Imperial College
London

Department of Life Sciences

Final Year Biochemistry/Biotechnology Handbook 2018/19

Life Sciences Education Office

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Dates of term 2018-2019

- **Autumn Term**: Saturday 29 September to Friday 14 December 2018
- **Spring Term**: Saturday 5 January to Wednesday 22 March 2019
- **Summer Term**: Saturday 27 April to Friday 28 June 2019

Disclaimer

The information given in these notes is current at the time of distribution/printing, but may be subject to alteration. The Department reserves the right to cancel a course or course component if it is not sufficiently well supported.

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Aims and Objectives

The final year of study for the Biochemistry and Biotechnology degrees introduces students to the latest advances in specialised areas and it will enable students to understand the experimental basis of biochemical knowledge. There is emphasis on the scientific literature, recent progress and breakthroughs, techniques, the interpretation of experimental results and the application of biochemical expertise to medicine and industry. Several courses have strong biotechnological themes. In each of the optional courses students should become aware of the limits of our knowledge in specialist areas and how recent research is impacting upon those limits. In this way, you should become familiar with research objectives. Your practical and transferable skills should benefit greatly from the research oriented approach of the teaching and in particular from the final year research project. In addition, high expectations on independent learning are placed upon students in the final year.

Your performance in the final year will depend on knowledge gained in the first and second years. Also, the overall mark awarded for your first and second year assessments will be used directly to calculate a mark for your overall degree.

Course Selection

You will now have been notified of the courses you have been allocated by email. Requests for a change in course should be made by submitting a change of course selection on Blackboard before the deadline for the appropriate module and after discussion with appropriate members of staff. Every effort will be made to accommodate such requests. **No change in course selection will be considered after the deadline.**

Degree Registration: Biochemistry and Biotechnology

Students registered for Biochemistry degrees will usually be able to re-register for Biotechnology degrees, and vice versa after consultation with the academic staff.

In the final year, students registered for degrees in biotechnology are expected to take course options that involve strong elements of studies of biotechnology. Each final year course offered to students is assigned a points value to indicate the biotechnology content with a maximum of 5 points assigned. Normally students should be taking courses which give a total biotechnology value of at least 8 points from the 3 courses taken (see Grid). If they wish to take courses with a total biotechnology value of less than 8 points, they normally will be expected to have their degree registration changed to the appropriate biochemistry title.

Please consult your Personal Tutor if you have any questions concerning this arrangement.

Please make sure that the Life Sciences Education Office is aware of any change in your degree registration. Please note that changes in degree registration can be made anytime up to the 1st of March in your 3rd year. A form to be filled in for the change in degree registration is given at the end of this booklet.

Degree Registration: Joint Honours with Management

The Biochemistry with Management degrees involve the first two years or all three years of study on the Biochemistry degree followed by the final year in the Business School. This final year gives students the opportunity to gain experience and insight into the management and operating environment of business organisations. Changes in degree registration involving the Management degree are possible and need to be made by March 1st of the your 3rd year in order to be considered.

Details of the Business School can be found here: http://wwwf.imperial.ac.uk/business-school/programmes/undergraduate/joint-honours-and-intercalated-bsc-programme/

Changes in Degree Registration

If you wish to change your degree registration you must complete a Change of Degree Registration form, available from the Education Office or on Blackboard in the Life Sciences General portal. Please make sure that your Personal Tutor is aware of any changes that you wish to make. Please note that changes in degree registration must be made anytime up to the 1st of March in your final year.

Projects

There will be a specific meeting early the Spring Term to discuss the arrangements for projects. You will be given a wide range of project titles and be required to choose eight of these. You will then be assigned to a project.

Please note that you will not be allocated to a project to be carried out in a laboratory where you have worked previously.

Important Information

Important information regarding your degree can be found in LifeSci Central - Your first stop for Life Sciences information on Blackboard. It includes the Scheme for Honours, Marking Criteria, Placement/Joint Honours Handbooks and the Mitigating Circumstances and Change of Degree forms. There is also information regarding careers, the minutes from the Student Staff Committee meetings, exam timetables and advice on using the college computer systems.

Final Year Biochemistry and Biology Degrees Grid 2018-19

Term	Week	Date	Biochemistry students take priority		Open to all students (with equal preference given to both streams)						Biology stream only	
Autumn Term	1	3rd Oct – 2nd Nov	Damage & Repair in Biol. Systems (Gounaris) 1	Structural Biology & Drug Design (Matthews) 4	Stem Cells, Regeneration & Ageing (Hall) 1	Metabolic & Network Engineering (Jones) Mi 5	Neuroscience Research (Djamgoz) 1	Medical Microbiology (Filloux) Mi 2	Plant Biotechnology & Development (Sena) 4	Principles of Development (Abzhanov/ Barkoulas) 1	African Biology Field Course (Savolainen) Ec	Population & Community Ecology (Banks-Leite) Ec
	2											
	3											
	4											
	5											
	6	5th Nov – 9th Nov	Reading week									
	7	12th Nov – 14th Dec	Cancer (Mann) 2	Mechanisms of Gene Expression (Weinzierl) 3	Advanced Bacterial & Eukaryotic Cell Biology (Beeby & Baum) Mi 1	Integrative Systems Biology (Endres) 5	Adv Topics in Parasitology & Vector Biology (Crisanti) 2	Symbiosis, Plant Immunity & Disease (Bidartondo) Mi Ec 1	Adv Topics in Infection & Immunity (Christophides) Mi 2	The Microbiome (Bell) Mi Ec 2	Evolutionary Applications (Koufopanou)	Biodiversity & Conservation Biology (Tobias) Ec
	8											
	9											
	10											
	11											
Spring Term	12	7th Jan – 9th Jan	Exams									
	13	14th Jan – 15th Feb	Medical Glycobiology (Drickamer & Taylor) 4		Mol Basis of Bacterial Infection (Frankel) Mi 3	Bioinformatics (Pinney & Stumpf) 4	Synthetic Biology (Baldwin) Mi 5	Systems Neuroscience: Exploring the Brain in Health & Disease (Brickley) 1		Biodiversity Genomics (Leroi) Ec 2	Advanced Immunology (Brady) Mi 1	Global Change Biology (Woodward) Ec
	14											
	15											
	16											
	17											
	18	18th Feb – 22nd Feb	Revision & Exam									
	19	25th Feb – 22nd Mar	Research Projects (continue after Easter) or Science Communication									
	20											
	21											
	22											
Summer Term	23	29th April –7th June	Research Projects (continued from Spring term) or Dissertation Projects									
	24											
	25											
	26											
	27											
	28											
	29	10th Jun – 14th Jun	Project vivas									
	30											
	31	24th Jun – 28th Jun	Final Moderation									

Absence from college

It is expected that students attend all lectures, practicals and tutorials. Students whose attendance and/or progress is unsatisfactory without good reason will be asked to withdraw from the College.

Absence of more than one day, or absence from a practical session, must be notified to the Life Sciences Education Office. A valid, recent, medical certificate from a recognised practitioner, is required when absence because of illness exceeds one week or if you are absent from more than one consecutive practical session. If part, or the whole, of an examination is missed through illness, a medical certificate will be needed as soon as possible.

Absence from a practical session without good reason will result in deduction of marks. It is equally important to note that punctual arrival at practicals is extremely important. It is usual for the lecturer in charge to devote time at the beginning of a practical to introducing the work and explaining safety issues. If you miss the beginning of the practical you might not be allowed to take part in the practical and consequently receive a zero mark for the assessment.

If you think you will be unable to attend an examination for medical or another valid reason, you must ensure that the Life Sciences Education Office is informed immediately. Documentary evidence of the reason for absence can be provided later.

Mitigating Circumstances

If you miss an examination through illness, you must complete a mitigating circumstances form and send it along with a medical certificate to the Life Sciences Education Office within one week of the missed exam. You should email the Education Office before the start of the exam and see a doctor on the same day to get the medical certificate.

If you miss any part of a course, and especially if you can't submit coursework, through illness or other personal issues you must notify the Life Sciences Education Office before the deadline by completing a mitigating circumstances form and emailing it to biochemistry.ug@imperial.ac.uk

This information is required to avoid penalties for late hand in of work and importantly for second and third year moderation in cases of more serious disruption to your work. All information will be kept to the minimum number of people within the Life Sciences staff but you must state if the information is to be kept completely confidential. It is also advisable to keep your personal tutor informed of any issues that may affect your performance.
Please do not contact the course convenor directly regarding extensions or absence from other sessions. Once you have submitted the form it will be sent to the convenor by the Education Office for a suitable extension to be decided upon

For further information on Mitigating Circumstances and Absence please use the below link:

http://www.imperial.ac.uk/physics/students/current-students/student-welfare/mitigating-circumstances/

Academic Integrity and Academic Misconduct

As your programme of study continues, you will be taught the concept of academic integrity and how you can ensure that any work that you complete now, or in the future, conforms to these principles. This means that your work acknowledges the ideas and results of others, that it is conducted in an ethical way and that it is free from plagiarism.

Academic misconduct is the attempt to gain an academic advantage, whether intentionally or unintentionally, in any piece of assessment submitted to the College. This includes plagiarism, self-plagiarism, collusion, exam offences (cheating) or dishonest practice. Full details of the policy can be found at:

www.imperial.ac.uk/student-records-and-data/for-current-students/undergraduate-and-taught-postgraduate/exams-assessments-and-regulations/plagiarism-academic-integrity--exam-offences/

Definitions of the main forms of academic misconduct can be found below:

Plagiarism

Plagiarism is the presentation of another person's thoughts, words, images or diagrams as though they were your own. Another form of plagiarism is self-plagiarism, which involves using your own prior work without acknowledging its reuse. The reuse of previously submitted work, even in parts, is not permitted because a student cannot gain marks for submitting prior work in subsequent assignments. You are reminded that all work you submit must be expressed in your own words and must incorporate your own ideas and judgments.

Plagiarism is considered a cheating offence and must be avoided, with particular care on coursework, essays, reports and projects written in your own time and also in open and closed book written examinations. This includes the use of text available on the internet.

Submission of a copy of another student's work is not acceptable and will be regarded as plagiarism. No mark will be awarded. If you suspect that your work has been copied, you should inform staff in the Education Office.

If you prepare a piece of work with other students, for example a practical report, you must write it up using your own words and incorporating your own ideas and judgements. If two or more reports are submitted using substantially the same language, a single mark will be applied and this mark will be divided equally between the two or more students who submitted them.

Similarly, direct quotations from the published or unpublished work of others, from the internet, or from any other source must always be clearly identified as such by being placed inside quotation marks, and a full reference to their source must be provided in the proper form. Remember that a series of short quotations from different sources, if not clearly identified as such, constitutes plagiarism just as much as a single unacknowledged long quotation from a single source. Equally, if you summarise another person's ideas or judgments, figures, diagrams or software, you must refer to that person in your text and include the work referred to in a list at the end of your submission. This list should identify published work that has been used for background preparation (General Bibliography) and also separately identify items that are specifically mentioned in the text. Full details of these references should be given: names of authors, title of work, year of publication and where appropriate the volume (mainly scientific journals), page numbers and publisher (mainly books) or Internet URL

Where plagiarism is detected in group work, members of that group may be deemed to have collective responsibility for the integrity of work submitted by that group and may be liable for any penalty imposed, proportionate to their contribution.

Where a first case of plagiarism has occurred and where the Board of Examiners judge that it does not form a significant part of the work and where the student concerned admits that plagiarism has occurred the case will be referred to the Chairman of the Board of Examiners for action. The action in such cases is:

The student concerned be informally reprimanded and:
The mark for the work be reduced, or
Zero mark for module

More serious cases of plagiarism will be reported to the Academic Registrar who will investigate the allegation. Note that repeated cases of "minor" plagiarism will be considered to constitute a serious case of plagiarism. If a student is found guilty of plagiarism the consequences can be severe, including the requirement to leave College.

Where collusion is suspected (i.e. use is made of another student's work with their consent) then both students will be penalised if found guilty.
Students should be aware that regular checks for plagiarism will be made on submitted work.
For further information, please refer the Colleges Plagiarism, Academic Integrity & Exam Offences site:

www.imperial.ac.uk/student-records-and-data/for-current-students/undergraduate-and-taught-postgraduate/exams-assessments-and-regulations/plagiarism-academic-integrity--exam-offences/

Collusion:

This is the term used for work that has been conducted by more than one individual, in contravention of the assessment brief. Where it is alleged that there has been collusion, all parties will be investigated under the Academic Misconduct procedure.

Exam offences

Exam offences include behaviour such as bringing authorised material into an exam, attempting to communicate with others apart from the invigilator, trying to remove examination material without permission, taking an exam for someone else or getting someone else to take an exam for you.

Dishonest practice

Examples of dishonest practice include bribery, contact cheating (buying work from an essay mill or other individual to submit as your own), attempting to access exam papers before the exam, making a false claim for mitigating circumstances or providing fraudulent evidence, falsifying documentation or signatures in relation to assessment.

Reference Lists

By this stage in your career, all lecturers will expect you to be using primary literature (journals) in preference to textbooks as sources of reliable and up-to=-date information. The reference reading lists in the course descriptions should be taken as guides only.

Guidance on citing URLS in coursework:

URLs are best avoided as references in essays, because of their relative impermanence, frequent bias, and general lack of attribution and peer-review. Citing them *is* only justifiable under specific circumstances.

Online journals and books

If the URL is merely an online copy of a journal or book, then use the proper citation along with the URL and date of access:

Watson, J. D. and Crick, F. H. C. (1953). Molecular structure of nucleic acids. *Nature* **171,** 737-738. <http://www.nature.com/genomics/human/watson-crick/index.html> 1st September 2005.

This style should be used for online journals, articles viewed through citation databases such PubMed, CD-ROMs, books accessed through Project Gutenberg, government publications, *etc*.

Online databases

The Internet contains data that are not present in the literature in their complete form. This is particularly true for DNA sequences, which are posted to sites such as NCBI, and X-ray crystallographic coordinate files, which are available from RCSB. These will usually be associated with a journal article, which you should cite:

Luger, K., Mader, A. W., Richmond, R. K., Sargent, D. F. and Richmond, T. J. (1997). Crystal structure of the nucleosome core particle at 2.8 Å resolution. *Nature* **389***,* 251. <http://pdbbeta.rcsb.org/pdb/explore.do?structureId=1aoi> 1st September 2005.

Other sites

If the webpage is not associated with any sort of 'real' literature, it is acceptable to cite the URL directly as though it were a book, with the URL as the 'publisher':

United States Government Central Intelligence Agency. (2005). The world fact-book. <http://www.cia.gov/cia/publications/factbook/index.html> 1st September 2005.

A future reader should be able to find the material you have cited easily; even if the URL no longer exists. These citations can only be justified if:

The information is more accurate than a conventional source would be, or is not available elsewhere. You should always use primary literature (*Nature*) in preference to secondary or tertiary (*New Scientist*, *The Times*).

The source is credible. Such sources *might* include the DTI, NASA, the Environment Agency or the Met office. These will generally be governmental websites or similar.

If the URL does not meet these criteria, then do not use it at all (unless you have been specifically asked to write an essay on *e.g.* media-driven health scares). The Internet is a good source of inspiration, but a terrible source of peer-reviewed data. Never base an essay on the first hit from Google.

NSS Survey

Towards the end of the final year of your programme, you will be invited to take part in the National Students Survey (NSS). NSS asks all final year undergraduates to rate a range of elements related to their student experience such as, academic support, learning resources and assessment and feedback. The nationwide survey compiles year on year comparative data for higher education institutions, with its results being made publicly available. For Imperial's results visit the Unistats website: **http://unistats.direct.gov.uk/**

All our surveys are anonymous and the more students that take part the more representative and useful the results, so please take a few minutes to give your views. The Union's "You Said, We Did" Campaign at **https://www.imperialcollegeunion.org/you-said-we-did** shows you some of the changes made as a result of survey feedback.

If you would like to know more about any of these surveys or see the results from previous surveys, please visit: http://www.imperial.ac.uk/students/academic-support/student-surveys/

Advanced Bacterial and Eukaryotic Cell Biology

Convenors: Prof Jake Baum and Dr Morgan Beeby

Aims

Cell biology studies the cell as the product of the emergent properties of its molecular components. We should, of course, be intimately associated with eukaryotic cells -- after all, we are made of them. Yet the diversity across eukaryotes is staggering. Since the dawn of microscopy, scientists have fascinated at the cellular basis of life and how this unit gives rise to everything in our bodies and the myriad single celled life in our environment. The modern cell biologist has genetics, chemistry, physics and systems approaches all at their fingertips. But there is still nothing quite as fantastic as looking down a microscope at their shape, their movement and how they interact with each other in multicellular tissues. And we shouldn't assume that non-eukaryotic life is any less fascinating as a cell. Gone are the days in which bacteria and archaea were considered 'sacks of enzymes'. Advances in microscopy have revealed intricately interconnected spatial regulation of bacterial cell biology over multiple scales. Fluorescence light microscopy has revealed the dynamic subcellular localisation control of structures involved in all aspects bacterial cell biology, including cell division, motility, and storage. Meanwhile electron microscopy has enabled imaging of entire cells to nanometre resolution, allowing insights into the molecular mechanisms underlying subcellular organization. This course will highlight recent advances in understanding bacterial and eukaryotic cell biology, uniquely bring these often separated worlds together, and comparing and contrasting the mechanisms employed by bacteria and eukaryotes to tackle the challenges they face.

Objectives

In attending this course, the student will to acquire the following understanding of advanced cell biology:

- A detailed understanding of the organisation and control of the eukaryotic and bacterial cell
- A detailed appreciation for imaging the cell using platforms from light and electron through to super resolution imaging
- Practical experience of working with cell tissue culture, imaging and image processing
- Exposure to the latest literature in cell biology and discussion of concepts relating to advanced eukaryotic and bacterial cell biology
- Opportunities to discuss and debate topics in cell biology, gaining an appreciation for the limits of current understanding

Who should take this course?

The course is appropriate for anyone with an interest in the mechanisms of cell biology across all life.

Course components and assessment

The course consists of about 25 lectures, 5 Q&A and debate sessions, a laboratory practical, and a short 2-hour computer-based workshop. The course will be assessed by summative (graded) assessments composed of a written examination (75%) and Course Work Assessment (25%). During the exam, you will answer 3 from a choice of six questions. Most questions are essay style, but one or more questions may be more in the form of a structured problem requiring analysis as well as writing. The 25% coursework component will centre on a preparation and analysis of a practical in that is undertaken weeks 3 and 4. The practical will be based on work in teams, though summative assessments will be based on individual work. The work will be assessed by an individual 2-page grant proposal following team based pitches (5%), a 500-word news and views article on a recent cell biology paper (5%), and an individual A1 poster of the cell biology practical (15%). There will also be a formative (non-graded) assessment component.

Advanced Immunology

Convenor: Professor Hugh Brady

Aims

This course follows on from the 2nd year Biological Sciences *Immunology* course. However, as biochemistry students have not covered so much Immunology in their 2nd year, there will be two revision lectures to begin the course. The course will cover six main topics:

1. The cellular basis of detection and killing in mammalian innate immunity and comparative evolution of immune responses.
2. The molecular basis of innate immunity in plants and how it comapres to mammalian innate immunity
3. Innate lymphoid cells – where do they come from and what do they do
4. Mechanisms of cellular immunoregulation – the development, plasticity and function of regulatory T cells
5. The role of gut microbiota in regulating immune responses and in disease
6. Cancer immunology, the role of the immune system in cancer development and how we can use immunotherapies to treat cancer

Objectives

In attending this course the student will gain an advanced understanding of the findings of recent immunological research. In addition, they will:

- Have a detailed understanding of specific molecular pathways critical to immune system function
- Practical experience of cell culture and flow cytometry-based immunological assays
- Have opportunities to discuss and debate state-of-the-art ideas that drive much of current and future immunology research

Who should take this course?

Anyone with an interest in how the immunes system works. Biochemistry students taking this course will have done the *Integrative Cell Biology* coure in their 2nd year and Biological Sciences students will have chosen the *Immunology* option in their 2nd year.

Course components and assessment

The course consists of about 26 lectures, two laboratory practicals, research paper presentation sessions and tutorial sessions. The course will be assessed by summative (graded) assessments composed of a written examination (75%) and Course Work Assessment (25%). During the exam, you will answer 3 from a choice of six questions. Most questions are essay style, but one or more questions may be more in the form of a structured problem requiring analysis as well as writing. The 25% coursework component will assessed from the two practicals and the research paper presentation. Both practicals will be written up in short proformas that will be assessed. Each student will also be assigned a recent research paper on which they will give an assessed 15min presentation.

Advanced Topics in Infection & Immunity

Convenor: Professor George K. Christophides

Lecturers and Instuctors: Dr Cecilia Johansson (Medicine), Dr Dina Vlachou (Life Sciences), Prof George K. Christophides (Life Sciences), Prof Gloria Rudenko (Life Sciences), Dr Laurence Bugeon (Life Sciences), Dr Marc S. Dionne (Life Sciences), Dr Masahiro Ono (Life Sciences), Prof Murray Selkirk (Life Sciences), Dr Nadia Guerra (Life Sciences), Dr Robert MacCallum (Life Sciences), Dr Sophie Rutschmann (Life Sciences) and Dr Tom P. W. Ford (Medicine). Invited lectures are given by Dr Julius Hafalla (Medicine).

Aims

The course builds upon fundamental knowledge covered in first and second year courses and aims to provide students with an appreciation of how paradigms of immunological research are being developed to address specific problems of infections by pathogens including bacteria, viruses and parasites. This will be achieved by focusing on selected topics that exemplify recent advances in this scientific field. A key aim of the course is to provide insights of the state-of-the-art infection and immunity research, in terms of technologies, methodologies and experimental design; and how experimental data are interpreted and integrated to lead to the current synthesis. The various topics are covered by lectures, tutorials and coursework that largely fall within focus sections including: state-of-the-art technologies, accompanied by an integrated practical; immune response, integration and homeostasis; and immunity to human diseases and immune evasion including respiratory and lung viral infections, HIV infections, and malaria and helminth parasitic infections.

Objectives

- Demonstrate an advanced and critical understanding of the topics covered in the lectures and tutorials;
- Describe state-of-the-art methodologies, design research and solve specific problems related to topics of Infection and Immunity;
- Write a research article based on data obtained in the practical, by introducing the background to the problem, describing the methodology, interpreting the results, and discussing their broader significance;
- Develop a research proposal for an early career development fellowship using data obtained during the practical as proof-of-concept and aiming at revealing new and important insights into specific topics of Infection and Immunity.

Who should take this course?

In general, the course will better suit students who have taken a number of other molecular courses, in particular Immunology.

Course components and assessment

The course consists of 25 1-hour lectures, 2 tutorials during which students of guided self-learning combined with 4 additional flipped classroom lectures, 1 integrated practical of 3 parts, and 4 tutorials during which students can discuss their progress in writing a research article and developing a research proposal, respectively. As a part of the coursework, each student will be requested to submit: (1) a research article reporting, analysing and discussing the results obtained during the practical (10% of the final mark), and (b) a proposal for a 3-year early stage career development fellowship to undertake advanced research in the topic researched during the practical and using the data obtained in the practical as preliminary data (15% of the final mark). Assessment is completed with a 3-hour written exam (75% of the total mark), during which students are asked to answer 3 out of 6 questions, each counting 25% towards the final mark.

References

Current Biology, *BioEssays.* Journals of the *Current Opinion* series (*Cell Biology*; *Genetics*; *Cell Biology & Development*; *Immunology*). Journals of the *Trends* series (*Biochemical Sciences*; *Genetics*).

Advanced Topics in Parasitology and Vector Biology

Convenor: Prof. Andrea Crisanti

Lecturers: Dr Tony Nolan and Others.

Aims

The course deals with a selected range of examples of parasites and their hosts (mostly man) and introduces current research in the basic molecular biology and immunology of parasites and their insect vectors. State of the art information is provided on parasite-host and parasite-vector molecular interactions as well as on parasite specific metabolic pathways to provide the rationale for the development of anti parasitic drugs, vaccine and anti-vector control strategies and to better understand the evolutionary relationship between parasite and host.

Objectives

- Describe and explain the molecular strategies that some parasite species (*e.g. Plasmodium* and *Trypanosoma*) have developed to generate antigenic diversity in order to evade the immune response.
- Describe specific molecular interactions that allow parasites to carry out their life cycle in the host and in the vector.
- Describe both the differences and the similarities of insect and vertebrate immune systems.
- Explain the concept of coevolution and its implication in understanding parasite-host and parasite-vector molecular interactions.
- Evaluate existing and proposed vector control programs.
- Explain how metabolic pathways of parasites can be used to design selective drugs.
- Apply the above examples as a model for an understanding of host parasite relationships in general.
- Use your knowledge of current methodology and techniques to propose experimental approaches to answering topical research questions in this field

Who should take this course?

Students with an interest in modern research techniques, disease research, applied healthcare, molecular biology, parasitology, or the biology of parasite vectors. It will appeal to those with an interest in how to formulate an experimental approach relevant for research into disease control.

Course components and assessment

The course consists of lectures on selected topics of general interest coupled with seminars delivered by experts in the field that focus on current state of the art research; a practical to introduce you to genetic tools available to manipulate mosquito vectors at the laboratory bench; critical appraisal, in the role of scientific referee for a journal, of a topical scientific article; a research project written in the form of a grant proposal (describing state of the art, experimental design and methodology) on a subject area of your choice among parasitology topics of biological and medical relevance, to be prepared in collaboration with two of your course colleagues; three tutorials in total on topics related to paper review and grant proposals and ad hoc email contact with lecturers.

Assessed coursework includes the practical (10%), the article review (40%) and the mock grant proposal (50%). There will also be a three hour written examination.

References

Eldridge, B.F et al. (2004) *Medical Entomology: A Textbook on Public Health and Veterinary Problems*. Springer

Marquardt, W.H. (2004) Biology *of Disease Vectors*. Academic Press

Kierszbaum, F. (1994) *The impact of major parasitic diseases on the immune system*. Academic Press.

Scott, M. E. (1994). *Parasitic Epidemiology*. Academic Press.

Journals of the *Current Opinion* series and Journals of the *Trends* series, other relevant articles in *Nature* and *Science* series of journals

African Biology Field Course

Convenor: Professor Vincent Savolainen

Lecturers: Dr Richard Gill, Dr Andrew Knight

This course is divided in two parts. The first two weeks will be held at Klipbokkop Mountain Reserve in South Africa, **at the start of the first term of the Final Year**; it forms the field element of this course. The next three weeks will be held at Imperial College South Kensington campus.

Aims

- To introduce participants to the excitement, challenges and opportunities for biological research and conservation in tropical and subtroppical habitats
- To provide first-hand experience of biodiversity research and conservation intropical forests through taught exercises and mini-projects with a special emphasis on mediterrean and subtropical ecology and biodiversity

Location

The course will be based at the Klipbokkop Mountain Reserve, where Fynbos dominates. Fynbos is the natural shrubland or heathland vegetation occurring in asmall belt of the Western Cape of South Africa, mainly in winter rainfall coastal and mountainous areas with a Mediterranean climate. The Fynbos ecoregion is within the Mediterranean forests, woodlands, and scrub biome. In fields related to biogeography, fynbos is known for its exceptional degree of biodiversity and endemism. http://en.wikipedia.org/wiki/Fynbos

There will also be a two night stay in Knysna Phantom Forest. On route there, we will also visit a private game reserve that hosts the elephants, lions, buffalos, rhinos, antelopes, etc. The Knysna-Amatole montane forests ecoregion, of the tropical and subtropical moist broadleaf forests Biome, is in South Africa. It covers an Afromontane area of 3,100 square kilometers (1,200 sq mi) in South Africa's Eastern Cape and Western Cape provinces.

http://en.wikipedia.org/wiki/Knysna-Amatole_montane_forests

Compulsory Training

The first week of the field course is dedicated to practical training in ecology and biodiversity. Activities such as orientation, introductions to field equipment, health & safety and security will be conducted. There will be identification workshops in the forest and guided walks on plants, birds, primates and insects. Students will prepare their own herbarium samples and mount tropical insects that they will have captured. Morning and evening lectures on primatology, botany, entomology, forest ecology, collecting techniques, etc, will complete the training.

The second week will be dedicated to students' personal research projects and training in conservation biology. There will be lectures and team-based learning sessions on evolution and diversification of the cape flora, abiotic and biotic factors affecting the cape biodiversity, invasion biology, ecology, and conservation.

The next three weeks will be dedicated to further lectures, self guided tours and quiz at Kew Gardens and the Natural History Museum, journal club, receiving feedback for the field report, writing up reports.

Assessment

The assessment will consist of a three hour written examination plus three coursework components, a field report, ID test (both completed in South Africa) and mini project (submitted at the end of the course in South Kensington)

Biodiversity and Conservation Biology

Convenor: Dr Joseph Tobias

Prof Tim Barraclough, Dr Martin Brazeau, Dr Morena Mills, Dr Andrew Knight (and guest lecturers)

Aims

The course provides an overview of the past, present and future of life on Earth. It explores how new species form, evolve and assemble into ecological communities, as well as how interactions among species influence community structure and function. It also examines the underlying processes giving rise to patterns in biodiversity over large temporal and spatial scales. Course lecturers will provide an introduction to a wide range of research methodologies for the study of biological diversity, and discuss how insights from ecology and evolutionary biology can be used to help conserve biodiversity in the face of human activities and environmental change. The course will be taught through a mixture of lectures, workshops and computer-based practicals involving simulation and statistical analysis; the practicals are based on the use of R, and provide a useful refresher before the start of Honours projects.

Objectives

By the end of this course, you should be able to:

- Define biodiversity and provide an explanations for its origins;
- Give an account of major patterns in the distribution of biodiversity through time and space;
- Understand and describe a range of mechanisms proposed to have shaped these patterns;
- Use standard statistical packages to analyse phylogenies, taxonomies, and other data to test hypotheses about the evolution and distribution of biodiversity;
- Give an account of the main threatening processes behind the current extinction crisis, and explain how and why species differ in their vulnerability to extinction;
- Describe the implications of extinction for ecosystem processes and services;
- Evaluate new developments in the theory and real-world practice of conservation biology;
- Perform and present statistical analyses using R, in preparation for Honours projects;
- Link together ideas from disparate parts of the course.

You will also gain further experience of working in pairs and small groups, and presenting work in a conference-style setting.

Links with related courses

This course is given in parallel with two other third-year courses: Population and Community Ecology, and Global Change Biology. The three courses can be taken in sequence, and while this is not compulsory, there are some benefits of doing so for students interested in ecological topics. Some themes – such as ecological competition, community structure, and ecosystem function - re-appear in the different courses, with content designed to be complementary. Biodiversity and Conservation Biology generally takes a more macroevolutionary and macroecological (global-scale) viewpoint, focusing in particular on terrestrial vertebrate systems.

Who should take this course?

There are no prerequisites, but this course will be of interest to students taking the Ecology stream in their Final Year, and will appeal to those interested in applying biological insights to conservation and ecosystem management.

Course components and assessment

The course consists of 24 lectures, 5 computer-based practicals, and 4 workshops (two optional). Assessed coursework includes a written macroecological analysis (12.5%), a conservation action plan presented in a conference setting (12.5%) and a 3 hour written examination (75%).

References

Coyne, J. A. & Orr, H. A. (2004) *Speciation*. Sinauer Associates, Sunderland, Massachusetts, USA.
Gaston, K. J. & Blackburn, T. M. (2010) Pattern and process in macroecology. Blackwell, Oxford, UK.
Naeem, S. et al. (2012) The functions of biological diversity in an age of extinction. *Science* 336: 1401-1406.
Milner-Gulland, E. J. & Mace, R. (1998) Conservation of biological resources. Blackwell, Oxford, UK.
The Biodiversity chapter of the Millennium Ecosystem Assessment (http://ma.caudillweb.com//en/products.global.condition.aspx) provides an authoritative technical overview of both the major patterns in biodiversity and how human actions are affecting it.

Biodiversity Genomics

Convenor: Prof Armand Leroi

Aims

Sequencing genomes has become cheap – and they are flooding the journals. This course is about how we can use them to explain the diversity of living things. It isn't about genomes *per se* in the sense of the structure of DNA sequences – though that will come into it. Rather, it is about the use of genomes to shed light on phenotypes. So we will see how genomics (and all the other 'omics – transcriptomics, proteomics, metabolomics etc.) can be used to unravel evolutionary history of life at scales that range from phyla to breeds. We'll pay a lot of attention to the genomic history of the human species. We will see how genomes illuminate development and metabolism. We will discuss the genes responsible for adaptation, speciation, domestication, plasticity, behaviour and ageing. We'll see how the concepts and tools of systems biology can be applied to evolution. In short, if there is an evolutionary problem, and if genomics sheds light on it, it could be in this course.

Objectives

- By the end of this course you should have a good grasp of:
- the mechanisms of genomic evolution;
- the basic developmental genetic architecture of plants and animals – and how they have evolved;
- how to detect selection in genomes;
- how to using genomic information to identify genes responsible for phenotypic variation;
- the genomics of adaptation, plasticity, domestication, life-history and speciation;
- the analysis of genomic information in terms of networks;
- the genomic history of our species.
- Who should take this course?
- You should have a grounding in cell, developmental and evolutionary biology. You should have an interest in natural history, genomics, systems biology.

Course components and assessment

~30 lectures, an essay, seminars and project.

Assessment: (i) essay (10%); (ii) seminar (5%); (iii) project (15%); (iv) 3 hour examination (75%).

References

Stern, D. 2010. Evolution, Development, and the Predictable Genome, Robert & Co.
Gilbert, S. 2009. *Developmental Biology*, 9th ed, Sinauer
Wagner, A. 2007. Robustness and Evolvability in Living Systems , Princeton
Freeman, A. and J.C. Herron 2006. *Evolutionary Analysis* (4th ed), Benjamin Cummings
Kirschner, M.W. and Gerhart, J.C. 2005. *The Plausibility of Life: Resolving Darwin's Dilemma*. New Haven: Yale University Press, 2005.
Leroi, A.M. 2004. Mutants: on the form, variety and errors of the human body. HarperCollins
Wilkins, A. 2002. The evolution of developmental pathways. Sinauer

Bioinformatics

Convenors: Dr John Pinney

Aims

This course aims to provide a solid theoretical foundation in the algorithms and methods used for computational analysis of macromolecular sequences and structures, complemented by extensive hands-on experience working with the software and data types likely to be encountered in a research project. The programming skills acquired should give students confidence to further extend their bioinformatics skill base through self-directed study.

Course objectives

By the end of the course, students should be better able to

- write simple programs in a high-level programming language (Python), used widely in the biosciences.
- compare the major databases for protein sequences and structures and select a data source appropriate to a bioinformatics task.
- use models of molecular evolution within a phylogenetic analysis.
- integrate commonly used tools in protein sequence and structure bioinformatics to answer biological questions.
- summarise the resources available for retrieval of genome sequences, RNAs and transcriptomic data.
- make use of software for genome assembly, genefinding and transcriptome analysis.
- assess the value of contemporary computational biology to the wider biosciences and the relationships between different specialisms.

Who should take this course?

There are no formal prerequisites for the course and no prior experience of computer programming is required. However, students are expected to be competent with basic maths and statistics and to be willing to apply themselves to learning the fundamental concepts of programming.

Course structure

The course is organized across four complementary strands:

- *Programming* will be taught through hands-on tutorials (5h) and in practical sessions (20h) focusing on finding solutions to real biological problems. The Python programming language will be used throughout the course.
- *Proteins* (10h lectures) examines the algorithms behind sequence alignment, phylogenetics and structure prediction.
- *Nucleic acids* (10h lectures) covers genome assembly, genefinding and the analysis of high-throughput sequence data.
- *Topics* (10h tutorials) introduces several areas of current research within computational biology.

Assessment

Coursework (25% of final mark) comprising of a topic presentation (5%), 2x reports on practical exercises (10% each)

Written examination (75% of final mark) comprising of 3x problem questions or essay titles from a choice of about 6 (25% each)

Cancer

Convenor: Dr David Mann

Aims

The aim of this course is to give undergraduate students an understanding of the molecular causes of cancer. General requirements of cancer cells as well as specific forms of cancer will be analysed in detail from the perspective of the underlying molecular lesions. The course will emphasize the biochemical interactions involved and potential therapies arising from our molecular insights. By the end of this course, students should appreciate the enormous scope of this research area and be able to make informed decisions about the future career prospects it offers.

Course Objectives

Students should gain an up-to-date perspective of our knowledge of the molecular changes underlying cancer. They should understand the interrelationships between different signalling pathways in relation to this group of diseases. Students should appreciate the use of model experimental systems for evaluating changes in protein function which may lead to disease. They should become able to critically analyse data and assess the prospects for therapy and research into cancer using knowledge gained from the fundamental biochemical and cell biological pathways which are disrupted.

Course Content

Lectures will include the following areas: general characteristics of cancer; cell cycle control; mitogenic signalling; oncogenes and tumour suppressors; viral infection and cancer; angiogenesis; adhesion: DNA damage/repair; cancer genetics; protein structural changes through mutation; tumour stem cells; molecular therapies; tumour immunology.

External speakers will be used where appropriate to provide information from the front line of biomedical research and to give alternative perspectives on common themes.

Students will take one laboratory practical class lasting which will allow student input into experimental design and data interpretation.

Lectures approximately 30

Practical 1 (approximately 4 days)

Problem Classes 2 in which published results are analysed and discussed.

Assessment

A) Coursework 25%

1 practical report (50% of the coursework mark)

1 Experimental Suggestion (25% of the coursework mark)

1 problem paper (25% of the coursework mark)

B) Examination 75%

Two section paper with section A comprising two problem questions and section B comprising four essay style questions; three questions to be answered in three hours with at least one answer coming from each section.

Key Skills Required

The ability to integrate and critically evaluate information from different scientific sources.

Written and oral presentation skills.

Core Biochemistry Content

Molecular biology, metabolism, molecular cell biology

Damage and Repair in Biological Systems

Convenor: Dr Kleoniki Gounaris

Aims

The aim of the course is to provide students with an understanding of the involvement of free radicals, partially reduced products of oxygen and reactive nitrogen species in the damage and repair processes of various biological systems. Emphasis is placed on human health and disease and particular attention paid to aging, mitochondrial dysfunction, neurodegeneration and the immune system.

Course Objectives

Students should understand the nature of oxidative damage and the antioxidant defence afforded by mammalian cells (bacteria and yeast are also briefly discussed). They should be familiar with both constitutive and inducible defence systems, appreciate the mode of damage and repair mechanisms for macromolecules (with particular emphasis on DNA damage and repair) and the role of oxidative damage in disease. Students should understand the mechanisms of directed cytotoxicity in the immune system, the generation of the oxidative burst, and mechanisms which promote apoptosis and programmed cell death.. Students should have an understanding of the involvement of free radicals in signalling cascades, neurodegeneration, cystic fibrosis, carcinogenesis and the process of ageing.

Course Content

Lectures focus on recent research involving reactive oxygen and nitrogen species in a variety of macromolecular damage processes and the mechanisms of repair. Emphasis is placed on work relating to human health and disease. Discussion on contradictory theories and ideas is encouraged. Extensive practical classes allow the students to have their own input in experimental design and interpretation of data. Seminars given by the students in small groups are designed to ensure that students are able to communicate scientific ideas and critically assess published scientific data.

Lectures 30

Practical 1 (five days)

Seminar presentations 1 per student. Each student presents a recent research publication to a member of staff and a group of about 6-7 other students and discussion follows the presentation.

Assessment

A) Coursework 20%

1 practical report

1 seminar presentation.

B) Examination 80%.

Four questions to be answered from a choice of eight in three hours.

Key skills acquired

The ability to understand complex biological phenomena, appreciate the limitations of experimental systems and critically assess data. The ability to extract and process information from different sources.

The ability to comprehensively present scientific literature is assessed through oral presentations. Thorough practical work planning, teamwork, time management and understanding of the scientific method are encouraged.

Evolutionary Applications

Convener: Dr Vassiliki Koufopanou

Aims

The course aims to apply principles of simple evolutionary theory to study the diversity of life and address some of the pressing problems of the day. We will show how the same principles can work at all different levels of organisation, from phenotypic to genetic to molecular levels, and can also be applied to help understand problems in real life and to design solutions, e.g. pests, diseases, conservation, etc Many examples will be discussed from experimental, comparative and DNA sequence evolution, to illustrate principles and their applications, also drawing from the vast amounts of recent information from genomic data analyses. Topics will include the generation of variation by mutation, the evolution, maintenance and loss of adaptation, effects of sex and recombination, evolution of resistance to pesticides and antibiotics, use of genetic engineering to control populations and disease, senescence, cancer etc. etc.

Objectives

- Understand the process of evolution and how to study it.
- Understand how to use basic principles to address theoretical and applied problems of interest.
- Understand the nature of phenotypic and molecular traits and their variation.
- Learn how to use DNA sequences to study evolution and to deduce the demographic and selective history of populations.
- Explain the evolution of selected topics in biology.
- Understand the scientific method, formulating questions and testing hypotheses - a written research proposal will contribute towards that goal.

Who should take this course?

Anyone interested in understanding the process of evolution in some depth, and how to use principles of simple theory to understand problems in real life.

Course components and assessment

Approximately 28 lectures; two or three sessions of problem sets; a computer-based bioinformatics/genomic practical, four sessions of discussions/tutorials, and a research proposal.
Assessed coursework (25%) includes a written report on the practical (7%), a written research proposal (14%) and its oral presentation (4%). There will also be a 3-hr written examination.

References

Barton, N. et al. 2007. Evolution. Cold Spring Harbor Laboratory Press, N.Y.
Futuyma, D. J. & Kirkpatrick, M. (2017). *Evolution*. Sinauer.
Zimmer, C. and Emlen, D..J. 2015. Evolution: making sense of life. Roberts and Company, Greenwood Village, Colorado.
Freeman, S. & Herron, J. C. (2013). *Evolutionary analysis*. Prentice Hall.
Bell, G. 2015. The evolution of life.

Global Change Biology

Convenor: Professor Guy Woodward

Prof. Colin Prentice, Dr Eoin O'Gorman, Dr Michelle Jackson, Dr Rebecca Kordas, Dr Samraat Pawar (+ Guest Lecturers)

Aims

To provide an overview of the biological and socio-economic consequences of the major drivers of global change in natural ecosystems. In this course, students will learn why it is critical to study systems across multiple organizational levels, from genes to ecosystems, and how theory and data can be combined to improve our predictive capacity to anticipate and cope with future change. The syllabus includes:

- The Sixth Great Extinction
- The collapse of global fisheries: cause, consequences and solutions
- Acidification in marine and freshwater ecosystems
- Climate change as a compound stressor
- Pesticides and other toxins: direct and indirect effects in complex systems
- Ecological consequences of land-use change: from local to global scales
- Dangerous synergies: interactive effects of multiple stressors in multispecies systems
- From ecology to society and back again: global change in the real world
- Students will be provided with a selection of references, drawn primarily from the state-of-the-art scientific literature, to guide the extensive background reading they are expected to do in their spare time. These papers will introduce students to the key bodies of theory, as well as the practical applications of monitoring, modeling and management of natural systems in a changing world.

Objectives

This course is designed to enable students to:

- Understand how structure links to function across multiple organizational levels, and how these relationships change in the face of environmental stress
- Appreciate the need to integrate theory with data and the challenges this creates when trying to predict ecological responses to anticipated future scenarios.
- Critically assess scientific papers, including data collection and statistical analyses
- Construct specific hypotheses and to analyse appropriate data to test them in the context of GCB
- Carry out a literature review, and design a poster summarizing the research conducted

Who should take this course?

There are no formal prerequisites but a background in ecology would be very useful. The Population and Community Ecology module in particular is highly recommended as many of the concepts covered in GCB follow a natural extension of the main areas covered in PCE: thus, although we are not requesting it as a compulsory prerequisite, students will be expected to have familiarised themselves with the broad concepts in general ecology (as covered in PCE and/or the Begon, Harper & Townsend textbook) before the start of GCB. Moderate proficiency in R is expected for the practical exercises.

Course components and assessment

The course consists of 28 lectures and 3 practicals: the the first two practicals are lab-based and the third is a "virtual" poster presentatation. Assessed work includes two practical reports (10 each%), a poster presentation (5%) and a written examination (75%).

References

Begon, M., Harper, J. L. & Townsend, C. A. (2005). Ecology: From individuals to ecosystems. Wiley-Blackwell.
Woodward, G., et al. Ecological networks in a changing climate. Advances in Ecological Research 42 (2010): 71-138.
Selected journal articles (e.g. from Nature Climate Change, Global Change Biology etc) – to be announced during the lectures – pdfs etc will be provided during the module.

Integrative Systems Biology

Convenor: Dr Robert Endres

Aims

To introduce quantitative analytical thinking in life sciences and to provide an overview over computational/theoretical methods for interpreting quantitative data in order to study biological processes holistically at the systems level.

Course Objectives

After taking the course students will have gained basic understanding for overcoming previous reductionist approaches in favour of an integrated analysis of biological systems. Students should become familiar with a range of experimental techniques used in integrated systems biology, including high-throughput imaging. These methodologies produce enormous amounts of data, which cannot be understood without a detailed statistical and mathematical analysis. To guide and interpret experiments, mathematical models need to be developed to predict, e.g. biological behaviour – either at the molecular, cellular or organism level. Therefore students will receive an introduction to computational modelling and data analysis, including a survey over mathematical, biophysical, statistical approaches used in analysing system level and biological network data. Overall, a quantitative perspective to life sciences will also be promoted, similar to how physicists think about non-living matter.

Who should take the course?

The course is open to all students in biology and biochemistry degrees. Given the importance of system-level approaches in all parts of biology, this course should be a useful foundation especially for those students, who are interested in pursuing graduate studies in modern biology. There is a substantial quantitative component in this course, so some knowledge of and basic training in mathematics and programming will be useful, but no formal requirements are being set. However, the material from the first-year biochemistry course 'Essential Maths' is assumed to be known to all ISB-taking students.

Course Content

The course consists of approximately 35 lectures, two mini projects, and 18 hours of computer practical. The bulk of the course is a combination of lectures and hands-on problem-based learning, supported by practicals to provide opportunity for structured personal study and feedback.

Assessment

There will be a 3-hour written examination that counts for 75% of the marks. The remaining 25% mark will be divided between 2 practical reports (10% each), and 2 short reports on the mini projects (2.5% each).

Textbooks: We will not follow a single textbook on systems biology. Some relevant materials can be found in

1. Physical Biology of the Cell, Rob Phillips, Jane Kondev, Julie Theriot, Garland 2008
2. Physical Principles in Sensing and Signaling, Robert Endres, Oxford 2013
3. An Introduction to Systems Biology, Uri Alon, Chapman & Hall/CRC 2006
4. Nonlinear dynamics and Chaos, Steven Strogatz, Westview Press, 2000

In the lectures we will refer extensively to original research literature and review articles.

Mechanisms of Gene Expression

Convenor: Dr Robert Weinzierl

Aims

This course aims at making students aware of the molecular events underlying controlled gene expression patterns during many different types of biological events. By the end of the course, they should be familiar with the current concepts and models of gene expression in organisms from all evolutionary domains and should develop an appreciation of the applications of such knowledge in many fields of contemporary biology and medicine.

Course Objectives

Students should become familiar with the structure and function of the basal transcriptional machineries in archaea, bacteria and eukaryotes, and how gene-specific transcription factors interact with them. They should develop a level of understanding that allows them to integrate the various molecular models with the results obtained from genetic and cell biological studies. They should be aware of the profound effect of chromatin structure, nuclear environment and post-transcriptional processing events on the expression of individual genes and gene families. Students should also develop an understanding of the large variety of *in vitro* and *in vivo* methods that are used to study gene expression. They should become familiar with practical applications of the knowledge gained about transcriptional control mechanisms in medicine and functional genome studies.

Course Content

The various lectures focus on individual topics and experimental model systems to illustrate the fundamental principles of gene expression. The lectures are designed to cover all the major aspects of the field in a comprehensive and up-to-date manner. In controversial subject areas the different points of views, and their theoretical implications, are presented. Students are provided with a selection of timely references to the original research literature to encourage them to carry out extensive background reading in their spare time. The laboratory-based practical introduces the students to several *in vitro* techniques used for studying the function of transcription factors

Lectures 25, Practicals 1 laboratory-based and 1 computer-based practical (10-12 days in total)

Assessment

A) Coursework: 25 % for a practical write-up and a video-based presentation (12.5% each)
B) Written Examination: 75 %
Three essay style questions to be answered from a choice of six in three hours.

Key skills acquired

An ability to synthesize and distil information from different (and occasionally conflicting) sources into a balanced and coherently-argued view.
An improved understanding of the general nature of the scientific process through exposure to original research publications, current reviews and laboratory-based practicals.
An enhanced ability to research a topic in depth using various library facilities, electronic databases and the resources available on the world-wide web.
Written and oral presentation skills.
Graphic analysis and display of molecular structures.

Core Biochemistry content: Molecular biology, protein structure and function.

Medical Glycobiology

Convenors: Prof Kurt Drickamer and Dr Maureen Taylor

Aims

The aim of this course is to give undergraduate students in-depth knowledge of the field of glycobiology, with an emphasis in on biomedically related topics. The goal is to develop a molecular understanding of carbohydrate-receptor interactions in cell-cell, cell-matrix and cell-pathogen interactions. Students will also be introduced to therapeutic applications and techniques used for the characterisation of glycosylation.

Course Objectives

Students should be familiar with the structures and functions of mammalian glycoproteins with a specific focus on glycans that are important in recognition and which have roles in leukocyte recruitment, clearance of pathogens, cancer and inflammation. They should have a detailed understanding of the way sugar-binding receptors function in intracellular protein targeting, cell-cell adhesion and the innate immune response. They should be familiar with the roles of proteoglycans in control of development through interaction with growth factors. They should be familiar with genetic diseases involving glycosylation and they should have a good understanding of mucins in the context of cancer. They should be aware of the potential for development of glycotherapeutics. They should understand the unusual aspects of cytoplasmic and nuclear glycosylation. Students should have a grasp of methods used for glycan analysis. They should know how to use molecular graphics to examine protein-carbohydrate interactions.

Course Content

Lectures cover the following major areas: overview of glycoprotein structure, biosynthesis and function; structure and function of the main classes of receptors that bind glycoproteins; molecular mechanisms of carbohydrate recognition; mucins and changes in patterns of glycosylation in breast cancer; structural roles of proteoglycans and their involvement in regulating the activity of growth factors; diseases resulting from genetic defects in glycosylation; cytoplasmic glycosylation. Lecture topics are reinforced and supplemented by a practical in which a pharmaceutically important recombinant glycoprotein is characterised and by a modelling exercise with an associated essay.

Lectures: 30

Practicals: One computer-based (about five half days) and one laboratory-based (one week).

Mini-conference: Students present talks based on the recent literature to their colleagues in a conference format.

Assessment

A) Coursework (25%)
1 review based on the computer practical
1 practical report in the style of a research journal
1 mini-conference presentation
B) Examination (75%)
Three essay-style questions to be answered from a choice of six questions in three hours.

Key skills acquired

An understanding of the structures of mammalian glycoproteins and proteoglycans and the roles they play in recognition events.
The ability to interpret and critically appraise the research literature.
Practical skills associated with glycoprotein characterisation.
Experience of molecular graphics.
Written and oral presentation skills.
The writing of practical reports in the style of a research journal.

Core Biochemistry content:
Structural biochemistry, molecular cell biology, applied biochemistry.

Medical Microbiology

Convenor: Prof Alain Filloux

Lecturers from the Department of Life Sciences and Faculty of Medicine.

Aims

- To describe the nature of some of the most significant causes of infections in human, how they are transmitted and how they cause disease.
- To outline the nature of the immune response to selected infectious agents.
- To explain the principles of diagnostic microbiology as they apply to selected bacteria and viruses.
- To discuss the spread of infections in communities and the strategies required to control infections (vaccines; chemotherapy).

Objectives

The framework of knowledge provided by this course will enable students to appreciate more fully the fine balance that exists between infectious agents and their human hosts. By the end of the course, students should be able to: -

Describe the structure, route of entry and virulence factors of the main human pathogens.

Understand the principles of resistance to infection and the nature of immunocompromise.

Describe and discuss the different ways in which the infectious causes of disease are diagnosed and identified.

Discuss the principles of prevention by vaccination and treatment with antibiotic and antiviral agents.

Describe the principles of the epidemiology of infection in the community at large and in institutions such as hospitals

Who should take this course?

A background in microbiology with virology is essential. All students who have not had virology lectures in previous years of study should have read free online chapter in Encyclopedia of Virology (Third Edition), Replication of Viruses, *Pages 406-412*, A.J. Cann for background information

Course components and assessment

There are 30 lectures, 2 laboratory practicals and 1 dry. The virology practicals (wet and dry) consist of exercises directly relevant to the diagnosis of respiratory viruses, and the bacteriology practical introduces the methods used for the routine diagnosis of bacterial infections in a diagnostic laboratory.

Formal assessment will be by a three-hour exam (75%) and coursework (25%). Students are required to submit a written account of the dry virology practical and the bacteriology practical in the style of a short journal article (10% each). Additionally, students will prepare a short oral presentation (5 minutes with maximum 5 slides) on a topic chosen from a list provided (5%).

References

The Encyclopedia of Life Sciences www.els.net
Society for General Microbiology review articles www.sgm.ac.uk
Eureka Bioscience Collection www.ncbi.nlm.nih.gov/books
Wilson M., McNab, R. & Henderson B. (2002). Bacterial disease mechanisms. Cambridge University Press.
Goering, R. V., Dockrell, H. M., Zuckerman, M. & Wakelin, D. (2007). Mims' medical microbiology. Elsevier.
Murray, P. R., Pfaller, M. & Rosenthal, K. (2005). Medical microbiology. Mosby.
Flint, S. J., Enquist, L., Racaniello, V. R. & Skalka, A. M. (2004). Principles of virology. ASM Press.
Collier, L. & Oxford, J. (2006). Human virology. Oxford University Press.
Sherris Medical Microbiology, Kenneth, Ray, Ahmad, Drew & Plorde.

Metabolic and Network Engineering

Convenor: Dr. Patrik Jones

Aims

The aim of the course is to introduce students to the theory and methodology that is used to engineer biology for an applied objective. Secondly, the aim is for students to appreciate (in part through direct experience) the challenges involved in the design, engineering and evaluation of biocatalytic systems. Thirdly, students will learn about the challenges and opportunities related to the application of engineered biology for commercial industrial purposes through direct discussions with representatives of industry and practical exercises in entrepreneurship.

Objectives

The course focuses on two distinct sub-fields of biological engineering, the micro-level pathway/catalyst (metabolic engineering) and the macro-level whole-cell system (network engineering).The objectives include

- Understand key factors that control metabolism and gene networks
- Know what tool/method to choose in order to achieve engineering objective and analyze/predict its outcome
- Design alternative strategies to overcome engineering challenges
- Understand factors that limit commercial use of engineered microorganisms
- Research and present a strategy to convert an idea into a biotechnological business

Course content

Lectures covering industrial biotechnology, host and portability, gene network engineering, genome engineering, metabolism for metabolic engineering, pathway engineering, flux balance analysis, industry workshops and entrepreneurship. Practicals covering computational flux balance analysis, case studies in metabolic engineering, genetic and environmental factors that influence biochemical production and biotechnology business development and pitching.

Assessment

A 3-hr written closed-book exam (75%) and coursework report in scientific journal format (11%), a small-group oral report on strategies to convert an idea into a biotechnological business (11%), Team-based learning exercise (3%).

Key skills

Suitable for Biochemistry, Biotechnology and Biology students. Course involves the following skills: Biochemistry, Molecular Biology, Computational programming (Matlab), Written and Oral presentation, Team-work, Basic sterile techniques and handling of microorganisms, Data analysis.

Molecular Basis of Bacterial Infection

Convenor: Prof. Gad Frankel

Aims

This course aims to develop an understanding, by undergraduate students, of some of the fundamental principles of infectious diseases. They will learn the basic mechanisms that determine the outcome of bacterial pathogen – host cell interactions. Bacterial infections and diseases result from a "dialogue" between the bacterial and eukaryotic cells rather than being a bacterial "monologue". This phenomenon will be at the heat of the course. The students will be exposed to biochemical, molecular and cellular technologies.

Course Objectives

Students should gain an understanding of modern studies on the molecular basis of bacterial infection. They will use examples of different bacterial infections to appreciate the subtle interplay between the host and the pathogen during infection. They should understand how the genetics of both the pathogen and the host affect the outcome of particular infectious events. They should be able to put this information into the context of the modern world. They should appreciate how knowledge of the molecular basis of infection can be used to design novel drug therapies both from man and farm animals. They should understand the importance of genomics in this area of science.

Course Content

Lectures focus on recent developments in studies on the molecular basis of infections caused by bacteria. In the first lectures the emphasis is on molecular mechanisms. These are later put into context using specific disease examples. Enterohaemorrhagic E. coli is used as a model to explore host/pathogen interactions, including genetics and immunity. The final lectures focus on the cellular responses to infection.

Lectures 24

Practicals Over a four day period with 16-20 hours of contact time.

Assessment

A) 10 MIN TOPIC PRESENTATION (10%)

B) COURSEWORK 15%

1 PRACTICAL WRITE-UP

B) EXAMINATION 75%

THREE ESSAY STYLE QUESTIONS TO BE ANSWERED FROM A CHOICE OF ABOUT SIX IN THREE HOURS.

Key Skills Acquired

Practical skills associated with handling infectious pathogens and employing immunological methodology in scientific research.

The ability to interpret and critically appraise the research literature.

Written and oral presentation skills.

Written presentation skills in reporting complex practical experiments.

Core Biochemistry content

Molecular biology, applied biochemistry.

Neuroscience Research

Convenor: Prof Mustafa Djamgoz

Dr Stephen Brickley, Dr Scott Fraser, Dr Anita Hall, Dr Kenji Okuse, and Prof. Bill Wisden

Aims

To come to grips with the principles of neuroscience research in elucidating key phenomena relating to the variety of ways in which neurones generate signals to interact with each other in the adult (and to a lesser extent during development); the emphasis is upon electro-physiological signalling and plasticity.

Objectives

- Describe and explain the variety of electrophysiological and biochemical signalling mechanisms that 'excitable' cells use for interacting with each other.
- Conceptualise, in terms of signalling components, how cells may interact generally in networks.
- Decide what method(s) to use if asked to elucidate some aspect of signalling in a cellular system.
- Explain how different behavioural parameters and patterns are generated (from transduction to muscle control).
- Understand how signalling can be 'modulated' as a result of learning and memory.
- Know where to look (and how) in given a group of cells to elucidate possible signalling malfunction in a disease state.

Who should take this course?

There is no strict pre-requisite but a background in cell biology and physiology would be useful. The course is strongly 'cellular' (with a molecular inclination) in its core and would be useful to molecular biologists and those interested in physiology and behaviour.

Course components and assessment

This course deals with central nervous system, including its development. Model systems are used extensively to illustrate key phenomena. Neuronal signalling may be intracellular (e.g. via second messengers), intercellular (*e.g.* via neurotransmitters, growth factors, hormones), or occur by means of physical contact (gap junctions). An important type of signal is a change in the membrane potential. Cellular signalling involving several different molecular components such as receptors, G-proteins, enzymes (*e.g.* protein kinases/phosphatases), second messengers, ion channels (including their macro-molecular complexes), pumps, exchangers are covered. Ionotropic and metabotropic receptor signalling and adult synaptic plasticity and networks are covered in detail. Examples are given, wherever possible, of disease states that result when some component(s) of signalling goes wrong. The course strives to relate cellular function/dysfunction to behaviour/disease on the one hand, and to the molecular level on the other. The 'climax' of the course is a workshop (library research project) when everything you will have learnt about neurophysiological signalling will be put to test in the form of an integrated critique of 5 recent primary research papers (derived from a computer-based literature search) and short presentation.

Assessed coursework (25% of total) includes one essay (7.5%); workshop report (12.5%) and its presentation (5%). There will also be the usual 3-hour written examination (75%).

References

Catterall WA, Raman IM, Robinson HP, Sejnowski TJ & Paulsen O (2012). The Hodgkin-Huxley heritage: from channels to circuits. *Journal of Neuroscience*. 32(41):14064-73.

Kandel ER, Dudai Y & Mayford MR (2014). The molecular and systems biology of memory. *Cell*, Volume 157(1), pages 163-86.

Sheng M & Triller A (2012) Synaptic structure and function. *Current Opinion in Neurobiology*, Volume 22, Issue 3, Pages 363-564.

Plant Development and Biotechnology

Convenor: Dr Giovanni Sena

Lecturers : Andrew Crossthwaite (Syngenta), James Murray, Peter Nixon, Giovanni Sena, Jie Song, Colin Turnbull.

Aims

The aim of this joint course for biochemistry and biology students is to provide an account of how plant molecular biology is being used to unravel how plants grow and develop, and affords the opportunity to develop biotechnological solutions to crop improvement and solar energy capture.

Objectives

Provide accounts of selected techniques in plant molecular biology.

Provides critical exemplars of current issues in plant developmental biology

Make critical assessment of plant molecular biology literature.

Demonstrate knowledge of how plant molecular biology can be utilised to enhance the growth and quality of both food and non-food crops.

Provides an Industry led perspective on plant biotechnology.

Provides an up to date critical perspective on how photosynthesis might be exploited for sustainable energy capture.

Who should take the course?

This course is aimed at biologists and biochemists that are interested in molecular approaches to understand plant science including paradigms of plant development, and wish to see how these approaches and knowledge are applied in plant biotechnology.

Course components and assessment

- The course consists of about 30 lectures, with workshops for literature reviews and research project writing, plus a lab practical. The course highlights the importance of plants in society when food and energy security are key. Plant genome structure and basic genomic techniques and bioinformatics will be presented along with an introduction to the basics of plant hormones and signalling in development. This will include:
- Plant hormone synthesis and signalling in development.
- Epigenetic control in plant development.
- Control of flowering and shoot architecture.
- Root architecture and plant nutrition.
- Molecular biology of the chloroplast.
- Crop modification by genetic engineering
- A workshop on writing a perspective on a plant molecular biology research paper will be carried out. A series of interactive discussions and presentations leads to the formulation of a research proposal around a topic of current importance to plant science research. A practical will include use of the GUS reporter gene to reveal sites of promoter activity.

Formal assessment will be by a three-hour exam (75%) and coursework (25%). Assessed coursework includes a practical write up (33.3%) , writing a perspective on a plant molecular biology paper (33.3%) and formulating a research proposal (33.3%).

References

Lists of references for each lecture set will be provided on Blackboard.

Smith *et al*. (2009). *Plant Biology*. Garland Science.

Population and Community Ecology

Convenor: Dr Cristina Banks-Leite

Dr. Cristina Banks-Leite, Dr. Eoin O'Gorman, and guest lecturers

Aims

To provide an overview of the most important concepts in population and community ecology, and how these concepts can be used in conservation and management. In this course, students will learn that processes occurring within populations can be used to understand community dynamics, as well as the drivers of species interactions and community assembly. The syllabus includes:

1- Demography, population growth, intraspecific interactions and Allee effects
2- Predation, competition, mutualisms, dispersal
3- How to measure and describe communities and community processes
4- Multi-species models of competition, food webs and trophic cascades, mutualistic networks, drift, speciation and spatial variation
5- Habitat loss, restoration and ecosystem functioning

The lectures will be complemented with both indoors and field praticals. Students will go to Silwood Park on three different days to set up an experiment with plasticine caterpillars in the forest located on campus. The students will then return to Silwood a few days later to collect the data and conduct data analyses. Other practicals will involve integral projection modelling by hand and in the computer, and simulation of data using marbles.

Objectives

This course is designed to enable students to:

Gain an overview of fundamental concepts in population and community ecology, how they link together and how they can be used to solve real world problems

Understand the (often no so obvious) link between theory and empirical data, and what constitutes evidence for the existence of a process.

Critically assess scientific papers, including data collection and statistical analyses

Collect and analyse population and community data

Set up an experiment, collect and analyse data, and write a 2,000 word scientific report.

Links with related courses

This course is given in parallel with two other third-year courses: Biodiversity and Conservation Biology and Global Change Biology. The three courses can be taken in sequence, and while this is not compulsory, there are some benefits of doing so for students interested in ecological topics. Some themes – such as ecological competition, community structure, and ecosystem function - re-appear in the different courses, with content designed to be complementary. PCE focuses on local scale processes and in particular on terrestrial plants and animals.

Who should take this course?

There are no prerequisites but a background in ecology and data analysis would be very useful. The course will not rely heavily on statistics and mathematics, but students will need to analyse the data from plasticine caterpillar experiment, and some assistance will be given for those using R.

Course components and assessment

The course consists of 24 lectures and 3 practicals, including 3 full days in Silwood Park collecting and analysing data. Assessed work includes one practical report (15%), two essay-style questions about the practicals (5% each) and a written examination (75%).

References

Chazdon, R. L. (2014) Second growth: the promise of tropical forest regeneration in an age of deforestation. University of Chicago Press.
Borcard, D., Gillet, F. & Legendre P. 2011. Numerical Ecology with R. Springer.
Morin, P. J. (2011) Community Ecology. Wiley.

Hubbell, S. P. 2001. The unified neutral theory of biodiversity and biogeography. Princeton University Press.

Principles of Development

Convenor: Arkhat Abzhanoz and Michalis Barkoulas

Lecturers: Dr. Arkhat Abzhanov, Dr. Michalis Barkoulas, Dr Colin Turnbull, Dr. Giovanni Sena, Dr. Tony Southall

Aims:

This course includes lectures on animals (both vertebrates and invertebrates) and plants, thereby covering many model systems. The aim of the lectures is to give an overview of developmental biology, providing a historical context when necessary but also focusing on recent key advances in the field. Topics covered include body plan formation, axis specification, cell differentiation and organogenesis, stem cell biology, neurogenesis, growth and regeneration and developmental mechanisms of evolutionary change.

Objectives:

- Gain fundamental knowledge of the developmental biology principles and learn what are the current areas of research and main biological problems addressed.
- Understand the techniques and experimental models used in this research field.
- Gain specialised knowledge on the complex organization of multicellular animals and plants, the developmental origin of natural diversity and developmental nature of some human biomedical conditions.
- Improve their critical understanding of primary scientific literature and refine their analytical and communication skills (through discussion and writing tasks and presentations).
- Learn more about good experimental design, data analysis, how to keep a good laboratory notebook and how to write-up scientific research through participating in a labbased practical focusing on embryonic development.
- Develop an awareness of the greater impact that studies on developmental biology (e.g. stem/progenitor cell biology and regeneration) may have on modern society.
- Gain an insight into possible careers (exposure to guest Lecturers working on various projects within developmental biology and related fields) and acquire transferable skills.

Who should take this course?

This course is aimed at biologists and biochemists who are interested in developmental biology. This course expands on the basic principles learnt during the Biological Sciences second year Cell and Developmental Biology module, which provides an introduction into this field. However students that have not taken CDB are still encouraged to take this course.

Course Components and Assessment:

- 24 Lectures
- Laboratory practical (spread over three weeks)
- Journal Club (2 hours)
- Grant Proposal workshop (3 hours)
- Visit to Natural History Museum
- Student seminar presentations
- Two writing tasks (“news and views” type of article and small “research grant”)

Formal assessment will be based on: 1) a Research Grant proposal (inspired by a visit to NHM or/and lectures): 10%, 2) a laboratory experiment write-up: 5%, 3) a write a “News and Views” style article for a published paper: 5%,4) an

oral presentation (same paper as “News and Views”): 5% and 5) a 3-hour exam (essay and data interpretation questions): 75%

Stem Cells, Regeneration and Ageing

Convenor: Dr Anita Hall

Aims

The course analyses stem cell biology in depth and guides the students through fundamental as well as very recent studies unravelling the mechanisms responsible for the maintenance, regeneration and ageing of tissues. Multiple adult tissues will be studied, with the haematopoietic system often used as a paradigm for studies of other stem cell based systems.

The course material is a combination of textbook and recent literature and particular emphasis is posed on currently controversial, or paradigm-changing findings. The students will participate in lectures, present some of the material themselves, perform a full laboratory experiment and present critical syntheses of their work and of the literature.

Course Objectives

To provide students with advanced knowledge about the cellular and molecular mechanisms underpinning stem cell-based tissues, regeneration processes and ageing, with stem cell biology being the overarching theme across the three topics.

To equip the students with the critical insights and research skills relevant to these rapidly growing fields.

To equip students with the ability to interpret experimental data.

To provide the students with the opportunity to experience laboratory work manipulating and monitoring differentiation of progenitor cells, starting from the experimental design to final critical evaluation of results obtained and plans for future work.

To equip students with transferable skills such as teamwork, written and oral communication, synthesis of large amounts of information, critical assessment of advantages and limitations of assays/studies.

To consider ethical implications related to stem cell research and clinical applications.

To experience an academic seminar as an example of how scientific research is communicated to peers.

Who should take this course?

SCRA is most enjoyed by those interested in cell biology, genomics and molecular biology

Assessment

Coursework contributes 25% of SCRA’s assessed mark and it includes:

Lab practical open book quiz (12.5%)

Effective science communication made up of the following 3 pieces of work:

Team presentation of a primary SCRA research paper to peers: 8%

Clear and engaging ‘Press release’ about the research you have presented: 2%

An outline of a possible future experiment developing the research in the paper you have presented in the form of a note to a collaborator: 2.5%

Written exam (75% of course’s assessment mark)

3 questions freely chosen from 6 essay-based and/or SCRA data discussion questions

Structural Biology and Drug Design

Convenors: Prof Steve Matthews and Dr Ernesto Cota

Course Aims:

- Develop a working understanding of the **principles** of **macromolecular structure determination**.
- Understand the **impact** that structural information can have **interpreting biological processes**.
- Learn about techniques in **modern drug design** that are relevant to **biochemists and structural biologists**.
- Follow and discuss strategies and conclusions from articles published in the fields of **structural biology** and **drug design**.
- Gain **practical skills** in solving a structural biological problem and interpreting drug binding data.
- Deepen your understanding through a **tutorial** series and a **field trip** to the **DIAMOND Light Source.**

Course Objectives: Lectures will cover modern aspects of macromolecular three-dimensional (3D) structure determination. These will focus on the application of 'state of the art' techniques for the elucidation of 3D structures of proteins and their complexes - nuclear magnetic resonance, X-ray diffraction and electron microscopy. The methodologies involved in obtaining high resolution structural information using these techniques will be discussed. Comparisons will also be made between the different disciplines together with the computational aspects of ligand binding and drug discovery. The course will also cover aspects of protein dynamics and its measurement and relevance to molecualr recognition. A description of the new opportunities for academia in drug development, current biophysical techniques for fragment-based drug discovery (FBDD) and emerging technologies for generation of high affinity ligands. The practical will include 'hands on' experience with interpreting diffraction and NMR data using the latest software packages used in structural biochemical research and the pharmaceutical industry. Furthermore, demonstrations and opportunities to gain experience operating instrumentation.

Course Content:

28 lectures in total comprising:
5 lectures on Electron microscopy and tomography (Morgan Beeby)
5 lectures on X-ray diffraction and crystallography (Erhard Hohenester)
5 lectures on protein nuclear magnetic resonance (Steve Matthews)
3 lectures dynamics and folding from nuclear magnetic resonance (Alfonso De Simone)
4 lectures computational aspects of structure prediction and comparison methods (Mike Sternberg)
4 lectures Methods for identification and generation of ligands for drug discovery (Ernesto Cota)
2 lectures on the use of X-Ray Free Electron Lasers in structural biology (James Murray)

Practicals:

A single project style course work with up to 20 hrs practical time that attempts to study a drug discovery task focussing on the HSP70, which is an essential and highly conserved ATP-dependent molecular chaperone that is involved in many cellular processes. NMR spectra of HSP70 will be assigned using the latest software tools and conclusions are drawn regarding structural and dynamic properties. This insight is then supported by atomistic model building into the diffraction-derived electron density. Finally, the analysis of NMR and X-ray HSP70 data together with ligand/drug binding data is interpreted in the light of the structures, such as the allosteric coupling between domains or the search for new HSP70 inhibitors. Marks are given for completeness, presentation, originality and evidence for outside reading. A suggested word count of ~2000 is suggested (not including figures captions, tables and references), but creativity in the style of report is encouraged.

Symbiosis, Plant Immunity and Disease

Convener: Dr Martin Bidartondo

Lecturers: Dr. Martin Bidartondo, Dr. Tolga Bozkurt, Dr. Sian Deller (Syngenta), Dr. Sebastian Schornack (Sainsbury Laboratory), Dr. Jörg Schumacher, Prof. Pietro Spanu.

Aims: This course focuses on the molecular features of a number of model plant-microbe interactions. Emphasis will be given to fungal and bacterial diseases, rhizobial legume nodulation and nitrogen fixation, and arbuscular mycorrhizas. The course will comprise a series of lectures that develop themes relative to each particular type of interaction. Students will produce a review essay, carry out a laboratory- and computer-based team learning exercise and a research proposal activity which will require knowledge from lectures and information from outside reading. Tutorials will be held to discuss the essay and proposal. The laboratory exercise will develop research skills.

Objectives: The course presents our current understanding of plant-microbe interactions, ranging from antagonism to mutualism, at the molecular level. By the end of the course the student will understand microbial biotrophy, the mechanisms by which plants respond and protect themselves against attack, the mechanisms used by microbes to infect, and the pathways involved in the establishment of mutualisms. The course builds on a prior understanding of basic molecular biology, plant biology and microbiology attained in first and second year courses, it provides a sound knowledge base for a final year project in any area of plant-microbe interactions and a suitable background for advanced studies in this or related fields.

Who should take this course?
There are no pre-requisites and students from all branches of biology and biochemistry with an interest in plant and/or microbes are encouraged to join the course.

Course components and assessment
The course consists of lectures, tutorials and a practical project. A proposal to investigate a microbe-host interaction will be presented as a poster. Assessed coursework (25% of course mark) includes a review essay (25%), a team-based learning exercise (30%) and a poster presentation (45%). There will also be a three-hour written examination (75% of course mark).

Introductory and further reading.
Aroca, R. 2013. Symbiotic Endophytes. Springer.
Bronstein, J.L. 2015. Mutualism. Oxford UP.
Evert, R. F., Eichhorn, S. E. 2012. Biology of Plants, 8th ed. Freeman.
Perotto, S. & Baluška, F. 2011. Signaling & Communication in Plant Symbiosis. Elsevier.
Martin, F. 2017. Molecular Mycorrhizal Symbiosis. Wiley Blackwell.
Schumann, G.L & D'Arcy, C.J. 2009. Essential Plant Pathology, 2nd ed. Am. Phytopath. Soc.
Sessa, G. 2012. Molecular Plant Immunity. Wiley-Blackwell.
Smith, S. & Read, D. J. 2008. Mycorrhizal Symbiosis, 3rd ed. Elsevier.
Sprent, J. 2009. Legume Nodulation. Wiley-Blackwell.
Walters, D. R. 2011. Plant Defense. Wiley-Blackwell.
Recommended journal articles to be listed in lectures and/or made available in Blackboard.

Synthetic Biology

Convenor: Dr Geoff Baldwin

Aims

The advent of the molecular biology age in the 1970s was brought about by the ability to construct recombinant DNA molecules. This has completely revolutionised biology and enabled the development of 'synthetic biology', where new gene arrangements can be constructed and evaluated. This has been tremendously successful, leading to a wide range of biotechnological applications. However, the engineering of useful synthetic biological systems is still undertaken on an individual *ad hoc* basis, which is expensive and inefficient. Synthetic biology as a discipline is now attempting to apply the principles of engineering and develop foundation technologies that make the design and construction of engineered biological systems easier, facilitating future development in biotechnology. This course will explore the challenges, problems and approaches to engineering biological systems.

Objectives

After taking the course you should be able to:

1. Understand the design approach in engineering and the concept of abstraction hierarchies; standardisation and optimisation.

2. Understand the engineering process at work and how hierarchical systems produce functional devices.

3. Develop a computer model and simulate a simple biological system.

4. Understand how biological components can be considered as parts and characterised as an engineered component (biobrick).

5. Analyse a biological system from a system perspective to understand how the biobricks interact to give rise to the observed biological behaviour.

Be able to design a simple biological system from a series of characterised biological parts (biobricks).

Who should take the course?

This course will suit biochemists and biologists who have an interest in biotechnology and systems biology. There are no pre-requisites, but it will suit those with a strong molecular background with good computing skills. You should enjoy teamwork and being challenged.

Course components

Reflecting the inter-disciplinary nature of the subject, this course is run jointly with Bioengineering. Students from the biology and biochemistry degrees will receive lectures on engineering and a computer modelling practical. Students from both disciplines will come together for the common part of the course. It will involve approximately 25 hours lectures; a large component of the course will use problem based learning and a computer practical. Students will participate in teamwork and be encouraged to think creatively; the final two weeks will involve a team mini-IGEM project. Students will work in teams with group feedback roundtables.

Assessment

75% of the assessment will be an examination with three parts. The first will assess the engineering component, and the second will assess the common course components; the third will be an essay question. 25% will be based on assessed coursework with computer lab practical (5%), mini-iGEM presentation (5%) mini-iGEM project and poster (15%).

References

The primary sources will be published literature and open access web databases. For an overview see Endy, 2005, Nature **438**, p449.

Systems Neuroscience Exploring the Brain in Health & Disease

Conven0r: Dr Stephen Brickley

Aims

This course will show how some of the basic concepts and principles of biophysics can be applied to the mammalian nervous system to gain an understanding of how neurons function. It will then show how this information can be utilised to aid understanding of complex neuronal processing with relevance to human health.

Objectives

Discuss the electrical basis of neuronal excitability, and understand the fundamental processes underlying learning, memory and pain pathways and relate this information to advances in clinical research.

Describe and explain the rationale underlying experimental strategies used at the forefront of neuroscience research.

Develop skills in communication (writing reports and presentations; group work; self-assessment; in-depth learning (literature searching, reading and summarising); information gathering and creativity.

Gain an appreciation of the intellectual rigour required to pursue scientific research at the highest level.

Who should take this course?

Students interested in neurobiology and neuroscience.

Course components and assessment

The course comprises a general overview of neuronal excitability and neurophysiological techniques; followed by an examination of brain disorders such as dementia, addiction and sleep disorders.

Assessed coursework includes an essay (75% of coursework) and a group presentation (25%). There will also be a 3 hour written examination.

References

Kandel, E. R., Schwartz, J. H. & Jessell, T. M. (2000). *Principles of neural science.* McGraw-Hill.

Squire, L. R., Bloom, F. E., McConnell, S.K , Roberts, J.L & Spitzer, N.C. & Zigmond, M.J. (2002). *Fundamental neuroscience.* Academic Press.

The Microbiome

Convenor: Dr Thomas Bell

Aims

The main aim of the course is to understand the diversity, temporal dynamics, and spatial patterns of microbial communities in light of underlying ecological and evolutionary processes. The first part of the course will outline how patterns are generated in ecological communities, and what tools can be used to understand those patterns. The second part of the course will focus on the techniques used to measure microbial communities in particular, including next-generation sequencing approaches. The third part of the course will draw on the expertise from around the college to look in detail at particular microbiomes, including for example the microbiomes of animals and plants, industrial microbiomes (e.g. sewage treatment, beer brewing), and environmental microbiomes (soil, freshwater, marine).

Bacteria coat every surface on Earth, living in soil and water and inside animals and plants. Microbes are therefore vital but understudied components of all ecosystems. Recent extraordinary advances, fuelled by new sequencing technologies, have resulted in a rapidly expanding field that has implications for a deeper understanding of the natural world. Microbiome research also offers enormous potential for applications to a wide range of industries, including health, and agriculture, and industrial processes. Even with the vast investment in microbiome research that is currently underway, it appears we are still at the tip of the iceberg, with excellent career opportunities for students with experience in this area.

Who should take the course?

The course will be relevant students with specialisation both in microbiology and ecology. Students in the microbiology stream receive training largely on the physiology of a small suite of specialist pathogens- the proposed course would broaden their perspective to think about microbes generally. The course is relevant to students interested primarily in pathogens because most pathogens can only be understood in the context of the surrounding microbial community. Students in the ecology stream will benefit since most of the focus of ecology is on larger organisms, with little appreciation or understanding of how microbes influence communities and ecosystems. Relevant second year courses: Bacterial physiology, Virology, Ecology. Complementary final year courses: Medical microbiology, Population and Community Ecology, Evolutionary Biology, Biodiversity Genomics.

Assessment

75% written exam: problem solving, data interpretation, essays.
15% practical: written report based on the outcome of the practical.
10% mini review

Reading

A general overview of some of the main topics can be found in the following books and Journals:
Barton and Northup. 2011. Microbial ecology. Wiley.
Peppa, Gerber, Gentry, and Maier. 2014. Environmental microbiology. Elsevier.
Kirchman. 2012. Processes in microbial ecology. Oxford University Press.
Nature Reviews Microbiology
Nature Microbiology
The ISME Journal
Environmental Microbiology
Microbiome

The following link provides a great overview of some of the latest microbiome research: https://www.nature.com/subjects/microbiome

Final Year Undergraduate Projects

The Final Year Project carries considerable weight in the calculation of the final class of honours. Placed at the end of the degree programme, it provides you with an opportunity to demonstrate your understanding of biological concepts and your ability to generate new ideas and/or experimental results. It allows you to show that you can contribute to the sum of biological knowledge. You need to put in some careful thought and a considerable amount of preparation if you are to use this opportunity effectively

The project may take the form of:

An individual practical research investigation.

A bioinformatic, meta-analysis or modelling project

A literature research dissertation.

The first two options start toward the end of the Spring term and then carry on during the Summer term. The final option starts at the beginning of the Summer term and must be taken in conjunction with a Science Communication module. We will provide you with details of the Science communication module when we release the list of projects later this year.

All Projects must be supervised by a member of the academic staff or a recognised teacher normally in Imperial College of London. In exceptional circumstances students can be supervised by other recognised scientists but in this case they must also identify an academic staff member who can oversee progress of the project. Some Projects may be undertaken at the Silwood Park campus. The Department will compensate for accommodation costs at Silwood where students have to maintain accommodation in London due to lease agreements (see below).

Project work may not be commenced until after the end of the Final Year examinations in the middle of Spring Term. However, some initial planning and reading can be started before that date.

Choice of Project

An extensive list of projects that members of staff are able to supervise will be posted on Blackboard. You will then have about 2 weeks to think about these (consult with staff as required) and choose 8 in order of preference. You must not choose more than one research and one literature project from the same supervisor. Neither must you approach a member of staff within the Department of Life Sciences to arrange a project privately. The system for allocation aims to provide the best possible choice for the greatest number of students. The great majority of students will receive one of their first few choices; some degree of iteration may be possible following allocation.

Whichever kind of project/dissertation you do, **it is essential to discuss it fully with your supervisor before you start**, and to agree with him/her the broad outline of what is to be achieved. Advance preparation is essential if you are to use the time available to its best advantage.

If you become ill or have an accident which prevents you from working during the period of the projects you must notify the Life Sciences Education Office as soon as possible specifying the date from which you were unable to continue working on your project. When you return to College you must give the Education Office a medical certificate signed by a doctor (preferably from the Student Health Centre) **stating the dates between which you were unable to work.** Failure to produce a medical certificate will mean that you will not be allowed any extra time to complete your project. Any claim for extra experimental or writing-up time **must be made through the Final Year Project Coordinator** in the first instance.

Conduct of the project and writing it up

Your supervisor will monitor the progress of your project and will report on its difficulty and on your conduct while carrying it out. It is in your interest to keep your supervisor up-to-date with your progress and with any difficulties you encounter while carrying it out (failure of experiments, inaccessibility of key references, failure of arrangements for getting materials) so that she/he can include them in their Supervisor's report.

You will find that writing up the report takes longer than you think. Allow at least a week, but start writing drafts of the different sections in spare moments while you are carrying out the Project. If you are writing a critical review you should start writing almost as soon as the project starts. You will probably wish to map out the structure of your report and prepare drafts of the various sections before compiling the final version for submission. The section on research methodology is usually the most straightforward to write and is where many students start.

Keep at least two copies of your project report on separate media (CDs/USB bars/Network Drive), and maintain hard copy print-outs of your drafts which could be handed-in if necessary. This will avoid last minute panics due to computer crashes.

The Project Report

Details on the format of the project report will be provided with the project lists in February.

Three copies of the completed, bound report must be handed in either to the Life Sciences Undergraduate Office (Wolfson) or to the Teaching Office at Silwood Park. **For each hour's delay in submission after the deadline, a percentage of marks will be deducted.**

Your project report will be assessed independently by a first examiner, nominated by your supervisor as being knowledgeable in the subject area, and by a second examiner with interests in the same general area of the life sciences. Their agreed mark will form one component of the project assessment. A second component will be provided by your supervisor, who will give an appraisal of your performance during the course of the project and also mark the project report, and the third will be based on your ability to present your work and answer questions in a *viva voce*. More details will be provided at 'Writing Up Your Project talks' in the Spring Term.

Whatever its form, the project will be assessed according to a common set of criteria, made available to the examiners and supervisor. You should pay particular attention to the following aspects of your report write-up:

Scientific rigor: your report must be objective and logical in its analysis of the problem and your data.

Understanding: your report should make clear that you understand the implications of your project and how your results and conclusions fit into a broader framework of knowledge.

Originality: the project must indicate some originality of thought and an ability to synthesize and develop ideas. *Paraphrasing other people's work, whether published or unpublished, is not enough, and straightforward copying without a proper attribution and acknowledgement will be severely penalised.*

Your *viva voce* oral exam will be held after submission of the project report. The examination will consist of a presentation followed by a discussion with your two examiners (your supervisor will not be present) and will test your understanding of your project and your report. You may be asked specific questions arising from your project report and more general questions relating your project work to wider issues in the life sciences.