UNIVERSITY OF CAMBRIDGE

PHARMACOLOGY

Part IB Course Handbook

2022 - 2023

Course organiser:

Dr Walid Khaled
E-mail: wtk22@cam.ac.uk

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Section 1 – General Course Information

Aims of the Course

Pharmacology deals with the effects of chemical substances on biological material and thus has roots in both the physical and biological sciences. The NST1B Pharmacology Course is intended to emphasise the basic mechanisms of drug action in relation both to drug-receptor interactions and to the operation of physiological and biochemical systems. It provides the foundation needed for the harnessing of our understanding of how drugs work for the successful development of drugs in the future.

Learning outcomes

At the end of the course students should be able to:

1. Explain the principles of ligand-receptor interaction, local and intracellular messengers and integration of signalling pathways.

2. Identify the major classes of drug receptors and sites of drug action within the body.

3. Identify typical examples of drugs which are used to restore physiological functions in the cardiovascular, renal, respiratory, digestive, reproductive, peripheral nervous and central nervous systems.

4. Demonstrate an understanding of the use of drugs to control inflammation and immune responses or to kill bacteria, viruses, parasites or malignant cells.

5. Apply the basic principles that govern the absorption, distribution and elimination of drugs to predict the time course of drug concentrations in the body and consider the implications of these principles for the therapeutic use of drugs.

6. Recognise the fundamental methods used in pharmacological research and be able to use basic pieces of research equipment.

Student feedback

Students have the opportunity to feed back their opinions/suggestions for the course via their course representatives in the Course Review Committee. A request is sent out to all students at the beginning of the year to volunteer as student representative. The Course Review Committee reports to the Departmental Teaching Committee; where all staff are represented, and student representatives are present. Each Committee meets at the end of every term to discuss all aspects of the course and the electronic feedback.

Anyone who would like to make an official suggestion or complaint, which will receive a reply, can do so by writing directly to the Course Organiser [Dr Walid Khaled, wtk22@cam.ac.uk]. If you prefer you may ask your Director of Studies to forward the message.

Student Feedback Surveys are sent out as announcements on the Moodle website at the end of each lecture series, we would appreciate you taking the time to complete these short surveys.

Responses to student feedback

As a course we pride ourselves in listening to and acting upon student feedback. This is not always easy to demonstrate to the students who provided it, since the changes are implemented the following year.

Student Complaints

The Student Complaints Procedure (the Procedure) allows a student to express dissatisfaction about the standard of service provided by the University. You can find all the information at:
http://www.studentcomplaints.admin.cam.ac.uk/student-complaints

Students with disabilities

The Department has facilities for wheel chair access, including a lift, toilet and dedicated areas in the seminar room. Any student with disabilities is encouraged to contact Dr Walid Khaled (wtk22@cam.ac.uk).

Safety

Apart from usual safety measures such as fire procedures, there are also specific safety issues arising as part of the practical work, including considerations regarding Covid. These are identified in the handbook practical section, in the introduction at the beginning of each practical and within the teaching application.

Course Outline

Eleven University Teaching Officers (UTOs) will lecture in this course. During practicals and the Drug Review Project, you will also be taught by other UTOs, post-doctoral fellows and PhD students. Two lectures in Lent Term will be online. ***Practicals will take place in the Teaching laboratory on the ground floor in the Department of Pharmacology on Tennis Court Road.*** Given the intensive nature of the Cambridge NST1B Course, it is recommended that students should spend 40h per week on formal teaching such as lectures, practicals and supervisions, as well as preparation for supervisions and private study in the course. Students are expected to use an appropriate amount of this time to study Pharmacology. These hours are based on the expectation that preparatory work, and revision and consolidation, will take place over vacation periods.

Lectures

The course follows the familiar pattern: three lectures per week. Nominally these are timetabled for Mondays, Wednesdays and Fridays at 11:00 a.m. These lectures will also be recorded and uploaded to Moodle after the lecture. Please consult the timetable below for the location of the lectures.

The online timetable can be found here: https://2022-23.timetable.cam.ac.uk/admin/

Lecture Capture

Recordings of lectures will be uploaded onto the NST Part IB:Pharmacology website within a reasonable time if the lecturer has consented to the recording. Please note The General Board's Education Committee (GBEC) Expectation to record lectures statement and Expectation to record lectures 22 - 23 policy.

Michaelmas Term

The first part of the course is concerned with understanding, at the molecular level, how receptors work. These lectures examine the fundamental processes of molecular recognition, and then consider in detail how, having recognised a drug, receptors are able to generate a signal that changes cellular activity. Progress in this area has been dramatic to the extent that we now know, at least for some receptors, which amino acid residues bind to which parts of a drug molecule and which are important for evoking a response.

The intracellular messengers that can mediate this response will be discussed in detail. These recent advances have resulted from multi-disciplinary approaches, which are reflected in the scope of our course where the importance of combining molecular biology and modelling with more traditional pharmacological approaches is recognised. Lectures continue with a series of discourses focusing on synaptic pharmacology. Michaelmas Term will continue with a discussion on the use of drugs that selectively inhibit the multiplication of bacteria, viruses or parasites, and problems associated with drug resistance. We then address the issues associated with cancer and anticancer drug and complete the term by exploring how in silico process can aid the drug discovery program.

Michaelmas Term Timetable

Date	Topic	Lecturer	Nominal time of lecture	Venue
Fri 7 Oct	Drug-Receptor Interactions	Dr S Millington-Burgess	11:00 – 12:00	Botany Large Lecture theatre, Dept Plant Sciences
Mon 10 Oct	Drug-Receptor Interactions	Dr S Millington-Burgess	11:00 – 12:00	
Wed 12 Oct	Drug-Receptor Interactions	Dr S Millington-Burgess	11:00 – 12:00	
Fri 14 Oct	Drug-Receptor Interactions	Dr S Millington-Burgess	11:00 – 12:00	

Mon 17 Oct	Drug-Receptor Interactions	Dr S Millington-Burgess	11:00 – 12:00	
Wed 19 Oct	Synaptic pharmacology	Prof E Smith	11:00 – 12:00	
Fri 21 Oct	Synaptic pharmacology	Prof E Smith	11:00 – 12:00	
Mon 24 Oct	Synaptic pharmacology	Prof E Smith	11:00 – 12:00	
Wed 26 Oct	Synaptic pharmacology	Prof E Smith	11:00 – 12:00	
Fri 28 Oct	Small Molecule Drug Discovery	Dr T Rahman	11:00 – 12:00	
Mon 31 Oct	Small Molecule Drug Discovery	Dr T Rahman	11:00 – 12:00	
Wed 2 Nov	Small Molecule Drug Discovery	Dr T Rahman	11:00 – 12:00	
Fri 4 Nov	Antimicrobial & antiviral drugs	Prof H vVeen	11:00 – 12:00	
Mon 7 Nov	Antimicrobial & antiviral drugs	Prof H vVeen	11:00 – 12:00	
Wed 9 Nov	Antimicrobial & antiviral drugs	Prof H vVeen	11:00 – 12:00	
Fri 11 Nov	Antimicrobial & antiviral drugs	Prof H vVeen	11:00 – 12:00	
Mon 14 Nov	Antimicrobial & antiviral drugs	Prof H vVeen	11:00 – 12:00	
Wed 16 Nov	Antimicrobial & antiviral drugs	Prof H vVeen	11:00 – 12:00	
Fri 18 Nov	Growth Factor Signalling	Dr Cath Lindon	11:00 – 12:00	
Fri 21 Nov	Growth Factor Signalling	Dr Cath Lindon	11:00 – 12:00	
Wed 23 Nov	Anticancer drugs	Dr W Khaled	11:00 – 12:00	
Fri 25 Nov	Anticancer drugs	Dr W Khaled	11:00 – 12:00	
Mon 28 Nov	Anticancer drugs	Dr W Khaled	11:00 – 12:00	
Wed 30 Nov	An Industry perspective on drug design: from discovery to development.	Dr Ambra Bianco	11:00 – 12:00	

Lent Term

The term begins with a description of processes that control the distribution and fate of drugs and how these in turn determine the relation between drug doses and drug concentrations near their sites of action.

These lectures are followed by those dealing with factors related to endocrinology, diabetes and reproduction. We will discover how we can modulate many of these disease states through the use of drugs. We will then move on to looking at the factors involved in local responses leading to irritation and inflammation, as well as asthma and the use of drugs that act in the periphery to relieve pain and inflammation and also attack the causes of the inflammatory response. Finally, this term we consider drug action across vascular and renal systems, which will illustrate in an integrated fashion how drug action can be exerted over several tissues or organs to have both desirable and undesirable effects. Molecular and structural characteristics, particularly of ion channels, will be combined with essential physiology to explain drug action in the wider context of the functioning of the normal and diseased heart.

Lent Term Timetable

Date	Topic	Lecturer	Nominal time of lecture	Venue
Fri 20 Jan	Pharmacokinetics	Dr M Harper	11:00 – 12:00	TBC
Mon 23 Jan	Pharmacokinetics	Dr M Harper	11:00 – 12:00	TBC
Wed 25 Jan	Pharmacokinetics (online)	Dr M Harper	11:00 – 12:00	Link will be emailed
Fri 27 Jan	Pharmacokinetics (online)	Dr M Harper	11:00 – 12:00	Link will be emailed
Mon 30 Jan	Inflammation	Dr D Bulmer	11:00 – 12:00	TBC
Wed 1 Feb	Inflammation	Dr D Bulmer	11:00 – 12:00	TBC

Fri 3 Feb	Inflammation	Dr D Bulmer	11:00 – 12:00	TBC
Mon 6 Feb	Inflammation	Dr D Bulmer	11:00 – 12:00	TBC
Wed 8 Feb	Inflammation	Dr D Bulmer	11:00 – 12:00	TBC
Fri 10 Feb	Cardiovascular	Dr M Harper	11:00 – 12:00	TBC
Mon 13 Feb	Cardiovascular	Dr M Harper	11:00 – 12:00	TBC
Wed 15 Feb	Cardiovascular	Dr M Harper	11:00 – 12:00	TBC
Fri 17 Feb	Cardiovascular	Dr M Harper	11:00 – 12:00	TBC
Mon 20 Feb	Cardiovascular	Dr M Harper	11:00 – 12:00	TBC
Wed 22 Mar	Cardiovascular	Dr M Harper	11:00 – 12:00	TBC
Fri 24 Feb	Cardiovascular	Dr M Harper	11:00 – 12:00	TBC
Mon 27 Feb	Cardiovascular	Dr M Harper	11:00 – 12:00	TBC
Wed 1 Mar	Cardiovascular	Dr M Harper	11:00 – 12:00	TBC
Fri 3 Mar	Cardiovascular	Dr M Harper	11:00 – 12:00	TBC
Mon 6 Mar	Endocrinology	Dr C Wilson	11:00 – 12:00	TBC
Wed 8 Mar	Endocrinology	Dr C Wilson	11:00 – 12:00	TBC
Fri 10 Mar	Endocrinology	Dr C Wilson	11:00 – 12:00	TBC

Easter Term

Is taken up by lectures that focus on several aspects of central nervous function and the drugs that influence them, and will include some notable diseases: neuroses such as anxiety, and psychoses such as depression and schizophrenia. Epilepsy, Parkinson's Disease and Huntington's chorea also receive attention as do centrally-acting analgesics, mood-affecting drugs, and drugs of abuse.

Easter Term Timetable

Date	Topic	Lecturer	Nominal time of lecture	Venue
Fri 28 Apr	Neuropharmacology	Dr P Miller	11:00 – 12:00	TBC
Mon 1 May	Neuropharmacology	Dr P Miller	11:00 – 12:00	TBC
Wed 3 May	Neuropharmacology	Dr P Miller	11:00 – 12:00	TBC
Fri 5 May	Neuropharmacology	Dr P Miller	11:00 – 12:00	TBC
Mon 8 May	Neuropharmacology	Dr P Miller	11:00 – 12:00	TBC
Wed 10 May	Neuropharmacology	Dr P Miller	11:00 – 12:00	TBC

Lecture Synopses

Introduction

1 lecture

Drug-Receptor Interactions

5 lectures and an online guided workshop given by Dr Sarah Millington-Burgess

This series of lectures provides an introduction to drug-receptor interactions. What are receptors? How do they very specifically recognise only particular molecules? How do interactions between receptors and their ligands determine drug affinity? How does drug efficacy influence cellular activity downstream of receptors? Why is an understanding of drug affinity and efficacy important in drug discovery? Lectures will cover the structure and function of different receptor families including ligand gated ion channels, enzyme-linked receptors, nuclear receptors and G-protein coupled receptors. The lecture series will end with a case study illustrating how the

concepts discussed throughout the course may be applied to drugs affecting cholinergic receptors. These lectures are complemented by an online guided workshop covering quantitative aspects of drug-receptor interactions and how these may be determined experimentally.

Synaptic pharmacology

4 lectures given by Prof Ewan Smith

- Introduction to the autonomic nervous system and the basic elements of chemical synaptic transmission.
- Cholinergic neurotransmission, with focus on the nicotinic acetylcholine receptor and signal transmission at the neuromuscular junction, as well as ganglionic transmission and post-ganglionic cholinergic transmission. Muscarinic agonists and antagonists. Cholinesterases and mechanism of action of anticholinesterases.
- Noradrenergic neurotransmission and drugs that interfere with noradrenaline synthesis, storage and degradation. Adrenoceptor agonists and antagonists.
- Co-transmission: Purinergic and peptidergic neurotransmission.

Small Molecule Drug Discovery

3 lectures by Dr Taufiq Rahman

Small molecules represent the major class of therapeutic agents. They are the most popular in terms of patient compliance due to the prospect of oral intake and not requiring to be injected under non-urgent clinical conditions. In oral dosage forms, they are also considerably cheaper than the injection-only agents that typically include the biologics or peptides. However, it is often not trivial to come up with a small molecule drug with the desired level of efficacy, safety and selectivity. A typical small molecule drug discovery endeavour entails a serious, expensive and high-risk undertaking that takes typically more than 10 years and involves iterative use of multidisciplinary techniques and knowledge. In these two lectures, we will have broad overview of various stages of the standard discovery and developmental pipeline of small molecule drugs that the pharmaceutical industries follow. Since it will not be practicable to discuss each and every stage of such pipeline in full detail within two lectures, we will focus mainly on the early phases of small molecule drug discovery and development hat include the initial hit finding, hit to lead optimisation and further lead optimisation towards developing pre-clinical candidates.

Antimicrobial & Antiviral Drugs

6 lectures given by Prof Hendrik van Veen

- Historical development. Synthetic drugs and antibiotics. Mechanism of action of sulphonamides. Cell wall inhibitors: actions of beta-lactam antibiotics. Drugs acting at the cell membrane. Antibiotics that inhibit protein synthesis.
- Antiparasitic drugs. Antiprotozoal agents & anthelmintics. Drugs that inhibit tubulin polymerisation and energy metabolism. Neuromuscular control as a target.
- Antiviral agents. The early antiviral drugs. Nucleoside antibiotics and synthetic nucleoside-like drugs. Anti-influenza, anti-herpes virus, anti-HIV agents.
- Mechanisms of drug resistance. Metabolic bypass. Alteration of drug target. Modification of drugs. Reduced drug uptake. Enhanced Drug efflux.
- Strategies to circumvent drug resistance. Combination chemotherapy. Inhibitors of drug resistance mechanisms. Novel strategies.

Growth Factor Signalling

2 lectures given by Dr Cath Lindon

These two lectures will explain the principles and mechanisms of the major signalling pathways that control cell proliferation. They will provide a basis for understanding the causes of cancer and pharmacological routes to treatment of the disease.

Topics covered will include:

- Signalling pathways, mechanisms of signal transduction, protein phosphorylation
- Tumour viruses and Growth Factor signalling pathways
- Structure and function of Receptor Tyrosine Kinases and their Growth Factor ligands
- Small G-proteins and MAPK cascades
- Growth Factor signalling in growth and development and how this is altered in cancers

- Pharmacological targeting of Growth Factor signalling pathways

Anticancer Drugs

3 lectures given by Dr Walid Khaled

Anticancer Drugs. Basic principles of cancer biology. What are the Hallmarks of cancer? How can we target them to treat cancer? Basic principles of the cell cycle. The cell cycle as a key target for cancer drugs. Targeted therapies for different types of cancers.

Pharmacokinetics

2 lectures + 2 online course given by Dr Matthew Harper

Pharmacokinetics describes the relationship between the administered dose and the drug concentration at the target site. Understanding a drug's pharmacokinetics is a key step in drug development. These lectures will explain the biological mechanisms that underlie absorption, distribution, metabolism and excretion of drugs, and how these factors affect drug concentrations in the body.

Pharmacokinetics is a quantitative topic. The accompanying online course will explore how mathematical models can be used to understand pharmacokinetics, and how these can be used to find major pharmacokinetic parameters (such as clearance, bioavailability and half-life) from experimental data. This understanding can be used to design safe and effective therapeutic strategies.

Inflammation

5 lectures given by Dr David Bulmer

- Histamine: synthesis, storage, release, receptors and antagonists
- 5-hydroxytryptamine (5-HT): synthesis, storage, release
- Peptide mediators of inflammation: bradykinin, tachykinins and their and antagonists; cytokines and interleukins
- Lipid mediators of inflammation: prostaglandins, leukotrienes. Platelet activating factor
- Corticosteroids and non-steroidal anti-inflammatory drugs (NSAIDs). Aspirin and cyclooxygenase inhibitors (COX-I and COX-2)
- The inflammatory response: 4 types of hypersensitivity reactions
- Characteristics of asthma. Treatment: steroids, β_2 agonists (e.g. salbutamol), cromoglycate and others
- Characteristics of rheumatoid arthritis. Treatment: steroids, NSAIDs, disease modifying agents, immunosuppressives, methotrexate and cytokine antibodies
- What are painful stimuli and how do nerve terminals respond to them?
- Inflammatory processes and how they can exacerbate pain
- Analgesics acting at the level of nerve terminals
- Transmission of pain in the spinal cord. Long-term processes involved in pain - neuropathic pain, phantom limb pain
- Centrally acting analgesics

Cardiovascular

10 lectures by Dr Matthew Harper

The aims of this course are to understand how drugs affect the cardiovascular system in healthy individuals and how drugs can be used to treat cardiovascular diseases. The course covers a wide scope, from drug action on individual ion channels to wide-ranging effects across the cardiovascular system. A key principle underlying these lectures is that drug action in one tissue can affect health and disease at many sites throughout the body.

The course covers:

- Ion channels as drug targets
- Drug action on the heart, blood vessels and kidney
- Treatment of cardiac dysrhythmias, hypertension, chronic heart failure, and ischaemic heart disease.

The course concludes by using beta adrenoceptor antagonists (beta blockers) as a case study, bringing together the pharmacological principles introduced in previous lecture courses.

Endocrinology

3 lectures given by Dr Cathy Wilson

The general principles of how hormones regulate the endocrine system will be explored.

- We will look at the mechanisms by which hormones are generated, released and activate differing organs.
- We will discuss mechanisms of feed forward and feedback regulation and how this can go wrong in disease.
- Then we will move to understanding the pharmacology associated with one of the primary endocrine disorders - diabetes.
- We will explore the role of insulin and the contribution that obesity plays in the onset of Type II diabetes. The pharmacological treatment of diabetes mellitus and obesity will be explored in detail to illustrate this interplay between basic science and the clinic.
- Finally, we will consider the reproductive and fertility pharmacology. We will discuss drugs during pregnancy, oral contraception and drugs to treat erectile dysfunction building from our initial understandings of how sex hormones are synthesised.

Neuropharmacology

6 Lectures given by Dr Paul Miller

The aim of these lectures is to understand how drugs interact with the nervous system to alter its function. This includes:

- How neurones function and communicate.
- The chemical transmitters that are used by different CNS pathways and neurological functions.
- The mechanism of neurological diseases and disorders.
- How drugs interact and alter neurotransmission (and therefore influence neuronal function and alleviate disorders).

By the end of the course you should have a clear comprehension of the following:

- The basic principles of neurotransmission.
- The mechanisms of drug interactions in the CNS.
- Fast excitatory (glutamatergic) neurotransmission.
- Fast inhibitory (GABAergic / glycinergic) neurotransmission.
- Neuromodulators (dopamine, 5-HT, noradrenaline, acetylcholine).
- Neurological disorders including: anxiety, epilepsy, Parkinson's disease, Alzheimer's disease, depression, schizophrenia and excitotoxicity.

Lecture Handouts and Moodle* Announcements

Virtual lectures, and lecture handouts are only available online at:
https://www.vle.cam.ac.uk/
Click: NST Part IB: Pharmacology Click: Resources
(Raven authentication required).

Moodle announcements will be sent out by email to alert students of any essential NST IB pharmacology course information (e.g., timetable changes etc.). Teaching materials associated with the course will be placed in the Resources section on Moodle at the relevant time but there will be no email notification.

It should be noted that the handouts posted on Moodle prior to the lecture courses might differ in detail from those provided during the lectures due to ongoing revision of the courses.

Practical Course

The practical course forms an integral part of the teaching. It consists of practicals, experimental design workshops and a drug review project, held on Tuesday or Wednesday afternoons (Tu. 2- 5pm *or* W. 2-5pm). A detailed timetable is at the beginning of Section II of this handbook, on Moodle and on the Pharmacology web site.

How to get the best out of the practical course?

The practicals and workshops in this course have been prepared with two objectives in mind. They are intended to teach basic pharmacology in a more interactive format than lectures, and they provide an introduction to the experimental basis of the subject. How much you get out of the practical course will depend primarily on the amount of effort you are prepared to put into it. In the practicals you are asked to display a small degree of manual dexterity, but more importantly you are asked to think.

Your time and effort will be much better spent if you read through the description of the experiment or demonstration before arriving at a class. Once there take advantage of the presence of the demonstrators to make sure that you fully understand the principles that are being illustrated. If subsequently you discover a point you find obscure, ask.

What, when and where?

Practicals are held from 2 pm to 5 pm and undertaken in the Teaching Laboratories on ground floor.

The practicals complement the lectures by providing practical experience of both traditional pharmacological techniques, still very much in use in drug discovery, and some of the most advanced techniques now available. Worked through examples of the two types of questions that may be included in the Written Practical Paper: (i) quantitative receptor pharmacology, and (ii) pharmacokinetics will be available online or in the practical workshops. Students are advised to gain further experience by self-practise and/or in college supervisions. For this purpose, previous exam questions are available on the Moodle website

Further Learning Resources

Books

There are two recommended textbooks for most of the course:

1. *Pharmacology 9th Edition* · Ed., Flower, Henderson, Loke, MacEwan and Rand (2019) Churchill Livingstone Elsevier.
2. *Basic and Clinical Pharmacology 12th Ed.* , B.C. Katzung, (2015) McGraw-Hill. Individual lecturers may give you additional reading lists and your college supervisors may also make recommendations.

Extra-departmental resources

Language learning is available for all NST1B undergraduates. For further information see: http://www.langcen.cam.ac.uk/lc/index.html Further computer facilities are available at the University Computing Service Public

Useful Websites

Information about Pharmacology and this course can be found on the Department's page in Moodle; The Natural Science Tripos web site: http://www.natsci.tripos.cam.ac.uk/ The Faculty of Biology maintains another useful site: http://www.biology.cam.ac.uk

Examination

Candidates are reminded that the entire course is examinable.

The examination will test knowledge and understanding of the materials contained in the course, and will be in two papers, in addition to the Drug Review Project.

Mark distribution

Paper 1 (extended answers) 60%
Paper 2 (written practical) 30%
Drug Review Project 10%

Paper 1

will last three hours. There will be 6 compulsory questions that have a choice of
2. These require extended answers in the form of bullet points, figures and written text. Each question will carry the same mark.

Paper 2

will be a three-hour written practical examination. It will consist of two questions and will assess ability in data handing, numerical manipulation, and logical reasoning. Questions may be drawn from any part of the course and will include questions on quantification of receptor-ligand interactions and pharmacokinetics. Each question ends with an extended answer related to receptor-ligand interactions and pharmacokinetics respectfully. Each question will carry the same mark.

Drug Research Project

During Lent term students will take part in a drug review project. Each student will select a drug from a list that will be provided at the start of Lent term and they will spend few practical sessions ***(see practical timetable for details)*** researching different aspects of the drug and then prepare a short presentation**.** Students will then present their slides ***(3 minutes max)*** and record the presentation as a short video. The submitted recording will be assessed by the examiners. All students will get an opportunity to submit a draft version of their presentations for feedback from a UTO. There will be an opportunity at the end of term to view the video submission of others on the course however, this will be ***optional*** and will not go towards the marks for the project. This exercise will give the students an opportunity to research a topic in depth and introduce them to presenting their findings in a succinct manner. ***There will be prizes for the top three videos as voted for by your peers.*** Full details of how the drug review project will run will be discussed by the course organiser at the introductory sessions in Lent term. Examples of the final videos/presentations (from previous students) can be found on the course Moodle website.

Copies of past examination papers

stretching back into antiquity should be available in most college libraries. Additional copies of the most recent past papers are also available on the departmental website at: http://www.phar.cam.ac.uk. It is a very good idea to get experience at answering examination questions by working through past papers. For the practical paper this is essential.

Examination skills and formative assessment

Class	Description
First	Work, which is excellent in the range and command of the material covered. Work that is excellent in its understanding of the subject; that has engaged closely with the question; and that is well planned and complete. A first class mark may be awarded on more than one set of criteria: there may be a great deal of relevant information, displaying substantial knowledge and understanding; the arguments and presentation may be stylish; the approach may be original, critical or unorthodox. An upper first would be an outstanding performance, meeting all, or virtually all, of these criteria; a low first would meet at least some of these criteria.
Upper Second	Work that shows a good knowledge of the topic and the material covered in lectures; that is presented in an organised way; and clearly argued and focused on the set question.
Lower Second	Work that overall shows a reasonable competence in the understanding and presentation of the relevant material. Certain types of uneven work would fall into this class: detailed factually- correct work that did not relate a broad knowledge of the topic to the specific question asked, or work with clear organisation and some insight but with serious omissions of factual knowledge.

Third	At the upper end of the class, work that just shows competent knowledge of the basic, core material. At the lower end of the class, work that shows some knowledge of the material but with serious deficiencies in understanding, coverage and organisation; this will include work that is unduly brief or largely misses the point of the question.
Fail	Work that is irrelevant, shows a considerable degree of ignorance or is short and superficial. Where the question is barely attempted.

Your main source of advice and assessment of progress is of course your college supervisor. He/she normally sets written work for each supervision. This may consist of essays or of data-handling problems, and is often based on past exam questions.

Learning to cope with exams is not an activity separate from learning the nature and reasoning of the subject. Further details of examination skills, prepared by the Faculty of Biology, are available at: https://www.biology.cam.ac.uk/exams/AllExams/skills

Examination Reviews

The University has robust policies in place to ensure that examination results are accurate. However, there may be circumstances where something unusual happens during the examination and you want it taken into account. The University has procedures in place to deal with this possibility.

Students are strongly urged to seek advice from their College Tutor (or relevant departmental staff). Students can also receive free independent advice regarding any University procedure from the Students' Unions' Advice Service at www.studentadvice.cam.ac.uk.

You have all the information of the process at http://www.studentcomplaints.admin.cam.ac.uk/examination-reviews.

Plagiarism

As a department we take plagiarism very seriously. Below are the Faculty of Biology Guidance on Plagiarism.

The following guidance has been issued by the Faculty Board of Biology:
As agreed by the General Board: "Plagiarism is defined as submitting as one's own work, irrespective of intent to deceive, that which derives in part or in its entirety from the work of others without due acknowledgement; or, in the case of self-plagiarism, unless explicitly permitted by regulation, submitting one's own work that has already been submitted for assessment to satisfy the requirements of any other academic qualification, or submitted for publication without due acknowledgement. It is both poor scholarship and a breach of academic integrity."

Such use of unfair means will not be tolerated by the University; if detected, the penalty may be severe and may lead to disciplinary proceedings being taken against you.

The scope of plagiarism

Plagiarism is defined as submitting as one's own work, irrespective of intent to deceive, that which derives in part or in its entirety from the work of others without due acknowledgement.
Examples of plagiarism include copying (using another person's language and/or ideas as if they are a candidate's own), by:

- **quoting verbatim** another person's work without due acknowledgement of the source;
- **paraphrasing another person's work** by changing some of the words, or the order of the words, without due acknowledgement of the source;
- **using ideas taken from someone else** without reference to the originator;
- **cutting and pasting from the Internet** to make a pastiche of online sources;

- **submitting someone else's work** as part of a candidate's own without identifying clearly who did the work. For example, buying or commissioning work via professional agencies such as 'essay banks' or 'paper mills', or not attributing research contributed by others to a joint project.

Plagiarism might also arise from colluding with another person, including another candidate, other than as permitted for joint project work (i.e. where collaboration is concealed or has been forbidden). A candidate should include a general acknowledgement where he or she has received substantial help, for example with the language and style of a piece of written work. Plagiarism can occur in respect to all types of sources and media:

- text, illustrations, musical quotations, mathematical derivations, computer code, etc;
- material downloaded from websites or drawn from manuscripts or other media;
- published and unpublished material, including lecture handouts and other students' work.

Acceptable means of acknowledging the work of others (by referencing, in footnotes, or otherwise) vary according to the subject matter and mode of assessment. Faculties or Departments should issue written guidance on the relevant scholarly conventions for submitted work, and also make it clear to candidates what level of acknowledgement might be expected in written examinations. Candidates are required to familiarize themselves with this guidance, to follow it in all work submitted for assessment, and may be required to sign a declaration to that effect. If a candidate has any outstanding queries, clarification should be sought from her or his Director of Studies, Course Director or Supervisor as appropriate.

Self-plagiarism is defined as submitting one's own work, that has already been submitted for assessment, to satisfy the requirements of any other academic qualification or submitted for publication without due acknowledgement.
Examples of self-plagiarism include:

- writing an essay twice or more for a single set of exams;
- writing the same essay, or a substantial part of an essay, twice in the same exam;
- memorising substantial blocks of text and reproducing them more than once as the whole or as parts of an answer in an exam.

Failure to conform to the expected standards of scholarship (e.g. by not referencing sources) in examinations may affect the mark given to the candidate's work. In addition, suspected cases of the use of unfair means (of which plagiarism is one form) will be investigated and may be brought to one of the University's Courts. The Courts have wide powers to discipline those found guilty of using unfair means in an examination, including depriving such persons of membership of the University, and deprivation of a degree.

How to avoid plagiarism

The stylistic conventions for different subjects vary and you should consult your Course Organiser or project supervisor about the conventions pertaining in your particular subject area. Most courses will issue written guidance on the relevant scholarly conventions and you are expected to have read and to follow this advice. However, the main points that apply to submitted work (e.g. dissertations, project reports) are:

- when presenting the views and work of others, include in the text an indication of the source of the material, e.g. 'as Sharpe (1993) has shown,' and give the full details of the work quoted in your bibliography;
- if you quote text verbatim, place the sentence in inverted commas and give the appropriate reference, e.g. 'The elk is of necessity less graceful than the gazelle' (Thompson, 1942, p 46) and give the full details in your bibliography as above;
- if you wish to set out the work of another at length so that you can produce a counter-argument, set the quoted text apart from your own text (eg by indenting a paragraph) and identify it by using inverted commas and adding a reference as above. NB long quotations may infringe copyright, which exists for the life of the author plus 70 years.
- if you are copying text, keep a note of the author and the reference as you go along, with the copied text, so that you will not mistakenly think the material to be your own work when you come back to it in a few weeks' time;
- if you reproduce an illustration or include someone else's data in a graph include the reference to the original work in the legend, eg (figure redrawn from Webb, 1976) or (triangles = data from Webb, 1976);
- if you wish to **collaborate** with another person on your project, you should check with the Course

Organiser to see whether this might be allowed and then seek their permission;

- if you have **been authorised to work together** with another candidate or other researchers, you must acknowledge their contribution fully in your introductory section. If there is likely to be any doubt as to who contributed which parts of the
- work, you should make this clear in the text wherever necessary, e.g. 'I am grateful to A. Smith for analysing the sodium content of these samples';
- be especially careful if **cutting and pasting work** from electronic media; do not fail to attribute the work to its source. If authorship of the electronic source is not given, ask yourself whether it is worth copying;
- don't memorise substantial blocks of text in lieu of essay answers;
- tailor your answer to the question being asked.

Please note that during written answers for unseen examination papers, you will not be penalised for failures to reference information in this manner.

The Golden Rule

The examiners must be in no doubt as to which parts of your work are your own original work and which are the rightful property of someone else.

Marking and classing criteria for the written papers are described in a document prepared by the Faculty Board. These are available at (Raven authentication required): https://www.biology.cam.ac.uk/file/markschemebbs21-22fbbapproved070222pdf-0

Transferable skills

All undergraduates are expected by the University to graduate with a number of transferable skills. Many aspects of the Pharmacology course are relevant to general skill acquisition. These include:

Intellectual	developed in practical classes, lectures and supervisions
Communication	written and oral skills are developed in practical classes and essay work
Organisational	managing workload and revision
Inter-personal	group work is carried out in the practical classes and in supervisions
Numeracy practical	work and the practical examination
Computer literacy	computer aided learning

Queries with respect to NST1B Pharmacology Course

Queries in respect to the NST1B Pharmacology Course can be directed to any teaching officer in the Department. Alternatively, you may wish to contact the Course Organiser: Dr Walid Khaled, or via e-mail: wtk22@cam.ac.uk.

Section 2– Practical Course Information

Pharmacology is an experimental subject. You cannot claim to understand the subject without a good idea of how data are obtained. The practicals, demonstrations and seminars in this course have been prepared with two objectives in mind:

1. They are intended to teach basic pharmacology in an interactive manner,

2. They provide an introduction to the experimental basis of the subject.

How to get the most out of the practical course.

This depends primarily on the amount of effort you are prepared to put into it. In the practicals you are asked to display some manual dexterity but, more importantly, you are asked to think. Your time and effort will be much better spent if you read through the description of the experiment or demonstration before coming to the class. Take advantage of the demonstrators to make sure that you understand fully the principles that are being demonstrated. If, subsequently, you discover a point you find obscure, ask.

Preparing for the Pharmacology Practical Paper

While lectures are your best guide to the Theory Paper, they are not an adequate preparation for our Practical Paper. The questions in the practical paper require you to use numerical data and other information to work out the answers. Note: (1) There are two compulsory questions – so if one is particularly difficult it is likely that it will be difficult for everyone else as well. (2) You cannot acquire the skill required to answer these practical questions by sitting in lectures and reading books. You need to practise. It is imperative that you spend time with your ***college supervisors*** to prepare yourselves adequately for the Practical Paper.

Drug Research Project

During Lent term students will take part in a drug review project. Each student will select a drug from a list that will be provided at the start of Lent term and they will spend few practical sessions ***(see practical timetable for details)*** researching different aspects of the drug and then prepare a short presentation**.** Students will then present their slides ***(3 minutes max)*** and record the presentation as a short video. The submitted recording will be assessed by the examiners. All students will get an opportunity to submit a draft version of their presentations for feedback from a UTO. There will be an opportunity at the end of term to view the video submission of others on the course however, this will be ***optional*** and will not go towards the marks for the project. This exercise will give the students an opportunity to research a topic in depth and introduce them to presenting their findings in a succinct manner. ***There will be prizes for the top three videos as voted for by your peers.*** Full details of how the drug review project will run will be described by the course organiser. Examples of the final videos/presentations can be found on the course Moodle website.

Lt

Most of the practical sessions are carried out in Lt, the web-based application we use in the teaching laboratory. Before the day of your first allocated practical, you will receive an invitation to access Lt. You will need to create a password using your university email. This password will be needed to access future practicals in the lab and also online (for those students who might need to do the practical remotely) so, please, make sure you remember your Lt details. See Appendix B for more information about Lt and on how to login to Lt individually and as a group.

Queries/ comments about this Practical Course

To produce an educational and enjoyable course, we constantly look into ways to improve the practicals, demonstrations and seminars. Your views do matter in the development of pharmacology teaching in Cambridge. Please feel free to contact the Course Co-ordinator, Dr Walid Khaled, wtk22@cam.ac.uk.

General points on procedures in the laboratory

An introduction will be given in the laboratory before the class. You must ensure that you arrive on time. Introductory material and a preparatory quiz will be made available on Moodle a week in advance of each

practical. You should ensure that you engage with this material in advance of coming to the practical.

Pracitcal classes are timetabled until 5pm and you should not schedule any other commitments that could clash. Take into account travelling time when planning your evening supervisions. At the end of each practical session, you will be asked to discuss your results with a demonstrator before being successfully registered as having completed the class. Trying to get signed off early on the basis that you have a supervision or rowing will not be acceptable. Completing the preparatory reading and quizzes will help you make efficient progress through the class and finish in good time. When both classes have finished the practical class, debrief material and a consolidatory quiz will become available on Moodle.

REMEMBER – SAFETY FIRST! You are required to comply with all rules and procedures laid down to ensure safety in the laboratory. These include the requirement that you wear shoes adequate to protect your feet. Open-toed shoes are inappropriate. You must wear a laboratory coat to protect your clothes from spillage and contamination. Laboratory coats are not supplied, you should bring your own or use plastic aprons provided to you. Any special safety equipment supplied to you should be used (e.g., gloves, aprons, safety glasses, etc.).

If you have any questions or concerns do not hesitate to speak to a demonstrator.

Practical Timetable

Practicals: Tues. or Wed. afternoons 2 pm

Classes will be held in the Department of Pharmacology, Tennis Court Road; Practicals (P) in the Teaching Laboratory, on the ground floor.

Michaelmas Term 2023

Date	Topic
11, 12 Oct.	Online binding affinity (Dr Millington-Burgess)
18, 19 Oct.	Dose ratios (Dr Millington –Burgess)
25, 26 Oct.	Saturation binding assay (Prof Ladds)
01, 02 Nov.	Competition binding assay (Prof Ladds)
08, 09 Nov.	Binding analysis and Exam Question (Dr Millington-Burgess)
15, 16 Nov.	Experimental Design Workshop – Transmural (Dr Millington-Burgess)
22, 23 Nov.	Transmural (Dr Millington-Burgess)
29, 30 Nov.	Antibiotics (Prof Van Veen)

Lent Term 2023

Date	Topic
24, 25 Jan	Pharmacokinetics material (online – Dr Harper)
31 Jan,01 Feb	Drug review week 1
07, 08 Feb	Drug review week 2
14, 15 Feb	Simheart (online only – Dr Millington-Burgess)
21, 22 Feb	Drug review week 3
28 Feb, 01 Mar	Experimental Design Workshop – Extended Investigation (Dr Millington-Burgess)
07, 08 Mar.	Extended Investigation (Dr Millington-Burgess)
14, 15 Mar	Drug Review viewing

Appendices

These appendices should help you to use the equipment you are supplied with, as always, if in doubt see a demonstrator.

Contents:

Appendix A (pp i-ii): Instructions on the use of the Gilson Pipette
Appendix B (pp iii): Instructions on the use of the Lt Software

Appendix A: Instructions on the use of the Gilson Pipette

Gilson Pipettes are an accurate way of measuring small volumes and are simple to use after a little practise.

They should always be used with the appropriate tip (see below) and are colour-coded to make this easy. Those with a blue circle on the top (1000 µl) use blue tips, those with a yellow circle on the top of the plunger (20 and 200 µl) use yellow tips.

Before fitting the tip adjust the reading on the side to reflect the amount you want to pipette by twisting the black nut or white head in the appropriate direction. The numbers are read from the top towards the tip and reflect different values depending on the size of pipette being used.

A 20 µl pipette will have two numbers in black corresponding to tens and units and a third in red for decimal points (e.g. 1-0-0 = 10.0 µl).

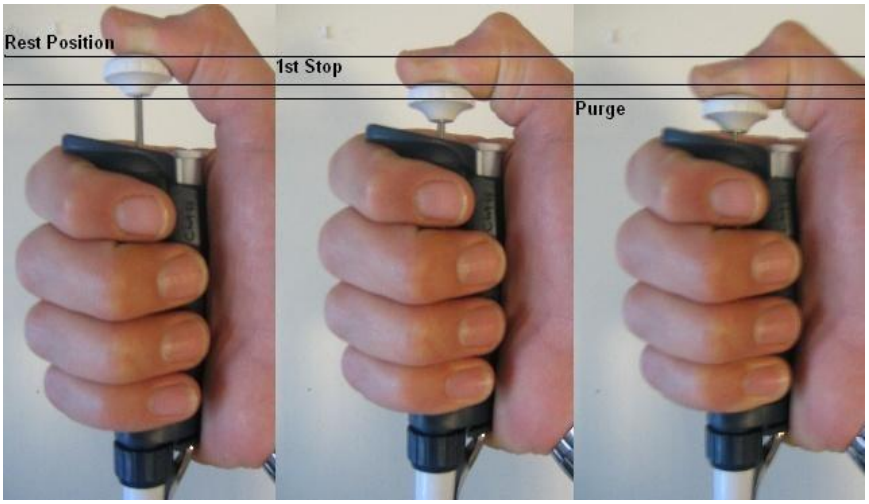
A 200 µl pipette will have three numbers in black corresponding to hundreds, tens and units (e.g. 1-0-0 = 100 µl)

A 1000 µl pipette will have 1 number in red corresponding to thousands and two numbers in black corresponding to hundreds and tens (e.g. 1-0-0 = 1000 µl)

They should never be used above their maximum stated volumes and the most appropriate pipette for the volume required should be used to ensure accuracy.

After setting the volume and fitting the tip there are five easy steps to using them:

1. Preparation: Hold the instrument in a vertical position and depress the plunger smoothly to the first stop



(see below).

2. Aspiration: Immerse the pipette tip in the liquid and allow the plunger to slowly move back up to the rest position. Wait one second to make sure all the liquid has entered the tip.
3. Distribution: Place the pipette tip at an angle (10-45^{o}) against the inside wall of the receiving vessel. Depress the plunger to the first stop position.
4. Wait one second then depress the plunger to the second stop. This “blow-out” stroke removes any remaining sample from the tip. Keeping plunger depressed remove the pipette by sliding the tip up the sidewall of the vessel.
5. Finally allow the plunger to return to the rest position and, using the second white button, expel the used tip into an appropriate receptacle.

Appendix B – Lt Labstation

You will use Lt when carrying practicals both remotely and in the lab.

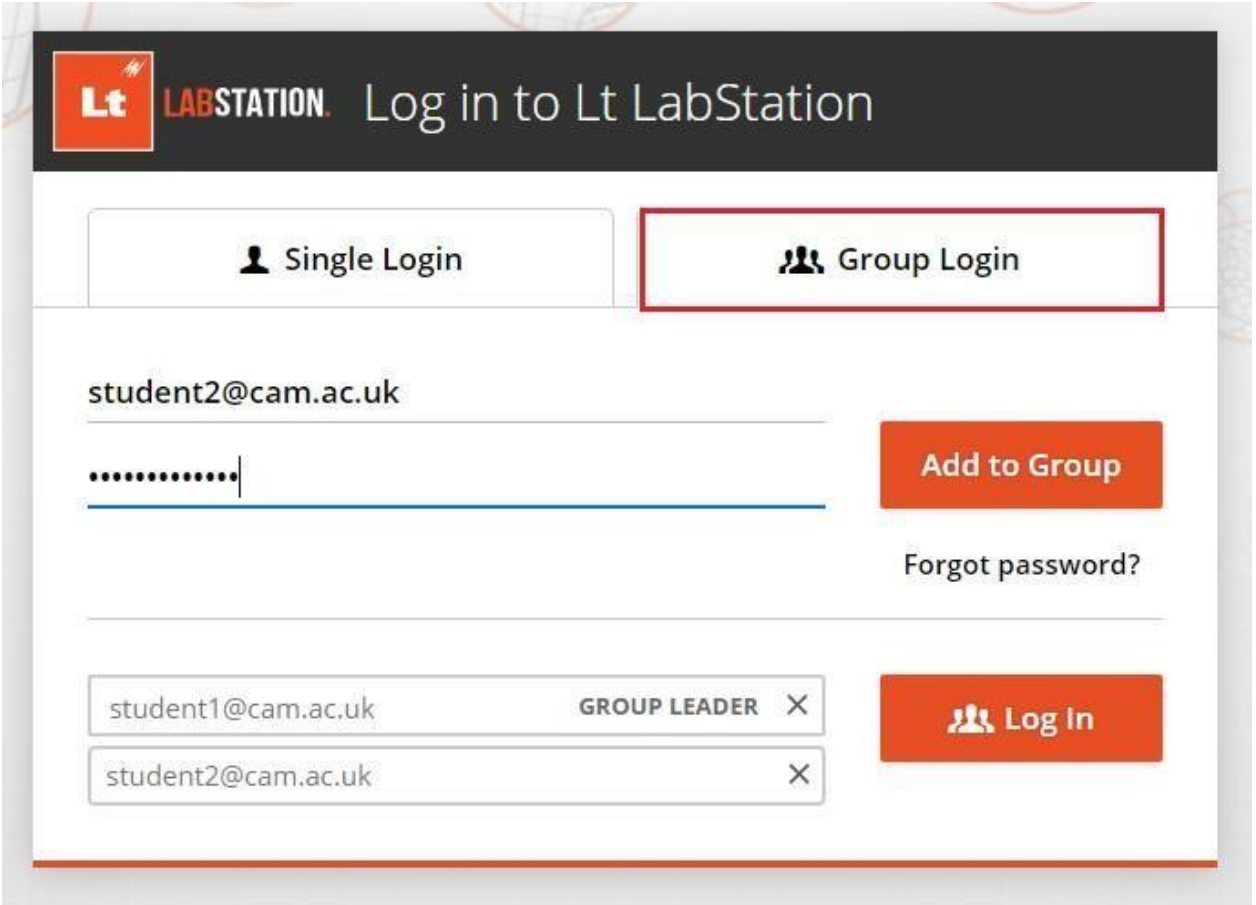
Instructions on how to login to Lt in the teaching laboratory

You will be working in groups of two students in the lab. You should access the application as group by following these simple steps:

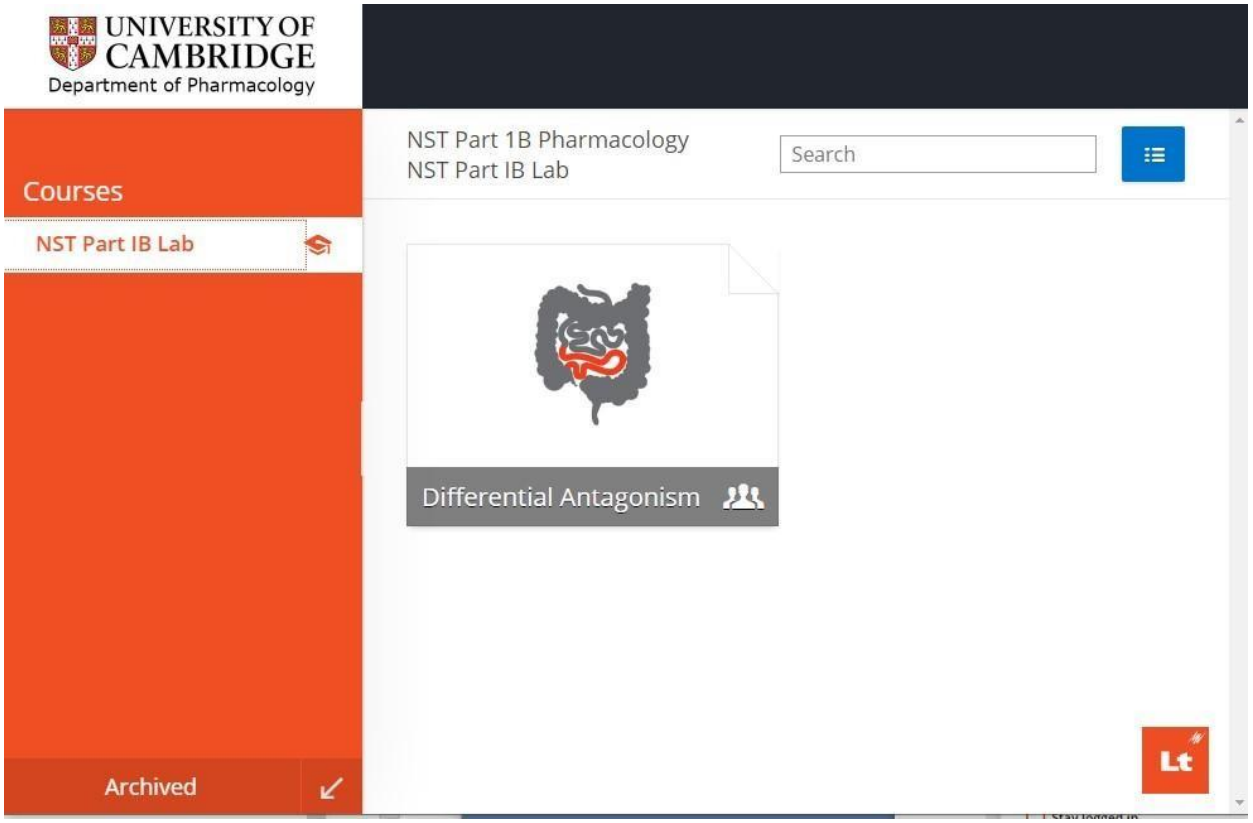
Click on the "Group Login" tag if hasn't been done already. See screenshot below.

Enter your university email and password, which you would have previously created after receiving the Lt Invitation at the start of Michaelmas term.

Click on the "Add to Group" button after entering your email and password. The first student added will appear as Group Leader.
Repeat the same steps described above for the second student. Then click on the "Log In" button once all members of the group have been added.



Select the NST Part IB Lab course and click on the practical available. See screenshot below.



Instructions on how to login to Lt from home or college

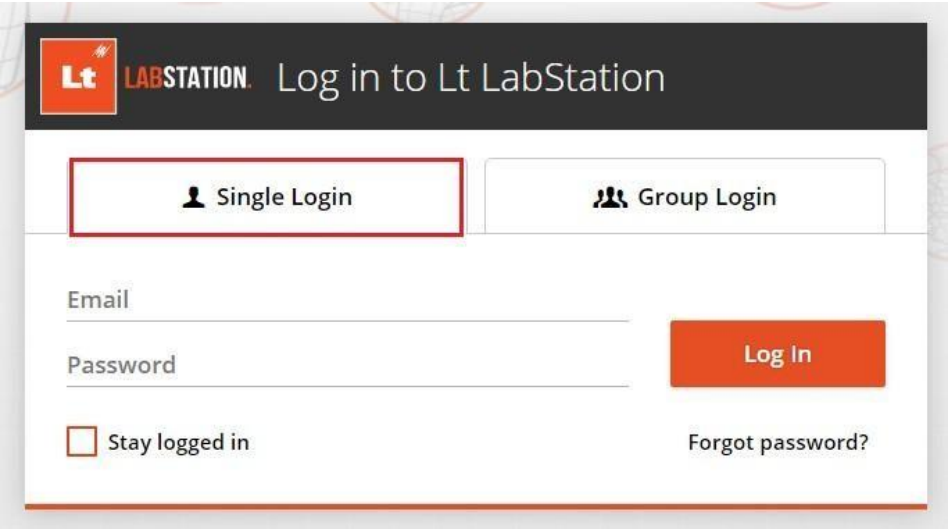
You will normally work individually if you need to attend a practical online. In this case, please follow these steps:

Click on the link you will be provided with.

Click on the "Single Login" tag. See screenshot below.

Enter your university email and password, which you would have previously created after receiving the Lt Invitation at the start of Michaelmas term.

Click on the "Log In" button.



Instructions and introductory videos are provided with each practical to guide you through the virtual practical

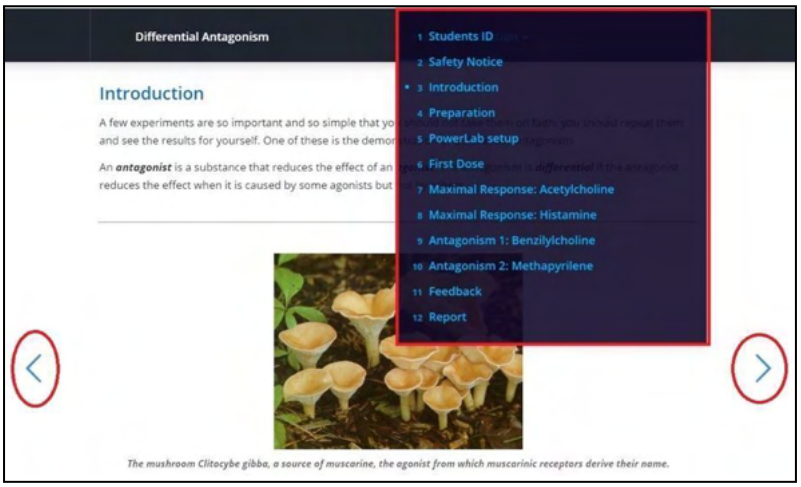
session. You will be provided with data previously recorded in the laboratory.

You will have the best experience when using Google Chrome, we recommend this browser wherever possible. If Google Chrome is not installed on your computer, you can download it from the official website:

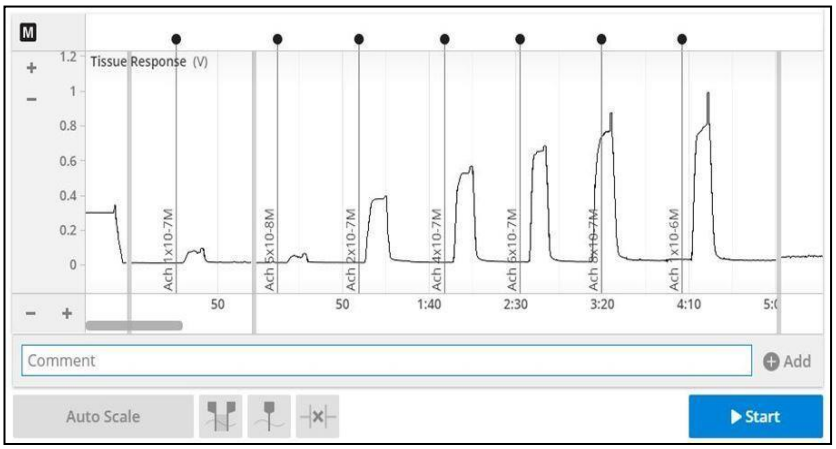
https://www.google.co.uk/intl/en_uk/chrome/

Instructions on how to login to Lt in the teaching laboratory

Experiments are divided into separate pages which should be followed sequentially using the arrow symbols at both sides of the screen (see below, circled in red). To jump straight to a particular page, use the drop down menu (at the top of the page) and select the desired page from the list (see below).



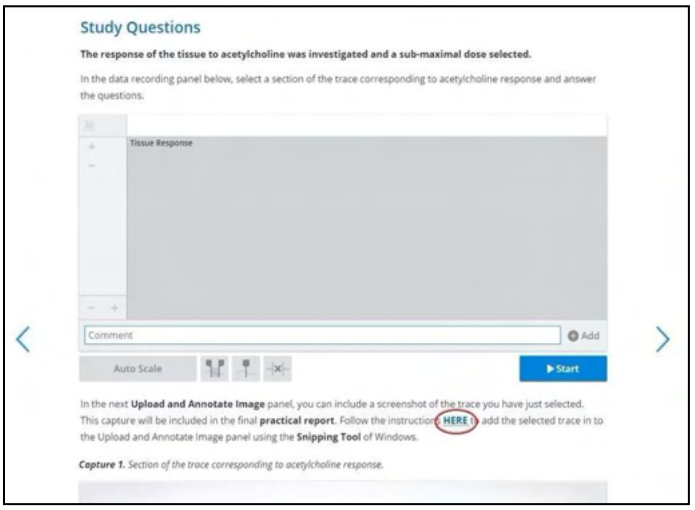
Full instructions are provided at each stage of the experiment to assist you in carrying out the required procedures. Some extra information or instruction can be accessed by clicking on words highlighted in blue, as for a normal hyperlink, which will bring up pop- up pages. Data are recorded and analysed using the data recording panel (see below).



Data can be collected (Start), analysed (Stop), and rescaled (Auto Scale), or scrolled through using the various buttons on the data recording panel (see above). Instructions and videos on how to do this are in the program itself. Moving the cursor across the trace displays values at the selected point. Use the comments box (see above) to record experimental notes on the trace; click in the box, enter text and press [ENTER] or click “Add” to insert the comment on the trace. Pausing the trace using the Stop button on the bottom right will allow comments to be selected and edited. Clicking on the trace, while paused, where a comment needs to be inserted and entering it is usual will insert it at the selected point. Sometimes data are required to be entered in a table. This functions as a normal spreadsheet and data can be directly entered/edited, unless the column is shaded in which case the data in that column is protected. Data displayed in “Value” panels can be dragged directly into a cell in a table.

Throughout the practical, you will find questions that relate to the experiment/page completed. To answer some of these questions you have to select sections of the trace by using the Snipping Tool of Windows.

Instructions on how to use the Snipping Tool are available in the Study Questions section (see below). This also includes a demonstration video.



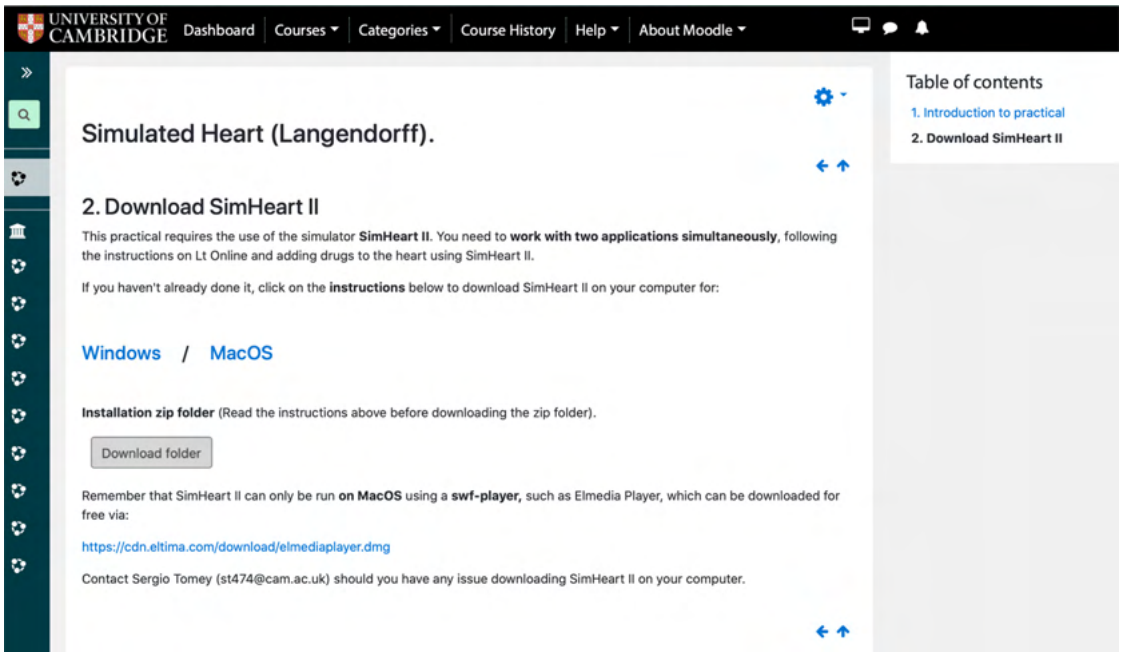
You will be assisted by demonstrators, ask them should you have any questions.

Appendix C

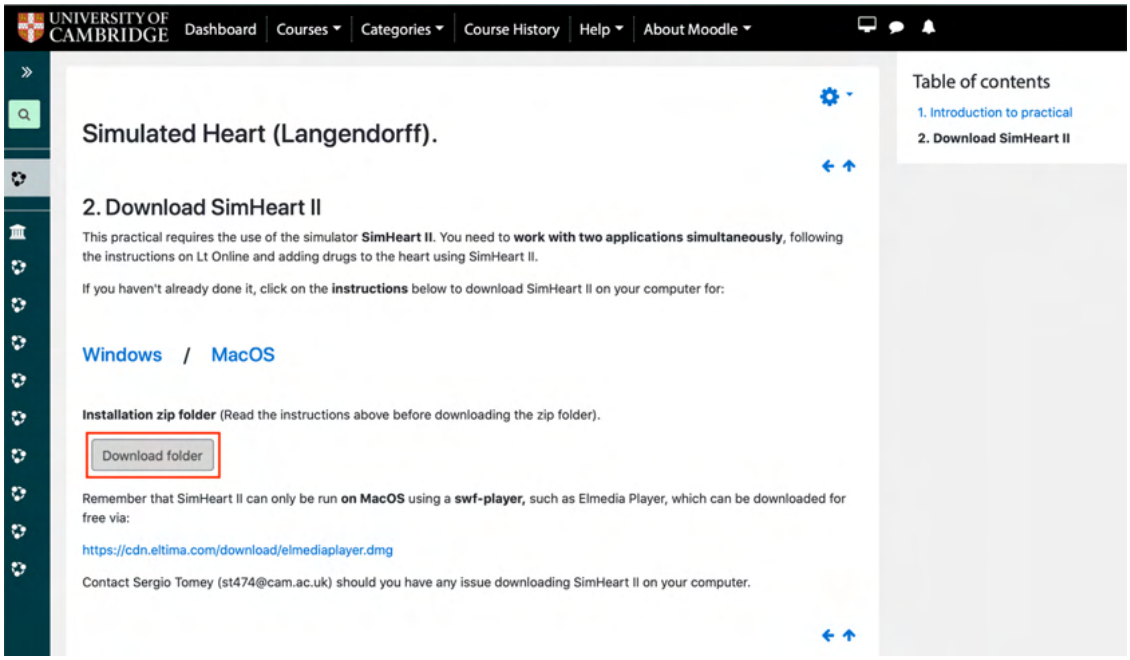
Download information for SimHeart II simulator for practical: "Langendorff isolated perfused heart Online"

(Download Links and Installation Information for Windows)

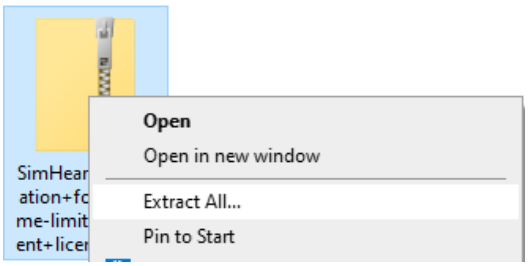
1. Log in to your **Moodle course**.
2. Follow **Practicals** > **Simulated Heart** (Langendorff) > **Download SimHeart II**.



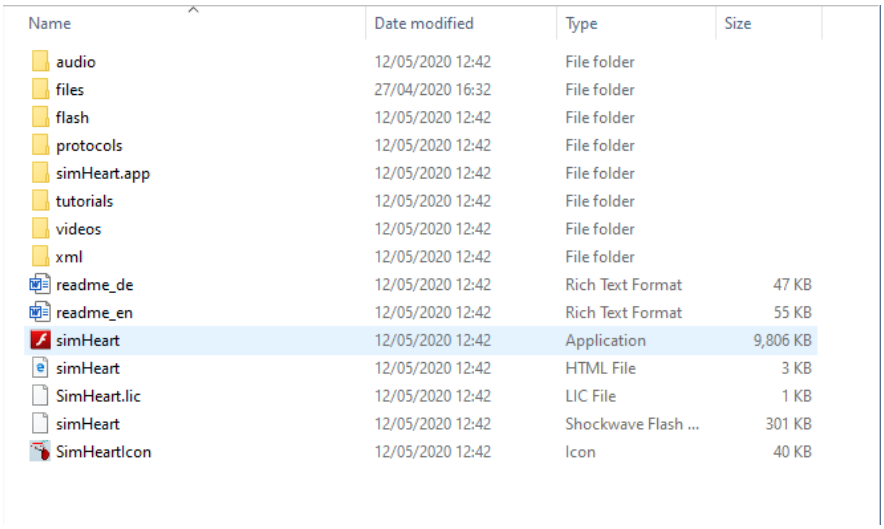
3. Download the installation **.zip folder** by clicking on "Download folder"..



4. Save and **unzip** (Extract All) the .zip folder you have downloaded.

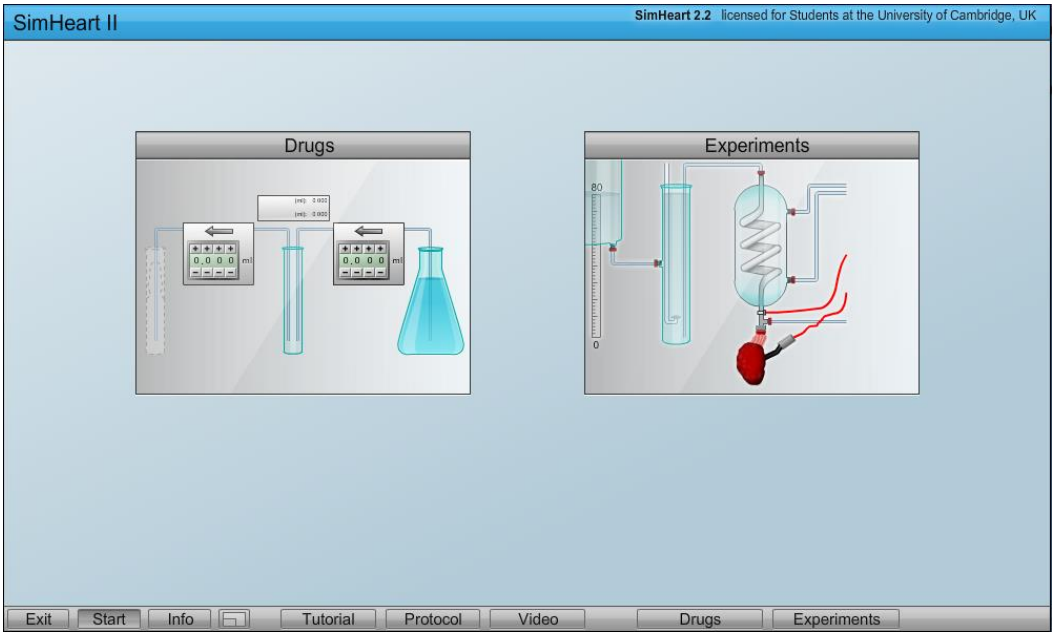


5. Open the folder you have generated and start the simulator via the **SimHeart.exe** file.

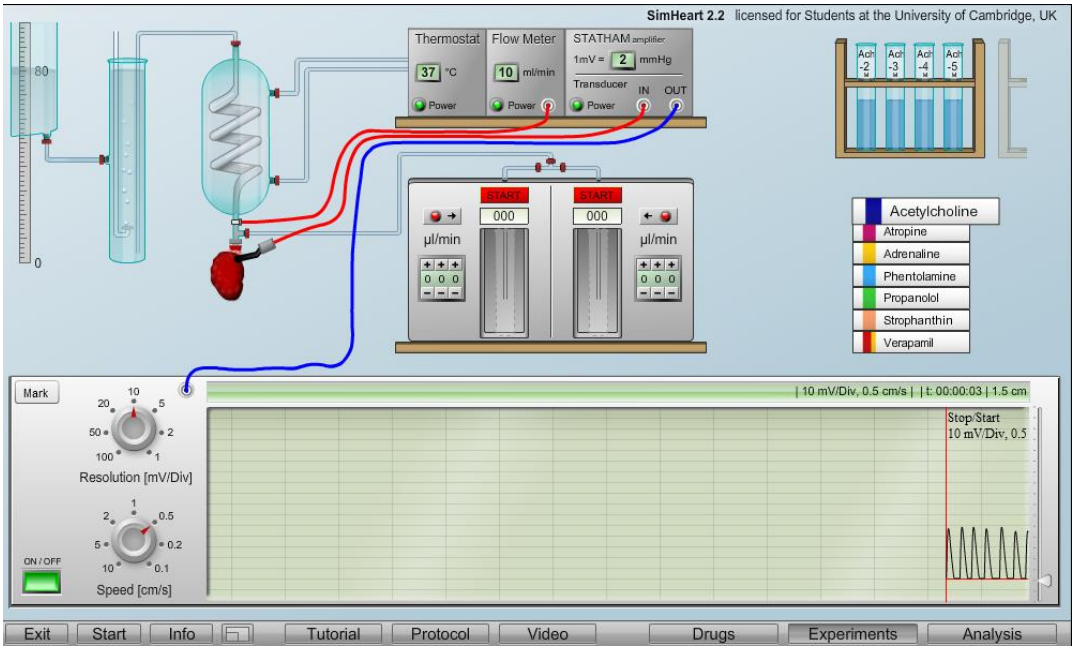


Name	Date modified	Type	Size
audio	12/05/2020 12:42	File folder	
files	27/04/2020 16:32	File folder	
flash	12/05/2020 12:42	File folder	
protocols	12/05/2020 12:42	File folder	
simHeart.app	12/05/2020 12:42	File folder	
tutorials	12/05/2020 12:42	File folder	
videos	12/05/2020 12:42	File folder	
xml	12/05/2020 12:42	File folder	
readme_de	12/05/2020 12:42	Rich Text Format	47 KB
readme_en	12/05/2020 12:42	Rich Text Format	55 KB
simHeart	12/05/2020 12:42	Application	9,806 KB
simHeart	12/05/2020 12:42	HTML File	3 KB
SimHeart.lic	12/05/2020 12:42	LIC File	1 KB
simHeart	12/05/2020 12:42	Shockwave Flash ...	301 KB
SimHeartIcon	12/05/2020 12:42	Icon	40 KB

6. The simulators should be opened as below.

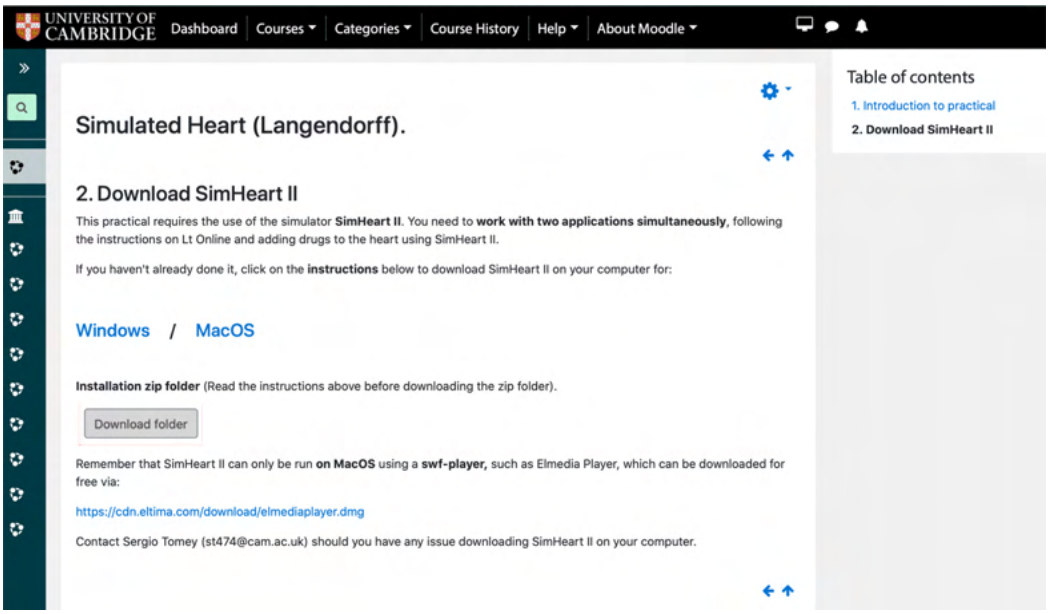


7. Click on the Experiments box to **start the simulation**, which will appear as follow.


SimHeart 2.2 licensed for Students at the University of Cambridge, UK
Thermostat
37 °C
Power
Flow Meter
10 ml/min
Power
STATHAM amplifier
1mV = 2 mmHg
Transducer
Power
IN
OUT
START
000
µl/min
START
000
µl/min
Acetylcholine
Atropine
Adrenaline
Phentolamine
Propanolol
Strophanthin
Verapamil
Mark
Resolution [mV/Div]
Speed [cm/s]
ON / OFF
| 10 mV/Div, 0.5 cm/s | | t: 00:00:03 | 1.5 cm
Stop/Start
10 mV/Div, 0.5
Exit
Start
Info
Tutorial
Protocol
Video
Drugs
Experiments
Analysis

(Download Links and Installation Information for MacOS)

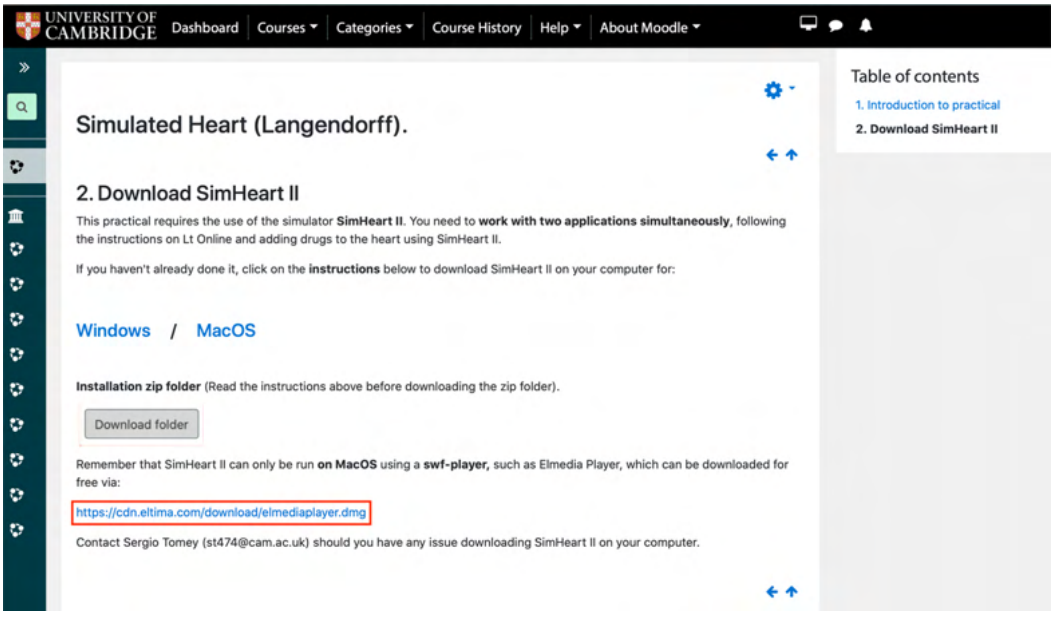
1. Log in to your **Moodle course**.
2. Follow **Practicals** > **Simulated Heart** (Langendorff) > **Download SimHeart II**.



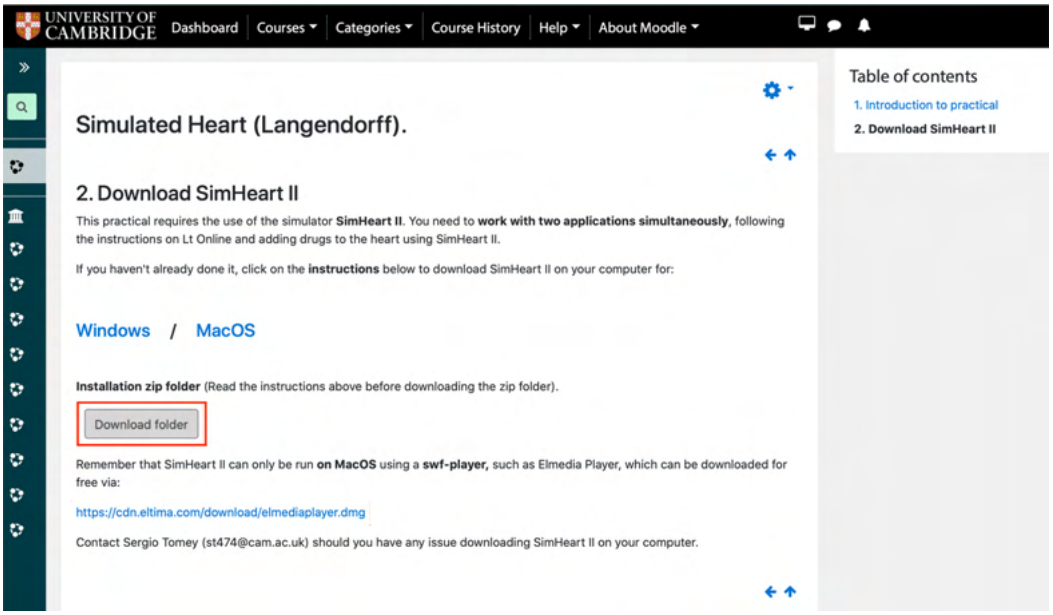
3. SimHeart II can only be run on MacOS using a **swf-player,** such as Elmedia Player, which can be downloaded for free via:

   https://cdn.eltima.com/download/elmediaplayer.dmg

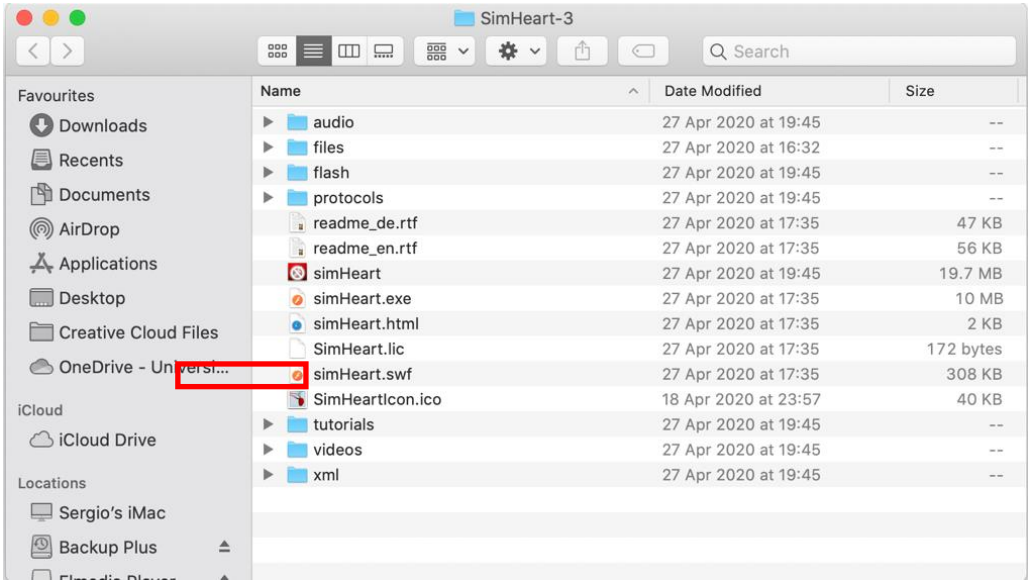
   You can also find this link in the Simulated Heart (Langendorff) page on Moodle.



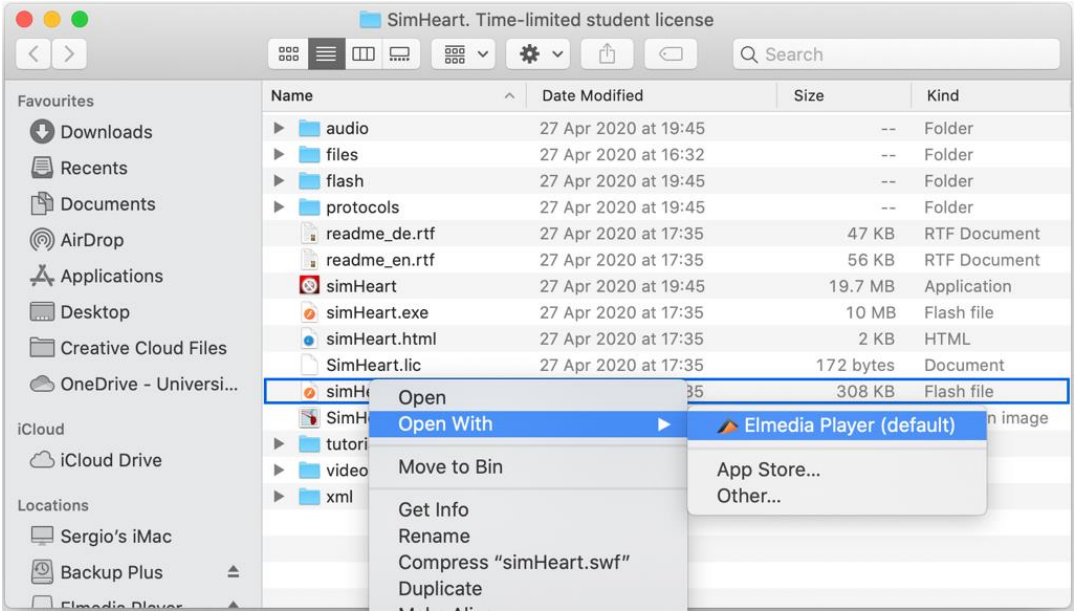
4. After downloading the swf-player (Elmedia Player), download the installation **.zip folder** by clicking on “Download folder”.



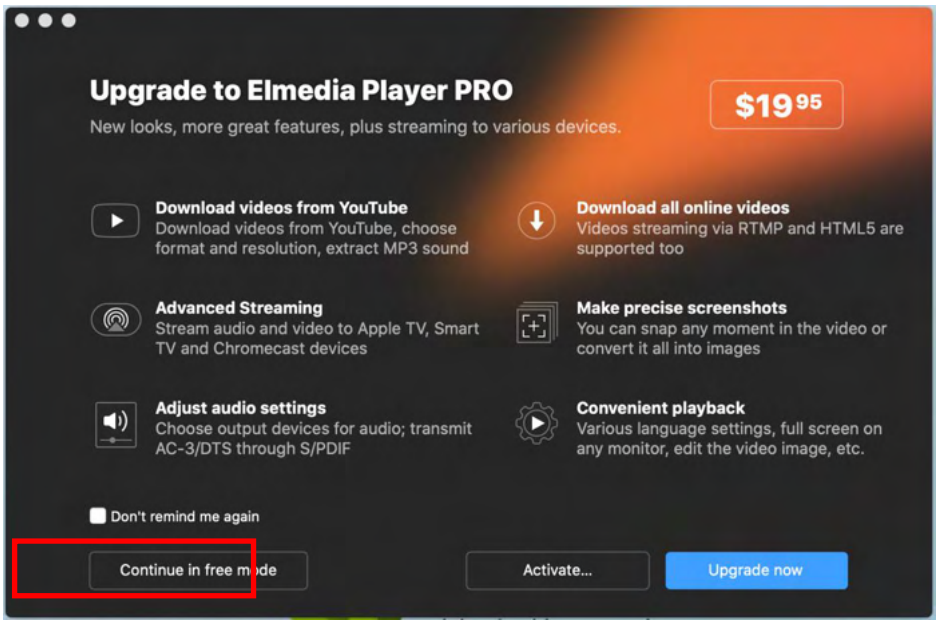
5. Open the .zip folder you have downloaded. Under “protocols” you will find the **SimHeart.swf** file.



6. To **open the simulator**, right mouse or double click on the SimHeart.swf file, select “Open With” and click on Elmedia Player.

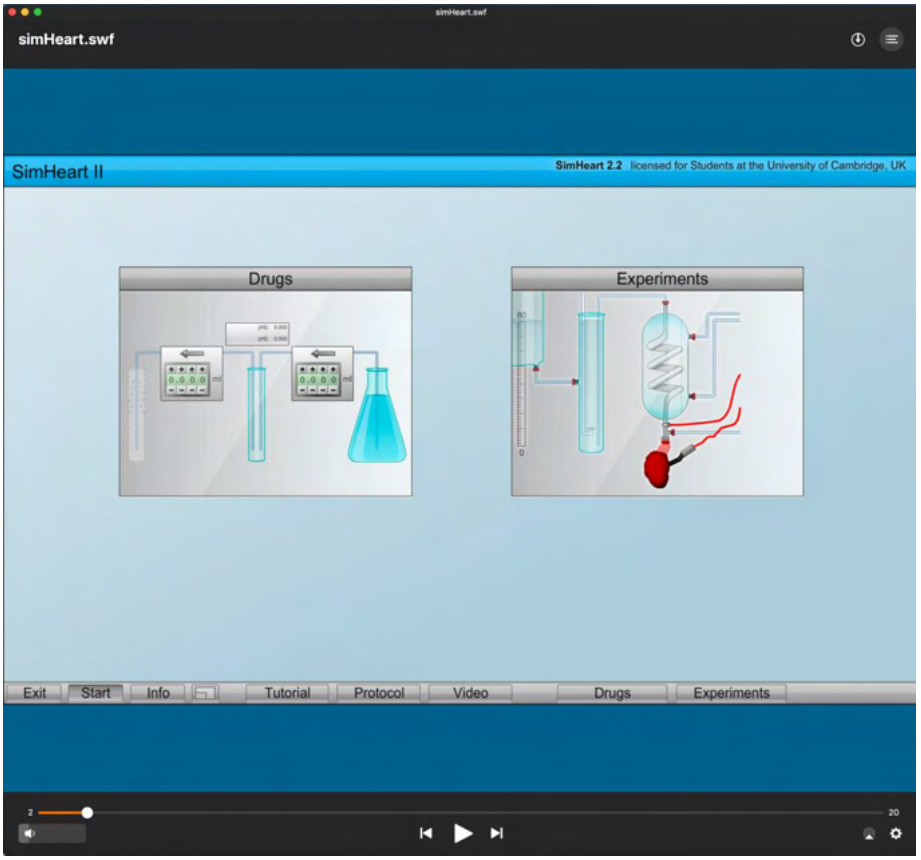


7. You will find the following window. Click on **"Continue in free mode"**.

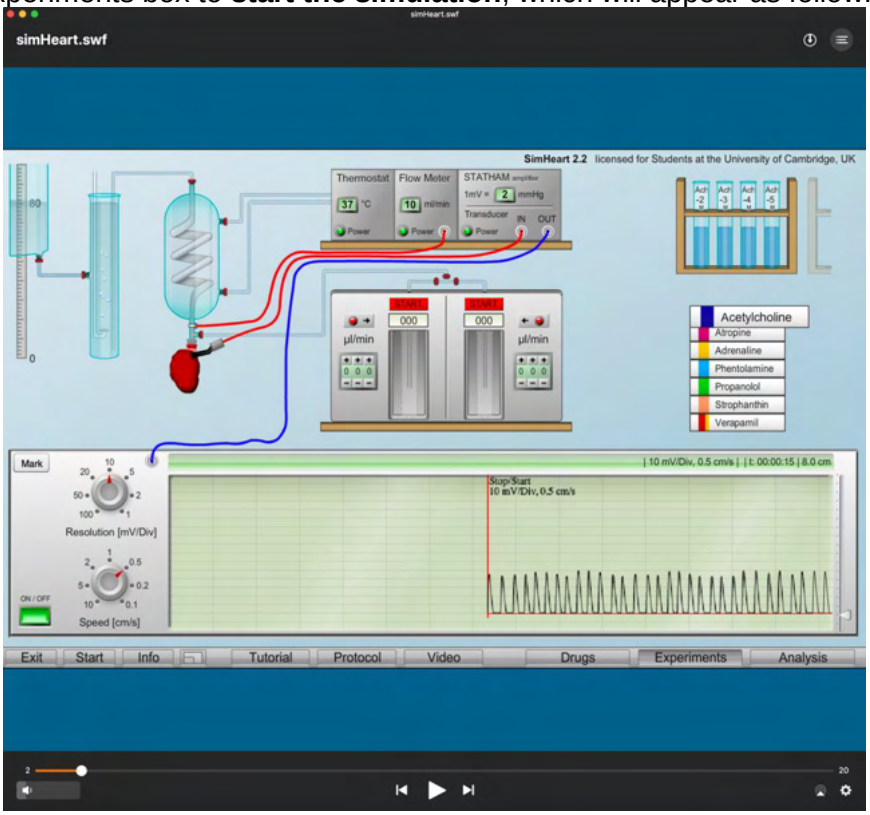


8. You may also find the following windows. Click on **"open"** and **"OK"** respectively.

9. The simulators should be opened as below.



10. Click on the Experiments box to **start the simulation**, which will appear as follow.



IMPORTANT: To play SWF files on Macs with a Silicon M1 Chip follow the instructions in the link below:

https://wiki.eltima.com/knowledge-base/elmedia-player-mac/play-swf-on-mac-with-m1.html

Or use the HTML5 version of SimHeart II (works with all devices!)

Alternatively, you can use the **HTML5 version of SimHeart**, which also works with **tablets and iPads**. Please, note **Internet connection is needed** to use the HTML5 version of the simulator.

https://www.virtual-physiology.com/licensedprogram/?program=SimHeart

Clicking on the link above will open a window with an input field where you shall **add the string below**, which you just need to copy and paste.

FAED970FEBEF06C396FA18C20A060E3B07BEFD0904B59EAC989524413A400F0C0AC0C7EAFE5B7835F9A47BFD11AFF606BB150AF39BD12F04CDF7FB02A8BB477B2E09301F1638E2EDE5BDDF8C6B4F0771514BC8C9CDC3

Contact Sergio Tomey (st474@cam.ac.uk) should you have any issue downloading SimHeart II on your computer.