Procedure			
Clinical context	**Insert module title**	**Insert module title**	**Insert module title**

Assessor's name					
Assessor's position				**Insert**	**Insert**

Difficulty of the procedure		**Low**	**Average**	**High**
Number of times procedure performed by student		**1–4**	**5–9**	**>10**

Please grade the following areas using the scale below	**Below expectations**	**Borderline**	**Meets expectations**	**Above expectations**	**Unable to comment**[1]
1. Understands scientific principles of procedure, including basic science underpinning it					

Please grade the following areas using the scale below	Below expectations	Borderline	Meets expectations	Above expectations	Unable to comment[1]
2. Has read, understands and follows the appropriate standard operating procedures, risk and COSHH assessments, and any other relevant health and safety documentation					
3. Understands and applies the appropriate internal and external quality control associated with the procedure					
4. Understands the risks associated with items of equipment and uses them appropriately					
5. Completes associated documentation accurately					
6. Output meets accepted laboratory/professional standards					
7. Carries out the procedure within the appropriate time frame					
8. Is aware of the limitations of the test					

Please grade the following areas using the scale below	Below expectations	Borderline	Meets expectations	Above expectations	Unable to comment[1]
9. Demonstrates awareness of the limits of responsibility and when to seek advice					
10. Professionalism					

[1]Please mark this if you have not observed the behaviour.

FEEDBACK AND DOCUMENTATION OF LEARNING NEEDS	AGREED ACTION

Outcome	Satisfactory Unsatisfactory		Date of assessment		Time taken for assessment	
Signature of assessor		Signature of student			Time taken for feedback	

A5.2: Case-based Discussion Template

Student identification data			
Brief description of output and focus of scenario discussed			
Module	**Insert title**	**Insert title**	**Insert title**
Complexity of the scenario	**Low**	**Average**	**High**

Assessor's name	
Assessor's position	

Please grade the following areas using the scale below	**Below expectations**	**Borderline**	**Meets expectations**	**Above expectations**	**Unable to comment**[1]
1. Understands clinical and/or scientific principles relevant to scenario					
2. Can discuss relevant health and safety issues					

Please grade the following areas using the scale below	Below expectations	Borderline	Meets expectations	Above expectations	Unable to comment[1]
3. Can discuss the procedures used to obtain the results					
4. Can discuss the quality control procedures to ensure the result is accurate					
5. Demonstrates a knowledge of relevant 'Best Practice' guidelines and other policies relevant to the scenario					
6. Can discuss the significance of routine patient results with reference to the reason for referral					
7. Is aware of, and can use as required, appropriate resources to aid in the interpretation of results					
8. Is aware of the importance of the audit trail and can complete the audit trail accurately					
9. Demonstrates awareness of the limits of responsibility and when to seek advice					

Please grade the following areas using the scale below	Below expectations	Borderline	Meets expectations	Above expectations	Unable to comment[1]
10. Professionalism					

[1]Please mark this if you have not observed the behaviour.

FEEDBACK AND DOCUMENTATION OF LEARNING NEEDS	AGREED ACTION

Outcome	Satisfactory Unsatisfactory		Date of assessment		Time taken for assessment	
Signature of assessor		Signature of student			Time taken for feedback	

A5.3: Observed Clinical Event Template

Student identification data			
Brief description of output and focus of scenario discussed			
Module	**Insert title**	**Insert title**	**Insert title**
Complexity of the scenario	**Low**	**Average**	**High**

Assessor's name	
Assessor's position	

Please grade the following areas using the scale below	**Below expectations**	**Borderline**	**Meets expectations**	**Above expectations**	**Unable to comment[1]**
1. History taking *Does the student obtain the information required prior to undertaking a procedure from the patient or a clinical colleague?*					
2. Communication skills *e.g. Does the student use language appropriate to the situation (verbal and/or body language) when explaining or discussing an aspect of clinical care (test results, diagnostic procedure, equipment repair at the bedside), do they check the understanding of the patient or their colleague?*					

Please grade the following areas using the scale below	Below expectations	Borderline	Meets expectations	Above expectations	Unable to comment[1]
3. Clinical examination skills *e.g. Does the student undertake a clinical skill, such as locating a vein for phlebotomy, performing a diagnostic test appropriately and accurately?*					
4. Clinical judgement *e.g. Is the procedure correct for the required outcome?*					
5. Scientific judgement *e.g. Was the choice of equipment appropriate for the required outcome, has it been correctly calibrated and any necessary settings correctly applied?*					
6. Professionalism *e.g. Did the student introduce themselves and their role or did they discuss the procedure/result with a colleague using appropriate language, considering any patient confidentiality or ethical issues?*					
7. Organisation and efficiency *e.g. Was the student well organised and efficient, ensuring all record keeping was appropriate and accurate; did they keep to time and ensure accurate recording of results; did they process the results in a timely fashion?*					
8. Overall clinical care *e.g. Did the student show respect, empathy and compassion for the patient and/or recognise the importance of the procedure/test within the care pathway for the patient or colleagues where the test contributes to a diagnosis, treatment or management?*					

For specific examples of opportunities where an OCE may be appropriate please visit the National School of Healthcare Science website (www.nshcs.org.uk/).

Appendix 6: Further Information

NHS Networks

An open network to share curricula produced for the Modernising Scientific Careers (MSC) programme.
www.networks.nhs.uk/nhs-networks/msc-framework-curricula/

Details of the Practitioner Training Programme including curricula from 2010/11 to 2015/16 can be found at:
www.networks.nhs.uk/nhs-networks/msc-framework-curricula/ptp

Details of the Practitioner Training Programme including curricula from 2016 onwards can be found at:
https://www.nshcs.hee.nhs.uk/

National School of Healthcare Science (NSHCS)

As part of the Modernising Scientific Careers (MSC) programme, the National School of Healthcare Science (the School) was established in October 2011 to support the implementation and delivery of the new healthcare science education and training programmes and to comply with the structures within 'Liberating the NHS: Developing Healthcare Workforce - Policy 16977 (January 2012)' acting on behalf of the Chief Scientific Officer (CSO) for England. It also provides some elements of support for the three other UK health departments.

On 1st April 2013, the School became part of Health Education England (HEE) and is hosted within the West Midlands.
The role of the NSHCS includes:

- Curricula management including assessment (new developments; review; fitness for purpose; version control etc);
- Coordination and monitoring of MSC Education and Training implementation;
- Quality management including accreditation of academic and work-based training environments;
- Monitoring and supporting the progress of trainees through the NSHCS themed boards (STP/HSST).

www.nshcs.org.uk

Chief Scientific Officer (CSO)

Source of information and news, including the CSO Bulletin, latest press releases, publications and consultations can be found at:
https://www.england.nhs.uk/tag/chief-scientific-officer/

Academy for Healthcare Science (AHCS)

The Academy for Healthcare Science (AHCS) brings together the UK's diverse and specialised scientific community who work across the health and care system including; NHS Trusts, NHS Blood and Transplant, Public Health England, independent healthcare organisations, and the academic sector across the UK.

The AHCS runs a Professional Standards Authority accredited Register for Healthcare Science Practitioners not covered by statutory regulation.
www.academyforhealthcarescience.co.uk/

Council of Healthcare Science in Higher Education (CHSHE)

The Council of Healthcare Science in Higher Education builds a unified identity of academic healthcare science by representing the interests of the sector. Working to improve and maintain quality in healthcare science education and training, the Council itself is made up of senior members of the academic healthcare science team. The work of the Council is also informed by two special interest groups made up of staff involved in the delivery and implementation of MSC programmes the PTP SIG and STP SIG.
www.councilofhealthcarescience.ac.uk/

Health and Care Professions Council (HCPC)

The Health and Care Professions Council is a regulator set up to protect the public. It keeps a register of health professionals who meet the HPC standards for their training, professional skills, behaviour and health.
www.hpc-uk.org/

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