MSc Drug Discovery Programmes

MSc Drug Discovery and Development
MSc Drug Discovery and Pharma Management

Programme Handbook

2018/19
Disclaimer

Every effort has been made to ensure that the information in this Handbook is correct at the time of going to press (September 2018). UCL reserves the right to make amendments to the information contained in this Handbook as a result of unforeseen events or circumstances beyond UCL's control or if deemed reasonably necessary by UCL.

This handbook is deemed to be the definitive version of information for all students on this taught programme of study.

In the event that amendments are made, UCL shall take reasonable steps to notify students as soon as possible.
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Welcome from the Programme Team

Welcome to the UCL School of Pharmacy and congratulations on gaining a place to study here on the MSc Drug Discovery Pathways. These programmes are designed for graduates in science-based subjects who wish to prepare for PhD-level research or pursue a career in the pharmaceutical industry or a government regulatory body.

There are two programmes offered which share a number of core modules:

- MSc Drug Discovery and Development
- MSc Drug Discovery and Pharma management

The MSc Drug Discovery and Development provides a broad overview of the drug discovery and development process with hands-on experience of molecular modelling and computer-based drug design, analytical and synthetic techniques, and novel aspects of drug discovery science.

The MSc Drug Discovery and Pharma management combines a broad overview of the drug discovery and development process, as above, with a deeper insight into the regulatory and commercial aspects of management in the pharmaceutical industry, entrepreneurship and business development.

Completing an MSc in 12 months is a challenge, particularly for international students who are studying in a foreign language. Moving to a new country, leaving behind family and friends can be overwhelming. Good time management and practising and improving your English will help you cope with the demands of the programme. You must also read this handbook carefully and keep it for reference throughout the year. Your tutors at the School and at the placement site are here to mentor and to support you, so if you have any problems or queries do come and talk to one of us.

We wish you good luck with your studies and look forward to getting to know you over the coming year.

Professor Mike Munday (Director), Dr Rosemary Smyth (Deputy Director)
The Programme Team
MSc Drug Discovery Pathways
1. General Information

1.1 PROGRAMME HANDBOOK

This Programme Handbook provides an introduction to the programme and contains the key information you need about the programme of study. Amongst other things, this handbook covers the curriculum, teaching and learning, administrative procedures, key personnel and assessment.

This handbook should be read in conjunction with the School Student Handbook which provides information about School staff, academic regulations and policies and administrative procedures.

The Handbook is relevant to you throughout your studies. There will inevitably be some changes during your time with us, possibly in relation to the teaching staff, programme content and assessment patterns and we shall keep you informed of any important changes. However, you should make sure that you keep up to date by reading our communications, checking the notice boards, reading your emails and browsing Moodle and the School and UCL Websites.

More detailed information on UCL procedures and policies in relation to students can be found on the UCL website at the following link: www.ucl.ac.uk/current-students. You can also find important information on the Schools Handbook and Policies Moodle page found here: https://moodle-1819.ucl.ac.uk/course/view.php?id=10597 Students are expected to be fully aware of procedures but, if in any doubt, please enquire at the Student and Academic Support Office (known as the School Office – SASO).

We hope you find this handbook useful. It is revised every year to include new information and to make it easier to use. If you have any comments about the handbook or suggestions for improving the information provided, please forward your comments to the School Office (SASO) (email sop.saso@ucl.ac.uk).
1.2 PROGRAMME STAFF

Programme Team
Most academic members of the Pharmaceutical and Biological Chemistry staff contribute to the MSc in Drug Discovery along with external experts from business and industry.

Programme Director
Professor Mike Munday
Room: G12
Tel: 020 7753 5875
Email: michael.munday@ucl.ac.uk

Deputy Programme Manager
Dr Rosemary Smyth
Room: 428
Tel: 020 7753 5950
Email: r.smyth@ucl.ac.uk

Academic Staff

<table>
<thead>
<tr>
<th>Professor Name</th>
<th>Position</th>
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</thead>
<tbody>
<tr>
<td>Professor Mike Munday</td>
<td>Programme Director, Professor of Pharmaceutical Biochemistry</td>
</tr>
<tr>
<td>Dr Rosemary Smyth</td>
<td>Deputy Programme Director</td>
</tr>
<tr>
<td>Dr Maria Jose Martinez-Bravo</td>
<td>Academic Teaching Fellow</td>
</tr>
<tr>
<td>Professor Frank Kozielski</td>
<td>Professor Chemical Biology, Head of Dept Biol Pharm Chem</td>
</tr>
<tr>
<td>Professor Nigel Ratcliffe</td>
<td>Visiting Professor, CEO Medolago, ex-VP Reg. Affairs, AstraZeneca</td>
</tr>
<tr>
<td>Professor Klara Valko</td>
<td>Visiting Professor, CEO Biomimetics, ex-GSK</td>
</tr>
<tr>
<td>Professor Mire Zloh</td>
<td>Visiting Professor of Chemistry</td>
</tr>
<tr>
<td>Dr Gergely Toth</td>
<td>CEO, Garderam Therapeutics, Visiting Lecturer</td>
</tr>
<tr>
<td>Professor Matt Todd</td>
<td>Professor of Drug Discovery</td>
</tr>
<tr>
<td>Dr Phil Holt</td>
<td>Visiting Lecturer, ex-Global Prod Director, AstraZeneca</td>
</tr>
<tr>
<td>Dr Andy Wilderspin</td>
<td>Senior Lecturer in Pharmaceutical Biochemistry</td>
</tr>
<tr>
<td>Dr Gary Parkinson</td>
<td>Senior Lecturer in Structural Biology &amp; Chemistry</td>
</tr>
<tr>
<td>Dr Geoff Wells</td>
<td>Senior Lecturer in Medicinal Chemistry</td>
</tr>
<tr>
<td>Professor Paul Fish</td>
<td>Professor of Medicinal Chemistry</td>
</tr>
<tr>
<td>Ms Usha Back</td>
<td>Senior Pharma and FinTech Consultant, Findia Partners</td>
</tr>
<tr>
<td>Dr Robin Williams</td>
<td>Clinical Director, CRUK</td>
</tr>
<tr>
<td>Dr Shozeb Haider</td>
<td>Senior Lecturer in Structure Based Drug Design</td>
</tr>
<tr>
<td>Professor Duncan Craig</td>
<td>Professor of Drug Delivery, Director UCL School of Pharmacy</td>
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<tr>
<td>Dr Colin James</td>
<td>Molecular Modelling</td>
</tr>
<tr>
<td>Dr Mike Brownleader</td>
<td>CEO Protein Ark, Visiting Lecturer</td>
</tr>
<tr>
<td>Dr Steve Hilton</td>
<td>Senior Lecturer in Chemistry</td>
</tr>
<tr>
<td>Dr Sab Takhar</td>
<td>Visiting Lecturer, Clinical Director, Roche</td>
</tr>
<tr>
<td>Dr Paul Stapleton</td>
<td>Academic Teaching Fellow</td>
</tr>
<tr>
<td>Dr Richard Angell</td>
<td>Leader Drug Discovery Research</td>
</tr>
<tr>
<td>Dr Khalid Sheikh</td>
<td>Lecturer in Quality Control and Clinical Trials</td>
</tr>
<tr>
<td>Dr Pervaise Khan</td>
<td>Managing Director, Accenture Life Science Strategy</td>
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</tbody>
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1.3 PROGRAMME ADMINISTRATION

The School Office (SASO) is the main administrative hub for your programme of study and is located in Room G11, Brunswick Square.

**Opening Hours and Contact Information**

<table>
<thead>
<tr>
<th>Hours</th>
<th>09.00 to 17.00 (Monday-Friday)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>Room G11, Brunswick Square</td>
</tr>
<tr>
<td>Tel/Fax</td>
<td>+44 (0) 20 7753 5831</td>
</tr>
<tr>
<td>Fax</td>
<td>+44 (0) 20 7753 5829</td>
</tr>
<tr>
<td>E-mail</td>
<td><a href="mailto:sop.saso@ucl.ac.uk">sop.saso@ucl.ac.uk</a></td>
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</tbody>
</table>

You may also need to visit the UCL Student Centre on some occasions and further information can be found here: [www.ucl.ac.uk/current-students/student-centre](http://www.ucl.ac.uk/current-students/student-centre)

**Academic and Welfare support**

Rosemary provides general support on academic and welfare matters for students on the full-time postgraduate programmes at the School (MSc and MRes).

Dr Rosemary Smyth

Room: 428

Tel: 020 7753 5950

Email: r.smyth@ucl.ac.uk

END OF SECTION 1
2. Programme Information

2.1 PROGRAMME DETAILS

Awards: MSc Drug Discovery and Development
MSc Drug Discovery and Pharma Management

Awarded by: University College London

Department: Pharmaceutical and Biological Chemistry

Length and Mode: 1 year full-time

Credits: 180 credits at Level 7

ECTS: 72 ECTS

Programme Director: Professor Mike Munday

Deputy Programme Director Dr Rosemary Smyth

Teaching site
UCL School of Pharmacy
29/39 Brunswick Square
London WC1N 1AX
UK
Tel: 020 7753 5800
Fax: 020 7753 5829

2.2 THE MSc DRUG DISCOVERY PROGRAMMES

MSc Drug Discovery and Development

The MSc in Drug Discovery and Development is a 12 month full-time taught postgraduate programme intended for those who wish to prepare for PhD-level research or pursue a career in the pharmaceutical industry or a government regulatory body.

Programme Structure
The MSc is designed to allow participants to gain a broad overview of drug discovery and development. The programme outlines the molecular basis of disease and the identification and validation of drug targets. It investigates the various approaches to the identification of
lead compounds and their development into active drug candidates. The degree programme exposes students to modern platforms for drug discovery and methods of drug synthesis and includes lectures from industry-based scientists and visits to industrial and biotechnological research laboratories. Students gain hands-on experience of molecular modeling and computer-based drug design, and analytical and synthetic techniques. The approach of the pharmaceutical industry to pre-clinical development, clinical pharmacology, clinical trials, and regulatory affairs form an integral part of the drug development process that is studied. Students gain an in-depth knowledge of individual examples of drug development throughout and specialize in selected scientific areas in the second part of the programme by choosing two specialised modules in drug discovery science:

- **PHAY0015** New Drug Targets in the Central Nervous System
- **PHAY0017** Anticancer Personalised Medicines
- **PHAY0019** Pharmacogenomics, adverse drug reactions and biomarkers
- **PHAY0022** Advanced Structure-Based Drug Design.

The programme culminates with a laboratory research project chosen in an area of drug discovery and development. This can be carried out in the UCL School of Pharmacy or as an external placement in industry, another university laboratory, hospital, research institute etc.

**MSc Drug Discovery and Pharma Management**

The MSc in Drug Discovery and Pharma Management is a 12 month full-time taught postgraduate programme intended for graduates in science-based subjects who wish to pursue a career in the pharmaceutical or biotechnology industry with a management or business development role. This degree programme combines a broad overview of the drug discovery and development process with a deeper insight into the regulatory and commercial aspects of management in the pharmaceutical industry.

The model for drug discovery in the pharmaceutical industry is changing. “Me too” products, may no longer be commercially viable and pricing of new products and market access is becoming more difficult. Today major companies look for innovation and service provision from smaller companies outside their own laboratories. In this environment research scientists can be involved in evaluating the business potential of their science as well as generating the science itself. There are real opportunities for business development and scientific enterprise.

This programme contains the science core of the MSc in Drug Discovery to ensure that students fully understand the process of drug discovery and development. Throughout this core, certain aspects of learning are tailored towards understanding the structure of the industry and the challenges it faces. In the second semester a further core module addresses advanced concepts in relevant Business Management. The MSc programme is led by Professor Mike Munday (UCL School of Pharmacy), Professor Nigel Ratcliffe (visiting Professor and former Vice President Regulatory and Commercial Affairs, Astrazeneca) and Dr Phil Holt (visiting lecturer and former Global Product Director, Astrazeneca).
**Programme Structure**

The programme outlines the molecular basis of disease and the identification and validation of drug targets. It investigates the various approaches to the identification of lead compounds and their development into active drug candidates. The degree programme exposes students to modern platforms for drug discovery and methods of drug synthesis and includes lectures from industry-based scientists and visits to industrial and biotechnological research laboratories. Students gain hands-on experience of molecular modeling and computer-based drug design, and analytical and synthetic techniques. The approach of the pharmaceutical industry to pre-clinical development, clinical pharmacology, clinical trials, and regulatory affairs form an integral part of the drug development process that is studied.


The programme culminates in a pharma management or business development project that is relevant to the field of drug discovery and development. This project will be supervised internally by a UCL academic but will hopefully be externally advised by an industrialist or business manager or relevant external professional. The project and can be carried out in the UCL School of Pharmacy or as an extramural placement in industry.

### 2.3 MASTER’S LEVEL DESCRIPTORS

Master’s level awards are set at Level 7 of the Framework for Higher Education Qualifications in England, Wales and Northern Ireland (FHEQ) published by the Quality Assurance Agency for Higher Education (QAA). Descriptors for the Level 7 qualification are in two parts – (1) what each student must demonstrate in order to gain the award, and (2) the wider abilities that the typical student is expected to develop.

**The MSc degree is awarded to students who have demonstrated:**

1. Systematic understanding of knowledge and skills required in the application of pharmaceutical care.
2. Critical awareness of current problems and/or new insights in pharmacy practice.
3. Comprehensive understanding of techniques applied to advanced scholarship in pharmaceutics, which include problem solving skills, evaluation, research methods and data analysis.
4. 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 pharmaceutics.
5. Conceptual understanding that enables the student to:
   • Evaluate critically current research and advanced scholarship in the discipline, and
   • Evaluate methodologies and develop critiques of them and, where appropriate, to propose new hypotheses.

**Typically, holders of the MSc degree will be able to:**

1. Deal with complex issues both systemically and creatively, make sound judgments in the absence of complete data, and communicate their conclusions clearly to specialist and non-specialist audiences;
2. Demonstrate self-direction and originality in tackling and solving problems, and act autonomously in planning and implementing tasks at a professional or equivalent level;
3. Continue to advance their knowledge and understanding through continuing professional development, and
4. Develop new skills to an advanced level in pharmaceutics.

**and will have:**

5. The qualities and transferable skills necessary for employment requiring:
   • The exercise of initiative and personal responsibility; decision-making in complex and unpredictable situations, and
   • The independent learning ability required for continuing professional development.

### 2.4 LEARNING AND TEACHING METHODS

Teaching methods are varied and include lectures, seminars, small group work, workshops, self-directed learning and research into case studies, practical classes, oral and poster presentations, data handling, dragons’ den presentations and individual research project work. Class size varies from 8 - 100 students depending on the teaching format and the module studied. A few lectures and seminars are shared with the MRes Drug Sciences when the material is relevant to these students also.

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**END OF SECTION 2**
3. Modules

3.1 MODULE CHOICE

The list of taught modules may change from year to year to reflect changes in the research areas of the staff and to ensure that the syllabus covers the latest research developments in the pharmaceutical sciences. Every effort is made to inform students of any changes before the programme starts.

Within the first two weeks of term 1 you must log onto the PORTICO Student Database in order to enrol for your modules. PORTICO can be found at the following link: https://evision.ucl.ac.uk/urd/sits.urd/run/siw_lgn

MSc Drug Discovery and Development

Students take 3 core modules and 2 optional modules (total of 120 credits)

Term 1 – Students take 2 core modules (total of 60 credits):

<table>
<thead>
<tr>
<th>Module Code</th>
<th>Module Title</th>
<th>Credits</th>
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<tr>
<td>PHAY0020</td>
<td>The Process of Drug Discovery (TPODD 1)</td>
<td>30</td>
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<tr>
<td>PHAY0029</td>
<td>Modern Aspects of Drug Discovery</td>
<td>30</td>
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</table>

Term 2 – Students take 1 core module and choose 2 out of 4 optional modules (total of 60 credits):

Core module:

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<tr>
<td>PHAY0021</td>
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Optional modules:

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<td>PHAY0015</td>
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<td>15</td>
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<tr>
<td>PHAY0017</td>
<td>Anticancer Personalised Medicines</td>
<td>15</td>
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<tr>
<td>PHAY0019</td>
<td>Pharmacogenomics, adverse drug reactions &amp; biomarkers</td>
<td>15</td>
</tr>
<tr>
<td>PHAY0022</td>
<td>Advanced Structure-Based Drug Design</td>
<td>15</td>
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</table>

Term 3 – Students take the core research module:

<table>
<thead>
<tr>
<th>Module Code</th>
<th>Module Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHAY0055</td>
<td>Dissertation - MSc Drug Discovery</td>
<td>60</td>
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</tbody>
</table>
**MSc Drug Discovery and Pharma Management**

Students take 4 core modules (total of 120 credits)

**Term 1 – Students take 2 core modules (total of 60 credits):**

- **PHAY0020** The Process of Drug Discovery (TPODD 1) 30 credits
- **PHAY0029** Modern Aspects of Drug Discovery 30 credits

**Term 2 – Students take 2 core modules (total of 60 credits):**

- **PHAY0021** The Process of Drug Development (TPODD 2) 30 credits
- **PHAY0023** Pharma Management 30 credits

**Term 3 – Students take the core research module:**

- **PHAY0055** Dissertation - MSc Drug Discovery 60 credits

### 3.2 MODULE OUTLINES

This handbook contains brief outlines of the modules that are available for the MSc Drug Discovery pathways. You will receive more detailed Module Outlines at the start of the module and the content may be slightly different to the information published here. This is because staff are constantly updating their teaching in light of developments in current research and new thinking.

The modules are listed in Module Code order by type:

(i) Core Modules

- **PHAY0020** The Process of Drug Discovery (TPODD 1) 30 credits
- **PHAY0021** The Process of Drug Development (TPODD 2) 30 credits
- **PHAY0023** Pharma Management 30 credits
- **PHAY0029** Modern Aspects of Drug Discovery 30 credits

(ii) Optional Modules (MSc Drug Discovery and Development only)

- **PHAY0015** New Drug Targets in the CNS 15 credits
- **PHAY0017** Anticancer Personalised Medicines 15 credits
- **PHAY0019** Pharmacogenomics, adverse drug reactions & biomarkers 15 credits
- **PHAY0022** Advanced Structure-Based Drug Design 15 credits
(i) Core Modules

PHAY0020  THE PROCESS OF DRUG DISCOVERY (TPODD1) – 30 credits

Module Leader: Professor Mike Munday

This module is core to both MSc programmes and follows the process of drug discovery. It runs throughout the first term (although occasional seminar speakers and concepts in the TPODD2 module in term 2 may still be relevant to this module). TPODD1 introduces the basis of drug discovery and the pharmaceutical industry through examining previous successes and current methods. The module includes:

Introduction to the molecular basis of disease, identification and validation of drug targets (Professor M Munday)
The molecular basis of disease is considered with examples of infection, genetic and multifactorial clinical conditions and the mechanism of action of certain drugs in their therapy. There is a detailed revision of basic macromolecular structure and the types of cellular components that constitute drug targets. This section examines the identification of drug targets and the genomic approaches to the validation of drug targets.

Drug Discovery and Lead Identification
(Prof M Munday; Prof P Fish; Dr G Wells; Dr R Angell; Prof M Todd)
The identification of drugs for human use has a long and fascinating history with its origins in witchcraft and magic through to the present time where techniques such as computer modeling, combinatorial synthesis and high-throughput screening are used. This section begins with a discussion of how ancient civilizations utilized a combination of witchcraft, magic and materials extracted from plants, animal and humans to attempt (usually unsuccessfully) to cure diseases. A number of natural products with genuine therapeutic activity such as salacin from willow bark (as an anti-inflammatory) and digitalis were discovered in this period and will be described in more detail. Discussions will then move to a later period where chemical techniques, although in their infancy, were used to isolate and structurally elucidate well-known natural products such as the major plant alkaloids. Discussion will then move to more modern times describing how modern drug leads are identified by a number of different techniques including combinations of molecular modelling, combinatorial libraries and high-throughput screening. The delivery of this module is supplemented by keynote lectures from academic and industrial experts with personal examples of drug discovery successes.

Advances in synthetic chemistry
(Prof P Fish; Dr R Angell; Dr G Wells; Prof F Kozieiski; Prof M Todd; Dr S Hilton)
Key themes of the application of modern synthetic methods in medicinal chemistry and drug discovery are covered in this section. Chemical-synthetic techniques that are utilized in the preparation of compounds for use in the chemical genetic approach will be discussed; importance will be given to the generation of novel natural product-like or -derived compound libraries. Topics include reaction mechanisms and asymmetric synthesis, retrosynthesis, combinatorial chemistry, pericyclic and multicomponent reactions, solid phase and microwave chemistry, and chemistry in flow. Fragment based drug discovery will be explored in detail.
High Throughput Screening of Compound and Natural product Libraries
(Dr A Wilderspin; Professor M Munday)
This section examines the types, molecular basis and technical procedures of biochemical and cell-based bioassays. Understanding the automation of the HTS process and the importance of bioinformatics and data processing in identification of lead compounds is an important component.

Molecular Modelling and Structure Based Design
(Dr G Parkinson; Dr C James; Dr S Haider; Prof M Zloh)
This section is designed to introduce the student to the principles and practice of modern drug discovery. The course will provide an awareness of rational drug design, based on understanding the three-dimensional structures and physicochemical properties of drugs and receptors. There is considerable “hands on” experience of computational chemistry and computer-based molecular modelling. This section will cover modelling drug/receptor interactions with the emphasis on molecular mechanisms, molecular dynamics simulations and homology modelling. Other topics will be selected from: conformational sampling, macromolecular folding, structural bioinformatics, receptor-based and ligand-based design and docking methods, in silico screening of libraries, semi-empirical and ab-initio methods, QSAR methods, molecular diversity, design of combinatorial libraries of drug-like molecules, macromolecular and chemical databases.

PHAY0021 THE PROCESS OF DRUG DEVELOPMENT (TPODD2) – 30 credits

Module leader: Dr Rosemary Smyth
This module is core to both MSc programmes and follows the process of drug development. It runs throughout the second term and builds upon concepts from term 1 as we progress along the drug discovery pipeline. The module includes:

Physicochemical Properties of Drugs (Absorption, Distribution Metabolism)
(Prof Klara Valko, GSK)
This section provides understanding of the physicochemical properties of molecules that can be used for compound selection at the early discovery stage. Students will study the traditional and newer high throughput methods for the determination of lipophilicity, solubility and pKa values and get an insight of the in silico calculations of these properties using software packages. Students will gain an understanding of how physicochemical properties influence cell permeability, oral absorption, protein binding, and blood/brain barrier distributions by discussion of various predictive models published in the literature. Course content includes: Discussion and practical demonstrations of methods for lipophilicity determination (octanol/water partition, chromatographic hydrophobicity index, micellar electrokinetic chromatography). Discussion and demonstration of methods for solubility determinations and their automation. Practical determinations of pKa values. Commercially available instruments with various levels of automation.

**Preclinical Development**
(Dr G Meneses-Lorente, Roche; Prof M Munday; Dr R Smyth; Prof F Kozielski)
This section covers phase 1 and phase 2 drug metabolism and factors that affect these processes. This includes chemical modification and the use of prodrugs to protect from metabolism. The industrial approach to Clinical Pharmacology is covered by Dr G Meneses-Lorente (Roche). The use of preclinical toxicology studies which are necessary before the drug can be administered to humans will be discussed in detail.

**Clinical Development**
(Dr R Williams & Dr S Nabarro & Dr P Jones, CRUK; Dr S Takhar, Roche; Dr K Sheikh)
The choice, preparation for and execution of the four phases of clinical trials are investigated. External experts from Roche, CRUK and NHS discuss a variety of issues and expertise.

**Regulatory Affairs, Commercial Affairs and Intellectual Property**
(Prof Nigel Ratcliffe, ex-Vice President Regulatory Affairs, AstraZeneca, Dr Daniel O’Connor MHRA, Dr Ana Hidalgo, EMA)
Discovering lead compounds and then developing them towards a marketable product are only the first two components of a very complex and expensive process. Once a lead compound has been suitably developed it then has to be tested extensively in animals before going into the first human clinical trials. If it successfully completes these trials, then the company has to apply for a license to market the product from the appropriate Government agency e.g. FDA in the USA, MHRA (Medicines and Healthcare products Regulatory Agency) in the UK and EMA (Europe). Before granting a license, these agencies will require extensive evidence that the product is efficacious and safe i.e. has a positive risk/benefit ratio. Even after a product license (e.g. a Marketing Authorization in the UK) is granted, the Government agencies of all countries in the developed world operate a Post Marketing Surveillance system supported by many different types of health workers, including doctors, pharmacists and nurses who report any adverse drug effects. If it becomes evident that in the larger general population the risk/benefit ratio is larger than anticipated, then the MA can be withdrawn.

It is crucial that Intellectual Property (known as IP) surrounding novel drug products are protected by processes such as filing patents and registering trademarks. Once protection is in place, a company that may have spent many millions discovering and developing a product
can then freely market it for approximately 20 years in the countries in which it is protected without fear of other manufacturers marketing a similar or generic product. Once patent protection has lapsed, then other companies are free to market generic versions of the products. This section will describe in detail all aspects of the IP protection process. It will discuss the recent trends for large pharmaceutical companies to merge into large international conglomerates, and for the formation of numerous small start-up biotechnology companies often based around academic programmes of research. These changes have transformed the pharmaceutical industry in the last 10 years with a trend towards new lead molecules being discovered, predominantly by smaller companies which then license their IP to the larger merged pharmaceutical companies. Many of the latter focus more on lead development, clinical trials and marketing than lead discovery.

**PHAY0023 PHARMA MANAGEMENT (30 credits)**
*Module Leader: Dr Phil Holt*
*Staff: Prof Nigel Ratcliffe, Ms Usha Back, Dr Gergely Toth, Dr Pervaise Khan, Dr Peter Willis*

This module covers the following key areas:

**The team approach to Research and Clinical Development.**
The module will discuss the important input from: Clinical Development, Intellectual property, Commercial Teams. Portfolio management. Business management.

**Global Regulatory Affairs**
Regulatory Objectives, Regulatory Agencies, Global Regulatory Package.

**Commercialising a product**
What is the market? How do you design a product for a market? How do you launch your product?

**How a Pharmaceutical Company is Structured**

**Product and Science Due Diligence.**
Where DD fits in the process. What the initial assessments will have told you and what the difference is here between early evaluation and Due Diligence
What the team looks like. What e rooms are, what paper rooms are like.
How a team is formed, who sits on the team and why? Where a bench scientist may sit, what they will be doing? What is the meeting like, who does what? What are you looking for, what interactions do you have with their scientists
Who rights the report, who takes notes? What's the legal standing of the reports? What do you do with the report? The kind of issues you find, what are the problems? What to look for. What to consider as an employee in Discovery? One day someone may undertake DD on your work

Clinical Development
Strategic Clinical Development and Medical affairs. Study types, Phase 1 2 and 3. The requirements pre toxicology for commencement of each phase. Multi-disciplinary teams. The role the scientist may play in metabolite identification, sample analysis etc.
Centre selection, Advisory board, Safety Board and Regulatory clearance. Ethics boards. Use of contract organisations. Data interpretation, audits

Introduction to Financial Evaluation of Science and Product Evaluation
The Financial Director in a Strategic Partnering and Business Development Team, what role do they play? A financial business case. What do you look for, what parameters do you study, what are the terms and what do they mean. What information do you need for a business case? Who do you need to influence?
What measures would make a business case approvable, i.e. what are the acceptable limits for a pre-clinical, phase 1, phase 2 opportunity etc.? Venture capital, what does this mean? How does it work? Basic Financial parameters.

Pharma Strategic marketing.
International marketing. Customer relations. Risk management.

Entrepreneurship and the challenges of setting up a company
Small and medium enterprises. Spin out and commercialising research. Biotech industry.
Raising Funds.

PHAY0029 Modern Aspects of Drug Discovery (30 credits)
Module Leader(s): Professor Mike Munday

This module introduces an overview of the pipeline of drug discovery and explores some themes that cover specific examples of drug discovery stories, techniques used in the analysis of drugs and their targets and the structure of the industry responsible for this process and the challenges that it faces.

The module is divided into three themes: ‘Drug Discovery Case Studies’ describes the discovery of beta blockers and GPCR drugs and targets (Professor Munday); inhibitors of protein-protein interactions (Dr Wells); enzymes as drug targets (Dr Wilderspin); antibiotics and the search for new antibiotic medicines (Dr Stapleton).

The theme ‘Techniques in Drug Discovery’ explains the use of HPLC (Prof Valko, GSK), electrophoresis and mass spectrometry (Dr Smyth), NMR in the investigation of drug molecules (Prof Zloh) and the use of X-ray crystallography (Dr Parkinson), immunochemistry (Dr Martinez-Bravo) and the state of the art modern technology used in the investigation of drugs and drug targets.
The theme ‘Pharmaceutical Industry and New Technologies’ describes the structure of large pharma and the small and medium enterprises involved (Dr Holt, ex-Astrazeneca); the challenges faced by the pharma industry (Prof Ratcliffe, ex-Astrazeneca); the opportunity for biotechnology and business development (Dr Gergely Toth, Garderam Therapeutics); pharma funding (Usha Back, Findia Partners) the rise in biopharmaceuticals (eg. hormones, cytokines, monoclonal antibodies and vaccines) and biosimilars that form a major part of new therapeutic technology (Prof Munday/Dr Wilderspin/Dr Martinez-Bravo). This section of the module draws heavily upon the experience of external teachers who are professionals in the pharma industry.
(ii) Optional Modules

PHAY0015   NEW DRUG TARGETS IN THE CNS (15 credits)

Module Leader: Dr Ahad Rahim

Diseases of the CNS are notoriously difficult to treat and have been a minefield of disasters in the pharma industry for a number of years. However, this is still an immensely important area made more so by an ageing population. There is new hope and new initiatives as advances in neuroscience are made.

This module addresses the molecular basis of selected neurological conditions, the animal and cellular models that are used to investigate these conditions, novel therapies such as CNS tissue engineering and gene therapy and the drug targets that have been/are being used in the development of lead compounds and drug molecules.

Neurotransmitter receptor proteins are a major target for drug action within the central nervous system (CNS). CNS drug discovery programmes have been revolutionized during the last ten years with the realization that rather than a single neurotransmitter receptor existing per neurotransmitter, multiple highly homologous neurotransmitter receptor subtypes exist for each inhibitory and excitatory neurotransmitter. Therefore, the challenge is to develop receptor subtype-selective therapeutic compounds with the hope that this new generation of drugs will have unique and selective therapeutic properties while reducing unwanted adverse effects.

PHAY0017   ANTICANCER PERSONALISED MEDICINES (15 credits)

Module Leader: Dr Geoff Wells

Cancer represents a collection of over 200 distinct diseases and is second only to heart disease as the cause of premature death in the Western world. Cancer is treated by surgery whenever possible, but there is often follow-up treatment with radiotherapy or chemotherapy, and the latter are sometimes used without surgery, either singly or in combination. Although there are a large number of cancer chemotherapeutic agents in current use, many of these cause unpleasant side effects and there is a need to develop novel agents with higher selectivity and less toxicity. This module begins with an overview of the various different classes of anticancer agents, focusing on their strengths and weaknesses. It will then discuss the various new approaches to cancer chemotherapy still in development that seek to reduce toxicity by enhancing selectivity. Examples will include the kinase inhibitors, anti-angiogenics, gene-targeting approaches and antibody targeted strategies such as ADEPT. The module will provide a background to the emerging role of personalized medicine and patient stratification in cancer therapy. Aspects of tumour diversity and heterogeneity, personalized medicines and preventative therapies will be investigated. The module will be enhanced by guest lectures from practising oncologists, medics and experts in anticancer drug development from the pharmaceutical industry.
This module will begin with an introduction to biomarkers and their importance. The different types of biomarkers will be discussed in detail with relevant examples. This will include the use of surrogate endpoints in clinical trials, the use of prognostic, pharmacodynamics and pharmacogenomics biomarkers in drug development. The module will then explore the concept of biomarker research and identification of new biomarkers. Some of the technologies used for biomarker identification will be covered such as the use of proteomics and metabolomics along with some current imaging techniques. The qualification and validation by the regulatory authorities of novel biomarkers for use in preclinical and clinical studies will be examined. Examples will be provided of current biomarkers for disease and toxicity. The translation of biomarkers from laboratory to the bedside will be explored.

The second part of this module addresses the individual responses of patients to drugs as a result of genomic variations called polymorphisms in the form of SNPs, microsatellite repeats and copy number variations (CNVs) in genes coding for drug metabolizing enzymes, drug transporters and drug targets. This is the basis of pharmacogenomics and explains not only variability in patient response but also many of the adverse drug reactions that occur. Examples of Adverse Drug Reactions are used to illustrate their relationship with these genome polymorphisms and the interactions between drugs and drugs and environmental factors. The increasing importance of genetic screening and the development of personalized medicines are key outcomes of pharmacogenomics and these rely on the development of companion diagnostics. The importance of diagnostics and biomarkers to personalised medicines will be considered.

The module will focus on the current methods in the computer aided drug design. Advanced modelling of drug/receptor interactions will be covered in detail, including predicting protein structure, homology modelling and molecular docking. Other topics will be selected from: conformational sampling, fragment based drug design, receptor-based de novo design and ligand-based drug design. This module uses the medium of considerable hands-on experience of advanced techniques and software in computer-aided modelling. Students will gain a more complete understanding of the drug design process.
4. Research Project

4.1 PHAY0055 DISSERTATION - MSc DRUG DISCOVERY PATHWAYS

A major component of the MSc programme is the research project.

Students in the MSc Drug Discovery and Development programme are expected to pursue a scientific research project that could be laboratory-based or achieved through computer modelling/database interrogation. Students will have a choice of projects and every attempt will be made to accommodate their preferences to work in specific drug discovery areas (for example: chemical synthesis, biochemistry and drug targets, pharmaceutical analysis of drug properties, pharmacology, natural product etc). Projects can be carried out in laboratories at the School of Pharmacy, with other academics within UCL, in industry with our industrial partners, in other universities and institutions in the UK or possible even abroad. Assessment of the project by dissertation and oral presentation is carried out by academics in the teaching team.

Students in the MSc Drug Discovery and Pharma Management programme are expected to pursue a research project that could be an investigation of management aspects of the pharma industry, or could be the development of a business case for bringing science or a product to market, or could be a comparison of regulatory requirements or business development between different countries, or could be an investigation/audit of processes within a small or medium sized pharma or biotech company.

Students are encouraged to develop their own ideas and strategies in discussion with their supervisors and wherever possible the project will be linked to an existing pharma or biotech company.

Assessment of the project by dissertation and oral presentation is carried out by academics in the teaching team.

END OF SECTION 4
5. Assessment and Regulations

5.1 PROGRAMME REGULATIONS

The full Programme Regulations for the MSc can be found on the UCL website at the link below and Scheme of Award https://moodle-1819.ucl.ac.uk/course/view.php?id=10597. Students must also read the information contained in the School Student Handbook. We have included a brief summary of the main regulations in this handbook; however students must read the regulations in full. https://www.ucl.ac.uk/srs/academic-regulations

Coursework
Students must complete a number of formative and summative assignments. Formative assignments give feedback to students on their performance but do not count towards final marks (however, it may still be a requirement to complete these). Marks for summative assignments do count towards the final mark for each module. The minimum pass mark is 50%.

Examinations
Students will normally take written examinations for PHAY0029 in January and written examinations for the other modules in April-June. Resit examinations are normally held in the last week of August or the first week of September and will be of the same format and duration as term 1 and 2 examinations. The minimum pass mark for examinations is 50%.

Overall module marks
Your overall mark for each module will be made up of your coursework and exam marks. All modules are assessed by 33% coursework and 67% examination. (see Scheme of Award for details of weightings).

Requirements to Pass a Module
To pass a module at level 7 you must achieve a weighted mean of at least 50%. The module mark is determined from the weighted mean of all components. See Scheme of Award https://moodle-1819.ucl.ac.uk/course/view.php?id=10597.

Attempts
The regulations permit students a first attempt at each assessment component and one second attempt only. No further opportunities are permitted. Students cannot re-sit modules...
which they have passed. Modules passed at resit are capped at the pass mark (50%) regardless of the individual component mark.

There is a maximum number of resits students are permitted to take in the late summer assessment period please see here: https://www.ucl.ac.uk/academic-manual/chapters/chapter-4-assessment-framework-taught-programmes/section-11-consequences-failure

**Award Requirements**

Please refer to the Taught Postgraduate Progression and Award Requirements in the Academic Regulations Manual in Chapter 4 Section 4.6 in particular the Masters Award Criteria http://www.ucl.ac.uk/srs/academic-manual/c4/progression-award/postgraduate#top

**Condoning**

Condonement allows a student to be awarded a qualification where they are carrying a small amount of failure, as long as their overall performance is of a good standard and the requirements of any relevant Professional, Statutory or Regulatory Bodies are met. Students who meet the Condonement Criteria will not be reassessed

On a Master’s programme 30 taught credits can be condoned if the failure falls within the condonable range 40% to 49%

Please refer to the Academic Manual, Chapter 4. http://www.ucl.ac.uk/srs/academic-manual/c4/progression-award/postgraduate#top

**Final Degree Mark**

In order to be awarded a Taught or Research Masters a student should pass all modules

A student who does not Pass all modules must nonetheless be considered to have met the Award Requirements if they meet all of the Condonement Criteria.

A student who meets the Award Requirements for a programme of study should be awarded a Pass, Merit or Distinction Classification

Please refer to the Taught Postgraduate Academic Regulations Classification for Masters-level Criteria, Chapter 4 Section http://www.ucl.ac.uk/srs/academic-manual/c4/classification/principles

The overall pass mark for the award of the MSc is 50%. The final degree mark is calculated on the average module marks weighted according to the number of credits they carry. The Master’s degree is worth 180 credits in total so a 30 credit module would contribute 30/180 to the final mark.

**Criteria for the Award of Pass, Merit and Distinction**

Please refer to the Taught Postgraduate Progression and Award Requirements in the Academic Regulations Manual in Chapter 4 Section 4.6 in particular the Masters Award Criteria http://www.ucl.ac.uk/srs/academic-manual/c4/progression-award/postgraduate#top

**Scheme of Award**

The Scheme of Award sets out the individual assessment components and their relative weighting. Students will be subject to the scheme of award in effect at the time they start the programme. The MSc is worth 180 credits. This is comprised of 120 credits of taught modules and a 60 credit dissertation. Schemes of award can be found on the Moodle page here https://moodle-1819.ucl.ac.uk/course/view.php?id=10597
5.2 ASSESSMENT STRUCTURE

All modules are assessed by coursework and an examination at the end of the module. The contribution of exam and coursework marks to final overall module mark will be exams = 67% and coursework = 33%

PHAY0029 MODERN ASPECTS OF DRUG DISCOVERY:

Exam: (3 questions from 6 in 3hr) 1 question from each of 3 themes.

Coursework: A case study, one worksheet per week for first 4 weeks. Open book report to be written in week 5. (Professor Munday) (50% marks). A data handling exercise. (Professor Munday) (50% marks).

PHAY0020 THE PROCESS OF DRUG DISCOVERY (TPODD 1)

Exam: (2 from 4 questions in 2hr)

Coursework: MCQ test on basic organic chemistry (Dr Smyth) (20% marks) Chemical Calculations test (Dr Smyth) (20% marks) Molecular Modelling case (Dr James) (10% marks) Laboratory write up of practical classes (Dr Smyth) - formative assessment in preparation for mini-project write-up. Mini-project poster presentation (Dr Smyth) (50% marks) students working in pairs will produce a scientific poster from data collected during the mini-project carried out in laboratory classes.

PHAY0021 THE PROCESS OF DRUG DEVELOPMENT (TPODD2)

Exam: (2 from 4 questions in 2hr)

Coursework: Business case or scientific paper based on data from the mini-project carried out in TPODD1. (Dr Smyth) (50% marks). Dragons Den Project to decide on future science/business strategies for company X. This project is carried out in teams of 4-5. (Dr Smyth, Dr Martinez-Bravo) (50% marks)
PHAYG0023  PHARMA MANAGEMENT

Exam: (2 from 4 questions in 2hr)

Coursework:
- Report on background and interpretation of business case (Dr P Holt) (50% marks).
- Round table discussion and presentation of business strategies for a Company case study (Dr P Holt, Ms Usha Back)

PHAY0015,0017,0019,0029 OPTIONAL SCIENCE MODULES (2 per student)

Exam: (1 from 2 questions in each module in 1hr. Therefore, 2 questions in 2hr).

Coursework:
- Report and/or presentation on background and interpretation of research publication.

PHAY0055  Research Project (60 credits) - Dissertation and Oral Presentation

Module Assessment (Core and Option modules)

<table>
<thead>
<tr>
<th>Assessment Component</th>
<th>Pass Mark</th>
<th>Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coursework</td>
<td>50%</td>
<td>33%</td>
</tr>
<tr>
<td>Unseen written examination</td>
<td>50%</td>
<td>67%</td>
</tr>
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</table>

Module Assessment (PHAY0055 Dissertation)

<table>
<thead>
<tr>
<th>Assessment Component</th>
<th>Pass Mark</th>
<th>Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written report and Oral presentation</td>
<td>50%</td>
<td>100%</td>
</tr>
</tbody>
</table>
5.3 SCHEME OF AWARD

The scheme or award sets out the individual assessment components and their relative weighting. Students will be subject to the scheme of award in effect at the time they start the programme. The MSc is worth 180 credits. This is comprised of 120 credits of taught modules and a 60 credit dissertation.

MSc in Drug Discovery and Development

The MSc comprises the following weighted assessment components:

<table>
<thead>
<tr>
<th>Module</th>
<th>Marks</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHAY0029 Modern Aspects of Drug Discovery</td>
<td>100</td>
<td>30</td>
</tr>
<tr>
<td>PHAY0020 The Process of Drug Discovery (TPODD1)</td>
<td>100</td>
<td>30</td>
</tr>
<tr>
<td>PHAY0021 The Process of Drug Development (TPODD2)</td>
<td>100</td>
<td>30</td>
</tr>
<tr>
<td>Option 1 Optional module 1 (15 credits)</td>
<td>100</td>
<td>15</td>
</tr>
<tr>
<td>Option 2 Optional module 2 (15 credits)</td>
<td>100</td>
<td>15</td>
</tr>
<tr>
<td>PHAY0055 Dissertation - MSc Drug Discovery Pathways</td>
<td>100</td>
<td>60</td>
</tr>
</tbody>
</table>

The marks for the two optional modules (1 and 2) are aggregated, i.e. the average mark for the two modules is awarded.

MSc in Drug Discovery and Pharma Management

The MSc comprises the following weighted assessment components:

<table>
<thead>
<tr>
<th>Module</th>
<th>Marks</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHAY0029 Modern Aspects of Drug Discovery</td>
<td>100</td>
<td>30</td>
</tr>
<tr>
<td>PHAY0020 The Process of Drug Discovery (TPODD1)</td>
<td>100</td>
<td>30</td>
</tr>
<tr>
<td>PHAY0021 The Process of Drug Development (TPODD2)</td>
<td>100</td>
<td>30</td>
</tr>
<tr>
<td>PHAY0023 Pharma Management</td>
<td>100</td>
<td>30</td>
</tr>
<tr>
<td>PHAY0055 Dissertation - MSc Drug Discovery Pathways</td>
<td>100</td>
<td>60</td>
</tr>
</tbody>
</table>

END OF SECTION 5
Appendix 1: Academic Calendar

The MSc is a full-time, twelve-month programme. Students should not plan any activities to interfere with the 9:00am – 5:00pm schedule, Monday to Friday for the entirety of the programme.

<table>
<thead>
<tr>
<th>Event</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Induction Week</td>
<td>24 September 2018</td>
</tr>
<tr>
<td>Term 1 Starts</td>
<td>24 September 2018</td>
</tr>
<tr>
<td>Classes start</td>
<td>1 October 2018</td>
</tr>
<tr>
<td>Term Ends</td>
<td>14 December 2018</td>
</tr>
<tr>
<td>Term 2 Starts</td>
<td>7 January 2019</td>
</tr>
<tr>
<td>Examination period</td>
<td>7 – 11 January 2019</td>
</tr>
<tr>
<td>Begin Project Work</td>
<td>End of March 2019</td>
</tr>
<tr>
<td>Term 2 Ends</td>
<td>22 March 2019</td>
</tr>
<tr>
<td>Term 3 Starts</td>
<td>23 April 2019</td>
</tr>
<tr>
<td>Research Project Starts</td>
<td>May 2019</td>
</tr>
<tr>
<td>Examination Period</td>
<td>April – June 2019</td>
</tr>
<tr>
<td>Deadline for Project Submission</td>
<td>Early September 2019</td>
</tr>
<tr>
<td>Late Summer Assessment Period</td>
<td>August-September 2019</td>
</tr>
</tbody>
</table>

**Important Notes**

1. UCL School of Pharmacy reserves the right to change these dates if necessary. The School will inform students of any changes.
2. Students must ensure that they are available to attend all classes throughout the terms.
3. Students on full-time Taught Master’s programmes study for a full calendar year. Therefore students are expected to study beyond the end of the third term to prepare their dissertation in time for submission in September.