Modernising Scientific Careers
Scientist Training Programme
MSc in Clinical Science
Curriculum
Genomic Sciences 2016/17
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READERSHIP

This Scientist Training Programme (STP) covers the Master's (MSc) in Clinical Science curriculum and describes the MSc Clinical Science programmes. In combination with the work-based Learning Guide, it provides the details of each themed STP in the UK for:

- Academic and administrative staff, including external examiners within Higher Education Institutions (HEIs)
- Trainees, host departments and managers of services that employ healthcare science staff, including those in public health and in blood transfusion services
- Work-based trainers, including all those involved in supervising, mentoring, coordinating, assessing and delivering STP education and training
- Local Education and Training Boards (LETBs) and all healthcare science education and training commissioning organisations in the UK
- Patients and the public
- National School of Healthcare Science MSc accreditation panels

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

1.1 Introduction to Modernising Scientific Careers (MSC)

1. The healthcare science (HCS) workforce plays a central role in safe and effective patient care across all pathways of care from health and wellbeing to the end of life. There are approximately 55,000 employees in the healthcare science workforce in the NHS throughout the UK. 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) sets out the principles and values on which good practice within healthcare science are founded.\(^1\) It makes explicit the professional standards of behaviour and practice that must be achieved and maintained by all those who work in healthcare science. GSP and the Education and Training Standards of the Health and Care Professions Council (HCPC) form the basis for all MSC training curricula, which contextualise the Standards of Proficiency -developed by the HCPC in a way that is accessible to the profession and the public.

3. The HCS workforce and services have traditionally been grouped into three broad areas called divisions, namely: Life Sciences/Clinical Laboratory Sciences, Physical Sciences/Medical Physics and Biomedical Engineering, and Physiological Sciences/Clinical Physiology Sciences. Within each division there are a number of healthcare science specialisms. With advances in scientific technology, changes to the delivery of healthcare scientific services and the development of MSC, the boundaries between these divisions have been shifting and a fourth division – Clinical Bioinformatics has been identified. MSC recognises this important change and to date has identified thirteen STP themes within healthcare science, which currently enables training across a total of 32 HCS specialisms, with curricula for additional specialisms still under development.

1.2 Introduction to the Scientist Training Programme (STP)

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

\(^1\) https://www.google.co.uk/?gws_rd=ssl#q=academy+for+healthcare+science+good+scientific+practice
5. The STP integrates and combines academic study leading to the award of a specifically commissioned MSc in Clinical Science and a work-based training programme. Completion of both will lead to the award of a Certificate of Completion of the Scientist Training Programme (CCSTP) by the National School of HCS (NSHCS). Graduates are eligible to apply to the Academy for Healthcare Science (AHCS) for a Certificate of Attainment and will then be eligible to apply to HCPC for registration as a Clinical Scientist. Recruitment to the programme is competitive and in England, the NSHCS leads the national recruitment process.

1.3 Scientist Training Programme Outcomes

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

7. On completion of the STP all graduates should be able to demonstrate the following outcomes of the programme:

Professional Practice

1. Professional practice that meets the professional standards of conduct, performance and ethics defined by Good Scientific Practice and the regulator (HCPC), and is safe, lawful and effective, within the scope of practice for the role undertaken, while maintaining fitness to practice.
2. Personal qualities that encompass communication skills, self-management, self-awareness, acting with integrity and the ability to take responsibility for self-directed learning, maintaining their own health and wellbeing, critical reflection and action planning to maintain and improve performance.
3. The ability to be an independent self-directed learner acting autonomously in a non-discriminatory manner when planning and implementing tasks at a professional level. Contributing to the education and training of colleagues; providing mentoring, supervision and support as appropriate and understanding the importance of participation in training, supervision and mentoring.
4. The ability to work, where appropriate, in partnership with other professionals, often as part of a multidisciplinary team. Supporting staff, service users and their relatives and carers while maintaining confidentiality.
5. The ability to work with the public, service users, patients and their carers as partners in their care, embracing and valuing diversity, as well as being aware of the impact of culture, equality and diversity on practice.
6. The ability to treat patients and their carers with respect, dignity and compassion in line with the NHS constitution.
7. An understanding of the limits of the concept of confidentiality; the principles of information governance and safe and effective use of health and social care information and the ability to recognise and respond appropriately to situations where it is necessary to share information to safeguard service users or the wider public.

Scientific and Clinical Practice

8. A systematic understanding of relevant knowledge and a critical awareness of current problems, future developments and innovation in health and healthcare science practice, much of which is at, or informed by, the forefront of their professional practice in a healthcare environment.
9. High-quality clinical and scientific practice that applies basic, core scientific knowledge, skills and experience in a healthcare setting, places the patient and the public at the centre of care, prioritising patient safety and dignity and reflecting NHS/health service values and the NHS Constitution.
10. The ability to perform quality assured appropriate diagnostic or monitoring procedures, treatment, therapy or other actions safely and skillfully, adhering to applicable legislation and in compliance with local, national and international guidelines.
11. The ability to maintain records appropriately, recognising the need to manage records and all other information in accordance with applicable legislation, protocols and guidelines.
12. The ability to deal with complex scientific and clinical issues both systematically and creatively, make sound judgments in the absence of complete data and communicate conclusions clearly to specialist and non-specialist audiences, including patients and the public.
13. The ability to define and choose investigative and scientific and/or clinical options and make key judgments about complex facts in a range of situations.
14. Originality in the application of knowledge, together with a practical understanding of how established techniques of research and enquiry are used to create and interpret knowledge in healthcare, healthcare science and their specialism.

Research, Development and Innovation

15. A comprehensive 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 care, the patient experience, clinical outcomes and scientific practice.
16. Conceptual understanding and advanced scholarship in their specialism, enabling them to critically evaluate and critique current research and innovation methodologies and, where appropriate, propose new research questions and hypotheses.
Clinical Leadership

17. Scientific and clinical leadership based on the continual advancement of their knowledge, skills and understanding through the independent learning required for continuing professional development.
18. The ability to critique, analyse and solve problems, define and choose investigative and scientific and/or clinical options and make key judgements about complex facts in a range of situations.
19. An understanding of the structure and function of health and social care services in the UK, the concept of leadership and its application to practice.

1.4 Overview of the MSc Clinical Science Programme

8. This document sets out the proposed structure, high-level learning outcomes and indicative content for the three year, part-time MSc in Clinical Science that forms part of the STP. The programme combines and integrates the generic professional practice learning, themed learning in a group of specialisms and individual programmes for each specialism.

9. Figure 1 depicts the overall structure and timing of each STP while Figure 2 depicts the broad framework around which all MSc Clinical Science programmes must be structured. Each division within the MSC has interpreted and adapted this framework in a way that is appropriate for the HCS theme.
Figure 1: Modernising Scientific Careers: STP: Diagrammatic representation of employment-based, pre-registration, three-year NHS-commissioned education and training programme.
### Figure 2: High-Level Framework for MSc Clinical Science

<table>
<thead>
<tr>
<th>Year 3 Specialist Practice</th>
<th>Healthcare Science</th>
<th>Research Project</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Specialist learning with integrated Professional Practice</td>
<td>Students would usually begin a work-based research project in Year 2 and complete the project in Year 3</td>
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<th>Year 2 Specialist Practice</th>
<th>Healthcare Science</th>
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<tr>
<th>Year 1 Core Modules</th>
<th>Healthcare Science</th>
<th>Healthcare Science</th>
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<tr>
<td></td>
<td>Integrating science and Professional Practice</td>
<td>Integrating underpinning knowledge required for each rotational element with Professional Practice</td>
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<td></td>
<td>[20]</td>
<td>[40]</td>
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</tbody>
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The numbers in [brackets] refer to the credit worth of the module.

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

#### 1.5 Entry Routes

10. In England there are two routes of entry into STP. Through the **direct entry route**, the trainee will be competitively appointed into a training post funded through the local Health Education England training board. Alternatively, some STP trainees may enter into training with the support of their employers through an **in-service training** route, as long as employers can demonstrate the ability to support STP training by meeting work-based accreditation standards. In both cases, potential STP applicants **must** participate in the national recruitment/assessment process and meet the minimum entry requirements for the academic and work-based programme. For direct entry applicants, this will be a competitive process for available posts, whereas in-service trainees will be required to complete the national recruitment process to be bench-marked against the standards for entry into STP, in order to ensure that they meet the standards for entry into a scientist training programme.
1.6 The MSc Clinical Science Curriculum

Purpose

11. The purpose of the STP MSc curriculum is to clearly set out the requirements of the programme, including the academic skills, knowledge and understanding that each trainee will be expected to gain, develop and apply during work-based training, so that these are explicit and clear. Set within an integrated academic and work-based programme, the outcomes of all MSc programmes should be read alongside the relevant work-based learning guide.

12. In addition, the MSc curriculum signals to providers the importance of ensuring that the current structure, strategic direction and priorities of healthcare delivery in the UK, for example The NHS Constitution, are emphasised during the academic programme. The requirement to prioritise patients and their care, ensuring that the patient and service provided by healthcare science is at the centre of all learning, assessment and work-based practice is equally important.

Professional Practice

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

14. Good Scientific Practice sets out for the profession and the public the standards of behaviour and practice that must be achieved and maintained in the delivery of work activities, the provision of care and personal conduct. It uses as a benchmark the Health and Care Professions Council (HCPC) Standards of Proficiency and Standards of Conduct, Performance and Ethics, but expresses these within the context of the specialisms within healthcare science. It is recognised that the three groups of the workforce, Biomedical Scientists, Clinical Scientists and Hearing Aid Dispensers are regulated by the HCPC. The aim is that the standards are accessible to the profession and easy for the public to understand.

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

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

17. The standards have been used to support curriculum development and will be used to underpin the process of judging individual equivalence, particularly for emerging specialisms. Key learning outcomes for professional practice for all STP trainees are shown in section 1.11 below.

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

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

Further details including the content of each domain can be found in the appendices.

**Curriculum Development and Maintenance, including curriculum review and updating**

18. Curriculum development began in 2010 and has been led by the Modernising Scientific Careers (MSC) team working with NHS and higher education colleagues and patients. Since 2012, the NSHCS has also contributed to curriculum development and maintenance via the professional leads and each of the NSHCS themed boards. Public health bodies have also reviewed relevant published STPs and led the development of a new STP (2014). Professional bodies and patients have been represented in most curriculum working groups and have also been invited to provide feedback as the work developed, either directly or via the NSHCS themed boards.

19. All programmes have been reviewed by HEE via the HCS Education and Training Working (now Scrutiny) Group (ETSG) and then subsequently approved by the HCS Implementation Network Group (HCS ING). External feedback from a review undertaken in 2012 by the Institute of Education has been incorporated into all programmes from 2013 onwards. All of the latest versions of the MSc Clinical Science programmes and work-based learning guides can be found on the NHS Networks website by following this link: [http://www.networks.nhs.uk/nhs-networks/msc-framework-curricula](http://www.networks.nhs.uk/nhs-networks/msc-framework-curricula). It is anticipated that curriculum will also shortly be available through the NSHCS website.
20. All MSC curricula will be subject to regular review, with all stakeholders given the opportunity to contribute to each review. This process is currently being set out in an MSC long-term curriculum maintenance plan. If you have any feedback with respect to this programme please contact NSHCS@wm.hee.nhs.uk.

1.7 MSC Accreditation

21. All MSc Clinical Science programmes must hold MSC Accreditation from the National School of Healthcare Science (NSHCS) to confirm that commissioned MSc in Clinical Science programmes delivered by an HEI meet the requirements of the MSC Scientist Training Programme.

22. The NSHCS is responsible for accrediting HEIs that deliver the Master's in Clinical Science. The STP MSc Accreditation Standards that must be met by HEIs can be found at [http://www.nshcs.org.uk/for-trainees/accreditation](http://www.nshcs.org.uk/for-trainees/accreditation). These standards address a number of key areas relating to the quality and delivery of programmes, including:

- Accreditation of Prior Learning
- Adhering to the QAA code of practice
- Assessment strategy
- Collaborative delivery of programmes
- Compensation/condonement
- Equality and diversity
- Fitness to Practise
- Induction
- Inter-professional learning
- Patient and public involvement
- Professional Practice
- Programme delivery and monitoring
- Programme titles
- Progression and annual monitoring of progress
- Trainee supervision, support and mentoring

1.8 Teaching and Learning

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

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

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

25. All contributors to the MSc should have up-to-date knowledge of the requirements of the programme, in addition to current HCS and education practice.

1.9 Assessment

Purpose of Assessment

26. The purpose of assessment is to enable the trainee to demonstrate that they have the requisite knowledge, skills, attitudes and beliefs to work as a Clinical Scientist and together with successful graduation from the work-based element of the STP, that they meet the HCPC standards of education and

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3 JISC TechDis: see http://www.jisctechdis.ac.uk/technologymatters/mobilelearning for further information with respect to mobile (m) learning.

4 Quality Assurance Agency Code of Practice.
training, professional skills and conduct performance and ethics to provide reassurance to the public.

The MSc Clinical Science assessment programme should support assessment for learning, and in particular:\(^5\)

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

27. 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, which is led by assessment experts. The approach to the assessment of the MSc Clinical Science should also be cognisant of and complement the work-based assessment programme.

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

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

1.10 Relationships and Partnerships

National School of Healthcare Science
NSHCS@wm.hee.nhs.uk and at www.nshcs.org.uk

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

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

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

The Academy for Healthcare Science
http://www.academyforhealthcarescience.co.uk/

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

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

1.11 Professional Practice

Within the MSc Clinical Sciences (Genomic Sciences), key professional outcomes for trainees for all modules are shown below:

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

The following sections of this MSc Curriculum provide an overview of the STP for the specialism(s) within this theme. The Generic, Division and Themed Learning Outcomes and Indicative Content of the curriculum, together with the high-level work-based learning outcomes, adhere to this.
Section 2: MSc Clinical Science (Genomic Sciences)

2.1 Overview of STP in Genomic Sciences

The diagram below provides a high level overview of the STP that trainees in Genomic Sciences will undertake, noting that trainees will specialise in one of the 3 areas, i.e. Genomics, Genomic Counselling or Molecular Pathology. This edition of the curriculum sets out the specialist curricula for Genomics and Genomic Counselling whilst the specialist curriculum in Molecular Pathology will be developed over the next year.

Modernising Scientific Careers: Scientist Training Programme (STP):
Diagrammatic representation of employment-based, 3 year NHS commissioned pre-registration education and training programme
2.2 Overview of the Clinical Scientist Training Programme in Genomics

The Role of the Genomics Clinical Scientist

Context

The Scientist Training Programme in Genomics has been designed to produce professional Clinical Scientists working within the healthcare environment; applying their genetics and genomics knowledge, skills, experience and attitudes to ensure the delivery of effective and safe patient care. Clinical Scientists in Genomics will practice robust science-based clinical care, with a focus on the range of genetic and genomic variation influencing health of the individual and family. In addition, their initial rotational training will ensure they have a broad base of knowledge, skills and experience across a group of related cognate specialisms reflecting the evolving clinical and scientific environment.

Scientific Services and Clinical Practice in Genetics and Genomics

Clinical Scientists in Genomics will have skills broadly linked to the main areas of specialism, namely:

- Assessment of the clinical utility of testing, selection of appropriate tests, and development and validation of appropriate testing strategies covering the entire range of genetic change from chromosome to single nucleotide variants (SNV) including methylation
- Interpretation and management of large datasets, such as those resulting from next generation sequencing (NGS) technologies and the annotation of genomic data
- Strong understanding of underlying science and the critical appraisal of literature
- Expansion of clinical knowledge and clinical interpretation with an emphasis on interpretation of the finding, the association of the genetic results with the phenotype, prognosis, further testing, implications for family members and the associated ethics, including consent
- Working in diverse settings including pathology

Clinical Scientists in Genomics will support clinical service provision, working closely with and within the multidisciplinary teams providing clinical services, to ensure that patient pathways are optimised via the appropriate use of genetic and genomic science. Clinical Scientists in Genomics will be flexible, able to work within an evolving field of health care and effectively communicate key issues of genetic and genomic science to colleagues, patients and their families.

Clinical Scientists in Genomics will understand principles, practice and competently work, for example, with the following genomic laboratory based functions:

- Assessment of the clinical utility of testing and choice of testing methods, understanding advantages and limitations
- Ensuring a quality service, including adherence to ISO 15189 standards and specific key performance indicators (KPI)
• The range of genetic testing methods currently in use to diagnose and confirm genetic disease
• Using bioinformatics software to process data
• Interpretation of data
• Information governance related to the storage of genomic datasets
• Legal and ethical issues

Clinical Leadership – Genomics

• Clinical Scientists in Genomics will influence strategic direction and will have both the knowledge and authority to support the current delivery and future development of the service, using visioning, scientific knowledge and expertise to ensure that the potential and rationale for new developments are understood. They will be practiced in influencing other colleagues so that excellent science remains at the forefront of clinical practice. Clinical Scientists will have a key role in promoting and ensuring quality and consistency of standards across services.

These aspects are all embedded in the academic (MSc) and work-based training components of this training programme.

The diagram overleaf provides an overview of the STP that each trainee in Genomic Sciences will follow.
2.3 Overview of the Clinical Scientist Programme in Genomic Counselling

Genomic Counselling and the role of the Genetic Counsellor\(^6\)

The World Health Organisation (WHO) defines Genetics as the study of heredity.\(^7\) Genomics is defined as the study of genes and their functions, and related techniques.\(^8\) The main difference between genomics and genetics is that genetics scrutinises the functioning and composition of the single gene whereas genomics addresses all genes and their interrelationships, in order to identify their combined influence on the growth and development of the organism.

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\(^8\) 2. WHA 57.13: Genomics and World Health, Fifty Seventh World Health Assembly Resolution; 22 May 2004
Genomic Healthcare involves the use of genomic information and technologies at any stage of the healthcare continuum to determine disease risk and predisposition, diagnosis and prognosis, and the selection and prioritisation of therapeutic options. Genomic healthcare also takes into account the potential ethical, psychological and social implications of genomic information and the application of genomic technologies.

Genetic counsellors have played an essential role in understanding and interpreting genetic data, presenting it in a manner that facilitates patient understanding and supports the use of genetic information within families. With scientific advances in genetics and the development of genomic science, genetic counsellors will need to develop additional knowledge and clinical skills to offer counselling in response to genomic sequencing and the impact on patients and families. The UK has a strong tradition in training Genetic Counsellors with these complementary skills and has been at the forefront of developing the profession, establishing standards that have been emulated across Europe and worldwide.

This STP in Genomic Counselling has been designed to produce Clinical Scientists with specialist expertise in genetics and genomics, combined with counselling skills. It is aimed at training Genetic Counsellors of the highest calibre, who are equipped for the genomics era by establishing a strong scientific core in genetics, genomics and bioinformatics in year one. In years two and three, this is applied to clinical cases through broad work-based learning while simultaneously learning relevant counselling theory and how to apply this to genetic and genomic counselling within the NHS.

Scientific Services and Clinical Care

Genetic Counsellors have traditionally practised within regional genetics centres to support individuals and families with rare genetic conditions. This has been through the unique application of scientific and clinical knowledge, alongside advanced communication and counselling skills in a healthcare context. The combination of these skills is applied in a healthcare context to directly support individuals and families attempting to comprehend and adjust to a genetic diagnosis by:

- applying genomic information to overall future healthcare for an individual and family
- interpreting and explaining complex, incidental or uncertain genomic information
- performing risk assessments for a range of genetic conditions and mechanisms
- providing practical and psychosocial support for those with rare genetic disease
- navigating the ethical challenges surrounding the disclosure and sharing of genetic information

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providing education for the wider healthcare workforce on the clinical application of genomics

Genetic Counsellors have their own caseload and contribute to the wider clinical genetics team alongside their medical colleagues and clinical scientists in the laboratory. More recently, the incorporation of these specialists within multidisciplinary teams has made an important contribution to their utilisation of genomic technologies and the interpretation and communication of genomic results in mainstream settings. The strength of such an integrated approach is in the combined fulfilment of clinical and educational roles in tandem. Development of such partnerships enables specialist, condition-specific input to be provided alongside genetics expertise and establishes a solid foundation for the implementation of genomic technology in mainstream healthcare.

Leadership and Management

This STP will equip Genetic Counsellors with the knowledge and authority to influence the strategic direction of genetic and genomic counselling practice, and will support the current delivery and future direction of the clinical service. They will be adept at influencing colleagues so that evidence based genetic and genomic counselling practice remains at the forefront of patient-centred healthcare. They will also have a key role in promoting and ensuring quality and consistency of standards across services.

With additional training and experience, Genetic Counsellors often take on management and leadership roles within clinical departments and more widely in health services.

Research, Innovation and Education

Genetic Counsellors will be educators, trained to support the development of colleagues within specialist multidisciplinary teams to understand and integrate genomic technologies outside of the traditional genetic setting. They will critically evaluate the benefits and opportunities offered by scientific discoveries and technological advances, as well as research around innovative genetic and genomic counselling. They will use this information to inform their own practice.

The inclusion of a relevant research project, either focusing on psychosocial or clinical aspects of genetics and genomics, within the training programme is an essential component that enables trainees to develop the analytical and research skills to both assimilate information for clinical practice and to continue to contribute to the evidence base, informing future genetic and genomic counselling.

The diagram overleaf provides an overview of the STP that each trainee in Genomic Counselling will follow.
Modernising Scientific Careers: Scientist Training Programme (STP): Diagrammatic representation of employment-based, 3 year NHS commissioned pre-registration education and training programme
2.4 Overview of STP in Molecular Pathology

The diagram below provides an overview of the STP that each trainee in Molecular Pathology will follow when the syllabus is developed for 2017/18.

Modernising Scientific Careers: Scientist Training Programme (STP): Diagrammatic representation of employment-based, 3 year NHS commissioned pre-registration education and training programme

[Diagram showing the structure of the STP programme for Molecular Pathology, including single specialism work-based programmes and integrated professional practice.]
Section 3: Generic Modules

Generic Curriculum

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

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

The generic STP work-based programme has generic curriculum modules, which are:

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

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

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

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

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

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

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

<table>
<thead>
<tr>
<th>Learning Outcomes: Knowledge and Understanding</th>
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<tbody>
<tr>
<td>On successful completion of this module the trainee will be able to:</td>
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**Scientific Basis of Healthcare Science**
1. Describe the cellular, tissue and system’s responses to disease and discuss those body systems and processes relative to your division/specialism;
2. Explain the main principles and core concepts of Genetics and discuss in the context of patients referred to services provided by your division/specialism;
3. Explain the main principles and core concepts of the sociology of health and illness and discuss those relevant to patients and the role of your division/specialism;
4. Explain the basis of epidemiology, public health and health protection and discuss in relation to patients and the safety of patients referred to services provided by your division/specialism;
5. Explain the basic principles of clinical pharmacology and therapeutics and discuss in relation to patients and the safety of patients referred to services provided by your division/specialism;
6. Explain the basic principles of physics that underpin healthcare science and discuss in relation to patients and the safety of patients referred to services provided by your division/specialism;
7. Discuss and justify how bioinformatics, including large biological datasets, contributes to patient safety, patient care and the practice of healthcare science, and defend the governance and ethical frameworks within which bioinformatics can be used.

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

**Clinical Leadership**
12. Discuss, compare and contrast a range of leadership models, including those that underpin current NHS Leadership and Competency Frameworks, and identify and critically evaluate how your personal values, principles and assumptions affect
13. Explain the current structure and management of health and social care systems and services at a national (UK-wide) and local level and the way in which the voice of patients and the public is embedded in all aspects of healthcare and healthcare education.

**Learning Outcomes: Practical Skills**

On successful completion of this module the trainee will be able to:

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

**Indicative Content**

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

**Review of pathophysiology: cellular, tissue and systems responses to disease**
- Review of the pathological processes underpinning common diseases:
  - cell death
  - inflammation
  - neoplasia
  - hypertrophy
  - hyperplasia
  - tissue response to injury and repair.
Introduction to the main principles and core concepts of Genetics
- Meiosis and Mendelian inheritance
- Nucleic acid structure and function
- Chromosome structure and function
- Nomenclature used to describe the human genome
- Common genetic disorders
- Impact of genetic disorders on the patient and their families
- Genomic technology and role of the genome in the development and treatment of disease.

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

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

Introduction to clinical pharmacology and therapeutics
- Overview of the basic principles of pharmacokinetics
- Overview of the basics of drug metabolism and excretion
- Basic mechanisms and clinical importance of drug interactions.

Basic principles of physics underpinning common measurement techniques used in healthcare science
- Structure of matter (atomic and nuclear models)
- Radiation: nature and its measurement and radiation safety
- Physics and mathematics of image formation
- Basic electricity and magnetism as it relates to the measurement of physiological signals
• Viscous and inertial flow of simple liquids.

**Ethical foundations of professionalism and the patient at the centre of care**

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

**Introduction to quality improvement**

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

**Introduction to history taking, clinical examination**

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

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

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

**Introduction to the structure of the NHS**
• Structure of the NHS across the four UK countries
  • Structure
  • Accountabilities
  • Funding arrangements
  • Working relationships
• NHS Constitution
  • The seven key principles that guide the NHS in all it does
• NHS Values
  ▪ Respect and dignity
  ▪ Commitment to quality of care
  ▪ Compassion
  ▪ Improving lives
  ▪ Working together for patients
  ▪ Everyone counts

• Quality improvement structures and processes within the NHS
• Patient safety and the requirement to protect patients from avoidable harm
• Patient focus
  ▪ Shared decision making with patients
  ▪ Access to information
  ▪ Choice
  ▪ Personalised care
  ▪ Safeguarding patients

Year 2: Generic Module
Research Methods
[10 credits]

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

Learning Outcomes: Knowledge and Understanding

On successful completion of this module the trainee will be able to:

1. Discuss and critically evaluate the context within which research, development, innovation and audit are undertaken to improve patient care, promote innovation and improve service delivery.
2. Describe, compare and contrast a range of research methods/approaches, including cohort studies, qualitative, quantitative, systematic review, sampling techniques and clinical trials.
3. Explain and justify current UK ethical and governance frameworks and processes spanning the conduct of human and animal research, innovation and audit.
4. Critically evaluate the literature/evidence base to identify a research question and create a new approach or technique to improve patient care or service delivery.
5. Discuss and justify the research, audit and innovation process from idea generation to dissemination/implementation, including patient/user involvement and intellectual property.
6. Describe and evaluate a range of data analysis techniques to ensure the validity, reliability and appropriateness to the research aim, design and conclusion.
7. Describe how clinical guidelines are produced and the concept of evidence-based practice, including the role of current statutory and advisory regulatory bodies.
8. Identify potential sources of research and innovation funding for healthcare science/Clinical Scientists.

Learning Outcomes: Practical Skills

On successful completion of this module the trainee will be able to:

1. Undertake an evidence-based literature review, critically appraise the output, draw appropriate conclusions and report the findings, and where appropriate, use the findings to inform a research project.
2. Identify, discuss and critically evaluate a research, innovation or audit project that has resulted in an improvement in patient care, diagnostics or service delivery.

Indicative Content

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

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

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

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

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

**Research and innovation funding**
• Sources of funding including research councils and charities
• Grant applications.
Section 4: Division/Theme-Specific Modules

4.1 Introduction to Genomic Sciences

This section covers the division/theme-specific module that will be studied by all trainees undertaking the Genomic Sciences STP programme.

**Division: Life Sciences**
**Theme:** Genomic Sciences
**Year 1:** [40 credits]
**Introduction to Genomic Sciences**

The overall aim of this module is to provide trainees with the knowledge that underpins the STP work-based rotational programme in Genomic Sciences. For ease of understanding, the module has been broken down into four rotations, each of 10 credits. It is recognised that these four rotations need not be delivered as separate entities.

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


4.2 Summary of rotational programme for Genomics

**MANDATORY ROTATIONS (A and B)**

- **Rotation A:** Genetics, Genomics and Molecular Science CG-1: [10 credits]
- **Rotation B:** Introduction to Clinical Bioinformatics and Genetics: (CBI-1) [10 credits]

**PLUS TWO ROTATIONS (Rotations C AND D) CHOSEN FROM THE OPTIONAL MODULES BELOW:**

- Clinical Biochemistry Rotation: CB-1: Investigation of Major Organ Function [10 credits]
- Haematology and Transfusion Science Rotation: HT-1: Introduction to Haematology and Transfusion Science [10 credits]
- Clinical Immunology Rotation: CI-1: Immunity and the Principles and Practice of Clinical Immunology [10 credits]
- Histopathology Rotation: HP-1: Introduction to the Principles and Practice of Histology [10 credits]
- Cytopathology Rotation: CP-1: Principles and Practice of Cervical Cytology and Diagnostic Cytopathology [10 credits]
- Reproductive Science Rotation: RS-1: Principles and Practice of Reproductive Science and Diagnostic Semen Analysis [10 credits]
- Genetic and Genomic Counselling Rotation: CG-1: Principles and Practice of Genetic and Genomic Counselling [10 credits]
4.3 Summary of Rotational Programme for Genomic Counselling

MANDATORY ROTATIONS (A, B and C)

- **Rotation A**: Principles and Practice of Genetic and Genomic Counselling: GC-1: [10 credits]
- **Rotation B**: Genetics, Genomics and Molecular Science CG-1: [10 credits]
- **Rotation C**: Introduction to Clinical Bioinformatics and Genetics: (CBI-1) [10 credits]

PLUS ONE ROTATION (Rotation D) CHOSEN FROM THE OPTIONAL MODULES BELOW:

- Clinical Biochemistry Rotation: Investigation of Major Organ Function: CB-1: [10 credits]
- Histopathology Rotation: Introduction to the Principles and Practice of Histology: HP-1: [10 credits]
- Reproductive Science Rotation: Principles and Practice of Reproductive Science and Diagnostic Semen Analysis: RS-1: [10 credits]

THE FOLLOWING PAGES IN THIS SECTION CONTAIN THE DETAILS OF ALL OF THE MODULES AVAILABLE IN THE ROTATIONAL PROGRAMME.
4.4 Rotational Modules

Division: Life Sciences  
Theme: Genomic Science  
Genetics, Genomics and Molecular Science  
CG-1 [10 credits]

This module will provide the trainee with an introduction to human genetics, genomics and molecular science. They will understand the organisation and delivery of a genetics and genomics laboratory service. In the work-based module, they will be expected to apply this knowledge as they learn to perform some common scientific technical methodologies used in genomics, gain an understanding of the interpretation of patient results in a variety of clinical settings and understand the impact of genomics on patients and their families.

Learning Outcomes: Knowledge and Understanding

On successful completion of this module the trainee will be able to:

1. Explain nucleic acid and chromosome structure and function.
2. Explain and apply the nomenclature used to describe the human genome.
3. Discuss patterns of inheritance.
4. Describe and evaluate the design, operation and performance of methods used to investigate genetic and genomic alterations associated with disease.
5. Describe the partnership of genetics and genomics with other clinical specialisms in the investigation and management of genetic and genomic disorders and the contribution to patient care.

Learning Outcomes: Associated Work-Based Learning

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

On successful completion of this module the trainee will be able to:

1. Observe and reflect on the patient pathway from sample receipt to issuing of the clinical reports for a range of genetic referrals.
2. Observe and reflect on preparation of samples for genetic analysis in current use.
3. Apply the correct genetic nomenclature to genetic alterations, including International System for Chromosome Nomenclature (ISCN) and Human Genome Variation Society (HGVS) nomenclature.
4. Identify the appropriate testing strategy for a range of referral reasons.
5. Apply the principles of internal quality control and external quality assessment and draw conclusions about assay performance.
6. Assist with the interpretation and reporting of laboratory results in the
Indicative Content

Nucleic acid and chromosome structure and function
- Introduction to the human genome
- Cell biology, meiosis and mitosis
- Chromosome structure and function
- Mechanisms of origin of numerical and structural abnormalities, and behaviour of structural chromosome anomalies at meiosis
- Nucleic acid structure and function, chemical structure of DNA and replication, transcription and translation

Nomenclature used to describe the human genome
- Current Human Genome Variation Society (HGVS) and International System for Chromosome Nomenclature (ISCN)

Patterns of Inheritance
- Autosomal dominant and recessive
- X-linked
- Non-Mendelian disorders

Design, operation and performance of methods used to investigate genetic and genomic diseases
- Introduction to the molecular basis of disease
- Current laboratory techniques, specifically: PCR, DNA sequencing, chromosomal microarrays, FISH, fragment analysis, cell culture, DNA extraction from lymphocytes and chromosome analysis
- Analytical and clinical sensitivity and specificity of these tests
- Analysis and interpretation of genetic variation in a clinical context
- Accurate clinical report writing
- The use of bioinformatic tools
- Potential application of relevant emerging technologies

Partnership of genetics with other clinical specialisms
- Multi-disciplinary team working
- The impact of genomics on patients and their families

7. Participate in activities that involve working in partnership with other clinical specialisms in the investigation of patients referred for genetic disorders.
This rotation will provide trainees with background knowledge of genetics and a knowledge and understanding of bioinformatics tools and infrastructure. In particular it will show how bioinformatics strategies can be used and applied to genomic and genetic data to generate information and knowledge that contributes to patient care and care pathways within a clinical setting. It will also introduce the ethical and governance framework appropriate for working with patient data in an NHS setting.

**Learning Outcomes: Knowledge and Understanding**

On successful completion of this module the trainee will:

1. Discuss the governance and ethical frameworks in place within the NHS and across the public health function [including, where relevant, the civil service] and how they apply to bioinformatics.
2. Discuss and justify the importance of standards, best practice guidelines and standard operating procedures: how they are developed, improved and applied to clinical bioinformatics.
3. Describe the structure of DNA and the functions of coding and non-coding DNA.
4. Discuss the flow of information from DNA to RNA to protein in the cell.
5. Describe transcription of DNA to mRNA and the protein synthesis process.
6. Discuss the role of polymorphisms in Mendelian and complex disorders and give examples of polymorphisms involved in genetic disease.
7. Describe appropriate bioinformatics databases capturing information on DNA, RNA and protein sequences.
8. Explain the theory of sequence analysis and the use of genome analysis tools.
10. Explain fundamental bioinformatic principles, including the scope and aims of bioinformatics and its development.
11. Explain fundamental genomic principles, including the scope and aims of genomics and its development.
12. Discover resources linking polymorphism to disease processes and antimicrobial drug resistance and discuss and evaluate the resources that are available to the bioinformatician and how these are categorised.
13. Discuss metadata and how it is captured in bioinformatics resources.
14. Interpret the metadata provided by the major bioinformatics resources.
15. Describe the use of ontologies in metadata capture and give examples of the use of ontologies for capturing information on gene function and phenotype.
16. Identify appropriate references where published data are to be reported.
17. Describe the biological background to diagnostic genetic testing and clinical genetics, and the role of bioinformatics.
18. Describe the partnership of Clinical Bioinformatics and Genetics with other clinical specialisms in the investigation and management of genetic disorders and the contribution to safe and effective patient care.
Learning Outcomes: Associated Work-Based Learning

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

On successful completion of this module the trainee will:

1. Perform analysis on DNA data and protein sequence data to infer function.
2. Perform sequence alignment tasks followed by clustering and phylogeny.
3. Select and apply appropriate bioinformatic tools and resources from a core subset to typical diagnostic laboratory cases, contextualised to the scope and practice of a clinical genetics laboratory.
4. Compare major bioinformatics resources for clinical diagnostics or pathogen typing and identification, and how their results can be summarised and integrated with other lines of evidence to produce clinically valid reports.
5. Interpret evidence from bioinformatic tools and resources and integrate this into the sum of genetic information for the interpretation and reporting of test results from patients.
6. Perform the recording of building or version numbers of resources used on a given date, including those of linked data sources, and understand the clinical relevance of this data.

Indicative Content

Genetics/Genomics
- Introduction to the history and scope of genomics
- The Genome Landscape
- The structure and function of coding and non-coding DNA
- The central dogma
- From DNA to RNA and proteins
- Non-coding regulatory sequence: promoters, transcription factor binding sites, splice site dinucleotides, enhancers, insulators
- Genetic variation and its role in health and disease

Sequencing
- Types of sequencing, applications and limitations; Sanger versus short read
- Analysis, annotation and interpretation
- Panel versus exome versus whole-genome resequencing

Statistics
- Basic statistics applied to clinical genetics/genomics
- Hardy-Weinberg, Bayes theorem, risks in pedigrees
- Hidden Markov Models
- Evolutionary Models
- Mathematical basis of phylogentic tree construction
Bioinformatic fundamentals

- Introduction to the history and scope of bioinformatics
- Primary biological sequence resources, including International Nucleotide Sequence Database Collaboration (INSDC) (GenBank, EMBL, DDBJ) and UniProt (SwissProt and TrEMBL)
- Genome browsers and interfaces, including Ensembl, University of California, Santa Cruz (UCSC) Genome Browser, Entrez
- Similarity/homology, theory of sequence analysis, scoring matrices, dynamic programming methods, including Basic Local Alignment Search Tool (BLAST), pairwise alignments (e.g. Smith Waterman, Needleman Wunsch), multiple sequence alignments (e.g. ClustalW, T-Coffee, Muscle), BLAT (BLAST-like Alignment Tool)
- Feature identification, including single-nucleotide polymorphism (SNP) analysis and transcription factor binding sites and their associated TF binding sequence motifs
- Ontologies – in particular Gene Ontology (GO), Human Phenotype Ontology (HPO), SnomedCT

Clinical application of bioinformatics

- Introduction to the clinical application of bioinformatic resources, including its role and use in a medical context in molecular genetics, cytogenetics and next generation sequencing for data manipulation and analysis, and genotyping microarrays (also used to predict copy number variants, CNVs)
- Background and application of specialist databases and browsers
  - Single-Nucleotide Polymorphism Database (dbSNP)
  - DECIPHER
  - Orphanet
  - Diagnostic Mutation Database (DMuDB)/NGRL Universal Browser
  - ClinVar (www.ncbi.nlm.nih.gov/clinvar/intro/)
  - OMIM
  - ECARUCA
  - Database of Genomic Variants (DGV)
  - Leiden Open (Source) Variation Database (LOVD)/Universal Mutation database (UMD) database software and scientific literature
  - Human Gene Mutation Database (HGMD)
  - Stanford HIV Drug Resistance Database
- Specific clinical analysis software
  - CNV analysis
  - Gene prioritisation (e.g. ToppGene, Endeavour, GeCCO)
  - Missense analysis (e.g. Align GVGD, SIFT, PolyPhen, Panther, PhDSNP, MAPP)
  - Splicing analysis applications (e.g. GeneSplicer, MAxEntScan, NNSplice, SSFL, HSF, NetGene2)
  - Commercially available software (e.g. NextGENe, Alamut, Cartegenia)
- Capture and representation of phenotype data
- Development of a simple application for clinical bioinformatic use

Standards and governance

- Data standards and formats
- International Union of Pure and Applied Chemistry (IUPAC) codes
- FASTA
- GenBank
- FASTQ
- Sequence Alignment/Map (SAM)/ Binary Alignment/Map (BAM)/CRAM
- Variant Call Format (VCF)
- General Feature Format (GFF)
- BED format
- Human Genome Variation Society (HGVS) variant nomenclature
- Human Genome Nomenclature Committee (HGNC) gene nomenclature
- RefSeq/RefSeqGene
- Locus Reference Genomic (LRG)
- Role and development of standard operating procedures
- Relevant standards (clinical, genetic, bioinformatic)
This module will provide the trainee with an introduction to the scope and diversity of genetic and genomic counselling practice. Such practice is wholly patient-centred and key themes such as the importance of the partnership between patient and counsellor and collaborative decision-making will be explored.

**Learning Outcomes: Knowledge and Understanding**

On successful completion of this module the trainee will be able to:

1. Explain the scope and diversity of genetic and genomic counselling practice.
2. Discuss the professional context of the work of the genetic counsellor in the UK and internationally.
3. Discuss and justify the changing ethos and values of genetic counselling in a historical context.
4. Discuss the use of family trees and generate risk figures for different individuals in a family, using knowledge of inheritance patterns including appropriate conditional information that will influence risk.
5. Discuss the concepts of probability, risk and uncertainty in the healthcare context and illustrate how different individuals perceive these differently.
6. Explain the principles that support the communication of complex information including information about risk and uncertainty.
7. Evaluate a range of effective approaches to explaining complex genetic concepts and helping individuals and families utilise genetic information and testing effectively.
8. Discuss the challenges faced by individuals and families affected by genetic conditions.
9. Critically evaluate the range of approaches used to achieve positive patient outcomes in genetic and genomic counselling practice.
10. Appraise the range of information resources relating to genetic conditions, tests and family support services that may be used to support genetic and genomic counselling.
11. Appraise the overarching psychological and social issues that can arise from genetic and genomic counselling.
12. Appraise the value and ethos of patient-centred care and discuss how you will embed patient-centred care in your clinical practice.

**Practical Skills**
The trainee will, in a safe learning environment:

1. Develop skills that support the communication of complex information.

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10 The trainee will have the opportunity to gain and practice these skills within a safe learning environment in the University setting.
Learning Outcomes: Associated Work-Based Learning

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

On successful completion of this module the trainee will be able to:

1. Critically reflect on the roles of multidisciplinary team members and the range of genetic and genomic practice, having attended genetic and multidisciplinary clinics.
2. Observe and assist during genetic and genomic counselling sessions under direct supervision.
3. Gather a comprehensive medical, family and obstetric history and under direct supervision, assess and communicate the genetic risk.
4. Following critical reflection on the role of the Genetic Counsellor in clinical practice, develop an action plan to inform their future practice.

Indicative Content

Genetic and Genomic Counselling Practice
- The role and development of clinical genetics services within the NHS
- The role and requirements of the HCPC and their standards of proficiency for clinical practice
- Clinical guidance from other agencies/bodies, e.g. Genetic Counsellor Registration Board (GCRB) and British Society of Genetic Medicine (BSGM)
- The Genetic Counsellor role in the UK and internationally
  - Multidisciplinary working
- Facilitators and barriers to accessing Genetic Counselling services within the NHS
- Philosophy and ethos of genetic counselling
  - From eugenics to patient empowerment
  - Supporting autonomy and core conditions of counselling
  - Reflective practice in the context of patient communication
- The impact of culture, equality and diversity on practice
- Patient safety (including safeguarding children, young people and vulnerable adults) and patient-centred care
- Limits of the concept of confidentiality
- The principles of information governance and awareness of the safe and effective use of health and social care information

Family history
- Family trees
  - 3-generation family trees
  - How to take a medical/obstetric history
  - Use (and limits) of the family tree in genetic risk assessment
Risk assessment

- Genetic risk assessment
  - Predicting risk to specified family members in the context of dominant, recessive, X-linked inheritance patterns
  - Online databases and sources of information for establishing the pathogenicity of genetic variants
  - Calculate an individual’s risk of inheriting or developing a genetic condition that runs or may run in their family, taking into consideration the inheritance pattern of the condition, their family structure and any conditional events that may have influenced their risk

- Communication of genetic risk
  - Risk perception (numerical vs perceived ‘burden’ of disease) including perceived *a priori* risk
  - Strategies for risk communication (e.g. framing, contextualization)
  - Counselling tools to convey risk and other complex information, including counselling aids

Psychosocial impact

- Introduction to the psychosocial impact of a family history of a (possibly) genetic condition and of genetic risk information

- Impact on the individual of a possible genetic condition:
  - Theories of psychosocial adjustment
  - Responses to loss (bereavement, loss of imagined future)
  - Responses to uncertainty

- Impact on the family of a possible genetic condition:
  - Impact of illness/disability on the family
  - Impact on the family when one (or more) family members have complex needs
  - Role of support services
OPTIONAL MODULES

Division: Life Sciences
Theme: Blood Sciences
Investigation of Major Organ Function
CB-1: [10 credits]

This module will provide the trainee with the knowledge and understanding of the normal physiology of the major organs and the biochemical parameters in common use for the investigation and management of major organ dysfunction. In the work-based module they will be expected to apply this knowledge as they learn to perform common methods used in the investigation of major organ function and gain experience of the interpretation of patient results in a variety of clinical settings.

Learning Outcomes: Knowledge and Understanding

On successful completion of this module the trainee will:

1. Explain normal physiological homeostasis of the major organs.
2. Describe and explain the pathophysiology and cause of common disorders of the major organs.
3. Explain the presentation, diagnosis and management of common biochemical disorders of major organ function.
4. Describe and evaluate the principles of common biochemical measurement techniques used to investigate major organ function.
5. Describe the design, operation and performance of automated analytical platforms used to investigate major organ function.
6. Describe the design, operation and performance of point-of-care testing devices supported by the clinical biochemistry laboratory.
7. Discuss and justify the biochemical investigation of major organ disease in the patient pathway, the correct sampling technique and the use and validity of reference ranges.
8. Explain and justify the principles of internal quality control (IQC) and external quality assessment (EQA).
9. Explain the use of laboratory information technology (IT) systems for handling, processing and storage of patient data.
10. Discuss the partnership of clinical biochemistry to other clinical specialisms in the investigation of disorders of major organs and patient care.

Learning Outcomes: Associated Work-based Learning

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

On successful completion of this module the trainee will:
1. Interpret routine requests for clinical biochemistry investigations of major organ function in the correct clinical context and process the specimens that accompany those requests.
2. Perform a range of laboratory and point-of-care techniques (POCTs) used in the workplace to investigate major organ function.
3. Apply the principles of internal quality control and external quality assessment and draw conclusions about assay performance.
4. Report the results of commonly performed clinical biochemistry investigations of major organ function.
5. Use laboratory IT systems for handling, processing and storage of patient data.
Indicative Content

- The normal physiology and function of the following major organs: kidney, liver, heart, lungs, bone and pancreas. To include water homeostasis and acid–base balance
- The clinical and scientific basis of common biochemical markers of function of the kidney, liver, heart, lungs, bone and pancreas
- The application of common biochemical markers of major organ function to a range of frequently encountered clinical disorders
- Presentation, diagnosis and management of common clinical biochemical disorders of major organ function
- The biological and statistical basis of biological variation, reference values and action limits
- Principles and practice of IQC and EQA
- Scientific basis of the following techniques: spectrophotometry, osmometry, ion selective electrodes, enzymology, immunochemical techniques, electrophoresis, chromatography and solid phase chemistry
- Design, operation and performance of automated analytical platforms, including random access, modular, robotics etc.
- Design, operation and performance of point-of-care testing devices supported by the clinical biochemistry laboratory
This module will provide the trainee with the knowledge and understanding of the formation of blood cells, the mechanism of haemostasis and the relevance of blood group antigens and antibodies. They will understand the principles and practice of common methods used in haematology, haemostasis and blood transfusion and perform some of them in the laboratory. They will understand common clinical disorders associated with abnormal haematology and haemostasis and gain experience of the interpretation of patient results in a variety of clinical settings. They will gain knowledge of blood transfusion in a variety of settings, and understand how to provide patients with safe and effective transfusion support.

**Learning Outcomes: Knowledge and Understanding**

On successful completion of this module the trainee will:

1. Explain the haemopoietic pathways and normal haemostatic mechanisms, and discuss disorders causing bleeding or thrombosis.
2. Describe the design, operation and performance of the routine tests used in screening and investigating haematological disorders and their normal limits.
3. Describe the design, operation and performance of the tests used to investigate disorders of haemostasis.
4. Discuss the concept of blood groups and the application of blood group serology in establishing compatibility between patient and donor.
5. Describe the design, operation and performance of the tests and procedures required to enable selection of safe and appropriate blood and blood components for patients with a range of clinical conditions.
6. Know the range of blood components and products in common use and the importance of correct storage.
7. Explain and justify legislation and guidance relevant to blood transfusion practice.
8. Discuss the partnership of haematology and transfusion science to other clinical specialisms in the investigation and management of common disorders and patient care.

**Learning Outcomes: Associated Work-based Learning**

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

On successful completion of this module the trainee will:
1. Perform a range of laboratory techniques used in screening and investigating haematological disorders.
2. Perform the range of laboratory and point-of-care techniques (POCTs) used in the investigation of disorders of haemostasis.
3. Perform blood group serology in the context of pre-transfusion testing.
4. Select safe and appropriate blood and blood components for patients with a range of clinical conditions.
5. Apply the principles of internal quality control and external quality assessment and draw conclusions about assay performance.
6. Use laboratory IT systems for handling, processing and storage of patient data.

**Indicative Content**

- Normal haemopoiesis and bone marrow function in the development and differentiation of blood cells
- Normal haemostasis and its components
- Role of the liver in the production of coagulation factors
- Principles, scientific basis and clinical application of commonly performed analytical procedures in haematology
- Principles and scientific basis of automated coagulation analysers and point-of-care instruments in the assessment of coagulation function
- Principles and scientific basis of automated cell counters and point-of-care instruments for numeration and identification of cellular blood components
- Point of care testing in haematology
- Presentation, diagnosis and management of common haematological disorders
- The establishment, application and limitations of biological normal reference ranges, including age, ethnic and sex related reference ranges
- Bone marrow aspiration, trephine biopsy, preparation and staining techniques for the morphological identification of cells in bone marrow in normal and pathological conditions
- Blood film preparation, staining and interpretation in normal and pathological conditions, including parasites
- Principles and application of internal quality control and external quality assurance programmes
- Basic blood group systems – genes, antigens and antibodies
- Manual and automated techniques for ABO/D typing, serological crossmatching, red cell phenotyping, antibody screening and identification
- Overview of blood transfusion services and range of blood components/products manufactured and their applications
- Principles of pre-transfusion testing
- Normal ranges and predictive values for pathology tests used to inform transfusion support
- Aetiology and clinical features of conditions requiring transfusion support
- Overview of legislation / guidelines relevant to blood transfusion practice
This module will provide the trainee with an introduction to the immune system and immune responses. They will understand the organisation and delivery of a clinical immunology laboratory service. In the work-based module they will be expected to apply this knowledge as they learn to perform some common methods used in clinical immunology and gain an understanding of the interpretation of patient results in a variety of clinical settings.

### Learning Outcomes: Knowledge and Understanding

On successful completion of this module the trainee will:

1. Explain the function of the immune system in health and the function of the major cells of the immune system.
2. Explain the function of the major humoral components of the immune response.
3. Explain the innate immune system and the adaptive immune response.
4. Discuss the co-dependence of the innate and adaptive immune systems.
5. Describe and evaluate the design, operation and performance of the tests and assays used within clinical immunology.
6. Describe the partnership of clinical immunology to other clinical specialisms in the investigation and management of disorders of the immune system and patient care.

### Learning Outcomes: Associated Work-based Learning

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

On successful completion of this module the trainee will:

1. Interpret routine requests for common clinical immunology investigations in the correct clinical context and process the specimens that accompany those requests.
2. Use laboratory IT systems for handling, processing and storage of patient data.
3. Perform a range of laboratory techniques used in the workplace in clinical immunology.
4. Report the results of commonly performed clinical immunology investigations of major organ function.
5. Apply the principles of internal quality control and external quality assessment and draw conclusions about assay performance.
Indicative Content

- Organisation and components of the immune system
  - Cellular components (lymphocytes, granulocytes, monocytes/macrophages)
  - Humoral components (antibodies/immunoglobulins, complement, cytokines)
  - Molecules of the immune system (major histocompatibility molecules class I and II, cluster of differentiation (CD) molecules/cell surface markers, receptor molecules, recognition molecules, adhesion molecules, effector molecules)
  - Antigen presentation
- Innate immune response (endothelial cells, neutrophils, macrophages, natural killer cells, complement)
- Adaptive immune response (antigen processing, dendritic cells, T cell responses, B cell responses, primary and secondary responses, vaccination/immunisation)
- Outcome of immune responses (immunity/immunological memory, inflammation, direct and indirect functions of antibodies, incidental tissue damage, hypersensitivity and allergy)
This module will provide the trainee with knowledge and understanding of the principles and practice of histology, as applied to clinical medicine. They will be expected to apply this knowledge and understanding in the workplace as they use a range of histological techniques and gain experience of interpreting results from patient investigations.

**Learning Outcomes: Knowledge and Understanding**

On successful completion of this module the trainee will:

1. Describe and recognise normal the cellular morphology of specified tissues and organs and relate these to the pathobiological processes associated with them.
2. Describe the receipt, preparation and processing of specimens for histopathological diagnosis.
3. Describe the appropriate demonstration technique as part of the diagnostic process.
4. Explain and evaluate microscopical examination techniques.
5. Describe and evaluate the application of quality assurance methodologies to histopathology.
6. Discuss the purpose and process of preparation and interpretation of clinical diagnostic reports.
7. Discuss the partnership of histopathology with other clinical specialisms in histological investigation and contribution to patient care.

**Learning Outcomes: Associated Work-based Learning**

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

On successful completion of this module the trainee will:

1. Receive, prepare and process specimens for histopathological investigation. To include dissection, tissue selection cutting, fixation and staining, as appropriate.
2. Select the appropriate demonstration technique in the investigation of representative histopathology specimens.
3. Use microscopic examination techniques to investigate histopathological specimens.
4. Recognise normal cellular morphology of representative tissues and organs and common pathobiological processes associated with them.
Indicative Content

- Normal cellular morphology and ultrastructure of specified tissues and organ systems, including skin, building on basic anatomy and physiology
- Introduction to tissue preparation techniques
- Specimen acquisition, viability, collection and delivery
- Principles and practice of fixation
  - Principles of specimen dissection and block selection
  - Tissue processing and embedding techniques
  - Pre-treatment, e.g. decalcification
  - Macrophotography
- Introduction to demonstration techniques and their rationale and hazards
  - Haematoxylin and eosin
  - Special stains to identify individual tissue/cellular components, e.g. connective tissues, nucleic acids, mucins, lipids, pigments
  - Histochemical techniques
  - Immunocytochemistry
  - Molecular diagnostics
  - Electron microscopy
- Microscopy principles and practice
  - Microtomy, cryotomy, ultramicrotomy
- Quality assurance
  - Artefacts
- Basic principles of pathobiology, to include inflammation, fibrosis, necrosis, hypertrophy, hyperplasia, atrophy, metaplasia and apoptosis
This module will provide the trainee with knowledge and understanding of cervical cytology and an overview of the role and limitations of diagnostic cytopathology. They will apply and relate this knowledge as they learn to recognise normal cells in cervical cytology preparations. They will also gain and apply knowledge of the cervical screening programme, the role of fine needle aspiration cytology and non-gynaecological cytology preparation techniques.

Learning Outcomes: Knowledge and Understanding

On successful completion of this module the trainee will:

1. Explain the physiology and pathophysiology of the female reproductive tract.
2. Describe the appearance of normal and relate this to abnormal cellular patterns in cervical cytology.
3. Discuss and evaluate the organisation and delivery of current cervical screening programmes.
4. Describe relevant techniques for non-gynaecological cytology samples.
5. Describe and evaluate the application of quality assurance methodologies to cytopathology.
6. Discuss the purpose and process of preparation and interpretation of clinical diagnostic reports.
7. Describe the partnership of cytopathology to other clinical specialisms in cytological investigation and contribution to patient care.

Learning Outcomes: Associated Work-based Learning

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

On successful completion of this module the trainee will:

1. Receive, prepare and process specimens for cytopathological investigation.
2. Select appropriate methods for preparation, fixation and staining.
3. Use microscopic examination techniques on a selection of cytopathology samples.
4. Recognise the appearance of normal and abnormal cellular patterns in Cervical Cytology.

Indicative Content

- Overview of the cervical screening programme, including aetiology, principles of screening, coverage, and call and recall and failsafe
- Understanding of the role and impact of Human Papilloma virus (HPV) vaccination and testing on the cervical screening programme
- Principles of quality assurance, including internal quality control (IQC), external quality assessment (EQA) and audit
- The anatomy and physiology of the female reproductive tract
- Cell patterns of normal and abnormal cervical cytology samples
- Basic understanding of the use of information technology (IT) systems in cytology laboratories and the interface with laboratory computer systems
- Treatment options for cervical intra-epithelial neoplasia (CIN) and cervical cancer
- Principles of liquid-based cytology and imaging technologies
- The roles of staff in a cytology department: pathologists, biomedical scientists, consultant biomedical scientists (advanced practitioners), ‘checkers’, medical laboratory assistants and cytology screeners
- Principles of non-gynaecological cytology preparation techniques
- The advantages and limitations of fine needle aspiration (FNA) cytology in the diagnosis of benign conditions and malignant disease
- The role of immunocytochemistry and molecular techniques in gynaecological and non-gynaecological cytology
This module will provide the trainee with knowledge and understanding of the normal physiology of the male and female reproductive tracts. They will apply this knowledge as they learn to perform a range of techniques and interpret results from diagnostic semen analysis. They will also gain knowledge of current legislation and regulations.

**Learning Outcomes: Knowledge and Understanding**

On successful completion of this module the trainee will:

1. Describe male and female reproductive anatomy.
2. Describe male and female reproductive physiology.
3. Explain and evaluate current legislation and regulation as it relates to reproductive science.
4. Describe relevant techniques for semen analysis and preparation.
5. Describe and evaluate the application of quality assurance methodologies to reproductive science.
6. Discuss the purpose and process of preparation and interpretation of clinical diagnostic reports.
7. Describe the partnership of reproductive science with other clinical specialisms and contribution to patient care.

**Learning Outcomes: Associated Work-based Learning**

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

On successful completion of this module the trainee will:

1. Apply and interpret quality assurance methodologies in reproductive science.
2. Apply health and safety methodologies and practices appropriate to the reproductive science laboratory.
3. Perform to accepted standard relevant techniques for semen analysis and preparation.
4. Prepare, interpret and report on diagnostic semen analysis (under supervision).
5. Work in partnership with the reproductive science laboratory and other clinical specialisms in the investigation of infertility.
Indicative Content

- Overview of sexual differentiation, including differentiation of the fetal testes and ovary, and the endocrinology and embryology of sexual differentiation
- The anatomy and physiology of the male reproductive tract
- The anatomy and physiology of the female reproductive tract
- Hormonal control of female reproduction, including the menstrual cycle, follicle growth, autocrine and paracrine factors regulating follicle growth, follicular fluid, ovulation, corpus luteum
- Hormonal control of male reproduction
- Basic understanding of the regulatory mechanisms associated with human assisted reproductive therapy (ART)
- The roles of ART centre staff: clinicians, scientists, clinical embryologists, nurses, counsellors
- Principles of and standards for diagnostic semen analysis
- Characteristics of normal and abnormal semen samples
- Semen preparation, including different methodologies, diagnostic tests and functional tests
## Section 5: Specialist Training Programme

### 5.1 MSc Clinical Science Specialist Modules for Genomics

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<th>Year 3</th>
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<td>Introduction to Healthcare Science, Professional Practice and Clinical Leadership [20]</td>
<td>Introduction to Genomic Sciences Underpinning knowledge for rotational elements and integrated professional practice [40]</td>
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[XX] = number of credits

- **Blue**: Generic Modules: Common to all divisions of healthcare science
- **Yellow**: Division/Theme-Specific Modules: Common to a division or theme
- **Orange**: Specialist Modules: Specific to a specialism
This module will provide the trainee with knowledge and understanding of the role and application of genetic and genomic testing for prenatal testing, including screening and diagnosis. It will also consider the potential impact of prenatal testing on the patient and their family.

### Learning outcomes: Knowledge and Understanding

On successful completion of this module the trainee will be able to:

1. Describe the principles of screening programmes and the difference between screening and diagnosis in the context of prenatal testing.
2. Explain the maternity clinical care pathway with respect to a strategy for prenatal testing and prenatal diagnosis of genetic and genomic disease.
3. Explain Rapid Aneuploidy screening and testing, including combined screening (biochemical and ultrasound scan) and the range of laboratory methods.
4. Explain prenatal diagnosis for genetic and genomic disease, including NIPT/D and invasive testing.
5. Discuss and debate the clinical, scientific, ethical and legal dimensions of prenatal diagnosis.
6. Recognise and describe the specific clinical risks associated with prenatal screening and testing, as well as the potential impact for the patient and their family.

### Learning Outcomes: Associated Work-Based Learning

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

On successful completion of this module the trainee will be able to:

1. Apply an appropriate testing strategy (the right sample, the right test, for the right reasons) meeting all relevant KPIs (key performance indicators, however defined).
2. Analyse and interpret results of specific defined tests.
3. Identify and respond appropriately to results.
5. Act in accordance with the high level of laboratory risk associated with prenatal testing and within limits of their responsibilities.

Indicative Content

Screening Programmes
- The clinical, scientific, ethical and social requirements for prenatal testing
- The organisation, delivery and performance of the national screening programme for aneuploidy and fetal anomaly
- The follow up pathways for screening programme positive cases

Maternity Clinical Care Pathways for prenatal testing
- The context of prenatal testing within the maternity clinical care pathway
- Specific diagnostic methods appropriate for screen positive results including:
  - Rationale
  - Limitations
  - Best Practice Guidelines (BPG)
  - National guidance and/or strategy, for example, the National Fetal Anomaly Screening Programme
- Key performance indicators (KPIs) as currently offered in the UK
- An awareness of developing methods, including those offered elsewhere but not formally adopted in the UK

Prenatal testing
All aspects of:
- Rapid Aneuploidy testing using current technology
- Prenatal Microarray
  - Validate and verify results
- Targeted mutation testing including:
  - suitability of platforms
  - sensitivity and specificity
  - follow up testing (which may include FISH or karyotyping or specific molecular testing for example)
  - the reason for the test, reasons for referral and the likely outcomes
  - the patient cohort
  - prior information required
  - the tissue for testing (blood, Chorionic Villus Sampling (CVS), amniotic fluid)
  - the potential for unexpected outcomes and how this is mitigated or dealt with
- Limitations of each of the above tests, including sensitivity and specificity including:
  - Mosaicism, and confined placental mosaicism
  - Maternal cell contamination
  - Polysomy
o Allele drop-out
o Twin pregnancies
- BPG and KPI for each of the tests listed above
- Result confirmation, when this is appropriate, by which method and at which time point (pre or post-natal)
- External Quality Assurance (EQA) schemes for each of the above tests
- Analysis of results, including identification of poor or substandard test performance and corrective action
- Interpret archived results based on older technologies and the implication and limitation of these results for the patient and family
- Awareness of the importance of turnaround time in the pathway of care

**Interpretation and reporting of results to include:**
- Utilisation of appropriate validated algorithms which are likely to include critical appraisal of literature, laboratory and publicly accessible databases
- Classification of finding where appropriate (pathogenic, likely pathogenic etc.)
- Clinical report writing
- Role of multi-disciplinary team (MDT) meetings to aid interpretation

**Non-invasive prenatal testing/diagnosis (NIPT/D)**
- accessibility for pregnant women (NHS commissioned tests, private providers, research projects)
- technical principles
- diagnostic scope
- sensitivity and specificity
- incidental findings for the following purposes:
  - fetal sexing
  - familial single gene mutations
  - Trisomy 21 and other aneuploidies
  - other chromosome imbalance

**Ethical and legal considerations of prenatal diagnosis**
- Consent for prenatal testing, storage of patient material and informed choice
- High risk nature of samples in relation to patient decision making
- Follow-up management including termination of pregnancy
- Legislation associated with pregnancy and the unborn fetus
Division: Life Sciences  
Theme: Genomics Science  
Specialism: Genomics  
Year 2: CG-3 [10 credits]  
Paediatric Genomics  

This module will provide the trainee with knowledge and understanding of the role and application of genetic and genomic testing in the diagnosis and management of paediatric patients with rare inherited diseases, including the implications for other family members.

The content for this module will focus on (as exemplars): newborns who present as dysmorphic, failure to thrive, ambiguous genitalia or who are hypotonic. those patients who have a clinical suspicion of Duchenne muscular dystrophy, spinal muscular atrophy, Prader-Willi and Angelman syndrome, fragile X syndrome, myotonic dystrophy, cystic fibrosis, disorders of sexual differentiation, children with developmental delay or delayed puberty.

**Learning Outcomes: Knowledge and Understanding**

On successful completion of this module the trainee will be able to:

1. Explain the clinical presentation and assessment of patients with paediatric genetic and genomic disorders.
2. Discuss and evaluate appropriate genomic laboratory testing strategies for paediatric patients according to current best practice.
3. Describe the design, operation and performance of a range of genomic tests relevant to the investigation of these disorders.
4. Discuss and debate the relevant clinical scientific, ethical and legal considerations in the field of paediatric genomics.
5. Describe the purpose and evaluate how integrated working between laboratory genetics and other clinical specialisms supports patient-centred care, including diagnosis and treatment strategies for patients and their families.

**Learning Outcomes: Associated Work-Based Learning**

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

On successful completion of this module the trainee will be able to:

1. Apply an appropriate testing strategy relevant to patients referred for paediatric disorders.
2. Perform appropriate whole genome analysis for patients referred for paediatric genomic testing.
3. Perform targeted testing for patients referred with paediatric genetic conditions.
4. Investigate the clinical significance of variants using a range of bioinformatics tools, following current best practice guidelines.
5. Interpret and report a range of genetic and genomic testing relevant to paediatric conditions, including the results of diagnostic testing which should encompass appropriate recommendations for patient management.

Indicative Content

Clinical presentation and assessment of patients
- Clinical presentation and types of inheritance, including pedigree analysis
- Importance of accurate phenotyping

Genetic laboratory testing strategies
- Laboratory testing pathway including reflex testing
- The potential advantages of trio testing design, operation and performance of a range of genetic tests
- The principles of cost effectiveness in regards to the tests used
- Testing methodology including limitations and sensitivity
- PCR based methods including triplet repeats and methylation and kit based testing
- Copy number variation detection (e.g. Multiplex Ligation-dependent Probe Amplification (MLPA), chromosomal microarray, FISH and G-band analysis)
- Sequencing – using all current methods in clinical use
- Validation and verification of sequencing results
- The importance of appropriate internal quality control and external quality assurance
- Bioinformatics for the processing of large datasets
- Awareness of the importance of turnaround time in the pathway of care
- Interpret archived results based on older technologies and discuss the implication and limitation of these results for the patient and family

Clinical scientific, ethical and legal considerations
- Consent for paediatric testing, storage of patient material and parental involvement
- National guidelines for testing in children
- Follow-up management including prenatal testing for subsequent pregnancies (of future siblings)
- Safeguarding children and young people
**Interpretation and reporting of results to include:**

- Analysis and interpretation including the relationship of the genetic alteration to the phenotype
- Clinical reporting
- The categories of genetic variation observed within this patient group
- The mechanisms of pathogenesis in paediatric genetic disorder
- Diagnostic and prognostic significance of genetic abnormalities found in this group of patients
- The use of linkage analysis and the risk of recombination to include Bayesian calculation
- The importance of appropriate internal quality control and external quality assurance
- Use of standardised nomenclature to describe genetic and genomic variation
- How to critically appraise relevant literature and databases to develop an awareness of the need for any further testing
- Role of multi-disciplinary team (MDT) meetings to aid interpretation and guidelines such as Improving Outcomes Guidance and NICE guidelines
The overall aim of this module, building on the Research Methods module, is for the trainee to undertake a research project that shows originality in the application of knowledge, together with a practical understanding of how established techniques of research and enquiry are used to create and interpret knowledge in a specialism of healthcare science. The research project may span scientific or clinical research, translational research, operational and policy research, clinical education research, innovation, service development, service improvement, or supporting professional service users to meet the expected learning outcomes. Research projects should be designed to take into account the research training required by individual trainees and the needs of the department in which the research is to be conducted.

Learning Outcomes: Knowledge and Understanding

On successful completion of this module the trainee will be able to:

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

Learning Outcomes: Practical Skills

On successful completion of this module the trainee will be able to:

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

Indicative Content

- Critical evaluation of the literature/evidence base
- Reference management
- Identification of a research question
- Research ethics and regulatory requirements, including issues related to access and use of information
- Data protection and confidentiality guidelines
- Patient safety
- Patient consent
- Sources of funding/grants
- Peer review/expert advice
- Possible risks and balancing risk vs benefit
- Project management techniques and tools
- Roles and responsibilities of those involved in the research
- Monitoring and reporting
- Data analysis
- Data interpretation
- Criteria/metric for assessing and grading research data and publications in the scientific, NHS and HE sectors
- Range of formats and modes of presentation of data
- Requirements for publications submitted to scientific, education and similar journals
- Current conventions with respect to bibliography and referencing of information
This module will provide the trainee with knowledge and understanding of the role and application of genetic and genomic testing in the diagnosis and management of patients with adult onset genetic and genomic disorders, as well as the implications for other family members.

The content for this module will focus on (as exemplars) patients who present with features of: inherited peripheral neuropathies, neurogenetic conditions, hypertrophic and dilated cardiomyopathy, infertility (using cystic fibrosis and chromosome disorders), Fragile X testing for premature ovarian failure, inherited breast cancer and Lynch syndrome, Huntington’s disease, myotonic dystrophy and Friedreich ataxia.

**Learning outcomes: Knowledge and Understanding**

On successful completion of this module the trainee will be able to:

1. Explain the clinical presentation and assessment of patients with adult onset genetic and genomic disorders.
2. Discuss and evaluate the appropriate genetic and genomic laboratory testing strategies for adult patients with genetic and genomic disorders according to current best practice.
3. Discuss the design, operation and performance of the range of genetic and genomic tests relevant to the investigations.
4. Discuss and debate the relevant clinical scientific, ethical and legal dimensions.
5. Describe the purpose and evaluate how integrated working across clinical specialisms supports patient-centred care, including the diagnosis and treatment strategies for patients and their families.

**Learning Outcomes: Associated Work-Based Learning**

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

On successful completion of this module the trainee will be able to:

1. Apply appropriate testing strategies relevant to patients referred for adult onset genetic and genomic disorders.
2. Perform appropriate level of whole genome analysis for patients with primary infertility.
Indicative Content

Clinical presentation and assessment of patients with adult onset genetic and genomic disorders
- Clinical presentation and types of inheritance, including pedigree analysis
- Importance of accurate phenotyping

Appropriate genetic laboratory testing strategies for adult patients with genetic disorders
- Design, operation and performance of a range of genetic tests
- The principles of cost effectiveness
- Laboratory testing pathway including reflex testing
- Single gene and massively parallel sequencing strategies
- The relative merits of panel based, whole exome and whole genome analysis
- Testing methodology including limitations and sensitivity
  - PCR based methods including triplet repeats and methylation and kit based testing
  - Copy number variation detection (e.g. MLPA, chromosomal microarray, FISH and G-band analysis)
  - Sequencing – using all current methods in clinical use
  - Validate and verify results
- The importance of appropriate internal quality control and external quality assurance
- Bioinformatics for the processing of large datasets
- Exclusion testing by linked microsatellite analysis in Huntington disease
- Importance of turnaround time in the pathway of care
- Interpret archived results based on older technologies and discuss the implication and limitation of these results for the patient and family

Clinical scientific, ethical and legal considerations
- Consent for testing and storage of patient material including deceased patients
- National guidelines for predictive and presymptomatic testing
The importance of counselling, e.g. in predictive testing of late onset disorders such as Huntington disease and the importance of distinguishing between diagnostic and predictive test requests

Follow-up management including prenatal testing for subsequent pregnancies

Safeguarding vulnerable adults

Interpretation and reporting of results to include:

- Analysis and interpretation including the relationship of the genetic alteration to the phenotype
- Proteomics for the interpretation of variants of uncertain significance
- Clinical reporting
  - Categories of genetic variation observed within these patient groups
  - The mechanisms of pathogenesis for these disorders including the difference between sporadic and inherited conditions, e.g. breast and colon cancer
  - Diagnostic and prognostic significance of genetic abnormalities found in these groups of patients
  - The use of linkage analysis and the risk of recombination to include Bayesian calculation
  - Use of standardised nomenclature to describe genetic and genomic variation
  - How to critically appraise relevant literature and databases to develop an awareness of the need for any further testing
- Role of multi-disciplinary team (MDT) meetings to aid interpretation and guidelines such as improving Outcomes Guidance and NICE guidelines
This module will provide the trainee with knowledge and understanding of the role and application of genetic and genomic testing in the diagnosis and management of patients with sporadic cancers.

The content for this module will focus on (as exemplars) patients who present with acquired cancers including Chronic Myeloid Leukaemia (CML), Acute Lymphoblastic Leukaemia (ALL), Acute Myeloid Leukaemia (AML), sporadic colorectal cancer and lung cancer.

**Learning Outcomes: Knowledge and Understanding**

On successful completion of this module the trainee will be able to:

1. Explain the difference between the utilisation of genetic and genomic testing in acquired disease compared with inherited disease with specific reference to diagnosis, prognosis, monitoring and treatment.
2. Explain the challenges of the analysis of mixed cell populations and sampling for testing.
3. Explain the clinical presentation and assessment of patients with the common referrals for acquired cancers: Chronic Myeloid Leukaemia (CML), Acute Lymphoblastic Leukaemia (ALL), Acute Myeloid Leukaemia (AML), sporadic colorectal cancer and lung cancer.
4. Discuss and evaluate appropriate genetic and genomic testing strategies for the above acquired cancers throughout the life of the patient and with reference to other testing modalities.
5. Describe the design, operation and performance of a range of genetic and genomic testing relevant to cancer.
6. Discuss the implications of the genomic tests considering diagnosis, prognosis and treatment of cancer patients within a patient-centred service, considering the views and wishes of patients and their families.
7. Discuss the partnership between genetics services and other clinical specialisms (Histopathology, Haematology and Oncology) in the cancer patient’s care pathways and the impact of national and international guidance.
8. Describe the role of clinical trials and the requirements for genetic and genomic testing therein.

**Learning Outcomes: Associated Work-Based Learning**

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

1. Apply appropriate sample selection criteria, taking into account the implications of acquired sporadic cancer with respect to sampling mixed cell populations, limits of detection, sensitivity of assay and patient management.
2. Apply an appropriate testing strategy for the commonly referred acquired sporadic cancers at all stages of the patient pathway.
3. Perform targeted testing for patients referred with sporadic cancer.
4. Perform whole genome testing for patients referred with sporadic cancer.
5. Analyse the results from genetic and genomic testing in acquired sporadic cancers.
6. Interpret and report a range of genetic and genomic testing relevant to acquired sporadic cancer.

Indicative Content

Scientific basis of canc er development
- The role of Loss of Heterozygosity (LoH)
- Knudson's two hit hypothesis
- Methylation in cancer development

Clinical presentation and assessment of patients
- Clinical presentation of patients with common referrals for acquired cancers: CML, ALL, AML, sporadic colorectal cancer and lung cancer
- Diagnosis of cancer using a multidisciplinary approach
- Clinical presentation and assessment of patients with known acquired cancers
- Genetic causes of sporadic cancer such as sporadic colorectal cancer, the gene pathways involved and their relation to inherited disease
- Difference between the utilisation of genetic and genomic testing in acquired disease compared with inherited disease

Genetic laboratory testing strategies
- Laboratory testing pathway including reflex testing
- Design, operation and performance of a range of genetic tests
- The use and limitations of a range of sample types to analyse tumour DNA including:
  - formalin fixed paraffin embedded material
  - fresh frozen tumour tissue
  - cell free circulating tumour DNA
  - bone marrow and peripheral blood
- Challenges of the analysis of mixed cell populations and sampling for testing
- The principles of cost effectiveness in regards to the tests used
- Testing methodology including limitations and sensitivity
- “hot-spot” mutations, including Sanger sequencing, pyrosequencing and real time PCR
• Next generation sequencing (NGS) panels for multiple cancer genes (advantages and challenges)
• Principles of FISH and chromosome analysis in identification of genetic changes associated with cancer
• Rearrangements and translocations commonly associated with solid tissue cancer and the named leukaemic types, their clinical significance and the methods used to detect them
• Bioinformatics for the processing of large datasets
• Interpret archived results based on older technologies and discuss the implication and limitation of these results for the patient and family
• Awareness of the importance of turnaround time in the pathway of care
• Role of multidisciplinary team (MDT) meetings and international guidance such as Improving Outcomes Guidance and NICE guidelines in the cancer patient care pathways

Clinical scientific, ethical and legal considerations
• Consent for testing and sample storage
• National guidelines
• Follow-up management including repeat testing for disease monitoring

Interpretation and reporting of results to include:
• Diagnosis of cancer
• Cancer prognosis and clinical care pathways associated with precision medicine
• Treatment monitoring
• Utility of genetic and genomic testing in monitoring the efficacy of treatment in cancer and named leukaemic types (including bone marrow transplantations)
• Disease monitoring and the principles underpinning quantitation of residual disease, e.g. CML, ALL
• Use of current actionable genetic biomarkers in the management and treatment of cancer
• The basis of large scale national and international projects focused on cancer and the importance of clinical trials
## MSc Clinical Science Specialist Modules for Genomic Counselling

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<td>Introduction to Healthcare Science, Professional Practice and Clinical Leadership</td>
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**Legend:**
- **Blue:** Generic Modules: Common to all divisions of healthcare science
- **Yellow:** Division/Theme-Specific Modules: Common to a division or theme
- **Orange:** Specialist Modules: Specific to a specialism

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The overall objectives of the specialist modules are to develop understanding and competence in the following broad areas of genomic counselling:

- using and applying genomic information to support the healthcare of individuals and families affected by genetic conditions
- interpreting and explaining complex, incidental or uncertain genomic information
- performing risk assessment for a range of genetic conditions and mechanisms
- providing practical and psychosocial support for those with rare genetic disease
- navigating the ethical challenges surrounding the disclosure and sharing of genetic and genomic information
- providing education for the wider healthcare workforce on the clinical application of genomics
This module will provide the trainee with an introduction to counselling theories relevant to the practice of genetic and genomic counselling, in addition to training in counselling skills. Trainees will understand the process of psychological adaptation to a genetic or genomic diagnosis in the family, including the range of coping responses to deal with uncertainty and potential future loss. In the work-based module they will be expected to observe and participate in patient-centred genetic and genomic counselling consultations, practising and applying effective counselling and communication skills to meet the psychological, social and cultural needs of individuals and their families.

### Learning Outcomes: Knowledge and Understanding

On successful completion of this module the trainee will be able to:

1. Recognise the appropriate use of counselling skills in the context of genetic and genomic counselling.
2. Describe relevant counselling theories and how these relate to the genetic and genomic counselling context.
3. Define and evaluate the counselling skills integral to conducting an effective genetic or genomic counselling session.
4. Describe and evaluate the range of potential psychological and emotional reactions to living with a genetic or genomic condition in the family or living at risk.
5. Explain the ethical concepts underpinning genetic and genomic counselling, including preserving confidentiality and enabling autonomous choice.
6. Identify the scope of a 'normal' response to bereavement and loss, drawing on current literature and contemporary models of grief and loss.
7. Describe the range of support agencies that may be used by patients and evaluate the effectiveness of these support structures from a patient perspective.
8. Discuss the role of critical reflection and use of supervision to support the development of counselling skills.

### Practical skills

The trainee will, in a safe learning environment:

1. Develop and reflect on the importance of the therapeutic relationship in genetic and genomic practice, having positive regard and respect for the autonomy of the individual.
2. Practise and use a range of counselling skills to enable individuals to express

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*The trainee will have the opportunity to practice these skills within a safe learning environment within the University setting.*
their beliefs, values and emotions.
3. Learn to recognise their own professional strengths and limitations, whilst developing and implementing action plans to support professional development.

Learning Outcomes: Associated Work-Based Learning

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

On successful completion of this module the trainee will be able to:

1. Apply core and advanced counselling skills within genetic and genomic counselling consultations under supervision.
2. Elicit and interpret appropriate medical, family and psychological history in a sensitive and culturally appropriate manner.
3. Facilitate individual/couple and family decision-making under direct supervision.
4. Refer individuals and/or families to other support agencies when required.

Indicative Content

Introduction to counselling theory

- Counselling theory as applied to practice, for example:
  - Person-centred counselling
  - Egan’s Skilled Helper model
  - Family Systems theory
  - Attachment theory
  - Psychodynamic theory
- Introduction to models of loss and grief
- Introduction to the tasks of mourning
- Responses to loss associated with genetic diagnosis or risk
- Psychological responses to genetic risk (e.g. monitoring, blunting)
- Individual and cultural influences on decision-making in a genetic counselling context
- Ethical approaches to genetic counselling and professional guidance (e.g. Association of Genetic Nurses and Counsellors (AGNC) Code of Ethics, The Genetic Counsellor Registration Board (GCRB) Code of Conduct, HCPC and their standards of proficiency for clinical practice)

Counselling skills

- Core skills (empathy, congruence, warmth)
- Advanced skills (advanced empathy, concreteness, challenge)
- How communication skills affect assessment of, and engagement with, individuals
  - Non-verbal communication, such as body language
  - Language, the use and interpretation of words
• How to modify means of communication to address and take account of factors such as age, capacity, learning ability and physical ability
• The characteristics and consequences of verbal and non-verbal communication and how this can be affected by factors such as age, culture, ethnicity, gender, socio-economic status and spiritual or religious beliefs
• How and when to assist the communication needs of patients and their families, including the use of an appropriate interpreter or advocate, where appropriate and taking into account different communication preferences/styles
• Skills development and assessment through use of role-play and video-recorded sessions
• Brief psychotherapy interventions for application in clinical practice
• Ways of enhancing positive coping and resilience

Reflective practice
• Continual development of counselling skills through the cycle of reflective practice
• Tools for reflective practice (e.g. use of KIDS framework/Johns model of structured reflection)
• The role of transference and counter-transference in the counselling relationship
• Becoming a reflective practitioner
• The use of supervision in a genetic counselling context
• The code of professional conduct for Genetic Counsellors

Support networks and other agencies
• The use of psychological support networks to help patients
• The role of lay organisations for patient information and support
This module will provide the trainee with a knowledge base across a breadth of commonly encountered genetic and genomic conditions. It will equip students with the skills to apply knowledge as they work in partnership with patients, their families and clinical colleagues and will help them consider the genetic and genomic counselling service from a patient perspective.

Using case based learning they will understand the diagnosis, course and prognosis, management, inheritance and recurrence risks for the most commonly encountered genetic and genomic conditions. The importance of collaborative decision making, treating patients and their families with empathy and respect, in addition to supporting choice and autonomy will be embedded into all learning. A comprehensive approach across life stages is undertaken. The emphasis will be on developing Genetic Counsellor professional competencies relating to clinical assessment and provision of accurate clinical, genetic and genomic information. Genomic and other investigations including predictive, carrier and prenatal testing, screening and family impact will also be included.

In the work-based module they will be expected to apply clinical knowledge within supervised genetic and genomic counselling practice across a range of clinical conditions. This includes providing risk assessment, clinical information, making appropriate referrals for clinical management and providing summary letters within a patient-centred clinical service.

**Learning Outcomes: Knowledge and Understanding**

On successful completion of this module the trainee will be able to:

1. Describe the clinical presentation of a range of commonly encountered genetic and genomic conditions, presenting in differing clinical situations, e.g. prenatal, paediatrics, inherited cancer and adult-onset conditions and discuss the impact of these across life stages.
2. Explain the genetic mechanisms and inheritance patterns underpinning a range of inherited conditions (e.g. single gene variants, chromosomal abnormalities, triplet repeats, imprinting, mitochondrial disease) and also the genetic and genomic contribution to multi-factorial conditions.
3. Access and critique resources and guidelines relevant to a specific clinical situation.
4. Discuss the concept of differential diagnoses and describe a range of investigations, including their underpinning evidence base, required to discriminate between conditions.
5. Discuss and interpret how genetic and genomic testing may be applied to individual clinical situations including the potential uses and limitations for supporting the family and collaborative decision-making.
6. Describe different ways of presenting risk and methods for calculating risks.
Learning Outcomes: Associated Work-Based Learning

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

Trainees will work under supervision to gain experience across the range of clinical situations including prenatal, paediatric, adult and cancer genetic and genomic counselling clinics.

On successful completion of this module the trainee will be able to:

1. Plan, structure, deliver and appropriately document Genetic Counsellor consultations of a less complex nature.
2. Organise and interpret appropriate genetic investigations in the context of risk assessment and patient clinical management.
3. Synthesise and critically analyse the literature (including clinical guidelines and pathways) to compile information on the aetiology and clinical presentation of a range of genetic and genomic disorders.
4. Communicate genetic information to individuals and their families referred across a range of clinical situations including prenatal, paediatric, adult (including cancer), being sensitive to patient information needs and the psychosocial and cultural context of the counselling session.
5. Use a multidisciplinary approach, including clinical supervision and teamwork to support the diagnosis and management of genetic and genomic disease, referral of patients and appreciate the context of genetic and genomic conditions within wider healthcare management of patients.
6. Provide information about potential research projects that patients may be eligible to join.

7. Discuss how psychosocial issues are considered during the process of genetic diagnosis and the importance of the partnership with the individual/family.
Indicative Content

Clinical context

Using a case based approach, trainees are expected to be familiar with a range of genetic and genomic situations including inheritance, risk, family impact and decisions, in addition to diagnosis and management within the context of different life stages (see below). The aim is to equip students with the skills to apply knowledge for investigation, differential diagnosis and evidence-based practice. Conditions in BOLD illustrate a breadth of conditions as minimal exemplars.

- 22q11 deletion
- Achondroplasia
- Anencephaly
- Angelman syndrome
- Cleft lip
- Cowden Syndrome
- Cri du chat
- Cystic Fibrosis
- Diabetes
- Down syndrome
- Duchenne Muscular Dystrophy (DMD)
- Fragile X
- Haemochromatosis
- Hereditary breast and ovarian cancer, colon cancer syndromes
- Huntington Disease
- Hypercholesterolaemia
- Hypertrophic and dilated cardiomyopathy, cardiac arrhythmias
- Klinefelter syndrome
- Myotonic dystrophy
- Neurofibromatosis Type 1 and Type 2 (NF1/2)
- Phenylketonuria (PKU)
- Retinitis pigmentosa (RP)
- Spinal Muscular Atrophy (SMA)
- Syndrome of mitochondrial encephalomyopathy, lactic acidosis, and stroke-like episodes (MELAS)
- Tuberous sclerosis (TS)

The module will explore the impact of genetic and genomic conditions, testing and management across the life stages, including prenatal (prenatal diagnosis, screening including national screening programmes, non-invasive prenatal diagnosis (NIPD) or testing (NIPT) and genetic single gene/array and combined screening such as biochemical and ultrasound), paediatric and adult (including adolescents and transition care).
**Diagnosis, testing and management**

Consider services from a patient perspective:

- The genetic basis of disease and the mechanisms of pathogenesis
- Clinical presentation and assessment of patients within a patient centred service
- How to promote shared decision making while respecting culture, equality and diversity
- Critically appraise and synthesise the literature and databases that underpin best practice guidelines (including NICE guidance)
- Diagnostic and prognostic significance of genetic and genomic test results
- Application of techniques for diagnosis including latest technologies (clinical exam/history, radiology, biochemistry, genomic analysis, arrays)
- Selection of appropriate diagnostic tests (biochemical, histochemical, single gene / genomic)
- Ordering of appropriate clinical investigations, receiving laboratory reports and delivering appropriate interpretation of results for risk assessment and decision-making
- Timely and appropriate delivery of results
- Clinical features of the disease including course and prognosis of disease
- Appropriate interpretation of risk and management options, including screening and prevention options
- The clinical scientific, ethical and legal requirements of prenatal, paediatric, presymptomatic, carrier and diagnostic testing
- Social and psychological impact of genetic testing

**Risk analysis**

- Risk assessment and interpretation including approaches applied to local situations, including risk communication
- Absolute
- Relative
- Odds ratios
- Natural frequencies (population)
- Life-time risk
- Age related risks

**Multidisciplinary working**

- The role of different clinical specialties in the care of patients with genetic conditions
- When and how to refer for clinical screening and management where appropriate
- Multidisciplinary practice, boundaries, diagnostic pathways and multidisciplinary care
- Role of clinical management processes including clinical supervision (AGNC definition of clinical supervision) and multidisciplinary team (MDT) meetings
- How to evaluate personal professional practice including identifying one’s own limitations, within the context of the professional practice guidelines of the Genetic Counsellor Registration Board (GCRB)
- Limits of the concept of confidentiality
The principles of information governance and awareness of the safe and effective use of health and social care information

Research
- Research opportunities for different patient groups
- The importance of research to inform clinical guidelines and evidence based practice
- Role of Good Clinical Practice for those who are involved in recruiting individuals to research projects, together with the roles and responsibilities of each individual member of the research team, including trainees in STP
- Ethical and research governance approval that must be in place for every research study
- Difference between consenting for a research project and consenting for genetic or genomic testing
The overall aim of this module, building on the Research Methods module, is for the trainee to undertake a research project that shows originality in the application of knowledge, together with a practical understanding of how established techniques of research and enquiry are used to create and interpret knowledge in a specialism of healthcare science. The research project may span scientific or clinical research, translational research, operational and policy research, clinical education research, innovation, service development, service improvement, or supporting professional service users to meet the expected learning outcomes. Research projects should be designed to take into account the research training required by individual trainees and the needs of the department in which the research is to be conducted.

**Learning Outcomes: Knowledge and Understanding**

On successful completion of this module the trainee will be able to:

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

**Learning Outcomes: Practical Skills**

On successful completion of this module the trainee will be able to:

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

- Critical evaluation of the literature/evidence base
- Reference management
- Identification of a research question
- Research ethics and regulatory requirements, including issues related to access and use of information
- Data protection and confidentiality guidelines
- Patient safety
- Patient consent
- Sources of funding/grants
- Peer review/expert advice
- Possible risks and balancing risk vs benefit
- Project management techniques and tools
- Roles and responsibilities of those involved in the research
- Monitoring and reporting
- Data analysis
- Data interpretation
- Criteria/metric for assessing and grading research data and publications in the scientific, NHS and HE sectors
- Range of formats and modes of presentation of data
- Requirements for publications submitted to scientific, education and similar journals
- Current conventions with respect to bibliography and referencing of information.
This module will provide the trainee with opportunities to critically evaluate theories of advanced counselling and develop their communication skills to support the delivery of high quality, compassionate and patient-centred genetic and genomic counselling. This module builds on the knowledge and skills acquired in the counselling and communication skills module in Year 2, to enable trainees to develop their skills of critical reflection, including the impact of their actions on the patient and the patient’s family. It will also enable the trainee to explore a range of ethical issues that arise in genetic and genomic counselling practice, e.g. around issues of confidentiality of genetic and genomic information in the family context and the ways in which these may be approached and managed.

**Learning Outcomes: Knowledge and Understanding**

On successful completion of this module the trainee will be able to:

1. Critically appraise current counselling theories and discuss how these can be applied to genetic and genomic counselling practice.
2. Apply suitable frameworks for the assessment and resolution of ethical and psychosocial dilemmas in clinical genetics practice.
3. Discuss the potential ethical and psychosocial impact of genetic test results, synthesising the published evidence base of patient and family experiences.
4. Critically evaluate the strategies professionals can use to provide support and facilitate ethical decision making in partnership with the patient/family.
5. Evaluate a theoretical framework to help explain family functioning (e.g. family systems theory) and evaluate its relevance to practice in supporting families around a genetic diagnosis or genetic test result.
6. Describe and critically evaluate current best practice guidelines for genetic and genomic testing.
7. Argue and defend specific ethical position(s) in relation to an issue arising from a clinical case in genetic counselling practice.
8. Reflect on how to manage complex ethical issues that arise in genetic and genomic counselling practice.
9. Justify the role of counselling supervision in managing ethically contentious cases.

**Practical skills**

In a safe learning environment, e.g. a HEI clinical skills centre, trainees will:

1. Practice applying advanced skills for counselling, showing a positive regard for the patient and family members with respect to their autonomy. They will use a range of counselling skills to develop further skills in supporting patients and their families to adjust to their genetic risk or status.
2. Practice the use of a range of more advanced counselling skills to support patients in decision making in relation to genetic testing and to address ethical issues raised by genetic testing.
3. Practice applying counselling theory in hypothetical scenarios to enhance understanding of individual people’s responses and develop competent and safe patient management.
4. Critically reflect upon own professional strengths and limitations.

### Learning Outcomes: Associated Work-Based Learning

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

On successful completion of this module the trainee will be able to:

1. Lead on establishing the patient agenda and psychosocial needs in complex genetic and genomic counselling consultations, under the supervision of an experienced Genetic Counsellor.\(^{12}\)
2. Facilitate complex decision making during genetic and genomic counselling consultations.
3. Communicate genetic test results in an empathic manner.
4. Use counselling supervision and multidisciplinary meetings to work through ethical and cultural issues in genomic counselling practice.

### Indicative Content

**Counselling theory and skills**

- Theories of psychosocial adjustment
  - Responses to loss (bereavement, loss of imagined future)
  - Responses to uncertainty
- Assessment of psychological status including screening questions/diagnostic criteria for clinical anxiety and depression
- Family impact, Family systems theory, Fostering resilience
- Application of counselling skills and theory for delivery of genetic testing
- Psychology and theory of decision-making

**Ethical principles and frameworks**

- Why ethics is important in clinical genetics and genetic counselling
- Ethics as theory vs ethics as governance

\(^{12}\) GCRB Registered Genetic Counsellor
Frameworks for thinking about ethics (e.g. normative ethics, consequentialism, deontology, bioethics)

Ethical issues in a multi-cultural society; providing genetic counselling to diverse groups; cultural perspectives and contexts in relation to science, genetics and disease

Ethical issues surrounding the reporting of incidental findings using examples from a pre-natal, childhood and adult setting

Ethical issues raised by NIPT (e.g. incidental cancer diagnosis picked up in the mother via the pre-natal test); the ‘prenatal exome/genome’

Professional codes of conduct and Legislation

Professional Codes of Conduct, e.g. Association of Genetic Nurses and Counsellors (AGNC) Code of Ethics, The Genetic Counsellor Registration Board (GCRB) Code of Conduct, HCPC and their standards of proficiency for clinical practice

Latest relevant policy on ethics and genomics, e.g. from the British Society of Genetic Medicine (in particular on Consent and Confidentiality best practice) and the Nuffield Council on Bioethics (on the ethical issues surrounding genomic data sharing)

Latest information about Legislation, Codes of Practice, Caldicott Guardian and Information Commissioner (e.g. to cover Data Protection Act, Mental Capacity Act, Human Tissue Act, Human Fertilisation and Embryology Act, Equality Act (formally the Disability Discrimination Act)

Privacy, confidentiality and (non) disclosure

Consent for genetic and genomic testing and data sharing

Genetic testing: consent and competence (adults and children)

Consent models used in a health setting (to include ‘broad consent’ used prior to sequencing and dynamic consent as a model for research)

Prenatal diagnosis, screening and disability issues

Opportunistic genomic screening for additional information (in addition to the diagnosis) searched for via genomic sequencing technologies

Patient identifiable data and information, relationship between data and information

Information system risks to patient safety, electronic and paper copies, safe havens, encryption, secondary uses of data, audit and research

Secure information exchange between professionals

‘Citizen Science’ and the return of data to patients (e.g. raw sequence data)

Handling requests for information about patients /clients

Patient support

Use of resources (including online) for psychological support and referral pathways

Assessing psychological status to ascertain patients who may benefit from referral

Critical reflective practice – including how to apply to work-based learning
This module will provide the trainee with an in-depth understanding of the role of genomic testing in establishing a genetic diagnosis. They will develop the expertise to support the diagnostic process (as part of a multidisciplinary team approach) through exploration of the relationship between genotype and phenotype. The trainee will also extend their understanding of genomics, how the patient’s phenotype and the family history can contribute constructively, together with expertise from clinical geneticists, clinical scientists in the laboratory and in bioinformatics, as well as other specialist colleagues, in determining the pathogenicity of variants.

In their work-based learning they will further develop their skills to support advanced genetic and genomic counselling practice and shared decision making in partnership with the patient. They will demonstrate their ability to autonomously handle cases that include pre-symptomatic testing, prenatal diagnosis, cascade screening and the management of rare and complex genetic and genomic disease within the context of the multidisciplinary team.

### Learning Outcomes: Knowledge and Understanding

On successful completion of this module the trainee will be able to:

1. Describe and critically evaluate the selection and differentiation of a range of current genomic testing strategies used to sequence targeted parts of the genome or the whole exome/genome and their application within prenatal, childhood and adult settings.
2. Explain the way genomic results are generated and how data is filtered using bioinformatic pipelines.
3. Evaluate and utilise approaches for the interpretation of genomic results and the use of genotype and phenotype data in establishing pathogenicity.
4. Describe the use of genomic results in personalised/precision medicine, pharmacogenetics and emerging therapeutics.
5. Explain and critically appraise the broader use of genomic screening for disease risk prediction.
6. Describe the role of the Genetic Counsellor in the partnership of genetics with other clinical specialisms in the diagnosis of genetic disorders.
7. Critique theories and approaches to adult education and how to apply these to genetics and genomics.

### Learning Outcomes: Associated Work-Based Learning

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

1. Lead, under supervision, complex consultations involving genetic testing in complex scenarios, and consultations involving the use of genomic technologies.
2. Contribute Genetic Counsellor expertise to multidisciplinary teams (MDT) by assimilating knowledge of patient pathways in a range of healthcare settings with genomics expertise.
3. Discuss very rare and/or complex genetic and genomic conditions with patients in an easy to understand format centred on the needs of the patient.
4. Advise patients and professionals on current and potential future use of genomic screening for risk prediction, including in multifactorial disease and explain the benefits and limitations of such approaches.
5. Prepare, deliver and evaluate teaching sessions in genetics and genomics for healthcare colleagues using a range of teaching methods.

**Indicative Content**

**Advanced Genomic Counselling**
- Pre-conception and reproductive genetic counselling that use genomic technologies, including prenatal diagnostic support
- Genomics in the fetal medicine clinic
  - Diagnostic challenges of antenatal scanning
  - NIPT
  - RCPath guidance on the sharing of incidental findings picked up in pregnancy
- The diagnostic odyssey and the specific benefits and challenges of genomics in a range of settings
- The use of sources for researching the natural history of rare diseases including:
  - OMIM
  - Orphanet
  - Gene Review
  - Pubmed
  - Eurogentest
  - Support groups such as Unique etc.

**Genomic testing strategies**
- Genomic testing strategies such as: gene focused, multiple genes or whole genome or exome and for detection of sequence, copy number or rearrangements, including when these might be applied by laboratory clinical scientists
- How laboratory clinical scientists determine the analytical sensitivity and specificity of genomic tests
- The health economic limitations of testing in a publicly funded health service
- Have an appreciation of the necessary interplay between genomics delivered via clinical services and subsequently research services (when the limits of what can be offered clinically have been reached)
Bioinformatic pipelines
- Principles applied to quality control of sequencing data, alignment of sequence to the reference genome, calling and annotating sequence variants and filtering strategies to identify pathogenic mutations in sequencing data
- Use of multiple database sources, in silico tools and literature for pathogenicity evaluation and familiarity with the statistical programmes to support this (e.g. EVS, dbSNP, polyphen etc.)
- Principles of integration of laboratory and clinical information, including knowledge of best practice guidelines for indicating the clinical significance of results

Evaluating pathogenicity
- Approaches to the evaluation of pathogenicity of variants in the context of an NHS clinical report
- The value and importance of phenotype and inheritance information alongside sequence analysis to determine diagnosis and pathogenicity [phenotype to genotype]
- Prediction of phenotype from variants obtained from a hypothesis free whole exome/genome analysis [genotype to phenotype] in established genetic conditions
- Analytical challenges in genomics as applied to rare inherited diseases including:
  o the benefits and potential risks of sharing, integrating and aggregating clinical data and information
  o the potential of electronic health records to enrich patient data
  o importance of phenotyping and use of databases such as ClinVar, OMIM and Decipher
  o use of large population datasets, e.g. ExAC
  o sharing information, e.g. Human Variome Project

The role of the Genetic Counsellor in the MDT
- Interpreting variant data in the clinic: the role of a Genetic Counsellor in the MDT to discuss pathogenicity of possible variants linked to a specific phenotype
- The role of the Genetic Counsellor and other members of the MDT in communicating uncertain information, variants of uncertain significance and incidental findings and counselling approaches to this
- Approaches to the management of incidental findings and the difference between this and opportunistic genomic screening
- The role of the Genetic Counsellor in facilitating supporting investigations including segregation analysis
- Approaches to and implications of the release of differing extents of genomic information

Use of genomic diagnosis
- Examples of the utility of a genomic diagnosis in establishing treatment strategies and personalised medicine, including in oncology, adult medicine, paediatrics and prenatal settings
- Non-invasive prenatal diagnosis
• Preimplantation genetic diagnosis
• Current uses of pharmacogenetics
• The role of genomics and other omics technologies in the development of new therapeutics, including gene therapy

Genomic screening for risk prediction
• Existing population screening programmes in antenatal, newborn and adult settings (e.g. Down syndrome screening, cystic fibrosis, haemoglobinopathies, familial hypercholesterolaemia, breast, cervical and bowel cancer)
• Emerging strategies of genomic screening for disease risk prediction in reproductive (e.g. panels for carrier testing) and adult settings (e.g. cancer, neuropsychiatric), including application in specific ethnic groups
• Approaches to opportunistic genomic screening internationally and the risks and merits of these approaches
• How to take ‘broad consent’, together with the pros and cons of this approach
• The challenges of genomic screening for risk prediction in multifactorial disease and evaluate current approaches to combining risk factors
• The evidence on how patients manage their behaviour in light of risk stratification information
• The differing impact of genomic screening within private healthcare and in the direct to consumer market, including the impact of such testing on the NHS

Clinical Education
• Major theoretical approaches to adult learning
  o Student centred and teacher centred learning
  o Learning styles
  o Active teaching and learning
• Teaching methods and generation of teaching resources
  o Planning and preparing to teach
  o Teaching methods:
    ▪ clinical skills
    ▪ lecturing
    ▪ small group teaching
    ▪ problem based learning
    ▪ Public engagement and education
    ▪ e-learning
    ▪ m-learning
• Core Teaching Skills
  o Questioning
  o Giving and receiving feedback
• Principles of assessment
Appendix 1: Contributor List

Members of the STP MSc and Work-based Programme Life Sciences: Genomic Sciences

The Health Education England (HEE) Genomics Education Programme, the National School of Health Care Science and the Modernising Scientific Careers team have coordinated development of the STP curriculum (MSc Clinical Sciences and Work-Based programme) for Genomic Sciences. The professionals who have contributed to the development of this revised and extended STP in Genomic Science in 2015-16 include:

Jennie Bell  National School of Healthcare Science
Caroline Benjamin  University of Central Lancashire
Michelle Bishop  HEE Genomics Education Programme
Laura Boyes  Birmingham Women’s NHS Foundation Trust
George Burghel  Central Manchester University Hospitals NHS Foundation Trust
Ann Dalton  Sheffield Children’s NHS Foundation Trust
Lorraine Gaunt  Central Manchester University Hospitals NHS Foundation Trust
Georgina Hall  Manchester Centre for Genomic Medicine
Lowri Hughes  Birmingham Women’s NHS Foundation Trust
Helen Jolley  Manchester Centre for Genomic Medicine
Anna Middleton  Wellcome Trust Sanger Institute, Cambridge
Marion McAllister  Cardiff University
Rhona MacLeod  Manchester Centre for Genomic Medicine
Christine Patch  Guy’s and St Thomas’ NHS Foundation Trust Hospital
Eileen Roberts  Southmead Hospital, Bristol
Heather Skirton  Plymouth University
Alison Taylor-Beading  Great Ormond Street NHS Foundation Trust

A wider, stakeholder review of this curriculum was undertaken in January 2016 providing professional bodies, patients/patient groups and other stakeholders the opportunity to provide feedback to shape final publication in May 2016.
Appendix 2: Programme Amendments

This section lists the programme amendments following first publication.

Amendments – March 2013

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

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

The new version is called STP MSc Genetic Sciences Version 3.0 for 2013-14.

Amendments – May 2016

These amendments apply to trainees commencing STP in the academic year 2016/2017.

The title of the STP was amended from Genetic Science to Genomic Sciences with three programme outcomes namely Genomics (revised Genetic Sciences curricula Version 3.0 for 2013-14); Genomic Counselling (new specialism to commence 2016/2017) and Molecular Pathology (new specialism to commence 2017/2018).

For the Genomics outcome the following amendments have been made to the STP MSc Genetic Sciences Version 3.0 for 2013-14 document:

1. An additional mandatory rotation has been added: Introduction to Clinical Bioinformatics and Genetics (CBI-1) this has been incorporated directly from the STP in Clinical Bioinformatics with no amendment.
2. The content for CG-1 has been revised and updated and is now called Genetics, Genomics and Molecular Science, the changes are minimal providing better clarity for the work based learning outcomes and including some broader genomic content relevant to current practice.

3. The content for the year 2 and year 3 specialist modules has been revised and updated to ensure they are congruent with emerging genomic technologies and clinical practice, and to remove some of the prescriptive nature of many of the learning outcomes and competences. Where possible the content has been future proofed to minimise the need for further revision.

4. The year 2 and 3 specialist modules have been re-ordered to be delivered as four specialist modules, which better reflect the patient pathway.

<table>
<thead>
<tr>
<th>STP MSc Genetic Sciences Version 3.0 for 2013-14</th>
<th>STP MSc Genomic Sciences Version 4.0 for 2016-2017</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Year 2</strong></td>
<td></td>
</tr>
<tr>
<td>Genetics of Learning Disorders [10 credits]</td>
<td>Prenatal Genomics [10 credits]</td>
</tr>
<tr>
<td>Genetics of Neuromuscular Disorders</td>
<td>Paediatric Genomics [10 credits]</td>
</tr>
<tr>
<td><strong>Year 3</strong></td>
<td></td>
</tr>
<tr>
<td>Infertility and Disorders of Sexual Differentiation [10 credits]</td>
<td>Adult Genetic and Genomic Disorders [15 credits]</td>
</tr>
<tr>
<td>Cancer [10 credits]</td>
<td></td>
</tr>
</tbody>
</table>

The new version is called STP MSc Genomic Sciences Version 4.0 for 2016-17.

**Amendments March 2017**

1. For the Genomics specialism the following amendment has been made to the STP MSc Genomic Sciences Version 4.0 for 2016-17: the module CG-1 Principles and Practice of Genetic and Genomic Counselling has been added to the optional rotations in Year 1. The new version is: STP MSc Genomic Sciences Version 4.1 for 2016-17.
Appendix 3: Good Scientific Practice

Good Scientific Practice

Section 1: The purpose of this document
There are three key components to the Healthcare Science workforce in the UK:

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

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

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

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

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

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

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

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

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

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

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

Section 2: The domains of Good Scientific Practice

Domain 1: Professional Practice

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

1.1 Professional Practice

1.1.1 Make the patient your first concern
1.1.2 Exercise your professional duty of care
1.1.3 Work within the agreed scope of practice for lawful, safe and effective Healthcare Science
1.1.4 Keep your professional, scientific, technical knowledge and skills up to date
1.1.5 Engage fully in evidence-based practice
1.1.6 Draw on appropriate skills and knowledge in order to make professional judgements
1.1.7 Work within the limits of your personal competence
1.1.8 Act without delay on concerns raised by patients or carers or if you have good reason to believe that you or a colleague may be putting people at risk
1.1.9 Never discriminate unfairly against patients, carers, or colleagues
1.1.10 Treat each patient as an individual, respect their dignity and confidentiality and uphold the rights, values and autonomy of every service user, including
their role in the diagnostic and therapeutic process and in maintaining health and wellbeing

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

1.2 Probity

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

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

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

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

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

1.3 Working with Colleagues

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

1.3.2 Work effectively as a member of a multidisciplinary team

1.3.3 Consult and take advice from colleagues where appropriate

1.3.4 Be readily accessible when you are on duty

1.3.5 Respect the skills and contributions of your colleagues

1.3.6 Participate in regular reviews of team performance

1.4 Training and Developing Others

1.4.1 Contribute to the education and training of colleagues

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

1.4.3 Ensure that junior colleagues and students are properly supervised

1.4.4 Support colleagues who have difficulties with performance, conduct, or health

1.4.5 Share information with colleagues to protect patient safety

1.4.6 Provide work-based development for colleagues to enhance/improve skills and knowledge
Domain 2: Scientific Practice

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

2.1 Scientific Practice

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

2.2 Technical Practice

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

2.3 Quality

2.3.1 Set, maintain and apply quality standards, control and assurance techniques for interventions across all clinical, scientific and technological activities
2.3.2 Make judgements on the effectiveness of processes and procedures
2.3.3 Participate in quality assurance programmes
2.3.4 Maintain an effective audit trail and work towards continuous improvement
Domain 3: Clinical Practice

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

3.1 Clinical Practice

3.1.1 Ensure that you and the staff you supervise understand the need for and obtain relevant consent before undertaking any investigation, examination, provision of treatment, or involvement of patients and carers in teaching or research

3.1.2 Ensure that you and the staff you supervise maintain confidentiality of patient information and records in line with published guidance

3.1.3 Ensure that you and your staff understand the wider clinical consequences of decisions made on your actions or advice

3.1.4 Demonstrate expertise in the wider clinical situation that applies to patients who present in your discipline

3.1.5 Maintain up-to-date knowledge of the clinical evidence base that underpins the services that you provide and/or supervise and ensure that these services are in line with the best clinical evidence

3.1.6 Plan and determine the range of clinical/scientific investigations or products required to meet diagnostic, therapeutic, rehabilitative, or treatment needs of patients, taking account of the complete clinical picture

3.1.7 Plan and agree investigative strategies and clinical protocols for the optimal diagnosis, monitoring and therapy of patients with a range of disorders

3.1.8 Ensure that detailed clinical assessments are undertaken and recorded using appropriate techniques and equipment, and that the outcomes of these investigations are reviewed regularly with users of the service

3.1.9 Ensure the provision of expert interpretation of complex and/or specialist data across your discipline in the context of clinical questions posed

3.1.10 Undertake and record a detailed clinical assessment using appropriate techniques and equipment

3.1.11 Provide specialised clinical investigation and/or analysis appropriate to your discipline

3.1.12 Provide interpretation of complex and/or specialist data in the context of the clinical question posed

3.1.13 Provide clinical advice based on results obtained, including a diagnostic or therapeutic opinion for further action to be taken by the individual directly responsible for the care of the patient

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

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

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

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

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

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

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

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

Domain 4: Research, Development and Innovation

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

4.1 Research, Development and Innovation

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

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

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

4.1.4 Manage research and development within a governance framework

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

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

4.1.7 Interpret data in the prevailing clinical context

4.1.8 Perform experimental work, produce and present results

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

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

Domain 5: Clinical Leadership

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

5.1.1 Maintain responsibility when delegating healthcare activities and provide support as needed
5.1.2 Respect the skills and contributions of your colleagues
5.1.3 Protect patients from risk or harm presented by another person’s conduct, performance, or health
5.1.4 Treat your colleagues fairly and with respect
5.1.5 Make suitable arrangements to ensure that roles and responsibilities are covered when you are absent, including handover at sufficient level of detail to competent colleagues
5.1.6 Ensure that patients, carers and colleagues understand the role and responsibilities of each member of the team
5.1.7 Ensure that systems are in place through which colleagues can raise concerns and take steps to act on those concerns if justified
5.1.8 Ensure regular reviews of team performance and take steps to develop and strengthen the team
5.1.9 Take steps to remedy any deficiencies in team performance
5.1.10 Refer patients to appropriate health professionals
5.1.11 Identify and take appropriate action to meet the development needs of those for whom you have management, supervision, or training responsibilities
5.1.12 Act as an ambassador for the Healthcare Science community

Good Scientific Practice AHCS V.2 Final
## Appendix 4: Glossary

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical experiential learning</td>
<td>The cyclical process linking concrete experience with abstract conceptualisation through reflection and planning.</td>
</tr>
<tr>
<td>Clinical experiential learning outcomes</td>
<td>The activities that the trainee will undertake to enable and facilitate their learning in the workplace.</td>
</tr>
<tr>
<td>Competence</td>
<td>The ability of an individual to perform a role consistently to required standards, combining knowledge, understanding, skills and behaviour.</td>
</tr>
<tr>
<td>Competence statements</td>
<td>Active and outcome-based statements that provide a further breakdown of the Learning Outcomes – reflecting what the trainee will be able to do in the workplace at the end of the programme. Each competence should be linked back to the numbered Learning Outcomes.</td>
</tr>
<tr>
<td>Component</td>
<td>An indication of the type of module within a learning guide, i.e. rotational, specialist, or elective.</td>
</tr>
<tr>
<td>Curricula</td>
<td>An outline of the expected educational outcomes across a subject area. The learning that is expected to take place during the Scientist Training Programme described in terms of knowledge, skills and attitudes.</td>
</tr>
<tr>
<td>Division</td>
<td>A high-level description of an area of practice within healthcare science. There are three divisions: Life Sciences, Physical Sciences and Biomedical Engineering and Physiological Sciences.</td>
</tr>
<tr>
<td>Domains of learning</td>
<td>Cognitive (knowledge and intellectual skills), affective (feelings and attitudes), interpersonal (behaviour and relationships with others) and psychomotor (physical skills).</td>
</tr>
<tr>
<td>Feedback</td>
<td>Specific information about the comparison between a trainee’s observed performance and a standard, given with the intent of improving the trainee’s performance (van de Ridder JMM, Stokking KM, McGaghie WC and ten Cate OT. What is feedback in clinical education? <em>Medical Education</em> 2008: 42: 189–197).</td>
</tr>
<tr>
<td>Genetics</td>
<td>The study of hereditary</td>
</tr>
<tr>
<td>Genomics</td>
<td>The study of genes and their functions, and related techniques</td>
</tr>
<tr>
<td><strong>Genomic Healthcare</strong></td>
<td>The use of genomic information and technologies at any stage of the healthcare continuum to determine disease risk and predisposition, diagnosis and prognosis, and the selection and prioritisation of therapeutic options. Genomic healthcare also takes into account the potential ethical, psychological and social implications of genomic information and the application of genomic technologies.</td>
</tr>
<tr>
<td><strong>Good Scientific Practice</strong></td>
<td>Non-statutory guidance on the minimum requirements for good practice for the healthcare science workforce.</td>
</tr>
<tr>
<td><strong>Host department</strong></td>
<td>The department that is responsible for the three-year training programme and in which the training officer is based.</td>
</tr>
<tr>
<td><strong>Job</strong></td>
<td>A specific definition of the work activities, requirements and skills required to undertake work activities within a local context. This differs from a role – see below.</td>
</tr>
<tr>
<td><strong>Key learning outcome</strong></td>
<td>A defined learning outcome linked to relevant competence(s) within the workplace Learning Guide.</td>
</tr>
<tr>
<td><strong>Knowledge and understanding</strong></td>
<td>The knowledge and understanding that must be applied in the workplace to achieve the stated competence.</td>
</tr>
<tr>
<td><strong>Learning framework</strong></td>
<td>The specification for work-based learning contained within the Learning Guide.</td>
</tr>
<tr>
<td><strong>Learning module</strong></td>
<td>A distinct set of learning outcomes and competences that form part of a programme. Modules may be rotational, specialist, elective, or professional practice and can be combined to meet the needs of specific programmes.</td>
</tr>
<tr>
<td><strong>Learning outcome</strong></td>
<td>A high-level, outcome-based statement that describes what a trainee will be able to do at the end of the module.</td>
</tr>
<tr>
<td><strong>Mentoring</strong></td>
<td>Mentoring is a process in which a trainer (mentor) is responsible for overseeing the career and development of the trainee. The emphasis is therefore on the relationship (rather than the activity).</td>
</tr>
<tr>
<td><strong>Module aim</strong></td>
<td>The overall objective of a work-based learning module – defining the intended learning achievements of the trainee. The aim works together with the ‘Scope’ statement to define the overall objectives and scope of the module.</td>
</tr>
<tr>
<td><strong>Module scope</strong></td>
<td>A statement within work-based learning modules that defines the range/limits of the learning undertaken by the trainee in a module – patients/investigations/equipment/modalities, etc.</td>
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<tr>
<td><strong>National Occupational Standards</strong></td>
<td>Nationally recognised standards of expected workplace performance and level of competence for a role. The standards are outcome based, defining what the role holder should be able to do, as well as what they must know and understand to demonstrate competent work performance. National Occupational Standards are supported by nationally agreed frameworks of expected attitudes, behaviour and skills.</td>
</tr>
<tr>
<td><strong>Practical skill</strong></td>
<td>A cognitive, psychomotor, physical, or communicative ability that supports performance of the required role.</td>
</tr>
<tr>
<td><strong>Programme</strong></td>
<td>The package of learning, teaching assessment and quality assurance leading to an award.</td>
</tr>
<tr>
<td><strong>Provider</strong></td>
<td>An organisation that delivers required training and learning activities to specified quality assurance requirements.</td>
</tr>
<tr>
<td><strong>Role</strong></td>
<td>A collection of functions undertaken in the workplace that represent the main broad areas of work for all similar workers at national level. A role differs from a job, the latter being defined specifically for a local context.</td>
</tr>
<tr>
<td><strong>Specialism</strong></td>
<td>A focused area of practice within a theme of healthcare science.</td>
</tr>
<tr>
<td><strong>Sporadic cancer</strong></td>
<td>Cancer that occurs in people who do not have a family history of that cancer or an inherited change in their DNA that would increase their risk for that cancer.</td>
</tr>
<tr>
<td><strong>Trainer</strong></td>
<td>A qualified individual who provides learning and development support for trainees.</td>
</tr>
<tr>
<td><strong>Theme</strong></td>
<td>A cluster of related specialisms within a division of healthcare science.</td>
</tr>
<tr>
<td><strong>Work-based learning</strong></td>
<td>Learning that takes place in a real work setting and involves the application of academic learning to real work activities.</td>
</tr>
<tr>
<td><strong>Work performance</strong></td>
<td>The requirements of satisfactory and consistent demonstration of competence in specified functions for a work role.</td>
</tr>
<tr>
<td><strong>Workplace</strong></td>
<td>A real work setting in which the trainee can apply learning.</td>
</tr>
</tbody>
</table>