UNSW AUSTRALIA | Medical Sciences Medicine

DEPARTMENT OF PHARMACOLOGY

PHAR 3101

Drug Discovery, Design and Development

COURSE OUTLINE

SESSION 2, 2016

CRICOS Provider Code: 00098G

CONTENTS

Please read this outline in conjunction with the following pages on the School of Medical Sciences website:

- Advice for Students
- Learning Resources

(or see "STUDENTS" tab at medicalsciences.med.unsw.edu.au)

PHAR3101 Course Information

Drug Discovery, Design and Development (PHAR3101) is a 3rd year Science Course worth six units of credit (6 UOC). The course is usually undertaken as part of a major in Pharmacology for the Bachelor of Science or Bachelor of Medical Sciences or as part of the Bachelor of Medicinal Chemistry. The course builds on the information you have gained in Pharmacology (PHAR2011, PHAR3102 & PHAR3251) and Physiology (PHSL2101 & PHSL2201).

OBJECTIVES OF THE COURSE

This course will explore the process of drug development, from target identification to final drug registration. It will present drug development as a process involving target selection, lead discovery using computer-based methods and combinatorial chemistry/high-throughput screening. Safety evaluation, bioavailability, clinical trials, and the essentials of patent law will also be discussed. Along the way you will learn about molecular recognition, computer-aided drug design, and toxicology as applied to the development of new medicines

COURSE CO-ORDINATOR and LECTURERS:

Course Coordinator:	A/Prof. Renate Griffith Wallace Wurth Building, level 3E ph: 9385 1912

Students wishing to see the course coordinator outside scheduled lecture, tutorial, or practical times should make an appointment *via* email.

Lecturers in this course:

Dr Trudie Binder	w.binder@unsw.edu.au
Dr Orin Chisholm	o.chisholm@unsw.edu.au
Dr Angela Finch	a.finch@unsw.edu.au
A/Prof. Renate Griffith	r.griffith@unsw.edu.au
Dr Nicole Jones	n.jones@unsw.edu.au
A/Prof. Laurence Wakelin	l.wakelin@unsw.edu.au

COURSE STRUCTURE and TEACHING STRATEGIES

Learning activities occur on the following days and times:

- Lectures: Tuesday 12-1 pm, **weeks 1-12**; Wednesday 1-2 pm, **weeks 1-12**
- Tutorials: Thursday 11-12 am or* 12-1 pm; **weeks 2-4, 5 (TEST), 6-13**
- Practicals: Wednesday 3-6 pm; **weeks 2-13**

*: Once enrolled in one of the two sessions, students cannot change.

Students are expected to attend all scheduled activities for their full duration (2 hours of lectures per week and up to 4 hours of practical and tutorial sessions per week). Students are reminded that UNSW recommends that a 6 units-of-credit course should involve about 125-150 hours of study and learning activities. The formal learning activities are approximately 60 hours throughout the semester and students are expected (and strongly recommended) to do at least the same number of hours of additional study.

Lectures will provide you with the concepts and theory essential for understanding the processes involved in drug development. To assist in the development of research and analytical skills practical classes and tutorials will be held. These classes and tutorials allow students to engage in a more interactive form of learning than is possible in the lectures. The skills you will learn in practical classes are relevant to your development as professional scientists.

APPROACH TO LEARNING AND TEACHING

The learning and teaching philosophy underpinning this course is centred on student learning and aims to create an environment which interests and challenges students. The teaching is designed to be relevant and engaging in order to prepare students for future careers.

Although the primary source of information for this course is the material covered in lectures, tutorials, and practical classes, effective learning can be enhanced through self-directed use of other resources such as textbooks and Web based sources. Your practical classes will be directly related to the lectures and **it is essential and required to prepare for practical classes before attendance *via* the pre-lab modules**. It is up to you to ensure you perform well in each part of the course: preparing for classes; completing assignments; studying for exams and seeking assistance to clarify your understanding.

STUDENT LEARNING OUTCOMES

PHAR3101 will develop those attributes that the Faculty of Science has identified as important for a Science Graduate to attain. These include skills, qualities, understanding and attitudes that promote lifelong learning that students should acquire during their university experience.

Graduate Attributes

A. Research, inquiry and analytical thinking abilities
B. The capability and motivation for intellectual development
C. Ethical, social and professional understanding
D. Effective communication
E. Teamwork, collaborative and management skills
F. Information Literacy – the skills to locate, evaluate and use relevant information.

On completion of this course students should:

1. be able to describe the process of drug discovery and development
2. be able to discuss the challenges faced in each step of the drug discovery process
3. have gained a basic knowledge of computational methods used in drug discovery
4. be able to organise information into a clear report
5. be able to demonstrate their ability to work in teams and communicate scientific information effectively

See also: UNSW Graduate Outcomes

ASSESSMENT PROCEDURES

- Progress exam (45 min duration): short and long answer questions **8%**
- Practical assessment (1 report) **15%**
- Formative assessment **5%**
- Group assignment **12%**
  (6% for each individual's report and 6% for the group synopsis)
- End of session examination (2 hours duration) **60%**
  (short and long answer questions)

The *practicals and tutorials* are provided to support lecture material and practise analytical skills. The practical classes and tutorials help you to develop graduate attributes A, C, D & E.

During the practical course you will submit a written report covering three of the practical sessions. The report should be in the form of a scientific communication comprising aims, results and discussion (see separate handout for instructions). Reports must be as concise as possible, and are limited to a maximum of 2000 words of writing (excluding tables, figures and computer traces). **The report will be due Monday, 19 Sept (week 9), at 10 am**.

Students will work in teams to research the drug discovery process of a given drug. They will submit an *individual written report* and a *group synopsis* on their findings by Monday, October 17 (week 12). This assessment task will allow you to develop your research, information literacy, communication and time management skills, as well as allowing you to demonstrate your ability to work in a team and collaborate successfully (Graduate attributes A, D, E &F). The marking criteria and instructions are in a separate handout.

Written assessment tasks must be accompanied by a signed plagiarism form and must be submitted at the BABS.SOMS.BEES (B.S.B.) Student Office, G27 Biosciences Building. They also have to be submitted electronically *via* Moodle, through Turnitin. A penalty will apply for late submissions (10% per day).

The *progress examination* will be held during the tutorial sessions in week 5, on the 25th of August. This exam will give you feedback on how you are succeeding in the course. **The *progress examination* and *end of session examination* will test not only your knowledge of the process of drug design and development but also your ability to apply the knowledge you have acquired from multiple lectures, practicals and tutorials to drug development scenarios. The examination will be in the format of short and long answer questions. The questions will be based on the material covered in the lectures, practical classes and tutorials. Material covered prior to the progress exam may be examined again in the final exam.** The examinations will address graduate attributes A and B. The end of session examination will be held during the official examination period.

The goal of *formative assessment* is to provide ongoing feedback that you can use to improve your learning. Formative assessment tasks help students identify their strengths and weaknesses and therefore the areas they should focus on.

Pre-tutorial questions and instructions will be posted on Moodle a week before scheduled tutorial sessions. Students will need to print these and attempt to answer them. They need to be shown to the tutor at the beginning of the tutorial, and credit will be given if students have attempted to answer the questions. Feedback will be provided during the tutorial session.

TEXTBOOK AND READING LIST

Recommended Primary Texts:

- Drug Discovery and Development - Technology in Transition. Hill & Rang. Elsevier Ltd 2nd edition 2013.
- Pharmacology in Drug Discovery. T. P. Kenakin. Elsevier, 1st Edition 2012.
- An introduction to medicinal chemistry. G. L. Patrick. 5th Edition Oxford UK, Oxford University Press, 2013.

These textbooks will be available at the UNSW bookshop. They are also available in the library.

Other Resources:

The following electronic journals are accessible *via* the UNSW library.

- Nature Reviews: Drug Discovery.
- Drug discovery and development
- Drug discovery today.
- Science online special "Drug discovery" www.sciencemag.org/sciext/drugdisc/

Links to additional articles of interest may be placed on the course pages on Moodle.

COURSE EVALUATION AND DEVELOPMENT

Each year feedback is sought from students about the courses offered in the Department of Pharmacology and continual improvements are made based on this feedback. The Course and Teaching Evaluation and Improvement [CATEI] Process of UNSW is the way in which student feedback is evaluated and significant changes to the course will be communicated to subsequent cohorts of students. A staff-student liaison group will also be set up and students will be invited to become class representatives to seek feedback from their colleagues and meet with academic staff to discuss any issues that arise.

Several improvements to PHAR3101 have been made based on feedback given in 2006 to 2014. These changes include: a new textbook, increased tutorial support and changes to lecture and practical content. Two new practicals were introduced in 2010. The lecture content was revised in 2012. Pre-lab modules and pre-tutorial questions were introduced in 2014. New lectures and tutorials were introduced in 2015 and the practical in week 5 was revised. For 2016, the practical in week 8 was revised.

GENERAL INFORMATION

The Department of Pharmacology is part of the School of Medical Sciences and is within the Faculty of Medicine. It is located in the Wallace Wurth building C27.

General inquiries can be made at the BABS.SOMS.BEES (B.S.B.) Student Office, located on the Ground Floor Room G27, of the Biosciences Building.

Office hours are 9.00 am - 5:00pm. Email: SOMSenquiries@unsw.edu.au

Professor Margaret Morris is Head of Department and appointments to meet with her may be made via email (m.morris@unsw.edu.au).

Departmental Vacation Scholarships: The School of Medical Sciences supports several summer vacation scholarships each year to enable good students to undertake short research projects within the school. For further details contact the Administrative Officer.

Honours Program: Any students considering an Honours year should discuss the requirements with the coordinator Dr Thomas Fath (t.fath@unsw.edu.au), ph.: 9385 8495.

Honours Administrator: Vicky Sawatt (v.sawatt@unsw.edu.au) ph:9385 8195.

Postgraduate degrees

The Department of Pharmacology offers students the opportunity to enter into the following graduate programs:

Coursework Masters: Masters in Pharmaceutical Medicine. For more information contact Dr Orin Chisholm (o.chisholm@unsw.edu.au)

Research Masters: In Pharmacology. For more information contact the post-graduate co-ordinator Dr Pascal Carrive (p.carrive@unsw.edu.au)

Doctorate (***Ph.D)***: In Pharmacology. For more information contact the post-graduate co-ordinator Dr Pascal Carrive (p.carrive@unsw.edu.au)

Attendance Requirements

For the Policy on Class Attendance and Absence, including guidelines on extra-curricular activities affecting attendance, see Advice for Students and the Policy on Class Attendance and Absence.

Attendance at practical classes is compulsory, and must be recorded in the class roll at the start of each class. Arrival more than 15 minutes after the start of the class will be recorded as non-attendance. It is your responsibility to ensure that the demonstrator records your attendance and no discussions will be entered into after the completion of the class.

Satisfactory completion of the work set for each class is essential. It should be noted that non-attendance for other than documented medical or other serious reasons, or unsatisfactory performance, for more than 1 practical class during the session may result in an additional practical assessment exam or ineligibility to pass the course. Students who miss practical classes due to illness or for other reasons must submit a copy of medical certificates or other documentation to the course coordinator.

Certificates should be lodged no more than 3 days after an absence. Certificates lodged after 7 days will not be accepted. The following details must be attached: Name, Subject number, Student number, Date of the class, Name of class/es missed.

Practical Classes

The practical class is an opportunity for students to develop graduate attribute C by behaving in an ethical, socially responsible and professional manner within the practical class.

The experimental procedure for each practical is given in separate practical notes. Students are required to familiarise themselves with the experimental procedure before attending each class.

NOTE: Pre-lab modules will be provided on Moodle for practicals. These must be completed at least 1 hour prior to attending each practical class.

Students who do not successfully complete the module will not be allowed to start the experiment until they have done so in class.

Students must take due care with biological and hazardous material and make sure all equipment is left clean and functional. In the interests of safety, special attention should be paid to any precautionary measures recommended in the notes. If any accidents or incidents occur they should be reported immediately to the demonstrator in charge of the class who will record the incident and recommend what further action is required.

See also: Advice for Students-Practical Classes

Missed Exams

If in any circumstances you unavoidably miss an examination, you must inform the course coordinator. Normally, if you miss an exam (without medical reasons) you will be given an absent fail. If you arrive late for an exam, no time extension will be granted. It is your responsibility to check timetables and ensure that you arrive with sufficient time.

PLEASE NOTE that if you miss any examinations for medical reasons you can apply for Special Consideration. The application must be made via Online Services in myUNSW within 3 DAYS.

Please refer to UNSW-Special Consideration and Student Advice-Special Consideration

for further details. Your request for consideration will be assessed and a deferred exam may be granted. You cannot assume you will be granted supplementary assessment. The deferred exam may include a significant oral element.

The supplementary exams for the School of Medical Sciences in Semester 2, 2016 have not been timetabled yet, but will likely be held in the week starting 5 Dec, 2016.

For further details: medicalsciences.med.unsw.edu.au/students/undergraduate/science

If you unavoidably miss the progress exam in PHAR3101, you must lodge an application with UNSW Student Central for special consideration within 3 DAYS.

If your request for consideration is granted an alternative assessment will be organised which may take the form of a supplementary exam or increased weighting of the final exam.

Drug Discovery, Design and Development

LECTURE and PRACTICAL OUTLINES

The course timetable can be found on Moodle.

The course is divided into 6 main themes covering the drug development process from bench to bedside.

1. Introduction to Drug Design and Development
2. Drug targets
3. Lead Identification and Modification
4. Computer-Aided Drug Design
5. Drug Delivery
6. Pre-clinical and Clinical Testing

1. Introduction to Drug Design and Development

Drug Discovery as a Process

This lecture stresses the important realisation that drug discovery is a lengthy, expensive, and complicated process that requires the collaboration of a large number of research scientists with skills ranging from computational and structural chemistry, through synthetic organic chemistry, molecular cell biology, genomics, proteomics, physiology, pharmacology, toxicology, and clinical biochemistry, amongst others.

Target Identification and Validation

In this lecture the role of genomics and bioinformatics in target selection and drug design and development will be explored. The use of genetic approaches to identify target candidates, genomics and proteomics will be covered. Also covered will be the role of bioinformatics in the analysis of nucleic acid sequence, protein sequence and structure, expression databases and functional pathway data contained in databases.

Target Validation and Drug Validation Practicals

Practical 1: Target Validation will use siRNA to test the role of a specific tropomyosin to regulate cancer cell growth. Each student team will get to fix and stain cells treated with various siRNAs to estimate impact on cell colony forming capacity. The students will count cell colonies by eye in a 6 chamber plate.

Practical 2: Drug Validation will use the same methodology to generate a dose response curve for cell colony formation after exposure to a lead compound. Members of each team will also evaluate the impact of the drug on the intracellular target by viewing on their computer screen cell images displaying different parts of the cytoarchitecture. Students will count cells which have intact actin filaments and intact microtubules.

2. Drug targets

Targets: Membrane Proteins

This lecture will explore the advantages and disadvantages of membrane proteins as drug targets. The qualities that make a good drug targets include: contribution to a biological pathway involved in the pathophysiology of a disease, functional and structural information about the target and that the target is “druggable”. Membrane proteins such as receptors, ion channels and transporters are key regulators of cellular function. Membrane proteins account for up to two thirds of known drug targets, demonstrating they are “druggable”. However, membrane receptors pose an increased challenge due to the difficulty in obtaining pure, correctly-folded protein in sufficient quantity for functional or structural assays.

Targets: DNA

DNA, messenger RNA, and ribosomal RNA are important molecular targets for cancer, viral, and microbial chemotherapy. Drugs that bind to these targets inhibit DNA replication, the transcription of mRNA, and its translation into proteins. In this lecture we will focus on how structure-based approaches have been applied to the rational design of DNA groove binding agents that recognise specific nucleotide sequences, and how this provides the opportunity for the development of gene-specific inhibitors of transcription – a holy grail of many molecular pharmacologists.

Targets: RNA

In the “Targets: DNA” lecture we focussed on DNA-binding agents that specifically inhibit the transcription of designated genes, here, in the “Targets: RNA” lecture we will consider the development of agents that selectively block mRNA so as to inhibit gene expression at the level of translation. We will discuss three different approaches: (1) the development of anti-sense oligonucleotides, (2) the design of ribozymes that selectively cleave designated mRNAs, and (3) the use of small inhibitory RNAs, known as siRNAs, in post-transcriptional gene silencing.

Targets: Enzymes

Many cellular processes involved in disease are mediated or controlled by the specific action of enzymes. A number of disease processes can therefore be reduced or eliminated by manipulating the activity of specific enzymes. This lecture will briefly outline how selected enzymes are identified as drug targets and then validated. Examples of how several drugs exert their therapeutic effects by interacting with these enzymes will also be given.

3. Lead Identification and Modification

Biological Assays: Lead Identification and High Throughput Screening

In the past, drugs were discovered by chance in a trial and error approach. The introduction of new technologies, such as high throughput screening (HTS), which can experimentally test hundreds of thousands of compounds a day, has resulted in a more successful identification of promising drug candidates or reduced drug development costs. The first of these lectures will examine the types of assays that can be used in hit compound identification and the advantages and disadvantages of each assay type. The second lecture covers assay development and the qualities needed in a screening assay. The role of high throughput screening and the advantages and challenges it brings to the drug discovery process will be discussed.

Lead Identification and Modification Practicals:

Drug discovery teams (groups of 3-4 students) will test a series of structurally related compounds to determine their affinity, potency and efficacy at the human β_2 adrenoceptor.

Radioligand Binding Assays (Week A)

The analysis of binding data obtained from cells expressing the human β_2 adrenoceptor. Kinetic, saturation and competition binding parameters, e.g. the dissociation constant (K_D) and maximum binding capacity (B_{max}) of a radioligand; IC_{50} and inhibitory constants (K_I) for a series of compounds will be determined.

Functional Assay (Week B)

Functional assays measuring cAMP accumulation will be performed to determine the potency (EC_{50}) and efficacy (E_{max}) of the compounds at the human β_2 adrenoceptor.

Structure Activity Relationships (Week C)

The data generated in weeks A and B will be analysed and the relationship between the structure of a compound and its affinity, potency and efficacy at the human β_2 adrenoceptor will be explored. Physicochemical properties will be calculated for each compound (such as logP, number of rotatable bonds, polar surface area) and the effect of the substituents and stereochemistry of the compounds on activity will be examined.

Sources of active compounds

The decade of the 1990s has seen a revolution in medicinal chemistry, with the introduction of combinatorial methods of general organic synthesis. These approaches make it possible to generate tens of thousands of compounds in a few days, in a form suitable for evaluation in high-throughput biological assays. However, other sources of active compounds will also be discussed in the lecture, in particular natural products and their identification. A recent new approach to the identification of novel hit compounds, which involves screening of mixtures of very small molecules (fragments), typically by using NMR spectroscopy or X-ray crystallography, will be introduced.

Biologics

This lecture will introduce therapeutic proteins, also called biologics. The advent of recombinant DNA techniques allowed the practical production of proteins such as human insulin which was the first recombinant DNA product approved for therapeutic use in 1982. Biologics can be divided into 3 categories: antibodies, replacement or modulators of enzymes and of cell surface receptors. Examples will be given and their advantages and limitations outlined.

4. Computer-Aided Drug Design

Molecular Modelling

Computer-aided drug design methods are widely used today in academic and industrial environments. This lecture will explain the basics on how the structures of molecules can be entered into a computer and manipulated *in silico*. This includes methods for geometry optimisation, molecular dynamics simulation, and conformational searching.

Ligand-based Drug Design

To improve the properties of a potential drug, structure-activity relationships are established to identify structural moieties that contribute to the binding and activity of a compound. Computational methods will be discussed in this lecture which can be used to model and predict these properties, and to screen databases for new leads. These methods include quantitative structure-activity relationship (QSAR) and pharmacophore determination. A pharmacophore defines the structural features and geometry of a drug that impart biological activity.

Structure Determination

A fundamental requirement of rational drug design is knowledge of the 3-dimensional structure of the receptor, generally a protein, sometimes a nucleic acid, occasionally a protein-nucleic acid complex. In this lecture we will explore the experimental methods available for determining these structures, focussing on X-ray crystallography, NMR spectroscopy, and mass spectrometry.

Structure-based Drug Design

Where the detailed three-dimensional structure of the protein target is available, so called structure-based computer-aided drug design methods can be utilised to identify and modify lead compounds. If the protein structure is not available, then computer models, based on structures of similar proteins, can be prepared and are suitable for structure-based drug design. This lecture will introduce structure-based drug design and protein modelling methods.

Molecular Modelling Practical

This practical will teach how to use molecular visualisation software to explore the structure and properties of small, drug-like molecules, including conformational models and superimpositions.

Molecular Modelling Practical: Visualisation

Students will use the same molecular visualisation software to examine protein structures, protein/ligand interactions, and DNA/ligand interactions pertinent to structure-based drug design.

5. Drug Delivery

Bioavailability

Pharmacokinetics is the study of what the body does to a drug once it is within the body. A clinically important outcome of the body's treatment of a drug is how much drug is finally available in the body to bind to its intended therapeutic target (bioavailability). A brief outline will be given in this lecture on how ADME processes (Absorption, Distribution, Metabolism and Excretion) impact on a drug's bioavailability.

Pro-drugs and Drug Delivery

An inactive derivative of a known active drug may be called a prodrug and requires transformation within the body in order to release the active drug. Prodrugs can provide improved physiochemical properties such as solubility and enhanced delivery characteristics and / or therapeutic effect. This lecture outlines barriers to drug action, pro-drugs as drug delivery systems, and the application of pharmacokinetics and pharmacodynamics in drug delivery.

6. Pre-Clinical and Clinical testing

Pre-clinical Toxicology: *In Vitro*

From this lecture students will understand:

- the role of *in vitro* toxicity tests in establishing the safety of new drugs
- *in vitro* toxicity tests required by the world's regulatory bodies; tests for genotoxicity, cytotoxicity and others as required by chemical class
- the theory and methodology underlying various *in vitro* toxicology tests
- the role of Good Laboratory Practice in performing these tests

Pre-clinical Toxicology: *In Vivo*

From this lecture students will understand:

- the role of *in vivo* toxicity tests in establishing the safety of new drugs
- *in vivo* toxicity tests required by the world's regulatory bodies; genotoxicity, acute and short-term toxicity tests, tests for carcinogenic potential, Q-T prolongation and others as required by chemical class.
- the theory and methodology underlying various *in vivo* toxicology tests
- the ethics of *in vivo* toxicity testing and the potential for replacement by *in vitro* models

Pre-clinical Toxicology Practical: Ames Test

Chemicals which damage or mutate DNA and chromosomes are called mutagens. Damage to genetic material may lead to unregulated, cancerous growth of cells and tissues; indeed 80% of known carcinogens (cancer-causing chemicals) are also mutagens. Therefore one of the early, key tests performed on new chemicals or pharmaceuticals is a test for mutagenicity.

The standard *in vitro* test for mutagenicity is known as the Ames test, named for its inventor Professor Bruce Ames. It is a bacterial reverse mutation assay. In this practical specifically developed, mutant strains of *Salmonella typhimurium* are used, which are unable to synthesize the essential amino acid histidine. Thus the *S. typhimurium* strains will only grow

in medium including histidine as an added supplement. Mutagenic chemicals damage the bacterial DNA, causing the strains to revert (reverse-mutate) to the 'wild-type' state in which growth is independent of histidine.

In the practical the *S. typhimurium* strain TA98 will be grown in culture with a growth-limiting concentration of histidine. Various test chemicals will be added to the cultures to assess their mutagenic potential. The number of bacterial colonies which form on the culture plates indicates the growth rate; the greater the number of colonies, the greater the mutagenic potential of the chemical.

Clinical Trials

The regulation of therapeutic products and the phases (I-IV) of clinical trial that a drug must pass through before registration will be covered in this lecture.

Clinical Trial Design

This lecture will cover clinical trial design. The components of clinical trial design to be discussed will be: aims, design, controls and placebo, blinds, randomisation procedures, sample size, statistics, endpoints and ethics (ethics will be covered later in the course).

Clinical Bone Research

In this "in-house excursion", which will take place during the practical time slot in week 13, students will visit our clinical trials facility and will be introduced to bone densitometry. Students will be shown the Dual-Energy-X-ray absorptiometry system which is the gold standard in assessment of risk, diagnostic and drug efficacy and patient compliance.

Ethics of Human and Animal Experimentation

Testing of drugs in animals and humans is under strict regulation to limit any harm and distress to the research subjects. In this lecture we will discuss the ethical conduct of biomedical research, including the policies governing biomedical and animal research in Australia. The role of institutional human ethic committees and what constitutes informed consent will be discussed. The general principles for the care and use of animals for scientific purposes and the 3 R's, replacement, reduction and refinement will be covered and the role of institutional animal ethics committees will be covered.

Intellectual Property

The basic principles underlying the protection of intellectual property will be discussed, focussing on the legal issues relevant to the patenting of pharmaceutical agents. We will discuss the types of patents available and what can be protected, the notions of disclosure, prior art, innovation, challenges, and what needs to be included in a patent application.

Commercial Considerations in Drug Development

Commercial considerations in drug development will be covered from target discovery, indication selection and lead identification, through safety assessments, clinical trials and marketing. What drives decisions (Go/No-Go), time-scales, program planning and the interactive perspectives of different groups in small and large pharma companies will be covered.