School of Biochemistry and Immunology

SS Biochemistry
2017–2018
BIOCHEMISTRY SENIOR SOPHISTER MODULES (60 ECTS)

BI4115 NEUROBIOLOGY (5 ECTS)
This module covers the structure, function and pharmacology of neurotransmitters, neuron-glial interactions, intraneuronal signalling and the neurobiology of behaviour and neurodegenerative disorders.

BI4045 AUTOIMMUNE AND INFLAMMATORY CONDITIONS (5 ECTS)
This module covers basic and clinical aspects of autoinflammatory and autoimmune conditions, including rheumatoid arthritis and multiple sclerosis and immunodeficiency syndromes.

BI4055 MICROBIAL DISEASES (5 ECTS)
This module provides an introduction to parasitic protozoa such as trypanosomes and helminths. The biochemical and genetic mechanisms by which these parasites evade the host immune responses will be covered. Bacterial pathogens of medical importance will also be covered in detail.

BI4135 STRUCTURAL BIOCHEMISTRY AND CELLULAR IMAGING (5 ECTS)
This module addresses how biomolecular and cellular structure determine function. It also covers the high resolution and multidimensional imaging of molecules and cells.

BI4145 STEM CELL BIOLOGY (5 ECTS)
This module covers the cellular and regulatory mechanisms that control the cell cycle. It also covers the molecular basis of a stem cell and its potential use in therapies and the generation and use of transgenic organisms in research and medicine.

BI4155 CANCER BIOLOGY (5 ECTS)
This module covers the molecular basis of cancer, the progression of the disease and the therapeutic treatment strategies.

BI4165 METABOLIC DISEASES (5 ECTS)
This module covers the biochemistry of genetic deficiency diseases and metabolic diseases.

BI4175 IMMUNOLOGY (5 ECTS)
This module covers pathogen recognition by and signal transduction in immune cells. The biochemical and genetic mechanisms by which bacteria and viruses evade the host immune responses will be covered.

BI4195 RESEARCH PROJECT IN BIOCHEMISTRY (15 ECTS)
The module comprises of an original research project in biochemistry and a research thesis.

BI4015 DATA HANDLING (5 ECTS)
This module covers quantitative biochemical problems, biochemical techniques, bioinformatics and animal handling.

NOTE: Learning outcomes for each of the modules can be found on the School homepage http://www.tcd.ie/vpcao/academic-development/ects.php.

Explanation of ECTS

The European Credit Transfer and Accumulation System (ECTS) is an academic credit system based on the estimated student workload required to achieve the objectives of a module or programme of study. It is designed to enable academic recognition for periods of study, to facilitate student mobility and credit accumulation and transfer. The ECTS is the recommended credit system for higher education in Ireland and across the European Higher Education Area.

The ECTS weighting for a module is a measure of the student input or workload required for that module, based on factors such as the number of contact hours, the number and length of written or verbally presented assessment exercises, class preparation and private study time, laboratory classes, examinations, clinical attendance, professional training placements, and so on as appropriate. There is no intrinsic relationship between the credit volume of a module and its level of difficulty.

The European norm for full-time study over one academic year is 60 credits. The Trinity academic year is 40 weeks from the start of Michaelmas Term to the end of the annual examination period. 1 ECTS credit represents 20-25 hours estimated student input, so a 10-credit module will be designed to require 200-250 hours of student input including class contact time and assessments.

ECTS credits are awarded to a student only upon successful completion of the course year. Progression from one year to the next is determined by the course regulations. Students who fail a year of their course will not obtain credit for that year even if they have passed certain component courses. Exceptions to this rule are one-year and part-year visiting students, who are awarded credit for individual modules successfully completed.

For additional details see: http://www.tcd.ie/vp-cao/bd/vpdb3college_ects.php

Examinations and Breakdown of Marks:

<table>
<thead>
<tr>
<th>Senior Sophister Module Name</th>
<th>ECTS Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Neurobiology</td>
<td>BI4115</td>
</tr>
<tr>
<td>2) Autoimmune &amp; Inflammatory Conditions</td>
<td>BI4045</td>
</tr>
<tr>
<td>3) Microbial Diseases</td>
<td>BI4055</td>
</tr>
<tr>
<td>4) Structural Biochemistry &amp; Cell Imaging</td>
<td>BI4135</td>
</tr>
<tr>
<td>5) Stem Cell Biology</td>
<td>BI4145</td>
</tr>
<tr>
<td>6) Cancer Biology</td>
<td>BI4155</td>
</tr>
</tbody>
</table>
7) Metabolic Diseases  BI4165  5 ECTS
8) Immunology        BI4175  5 ECTS
9) Research Project in Biochemistry BI4195  15 ECTS
10) Data handling     BI4015  5 ECTS

**SS year** is broken down into a total of **60 credits**.

**Annual Examination Papers. Value: 40 credits or 66.66% of SS year**
There are four exam papers at the end of the SS year, each with equal weighting (total 40 marks or 66.66% of SS year) as follows:

**Paper 1 Value: 10 credits or 16.66% of SS year**
Specific questions related to modules 1-4 above. Exam paper divided up into 4 sections (one module per section). Answer 4 questions, one from each section.

**Paper 2 Value: 10 credits or 16.66% of SS year**
Specific questions related to modules 5-8 above. Exam paper divided up into 4 sections (one module per section). Answer 4 questions, one from each section.

Papers 3 & 4 are indirectly linked to modules listed above, being general in nature.

**Paper 3 Value: 10 credits or 16.66% of SS year**
Exam paper divided up into two sections. Answer 4 questions at least one from each section. The quantitative problems given in Section A will be related to those practiced in the Junior Sophister AND Senior Sophister year.

**Paper 4 Value: 10 credits or 16.66% of SS year**
Exam paper divided up into two sections. Section A- question 1: short questions, answer 10 out of 18 (compulsory question) -worth 50% of paper. Section B-answer 2 questions -worth 50% of paper

**All answers from the above exam papers are double-marked.**

**Research Project in Biochemistry Value: 15 credits or 25% of SS year.**
11-week research project and thesis.

**Data Handling Value: 5 credits or 8.34% of SS year.**
This module covers quantitative biochemical problems, bioinformatics, animal handling and a presentation by the student on a biochemical technique. Marks are awarded through continual assessment and in-course exams as follows:

- Quantitative Problems (4, assessed by `in-course exam` choice of 1 out of 2 (2 credits))
- Sequence Analysis (3, assessed by assignments submitted on-line) (1.25 credits)
- Biochemical Techniques (group work, assessed by oral presentation and summary documents) (1 credit)
- Animal Handling (assessed by in-course exam) (0.75 credits)
The overall degree mark is comprised of 80% of SS year and 20% of JS year.

On completion of their annual examinations, students sit a viva voce examination with the External Examiner. Students are considered ‘borderline’ if they are 2.5% or less off a grade and following the viva voce examination the External Examiner may recommend at the Examiners’ meeting that the students’ degree mark be brought up to the next grade.

Tutorials:
Tutors have been chosen randomly. Please contact your tutor during the first week of the first semester. You are expected to attend a tutorial every fortnight. Times and dates of tutorials given on timetable are a rough guide only. Your tutor will set various exercises and these should help you in your final examinations.

Practise Vivas:
Vivas (oral exams) are held approximately two weeks following the completion of your four exam papers. The maximum percentage marks that you can be brought up by is 2.5%. You cannot be marked down by a viva. You will not know your mark before sitting the viva.

How can you prepare for the viva?
Practise vivas will be held during the year. You will be assigned to a pair of academic staff members. The vivas take approximately 20 minutes and you will be asked a variety of questions. There are no marks going for this. Please regard these vivas not as a test of your knowledge but as useful practise. They are also good interview experience!

When you are called for a viva in the summer, you should read over your project thesis as the Extern often starts off by asking you about your project. He/she will want to relax you and will generally start you off on a topic you know a lot about. The Extern will probably cover about 4-6 topics during the viva and it is impossible to second guess what they will ask. However, if you feel you did badly in one particular exam question, it is a good idea to revise this topic. The Extern has access to all your marks and if he/she sees a blip in an otherwise very consistent set of marks they may wish to follow this up. The Extern may also ask you if there is a topic in Biochemistry that you find particularly interesting and that you wish to talk about. It is therefore a good idea to have something prepared but ensure that it is a specific topic. Do not be too general and say that you’re interested in protein structure! The Extern may also ask you on your views of the course; was there a part of the course you really enjoyed or not as the case may be. The role of the Extern is not only to assess your performance but also to assess our teaching capabilities and to identify strengths/weaknesses and even omissions in the course so that they can make recommendations for the following year.
**Quantitative Problem Sessions:**
All Quantitative Problems will be given out at introductory sessions by various staff members (*e.g.* **Prb 1 Intro** on the timetable), at the times indicated. You will attempt the problem in your own time and must bring the problem with you to a timetabled tutorial session (*e.g.* **Prb 1 Tutorial**). You must be able to demonstrate that you have attempted the problem to the staff member and failure to do so will result in being returned as non-satisfactory. In the tutorial session, the staff member will go through the solution with you and answer any queries you may have. Following completion of all Problem Sessions there will be an in-course exam (choice of 1 out of 2 quantitative problems).

**Sequence Analysis Sessions:**
There will be three three-hour Sequence Analysis Sessions (Dr Jerrard Hayes). Each session will begin with a brief introduction in FRED (2pm). You will then move to the East End Public Access Mac Room for the practical session. Submission dates for the Sequence Analysis Exercises are indicated on the timetable. Dr Hayes will advise you as to how and where you submit the exercises.

**Course Feedback:**
A Feedback Form for each course will be given out at the beginning of the term. These (anonymous) forms are a mechanism whereby students can make comments and suggestions that will help us to maintain and indeed improve the quality of the teaching offered by the School of Biochemistry & Immunology. Please fill out the form upon completing each course, do not wait until the end of term (you will forget!). Put the forms into the box provided in the secretary’s office.

**Addresses and Phone No's:**
Please enter your College based address, e-mail address and telephone number (if any) on the sheet provided at the Introductory Lecture. Please also include a home (or other contact) address and telephone number. This will enable us to contact you in an emergency or with important changes in such details as timetables, exam venues, etc. If you do not enter these details you may not be informed of any changes.

**Careers Talk:**
Karina Septore will give a Careers Talk tailored for Biochemistry students, on Friday 6th October at 11 am in FRED.

**Research Projects:**
At the start of first semester you will be given Project Summaries of all available projects. You then have two weeks to select your first choice for a project. Feel free to discuss these projects with Staff. **You may not select a project offered by a Staff Member with whom you have done a Summer Project.** Projects will then be allocated by the following procedure: any project with only one taker will be allocated to that student; any projects with more than one taker will be allocated by drawing one name out of a hat; losers and unallocated projects will then be placed into a second round; the allocation procedure will again take place, and will continue until all students and projects are exhausted. In this manner it is hoped than an element of
choice may operate in selection of projects. You may then, if you wish, change projects by mutual exchange between students. However, in the event you do not gain your project of choice no additional projects will be set.

Once projects are selected you should then contact your project supervisor for discussions. Most importantly, you should check that essential chemicals and equipment are, or will be, available when required.

Following submission of your project thesis you will give a 15 min oral presentation that explains your project, its aims your experimental approach, your results and conclusions (Friday 23rd March). Your presentation and your ability to answer questions will be assessed by a panel of three members of academic staff. It is advisable to arrange at least one practise practice with your project supervisor.

This oral presentation will account for 15% of the project mark.

**Project laboratory work** will start on November 13th and terminate on the 23rd February. After the completion of laboratory work, you will be given 3 weeks to present a thesis on your project. You will also present a **Project Poster** to the School at a poster session. There will be prizes for the best posters. A deadline for handing in projects will operate. **It is 5.00 pm on Friday 16th March.** For every working day that your thesis is late 2% will be deducted from your mark. Ms Roisin Cleere and Dr Audrey Carroll (Preparation Room) will advise you about the presentation of your poster and print it for you. Further details on Project write-ups and poster presentations will be given in the second semester.

**Project Marking Scheme:**
**Lab performance:** 15% (awarded by supervisor)
**Thesis:** 70% (awarded by supervisor & 1 other staff member)
**Oral presentation:** 15% (awarded by panel of 3 staff members)

The **Margaret Ciotti Medal** is awarded each year to a Senior Sophister student for excellence in undergraduate research. This award was initiated by Bruno Orsi to honour his wife's achievements in biochemistry and will now be a memorial to her. It is traditionally presented by Bruno on a date between the end of the exams and the vivas. This year the award ceremony and reception will take place on the afternoon of the 18th May. This award is independent of the poster prizes.

**Biochemistry Personnel and Contact Details:**
The Senior Sophister Course Co-ordinator is **Daniela Zisterer (phone extension 1628, email dzisterz@tcd.ie)**. The names of tutors are provided on a separate sheet. A complete list of the Biochemistry Staff can be found at [http://www.tcd.ie/Biochemistry/staff/](http://www.tcd.ie/Biochemistry/staff/)
Health and Safety Management:

1) Registration with Safety Officer
Preliminary safety registration takes place during one mandatory health and safety briefing session timetabled in Week 1 (see timetable). Later on you must register, in person, with the Safety Officer after you have been assigned your project. This is necessary in order to record your next-of-kin details in the unlikely event of an accident, to record where you will be working, to ascertain whether or not you have to work with major hazards during your project work (carcinogens, mutagens, cytotoxics, biological agents, GMOs, radioactivity, etc.), and to ensure that you and your supervisor understand that you have to conduct a HIRAC review (hazard identification, risk assessment and risk control) of the proposed work.

2) Formal Health and Safety Briefings
Mr Liam McCarthy (Chief Technical Officer) will describe the general management and security features of the building on the first day of term. Dr Nóirín Nic a’ Bháird, the School Safety Officer will give you a formal general Health and Safety briefing at 10 a.m. on Friday 30th September. Dr Nic a’ Bháird will give another more detailed Health and Safety workshop just before you start your project work in the research laboratories. ATTENDANCE AT THESE BRIEFINGS AND ANY ADDITIONAL TRAINING SESSIONS (e.g. Radiological Protection Workshop, viewing safety videos, etc.) IS MANDATORY. Some of these actions are legal, license or College's insurer's requirements that have to be complied with.

3) Safety Lab Coat & Spectacles
You must have at least one Howie-style laboratory safety coat, conforming to the NISO 1993, or better, standard, along with a pair of safety spectacles with you at all stages during active laboratory work.

4) Specific Aspects of Health and Safety Associated with Project Work
You are required to attend one scheduled and compulsory short briefing on aspects of Health and Safety in laboratories given by the School Safety Officer a few days before project work starts. Any hazardous materials, steps or procedures (including off-site work connected with your research such as collecting samples from other laboratories, etc.) involved in your project will have been identified by, and discussed with you by your project supervisor. He/she is required, by law, to perform this hazard identification, risk assessment and risk control (HIRAC) on every experiment undertaken by you, but you have a role to play as well in making sure that you record the conclusions of this procedure in you notebook. The control measures necessary to reduce or eliminate risk must be written in your notebook for each hazardous step or procedure. The law requires this to be done. You are still in training so you cannot be classed as a competent biochemist and thus able to do this yourself to ensure your safety. If in doubt about the proper procedures for any experiment, do not perform that experiment.

Senior Sophisters must make themselves aware of the College's and School's Safety Statement which is displayed prominently in every laboratory in the School. [It can be downloaded from the School’s Local Home-Page at this URL:
You are still bound by the 'Science Faculty's Health and Safety Guidance Manual' and the associated Health Questionnaire which you completed at the start of JF year. If your health status has changed since then in terms of the categories listed (including pregnancy or lactation) you have to complete a new Health Questionnaire. If your health status again changes during the year you must consult, in confidence, with the Safety Officer. [This particularly applies in the case of pregnancy.]

You are not permitted to work with unsealed radionuclide sources unless you have attended and satisfactorily completed a Radiological Protection Workshop. This is normally held sometime in January 2017. Please see following link for further details and dates [http://www.tcd.ie/Buildings/Safety/biosafety_website/](http://www.tcd.ie/Buildings/Safety/biosafety_website/)

Any student working with human materials (blood, buffy coats, semen, CSF, dialysis fluid, primary explants, etc.) must be vaccinated against Hepatitis B prior to commencing your project. You are not permitted to work with any risk group 3 or class 3 biological agents such as HIV, Hepatitis B and C, etc. or to culture Category 3 (or higher) pathogens.

You must request or otherwise obtain Material Safety Data Sheets (MSDS) for any toxic or dangerous chemicals or preparations that you are using in your project. These MSDS's have to be requested at the point of ordering any material. The MSDS must be stuck into your laboratory notebook. The guidance must be followed.

After 6:00 pm on working days, and at all times on weekends and public holidays, no Senior Sophister may work in any laboratory without the close presence of a member of the academic staff. It is the Senior Sophister's responsibility to ask that staff member if he/she will consent to act in a supervisory capacity for the time the student is working. During normal working hours no student may work alone in any laboratory.

Failure to observe these rules/procedures will cause the offenders to be officially warned, and be reported to the Head of School, school safety officer and project supervisor. Normal College disciplinary procedures can be invoked (including fines being levied as well as withdrawal of student i.d. card, etc.) Persistent failure to observe these rules may result in that student being banned from laboratory work with loss of those marks available for project work.

**Students with Disabilities:**
The University Policy Relating to students with disabilities is available at www.tcd.ie/disability. The Student Disability Service is located in Room 2054 Arts Building, phone = 8963111, email = [disab@tcd.ie](mailto:disab@tcd.ie). The Student Disability Services Committee provides the formal channel for raising issues affecting students with disabilities.
Plagiarism:
The full statement of College’s policy on plagiarism (see Calendar, General Regulations and Information, §82-§91 at http://tcd-ie.libguides.com/plagiarism are reproduced below. In addition members of staff of the School of Biochemistry & Immunology may scan your written assignments using plagiarism-detecting software such as Turnitin (additional information for which can be found at: http://turnitin.com/static/index.html). During your final year you will be expected to prepare material for the Biochemical Techniques course and to write a report on the research findings of your fourth year project. You will be provided with guidance notes for the completion of these exercises. In the first and second semester, Prof. Kingston Mills will give a tutorial class on how to prepare and write a report for your research project.

It is a college requirement that all students must complete an online tutorial on avoiding plagiarism ‘Ready, Steady, Write’, located at http://tcd-ie.libguides.com/plagiarism/ready-steady-write.

In addition, students must complete cover sheets or include text containing the following declaration when submitting assessed work in hard or soft copy or via Blackboard:

I have read and I understand the plagiarism provisions in the General Regulations of the University Calendar for the current year, found at: http://www.tcd.ie/calendar

I have also completed the Online Tutorial on avoiding plagiarism ‘Ready, Steady, Write’, located at http://tcd-ie.libguides.com/plagiarism/ready-steady-write

§82 General
It is clearly understood that all members of the academic community use and build on the work and ideas of others. It is commonly accepted also, however, that we build on the work and ideas of others in an open and explicit manner, and with due acknowledgement.

Plagiarism is the act of presenting the work or ideas of others as one’s own, without due acknowledgement.

Plagiarism can arise from deliberate actions and also through careless thinking and/or methodology. The offence lies not in the attitude or intention of the perpetrator, but in the action and in its consequences.

It is the responsibility of the author of any work to ensure that he/she does not commit plagiarism.
Plagiarism is considered to be academically fraudulent, and an offence against academic integrity that is subject to the disciplinary procedures of the University.

§83 Examples of Plagiarism

Plagiarism can arise from actions such as:
(a) copying another student’s work;
(b) enlisting another person or persons to complete an assignment on the student’s behalf;
(c) procuring, whether with payment or otherwise, the work or ideas of another;
(d) quoting directly, without acknowledgement, from books, articles or other sources, either in printed, recorded or electronic format, including websites and social media;
(e) paraphrasing, without acknowledgement, the writings of other authors.

Examples (d) and (e) in particular can arise through careless thinking and/or methodology where students:
(i) fail to distinguish between their own ideas and those of others;
(ii) fail to take proper notes during preliminary research and therefore lose track of the sources from which the notes were drawn;
(iii) fail to distinguish between information which needs no acknowledgement because it is firmly in the public domain, and information which might be widely known, but which nevertheless requires some sort of acknowledgement;
(iv) come across a distinctive methodology or idea and fail to record its source.

All the above serve only as examples and are not exhaustive.

§84 Plagiarism in the context of group work

Students should normally submit work done in co-operation with other students only when it is done with the full knowledge and permission of the lecturer concerned. Without this, submitting work which is the product of collusion with other students may be considered to be plagiarism. When work is submitted as the result of a group project, it is the responsibility of all students in the group to ensure, so far as is possible, that no work submitted by the group is plagiarised.

§85 Self plagiarism

No work can normally be submitted for more than one assessment for credit. Resubmitting the same work for more than one assessment for credit is normally considered self-plagiarism.

§86 Avoiding plagiarism

Students should ensure the integrity of their work by seeking advice from their lecturers, tutor or supervisor on avoiding plagiarism. All schools and departments must include, in their handbooks or other literature given to students, guidelines on the appropriate methodology for the kind of work that students will be expected to undertake. In addition, a general set of guidelines for students on avoiding plagiarism is available on [http://tcd-ie.libguides.com/plagiarism](http://tcd-ie.libguides.com/plagiarism).
§87 If plagiarism as referred to in §82 above is suspected, in the first instance, the Director of Teaching and Learning (Undergraduate), or their designate, will write to the student, and the student’s tutor advising them of the concerns raised. The student and tutor (as an alternative to the tutor, students may nominate a representative from the Students’ Union) will be invited to attend an informal meeting with the Director of Teaching and Learning (Undergraduate), or their designate, and the lecturer concerned, in order to put their suspicions to the student and give the student the opportunity to respond. The student will be requested to respond in writing stating his/her agreement to attend such a meeting and confirming on which of the suggested dates and times it will be possible for them to attend. If the student does not in this manner agree to attend such a meeting, the Director of Teaching and Learning (Undergraduate), or designate, may refer the case directly to the Junior Dean, who will interview the student and may implement the procedures as referred to under conduct and college regulations.

§88 If the Director of Teaching and Learning (Undergraduate), or designate, forms the view that plagiarism has taken place, he/she must decide if the offence can be dealt with under the summary procedure set out below. In order for this summary procedure to be followed, all parties attending the informal meeting as noted in §87 above must state their agreement in writing to the Director of Teaching and Learning (Undergraduate), or designate. If the facts of the case are in dispute, or if the Director of Teaching and Learning (Undergraduate), or designate, feels that the penalties provided for under the summary procedure below are inappropriate given the circumstances of the case, he/she will refer the case directly to the Junior Dean, who will interview the student and may implement the procedures as referred to under conduct and college regulations.

§89 If the offence can be dealt with under the summary procedure, the Director of Teaching and Learning (Undergraduate), or designate, will recommend one of the following penalties:
(a) Level 1: Student receives an informal verbal warning. The piece of work in question is inadmissible. The student is required to rephrase and correctly reference all plagiarised elements. Other content should not be altered. The resubmitted work will be assessed and marked without penalty;
(b) Level 2: Student receives a formal written warning. The piece of work in question is inadmissible. The student is required to rephrase and correctly reference all plagiarised elements. Other content should not be altered. The resubmitted work will receive a reduced or capped mark depending on the seriousness/extent of plagiarism;
(c) Level 3: Student receives a formal written warning. The piece of work in question is inadmissible. There is no opportunity for resubmission.

§90 Provided that the appropriate procedure has been followed and all parties in §87 above are in agreement with the proposed penalty, the Director of Teaching and Learning (Undergraduate) should in the case of a Level 1 offence, inform the course director and where appropriate the course office. In the case of a Level 2 or Level 3 offence, the Senior Lecturer must be notified and requested to approve the recommended penalty. The Senior Lecturer will inform the Junior Dean accordingly.
The Junior Dean may nevertheless implement the procedures as referred to under conduct and college regulations.

§91 If the case cannot normally be dealt with under the summary procedures, it is deemed to be a Level 4 offence and will be referred directly to the Junior Dean. Nothing provided for under the summary procedure diminishes or prejudices the disciplinary powers of the Junior Dean under the 2010 Consolidated Statutes.

School of Biochemistry & Immunology Guidelines on Marking:

Scheme for marking of examination answers:

I  Excellent; full understanding of concepts with excellent knowledge of subject; evidence of outside reading and thought beyond the content of specific courses.

II-I Very good answer demonstrating good understanding of concepts and broad knowledge of the subject. Lapse of content tolerated at the lower end of the scale.

II-II Good answer that is generally sound but with limited scope. Lapses in detail.

III Adequate but with significant shortcomings in content; containing errors in detail and with poor structure.

F1 Weak answer containing some relevant information but lacking substance and understanding.

F2 Poor answer; serious and absurd errors; contains few or no items relevant to the question.
Scheme for marking of projects:

The project mark is comprised of the Supervisor’s mark and one other Examiner’s marks for the project thesis. The Supervisor’s mark will be based on the student’s performance within the laboratory (technical ability, understanding of the project and literature pertaining to it, critical evaluation of results, demonstration of initiative and independent thought) and on the content and presentation of the first draft of the project thesis. The supervisor will also make the other Examiner of the project thesis aware of any unforeseen difficulties that arose during the course of the project.

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<thead>
<tr>
<th>Class</th>
<th>Mark Range</th>
<th>Criteria</th>
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<tbody>
<tr>
<td>I</td>
<td>85-100</td>
<td>Exceptional project report showing broad understanding of the project area and excellent knowledge of the relevant literature. Exemplary presentation and analysis of results, logical organisation and ability to critically evaluate and discuss results coupled with insight and originality.</td>
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<td>II-1</td>
<td>60-69</td>
<td>A good project report which shows a reasonably good understanding of the problem and some knowledge of the relevant literature. Mostly sound presentation and analysis of results but with occasional lapses. Some relevant interpretation and critical evaluation of results, though somewhat limited in scope. General standard of presentation and organisation adequate to good.</td>
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<td>II-2</td>
<td>50-59</td>
<td>A moderately good project report which shows some understanding of the problem but limited knowledge and appreciation of the relevant literature. Presentation, analysis and interpretation of the results at a basic level and showing little or no originality or critical evaluation. Insufficient attention to organization and presentation of the report.</td>
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<td>III</td>
<td>40-49</td>
<td>A weak project report showing only limited understanding of the problem and superficial knowledge of the relevant literature. Results presented in a confused or inappropriate manner and incomplete or erroneous analysis. Discussion and interpretation of result severely limited, including some basic misapprehensions, and lacking any originality or critical evaluation. General standard of presentation poor.</td>
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<tr>
<td>Grade</td>
<td>Description</td>
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<tr>
<td>Fail</td>
<td>An unsatisfactory project containing substantial errors and omissions. Very limited understanding, or in some cases misunderstanding of the problem and very restricted and superficial appreciation of the relevant literature. Very poor, confused and, in some cases, incomplete presentation of the results and limited analysis of the results including some serious errors. Severely limited discussion and interpretation of the results revealing little or no ability to relate experimental results to the existing literature. Very poor overall standard of presentation.</td>
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<tr>
<td>0-19</td>
<td>A very poor project report containing every conceivable error and fault. Showing virtually no real understanding or appreciation of the problem and of the literature pertaining to it. Chaotic presentation of results, and in some cases incompletely presented and virtually non-existent or inappropriate or plainly wrong analysis. Discussion and interpretation seriously confused or wholly erroneous revealing basic misapprehensions.</td>
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Dr Daniela Zisterer  
September 2017
Biochemistry
Breakdown of SS Papers I and II
2017-2018

Paper I

**Section 1: BI4115 ‘Neurobiology’**  
2 questions
- Neurochemistry (GD)
- Neurobiology (JH)
- Neurodegenerative disorders (GD)

**Section 2: BI4045 ‘Autoimmune & Inflamm. Conditions’**  
2 questions
- Biochemistry of the inflammatory process (JB)
- Rheumatoid arthritis (LON)
- Multiple sclerosis & EAE (JF/KM)
- Autoinflammatory diseases (EC)
- Immunodeficiency/clinical immunology (DD)

**Section 3: BI4055 ‘Microbial Diseases’**  
2 questions
- Trypanosomiases (DN)
- Prokaryotic pathogens (HW)
- Helminths (PF)

**Section 4: BI4135 ‘Structural Biochemistry & Cellular Imaging’**  
2 questions
- X-ray (AK)
- NMR (KHM)
- Cellular Imaging (DN)

*Answer one question from each section (4 OUT OF 8)*

Paper II

**Section 1: BI4145 ‘Stem Cell Biology’**  
2 questions
- Cell cycle (VK/PV)
- Stem cells (VK)
- Transgenics (VK/DN)

**Section 2: BI4155 ‘Cancer Biology’**  
2 questions
- Initiation & Progression (VK)
- Metastasis & Treatment (VK/KM)
- Apoptosis & Autophagy (DZ/JM)
Section 3: BI4165 'Metabolic Diseases'  
Genetic Diseases (AM)  
Metabolic Diseases (RP)  
Metabolic Control Mechanisms (RP)  

Section 4: BI4175 'Immunology'  
Cytokine Signalling (LON)  
Immunotherapies (AD/DF/FS)  
Viral Evasion (RMcL/AB)  

Answer one question from each section (4 OUT OF 8)
SS Course Summaries

2017-2018
Neurochemistry (5 lectures) Gavin Davey


**Lecture 2:** Aminergic neurotransmission: synthesis of catecholamines and serotonin; properties of the enzymes involved, nature and control of these processes and the effects of drugs. Vesicles (SSVs and LDCVs): composition, types, storage and transport, exocitosis. Post-synaptic events, metabotropic and ionotropic receptors and the roles of second messengers. Uptake and degradative processes and the effects of drugs on these. Trace amines.

**Lecture 3:** Affective disorders and aggression: evidence for the involvement of neurotransmitter systems. Possible genetic predisposing factors. The basis of therapy with MAO inhibitors, uptake inhibitors and receptor (ant)agonists - responses and adverse interactions. False transmitters. Melatonin synthesis and its regulation.


Nacetylaspartate, taurine and other possible modulators or messengers.

**Reading List:**

**General** (Textbooks that are worth consulting for further detail or clarification)

- *Basic Neurochemistry: Molecular, Cellular, and Medical Aspects* by G.J. Siegel et al. (1999). Lippincott Williams and Wilkins – uneven but a useful overview.
- *Proteins, Transmitters and Synapses* by D.G. Nicholls (1994) Blackwell, Oxford – The best on synaptic bioenergetics (out of print but there is a copy in the library).

**Glial cells**


**Growth factors**


**Transmitters and messengers & odd modulators**


**Reading List:**


– more D-serine complexities.


Iadecola C (1997) Bright and dark sides of nitric oxide in ischemic brain injury *Trends Neurosci.* 20, 132-139 - NO is not all bad.


Demougeot, C. et al. (2001) N-Acetylaspartate, a marker of both cellular dysfunction
and neuronal loss: its relevance to studies of acute brain injury. J. Neurochem. 77,
408-415.

**Some mental diseases** (excluding those covered by elsewhere in the course)
part of the associations between platelet monoamine oxidase activity and personality.
Behrens, A. & Aguzzi, A. (2002) Small is not beautiful: antagonizing functions for the

**Useful Reference Sources for Drug Action** (Not for bedtime reading)  

**Some Web Sites**

**A. General**

http://weber.u.washington.edu/~chudler/neurok.html - Neuroscience for kids; despite the name well worth looking at.  
http://pegasus.cc.ucf.edu/~Brainmd1/brain.html - brain model tutorial; basic but worth a view  
http://web.indstate.edu/thcme/mwking/nerves.html - Biochemistry of neurotransmitters; very simple  
http://www.acsiom.org/nsr/neuro.html - Neuroscience Web Search; find almost everything

**B. Drugs**

http://chemfinder.camsoft.com/ -ChemFinder; find the structures of all (or almost all) those compounds with silly names.

**C. Diseases**

http://www.mad-cow.org/ The Official Mad Cow Disease Home Page

**D. Toxins**

I have not been able to locate any comprehensive 'biochemical toxinology' site. Please let me know if you find one. Data on individual toxins can, however, be found through a Google search by named toxin. For example Conotoxin at  

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**Neurobiology (5 lectures) Jerard Hayes**

**Molecular mechanisms during exocytosis**  
- SNARE hypothesis of neurotransmitter release (molecular model of exocytosis)
• experimental approaches leading to this theory (biochemistry, pharmacology and electrophysiology)

**Interneural signalling: ion channels**
• voltage gated ion channels; ligand gated ion ion channels
• cholinergic and glycine gnergic signalling
• from protein purification to isolation of the respective cDNAs
• heterologous expression systems: functional analysis of ligand gated ion channels
• molecular mechanisms of the clostridial botulinus and tetanus toxins
• GABA receptors: structure-function and their pharmacology
• Glutamate receptors and their pharmacology

**Analysis of receptor/ ligand interactions**
• how to determine off- / on rates; Bmax, K_D etc
• practical approaches and theory

**Interneuronal signalling: neurotransmitter transporter proteins**
• from ionophores to the superfamily of neurotransmitter transporter proteins
• functional analysis of cloned transporters (pharmacological profiling)
• actual models of sustrate translocation
• using knock-out mice to identify the physiological function of proteins

**Neurobiology of behaviour: cognitive and affective diseases**
• learning and memory, neuronal plasticity
• neurotrophins: extra- and intracellular signalling pathways and synaptogenesis
• dysbalance of dopamine in schizophrenia and Parkinson desease
• dysbalance of noradrenergic and serotonergic neurotransmission in major depression
• animal models of depression
• molecular aspects of actual pharmacotherapy in mental illnesses

**Recommended reading:**
*Reviews:*

Textbooks:
1) The Biochemical basis of neuropharmacology
by JF Cooper, FE Bloom and RH Roth
Oxford University Press, Eighth Edition

2) Molecules and mental illness
by Samuel H. Barondes
Paperback - 216 pages (June 1999)
W H Freeman & Co.; ISBN: 0716760339

3) Essentials of Neuroscience and Behavior
by E. Kandel, JH Schwartz and TM Jessel
4) Drugs and the brain
by Solomon Snyder

**Neurodegenerative Disorders (5 lectures) Gavin Davey**

**Lecture 1:** Basic anatomy of human brain (including vasculature system). Review of intermediary metabolism; glycogen synthesis and breakdown, glycolysis, citric acid cycle, oxidative phosphorylation. Bioenergetics and ATP supply for plasma membrane potential.

**Lecture 2:** Aspects of energy metabolism and neurodegeneration: mitochondrial defects, reactive oxygen species, permeability transition pore, cytochrome c release – induction of apoptosis and necrosis. Brain Imaging Techniques: positron emission tomography (PET), single photon emission computed tomography (SPECT), magnetic resonance imaging (MRI) and electro-encephalography (EEG).


**Reading List:**


**Gene Therapy on the Internet:**
http://www.med.upenn.edu/ight/info/links1.html

**Brain Imaging on the Internet:**
http://www.askjeeves.com: Biomedical Research Foundation of Northwest Louisiana
http://www.fmrib.ox.ac.uk/fmri_intro/physiology.html


Schinder et al., (1996) Mitochondrial dysfunction is a primary event in glutamate toxicity. *Journal of Neuroscience* 16(19), 6125-6133

De Keyser et al. (1999) clinical trials with neuroprotective drugs in acute ischemic stroke: are we doing the right thing? *Trends in neurosciences*, Vol22, No 12, 535-540

Abe K et al. (1995) Ischemic Delayed Neuronal Death – A mitochondrial hypothesis. *Stroke*, 26, 1478-1489


Biochemistry of the Inflammatory Process (4 lectures)  
Jack Bloomfield


Rheumatoid Arthritis (2 lectures) Luke O’Neill


Lecture 2: Key role of cytokines – IL-1, TNF, IL6. Current therapies – NSAIDs, steroids, biologic therapies (anti-TNF, anti-IL-1, anti-IL-6, anti-CD20 and CTLA-4 Ig). Prospect for future therapies.

Multiple Sclerosis and EAE (3 lectures) Jean Fletcher & Kingston Mills
Lecture 1: Breakdown of tolerance in autoimmunity. Risk factors, pathogenesis, diagnosis and monitoring of MS

Lecture 2. MS therapies: Mechanisms of action, efficacy, side effects.

Lecture 3: EAE. Role of innate and adaptive immunity in pathogenesis of autoimmune diseases. Role of regulatory T cells in preventing autoimmune diseases.

Autoinflammatory diseases (2 lectures) Emma Creagh

Lecture 1: Key features of systemic autoinflammatory disorders. Classic hereditary 'Periodic Fever Syndromes' - FMF (Familial Mediterranean Fever), TRAPS (TNF Receptor Associated Periodic Syndrome) and HIDS (Hyperimmunoglobulinemia-D with periodic fever syndrome).

Lecture 2: NLRP3/Cryopyrin-associated periodic syndromes (CAPS): Familial Cold Inflammatory Syndrome (FCAS); Muckle-Wells Syndrome (MWS) and Neonatal onset multisystem inflammatory disease (NOMID). Autoinflammatory disorders associated with skin pustules, such as DIRA (deficiency of IL-1R antagonist), CARD14 mediated psoriasis (CAMPS) and early onset inflammatory bowel diseases (EO-IBD).

Immunodeficiency/ Clinical immunology (4 lectures) Derek Doherty

Lecture 1: Primary immunodeficiencies. This lecture will cover the genetic bases, clinical presentations, diagnoses and treatments of primary immunodeficiencies, including antibody, complement, MHC and lymphocyte deficiencies.

Lecture 2: Acquired immunodeficiencies. This lecture will cover the different causes of acquired immunodeficiencies but will focus mainly on HIV-associated disease, including the virology, immunology, clinical features and recent progress in vaccine development. The significance of HIV in the developing world, where many other infectious disease are also endemic, will be emphasized.

Lecture 3: Autoimmune disease. The lecture will start with an overview of autoimmune diseases, emphasizing the heterogeneity of such diseases and the roles of T cells, B cells and other cells of the immune system in the pathogenesis. We will then focus on the example of coeliac disease as an
illustration of how multiple pathogenic hits can result in disease and how the disease can be diagnosed and treated.

**Lecture 4:** Antibody-mediated autoimmune diseases. This lecture will focus on autoimmune diseases whose pathologies are mainly mediated by antibodies, such as systemic lupus erythematosus, myasthenia gravis and autoimmune vasculitis.

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**BI4055 Microbial Diseases (5ECTS)**

**African trypanosomes (8 lectures)Derek Nolan**

The aim of these lectures is to provide an introduction to African trypanosomes, parasitic protozoans that cause sleeping sickness in humans and a related disease, Nagana, in cattle. These parasites are a major problem for human and veterinary health throughout sub-Saharan Africa and a serious barrier to economic development of the region. Perhaps the most striking feature of these parasites is that they are exclusively extracellular. They grow and divide in the mammalian vasculature and consequently expose the adaptive and innate defence responses of their mammalian hosts. In addition, for a variety of reasons, African trypanosomes have become a favourite model organism for molecular and cell biologists and many discoveries of broad significance have emerged from studies on these model unicellular eukaryotes. Areas where such discoveries have been reported will be illustrated in the lectures where appropriate. The course is organized into two parts.

**Trypanosomes Part 1: Stealth strategies of an elusive parasite**

1. How are trypanosomes, such as *Trypanosoma brucei*, able to evade the host humoral immune response given that they are constantly exposed to this arm of the immune response?
2. What other strategies do trypanosomes employ to circumvent the innate immune responses?
3. How are these parasites able to acquire essential macromolecular growth factors from their hosts without attracting a response?

**Trypanosomes Part 2: What is the molecular basis of human sleeping sickness?**

The focus in part II is on the innate immunity that humans and other primates have to infection by all but a few trypanosomes. In effect in this part we will consider the molecular basis of African human sleeping sickness. We will consider
the nature of the trypanolytic toxin present in human serum and how this toxin kills these parasites. We will see an amazing link between the toxin and an unsuspected programmed cell death pathway. Finally, we will see how two strains of trypanosomes have responded by developing independent mechanisms to resist this toxin and how in turn certain human populations are able to overcome this resistance and the price they pay for this capacity.

**Reading List:**
Additional specific references for key experiments will be provided within the lectures which are available on the school website.

**Trypanosomes Part I**
Nuclear architecture underlying gene expression in Trypanosoma brucei

**Trypanosomes Part II**
Association of trypanolytic ApoL1 variants with kidney disease in African Americans
(5) Pays E. et al. (2014) The molecular arms race between African trypanosomes and humans  
Nature Reviews Microbiology VOLUME 12  575-584.  
(6) Vanwallegheem G. et al. (2015) NATURE COMMUNICATIONS | 6:8078 | DOI: 10.1038/ncomms9078 Coupling of lysosomal and mitochondrial membrane permeabilization in trypanolysis by APOL1

**Helminths of Human Importance (4 lectures)  Padraic Fallon**

A third of the world’s population is infected with parasitic worms. These lectures will address the major parasitic worms that are of medical importance.

**Lecture 1-2:**  
Introduction to the major helminth parasites that infect man. Medical and economic impact of helminth parasites on society.

**Lecture 3-5:**  

*A reading list will be given out during the course*

**Prokaryotic pathogens (4 lectures)  Henry Windle**

**Lecture 1:** Introduction to prokaryotic pathogens of medical importance. Emerging and re-emerging diseases.

**Lecture 2:** Overview of molecular mechanisms of bacterial induced disease - modulation of host cell signalling responses and pathogenesis. Strategies to identify vaccine candidates/therapeutic targets.

**Lecture 3:** Bacterial pathogens as a paradigm for chronic infection I. Infection and cancer – the *Helicobacter pylori* connection: molecular basis of pathogenesis.
Lecture 4: Bacterial pathogens as a paradigm for chronic infection II. Animal models of disease. Microbiomes, metagenomics and engineering microbes for our benefit. Mixed microbial populations and disease.

General Reading:


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**BI4145 STEM CELL BIOLOGY (5ECTS)**

**Cell Cycle (6 lectures) Vincent Kelly & Paul Voorheis**

**Lecture 1. The cell cycle & growth (VK):** This lecture will cover some of the seminal discoveries of the cell cycle, discussing the experiments performed on frog oocytes, sea urchins and yeast. Key regulators of cell cycle progression, as determined by these early studies, MPF, Cdc2/cdc28, wee1 and Cdc25, will be covered. Components of the mammalian cell cycle, which have been discovered principally via bio-informatic approaches, will be discussed including mammalian cyclin dependant kinases (CDKs) and cyclin-dependant kinase inhibitors (CKI).

**Lecture 2. Start of the cell cycle, G1 (VK):** Signals for a cell to start proliferation are essential for initiation of the cell cycle. Examples will be provided of how growth signals through PI3K, AKT, mTOR and myc are co-ordinated to the uptake of amino-acids and glucose. In addition, we will discuss how cell-cell and cell-matrix contacts must be altered to permit cell cycle progression.

**Lecture 3. S-phase, DNA replication & DNA repair checkpoints (VK):** The control of DNA replication is a major decision point of the cell cycle. This lecture will describe the replication licensing process, the selection of the origin(s) of replication and the proteins that make up the origin replication complex, e.g. Mcm,
Cdc6. If the DNA to be replicated is not properly loaded or is damaged the cell initiates various checkpoints, i.e G1- and S-phase checkpoint. This lecture will cover the various protein complexes such as 911, the MRE11-Rad50-NBS1/H2AX complex and the kinase pathways used to tell the cell to stop the cell cycle process including ATM & ATR, BRCA1, Chk1 Chk2 and P53.

**Lecture 4. Mitosis (VK):** Mitosis is a huge undertaking for the cell and requires the co-ordinated disassembly/assembly of numerous cellular macromolecules and membranes. A selection of these processes will be discussed including chromosome cohesion and separation of sister chromatids. An overview of the ubiquitin/ubiquitin ligases that control the cell cycle, the SCF complex in G1 to M phase transitions and the APC complex at anaphase entry will be covered.

**Lecture 5. Mechanics of chromosomal partition (HPV):**

A. Dissolution of the nuclear envelope and role of the nuclear scaffold proteins in prometaphase
   1. Laminin A & laminin B
   2. Role of cyclin-dependent kinase

B. Role of cohesins, condensins and the cohesin-specific protease during metaphase & anaphase
   1. Regulation of expression
   2. Condensed phase chromosomes
   3. Cohesin attachment & pairing of sister chromatids
   4. Spindle attachment checkpoint
   5. Destruction of cohesins at the beginning of anaphase

C. Structure of the mitotic spindle and polarity of the spindle microtubules
   1. Centrosomes & the centrosomal cycle
   2. Bipolar spindles without centrosomal involvement
   3. Kinetocore & astral microtubules
   4. Microtubule growth from centrosomes
   5. Kinetocore capture
   6. Metaphase plate

D. Molecular motors on the spindle and force-generation for chromosomal partition
   1. Kinesins
   2. Dyneins
   3. Orientation of the spindle
   4. Role of MAPS
   5. Role of catastrophins
   6. Chromosomal sliding & chromosomal oscillations
   7. Anaphase A & anaphase B

E. Reformation of the nuclear envelope during telophase
   1. Location of the laminins during mitosis
   2. Dephosphorylation of the laminins

3. Mechanics of nuclear membrane fusion & reformation of the envelope
4. Schizogony: nuclear division without cytokinesis followed by cytoplasmic
**Lecture 6. Establishing the plane of cytokinesis & the separation of daughter cells (HPV):**

A. Role of the spindle
   1. The cleavage furrow
   2. Septins
   3. Symmetric & asymmetric partition of total cell contents

B. Role of actin and Myosin II
   1. Structure of the contractile ring in animal cells
   2. The pre-prophase band, phragmoplast & cell plate in plants
   3. Cells without myosin II
   4. Polo-like family of protein kinases
   5. Contractile mechanism of the contractile ring & mid-body formation

**References:**


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**Stem cells (5 lectures) Vincent Kelly**

**Lecture 1. The embryonic stem cell:**
Early studies on stem cells; Development of the fertilised egg; Pre-implantation embryonic cell lineages; The embryonic epiblast; teratocarcinomas; Chimeric animals; Embryonic stem (ES) cells; Culture of ES cells; Essential signalling pathways in stem cell maintenance LIF, BMP4, Smad, TGFβ, FGF2, sonic hedgehog. Transcription factors Oct4, Sox2 and Nanog. Wnt, β-Catenin and the determination of cell fate; primordial germ cells.

**Lecture 2. Histone & DNA modifications affecting pluripotency**
Cloning of animals; Re-programming by somatic nuclear transfer; Differentiation versus pluripotency; Histone modifications; Heterochromatin & euchromatin; DNA methylation; Transcriptional inactivation; X-inactivation; XIST RNA; Polycomb group proteins

**Lecture 3. Imprinting & epigenetic regulation of pluripotency**
Imprinted genes; parthenogenesis; Studies on primordial germ cells; Epigenetics and differentiation; Induced pluripotent stem cells; Oct4, Myc, Sox3 and Klf4 and their role in iPS.

**Lecture 4. The stem cell niche**
**Lecture 5. Stem cells in medicine**
The clinical potential of adult stem cells; Leukaemia and bone marrow transfer; Pluripotency and plasticity of adult stem cells; Reprogramming adult somatic cells; Stem cell therapy with iPS cells; Treating sickle cell anaemia with iPS; The cancer stem cell; Discussion on the ethics of stem cell therapy.

**Reading List:**


**Transgenics (5 lectures) Vincent Kelly & Derek Nolan**

**Lecture 1. Mutagenic, transgenic & cloning technology (VK):** The concept of forward and reverse genetics in understanding gene function will be considered and how these mutations are physically introduced into the genome through random mutagenesis, viral mutagenesis, gene replacement and gene-targeting strategies. The process of microinjection to create transgenic animals, gene knockouts and cloned animal will be covered and the generation and use of induced pluripotent stem cells (iPS) in biomedical research applications.

**Lecture 2. Design and development of transgenic constructs (VK):** The design of targeting vectors relies on a detailed structural/functional understanding of the gene under study. Various strategies for controlling the activity of the gene are available including the creation of knock-outs, knock-ins, conditional knockout and reporter systems. Gene-trap technology has, in recent times, gained significantly in popularity and the methodology will be examined in some detail.

**Lecture 3. Zinc Finger Nucleases and Talen Nucleases(VK):** These state-of-the-art technologies have the potential to revolutionise the manipulation of the eukaryotic genome, from cells in culture to mice, rats, rabbits, pigs etc.
This lecture will cover the principles of this technology and how it is being currently exploited in research.

**Lectures 4 & 5. RNA interference (DN):** The discovery of the classical RNA interference pathway involving siRNA will be described. The lectures will consider the concept of regulation of expression through siRNA and microRNAs along with the use and design of RNAi based approaches in functional genomics. The advantages and limitation of such approaches will investigated through the use of specific examples. The potential use of RNAi in therapeutic approaches will be outlined.

**Reading List:**
**Lectures 1-3:**
** Highly relevant material**

# Papers relate to the endothelin B receptor and conditional mouse. These papers are discussed in the lectures and are given as an example of the power of inducible transgenics.


**Bockamp et al. 2002. Of mice and models: improved animal models for biomedical research. Physiol. Genomics. 11:115-132 (Very good overview of mouse transgenics, covers the endothelin receptor B example described in lectures)


#Lee et al. 2003. The endothelin receptor-B is required for the migration of neural crest-derived melanocyte and enteric neuron precursors. Developmental Biology 259; 162–175

**Lectures 4-5**


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**BI4155 CANCER BIOLOGY (5ECTS)**

**Initiation & Progression (4 Lectures) Vincent Kelly**

**Lecture 1. Underlying causes of cancer (VK):** The characteristics that are used to classify cancers and their stage of development will be described. A number of examples will be given of how environmental factors, i.e. xenobiotics, radiation and oxidative damage contribute to multistep carcinogenesis. The means by which cancer is limited by DNA damage sensing, DNA repair and cellular adaptation to oxygen/radical damage will be covered.

**Lecture 2. Oncogenes and tumour suppressor genes (VK):** Many of the original discoveries on oncogenes were derived from work on viruses. The concepts of oncogenes and proto-oncogenes will discussed such as *src* and the Rous sarcoma virus and there will be an in dept examination of the ras oncprotein pathway an the function of other oncogenes including *abl, sis, c-myc* and how they influence cellular proliferation. Suppressor genes play an important role in limiting cancer formation and a number of models were put forward from original studies including Knodson’s two-hit model and haploinsufficiency. The mode of action of tumour suppressors such as APC, MSH2, MLH1, BRCA1, p53 will be examined with particular focus on p53, Rb and APC.
Lecture 3. Cancer epigenetics (VK): Changes in the genetic code is but one means to arrive at a pre-malignant crossroads. Epigenetics changes in gene expression have been found to alter tumor suppressor gene activity through. These epigenetic changes may occur as a consequence of altered DNA methylation status at CpG promoter regions of aberrant histone modification. In fact, cooperative suppression by both mechanisms has recently become the focus of new anti-cancer therapies through the development of DNMT and histone deacetylase inhibitors.

Lecture 4. Cancer metabolism & the tumor microenvironment (VK): Many of the control points of cancer, oncogenes, tumor suppressor genes (including mTOR, PI3K, Akt, p53, AMPK) are intimately linked to metabolism, especially glycolysis, which provides the cancer with the building blocks for growth. The tumor cell microenvironment is invariably acidic and hypoxic causing the transcription factor HIF1a to set in place protective responses including unregulating the production of monocarboxylate transporters, VEGF, matrix metalloproteinases and angiogenic factors.

Metastasis and Cancer Treatments (6 Lectures) Vincent Kelly & Kingston Mills

Lecture 1. Angiogenesis and metastasis (VK): The process by which cancer cells develop new blood supplies (angiogenesis) is reliant on being able to remodel the tumor environment and the extracellular matrix. A discussion of how this remodelling occurs through matrix metalloproteinases and plasminogen will be given along with the cause and consequences of breaking cell-cell interactions. The means used by cancer cells to physically move from the primary tumor (e.g. epithelial-mesenchymal transition) and how the immune system promotes this process will be described. Breast cancer will be used as a model of how cancer cells choose secondary sites for proliferation, especially the bone marrow; ‘the vicious cycle’.

Lecture 2. Colon cancer, genetics and epigenetics (VK): Arguably, colon cancer is one of the best studied cancers in terms of its formation and progression. This lecture will discuss the contribution of chromosomal instability in terms of changes to APC, COX2 and Smad4 and microsatellite instability caused by epigenetic suppression of mis-match repair enzymes including MSH2 & MLH1. The contribution of inflammation to colon cancer will be considered and how NSAIDS and IL-10 mediate polyp formation.

Lecture 3. Stem cell theory of cancer, focusing on colon cancer (VK): The intestinal crypt stem cells are maintained in a specialized compartment of the intestinal crypt through the Ephrin receptors. The maintenance and proliferation of these stems cells will be covered including the various signals used to control their
proliferation, such as hedgehog, WNT, PDGF, Eph, NOTCH and BMP. The importance of the intestinal stems cells to cancer development and treatment will be considered.

**Lecture 4. Cancer treatment (VK):** Classical anti-cancer drugs such as antimetabolites, alkylating agents and antimitotic agents are still widely used in therapy today despite severe side-effects. Newer 'magic bullets, hold promise of more specific cancer treatment strategies such as Imatinab in the treatment of CML. However, drug resistance is a problem and has revealed the phenomenon of oncogene addition. Recent drug strategies have begun to focus on targeting tumor cell metabolism, its environment and the cancer initiating cells (cancer stem cells) that perpetuate proliferation even after treatment.

**Lecture 5. Cellular and humoral Immune responses to tumors (KM):** These lectures include the role of antibody, cytotoxic T lymphocytes, macrophages, NK cells and Th1 cells; Evasion and subversion of immune responses by tumors - anti-inflammatory cytokine production and regulatory T cell induction; Tumor-specific antigens and breaking tolerance to self antigens

**Lecture 6. Tumor immunotherapy (KM):** Antibodies, Toll-like receptor agonists and cell-based therapies; Tumor vaccines - killed tumor cells, tumor specific peptides and antigens, heat shock proteins and dendritic cell vaccines

**Cancer References:**

Apoptosis (5 lectures)  Danny Zisterer

Lecture 1: Introduction to apoptosis. Role in development, maturation of the immune system and in cell turnover. Morphological features of apoptosis. Comparison with necrosis. Biochemical methods used for examination of apoptosis e.g. Annexin V staining. Aberrations in apoptosis: implicated in cancer and neurodegenerative diseases e.g. Alzheimer's. Genetic studies into nematode C. elegans provides key insights into molecular mechanisms regulating apoptosis.

Lecture 2: Caspases: family of cysteine proteases: 'death executioners' in apoptosis. 14 caspases identified to date. Caspases subdivided into 3 categories: substrate specificity, prodomain length and prodomain sequence. How are caspases activated? By autoactivation, transactivation or proteolysis by other proteases. Experimental evidence that caspases are important in apoptosis. Biochemical measurement of caspases: fluorogenic assays and Western Blotting assays.

Lecture 3: Apoptotic signal linked to caspases through 'sensor' and 'adapter'. Model for regulation of apoptosis by APAF1: cytochrome c released from mitochondria as 'sensor' and APAF1 (apoptosis activating factor 1) as 'adapter'. Formation of apoptosome. IAPs (inhibitor of apoptosis proteins) which bind to and inhibit caspase activity. Smac/DIABLO which binds to and neutralises IAPs inhibitory activity. Subcellular localisation of caspases: cytosol, nuclei, mitochondria and ER. Caspase substrates e.g. PARP (poly ADP ribose polymerase), Lamins and CAD (caspase activated DNAase). Caspase 12: link with Alzheimer's disease? Caspase-independent cell death. AIF, Endo G, Omi/HtrA2.

Lecture 5: Death Receptors: signalling and modulation. Examples of death receptors and signalling mechanisms involved: Fas, TNFR1 (tumour necrosis factor receptor1), DR3 (death receptor3), DR4 and DR5. Death domains (DDs), Death effector domains (DEDs), caspase-recruitment domains (CARDs); DISC (death inducing signalling complex). Experimental evidence for TNFR1 signalling pathway. Modulation of apoptosis by decoy receptors e.g. DcR1 and DcR2 in TRAIL signalling. Apoptosis induction by Granzyme B. Mitogen-activated protein kinases and apoptosis. Induction of apoptosis by cancer chemotherapy. Mechanisms of evasion of apoptosis by tumour cells.

Apoptosis Reading List:

General:

Caspases:

Intrinsic pathway:

Extrinsic pathway:

Cancer:

**p53:**

**Autophagy (2 lectures) James Murray**

**Lecture 1: The mechanics of autophagy**
- Early signalling events in autophagy
- Omegasomes: PI3P platforms that manufacture autophagosomes
- Sources of the autophagosome membrane
- Ubiquitin-like conjugation systems that mediate membrane formation
- Autophagosome maturation and lysosomal fusion

**Lecture 2: Selective autophagy & disease**
- Chaperone-mediated autophagy, macro/microautophagy & mitophagy
- Autophagy and cell death
- Autophagy and ageing: age-related neurodegenerative diseases
- Autophagy in cancer prevention, development and therapy
- Autophagy as a defence against intracellular pathogens

**Reading list:**
“Autophagy: molecules and mechanisms” by Jon Lane.

A list of suitable reviews will be given out during the lecture course.
**Gene-nutrient interactions (5 lectures) Anne Molloy**

**Lecture 1: Genome responses to nutritional exposures:** Nutrition is the most persistent and variable environmental exposure to apply evolutionary pressure to the human genome. This lecture will consider the idea of how sub-optimal – or even unbalanced - micronutrient status might alter genomic responses and conversely how genetic variability might affect nutritional responses. The idea of the fetal origins of adult disease is introduced and how long-term risk of chronic disease might be influenced by variability in genes involved in nutrient availability, metabolism or function.

**Lecture 2: One-carbon metabolism in intermediary metabolism:** One-carbon units (methyl, methylene and formyl groups) are required both for synthesis and maintenance of DNA and to provide the methyl group (-CH₃) for all biological methylation reactions, which control many important epigenetic and signaling events. In lecture 2, the biochemical pathways involved in one-carbon metabolism will be described. It will be shown that four vitamins - folate, riboflavin (B₂), pyridoxal phosphate (B₆) and cobalamin (B₁₂) - are required as cofactors of enzymes in these pathways and that cell proliferation and gene expression systems link in with availability of these nutrients.

**Lecture 3: The 677C->T polymorphism in the folate dependent enzyme MTHFR:** This lecture will consider an example of a common functional polymorphism that has important nutritional, functional and disease implications. Through studying the metabolic effects of this polymorphism, the lecture will explore the common disease-common variant hypothesis whereby complex disease conditions are driven in part by polymorphisms that confer a relatively minor risk at the individual level but may have a significant effect on the burden of disease at the population level.

**Lecture 4: Nutrigenomics; a tapestry of Nature and Nurture.** The specific example of one-carbon metabolism will be discussed in relation to the known metabolic links between low B vitamin status and medical conditions such as neural tube defects, cardiovascular disease, cancer and cognitive dysfunction. The lecture will consider how nutrient dependent methylations of DNA and histones, through the one-carbon network, exert epigenetic control over cellular protein synthesis. The lecture will expand on the hypothesis that maternal nutritional factors can influence epigenetic imprinting in foetal tissues and this may be
associated with changes in postnatal development and long-term susceptibility to disease.

**Lecture 5: The broader concept of genes and nutrients:** This final lecture will round off the topic by discussing other types of gene-nutrient interactions. As examples, the role of vitamin D as a transcriptional regulator will be discussed and how cellular iron balance is controlled by an integrated transcriptional system. The module will close on a discussion of how exploration of bio-bank data from large population cohorts can lead towards a better understanding of biological function, using an unusual example from cholesterol metabolism.

**References:**


**Metabolic Control Analysis (4 lectures) Richard K. Porter**


References:


MCA website: [http://bip.cnrs-mrs.fr/bip10/mcafaq.htm](http://bip.cnrs-mrs.fr/bip10/mcafaq.htm)  
https://en.wikipedia.org/wiki/Metabolic_control_analysis

**Obesity & Diabetes (5 lectures) Richard K Porter**

Lecture 1. Control of appetite
Lecture 2. Obesity

Lecture 3. Physiology and biochemistry of insulin action

Lecture 4. Type I diabetes

Lecture 5. Type II diabetes

References:
X-ray crystallography (6 lectures) Amir Khan

Lecture 1. Introduction to X-ray methods, interaction of X-rays with protein crystals, basic diffraction theory

Lecture 2. Definitions of crystalline lattice, point groups, two-dimensional plane groups, and three-dimensional space groups

Lecture 3. Fourier transforms and the reciprocal lattice, introduction to the Ewald sphere, Argand diagrams of diffracted waves

Lecture 4. Introduction to the phase problem in macromolecular X-ray crystallography and methods in phase determination

Lecture 5. Methods in phase determination II

Lecture 6. Phase refinement, validation of structures, and overview of the Protein Data Bank.

Recommended reading:

Crystallography Made Crystal Clear
Gale Rhodes

Protein Crystallography: A concise guide
Eaton Lattman and Patrick Loll

NMR spectroscopy (5 lectures) Ken Hun Mok

Lecture 1: A rapid review of the principles of optical spectroscopy + How do they compare with the principles of NMR spectroscopy; Why Heisenberg’s Uncertainty Principle is, “in no uncertain terms”, crucially important for NMR.
Lecture 2: Magnetic resonance; Listening to radio waves; Chemical shifts; Coupling

Lecture 3: Relaxation times; Two-dimensional NMR – why NMR likes to be “NOESY” and “COSY”

Lecture 4: Applications to biological molecules and biological systems, MRI (Magnetic Resonance Imaging)

Lecture 5: NMR in structural genomics; metabolomics and metabonomics

Reading List:


Cellular Imaging (4 lectures) Derek Nolan

Lecture 1: Introduction to imaging and the concept of resolution. Application of electron microscopy in cell imaging.

Lecture 2: EM tomography and specialized techniques. Introduction to light microscopy.

Lecture 3: Advanced light microscopy: wide field and confocal microscopy.

Lecture 4: Application of fluorescent proteins and probes in multidimensional imaging in fixed and live cells.

Suggested reading and references.

http://www.nature.com/milestones/milelight/index.html
An excellent resource available on line. This series highlights the most influential developments in light microscopy in a series of short articles, each describing a major achievement. Almost a one stop shop
http://www.olympusmicro.com/
The Olympus Microscopy Resource Center.

BI4175 IMMUNOLOGY (5 ECTS)

**Cytokine Signalling (5 lectures) Luke O'Neill**

**Lecture 1:** Cytokine families: interleukins, interferons, tumour necrosis factors, chemokines, colony stimulating factors. Properties and functions: inflammation, hemopoiesis, immune cell activation, anti-inflammatory cytokines. Class I cytokine receptors: JAKs and STATs. Specificity in signalling. WSWS motif. gp130 as second chain. Common and unique receptor chains. Complexity of IL2 signalling: PI3 kinase, IRS-1.

**Lecture 2:** Type II cytokine receptors: Interferon receptor signalling: discovery of ISGFs and Tyk. Use of JAK and STAT nomenclature. JAK and STAT knock-out mice: key features. Interferon responsive genes and anti-viral effects. IL10 signalling. Suppressors of Cytokine signalling.

**Lecture 3:** Type III cytokine receptor family: TNF receptors. Homology between TNFR, NGFR, Fas and CD40. TNF signalling: TRADD, RIP, FADD and caspases. TRAFs. Pathways to NFκB and apoptosis. Mechanism of activation of NFκB. IKK complex. CARD-containing proteins.

**Lecture 4:** Type IV cytokine receptors: IL1 family. IL1 receptor signalling: IL1 pathway as prototypical 'stress' response in plants and animals. The TIR domain: structure and function. Toll-like receptors in mammals and innate immunity. LPS and IL18 receptors/ MyD88 as key adaptor. Roles of TLR-1 to TLR-10: recognition of PAMPs by PRRs. Primacy of TLRs in innate immunity.

**Lecture 5:** Signal transduction pathways activated by the TIR domain. MyD88, IRAK1 – IRAK-4. TAB1/TAK-1. Traf-6 and ubiquitination. Regulation Stress
activated protein kinases: p38 MAP kinase and JNK. Comparison to classical MAP kinases. IKK activation by TAK-1. Lessons from knock-out mice: Specific adapters for different TLRs? The role of Mal in LPS signalling. NALPs and NODs. Regulation of caspase-1

Reading List:


Immunotherapies (5 lectures) Aisling Dunne (AD), Fred Sheedy & David Finlay (DKF)

Lecture 1: Immunotherapy – Striking a balance (DKF) This lecture provides an introduction to immunotherapeutic strategies and the potential adverse effects of long-term immune-modulation.

Lecture 2: Immunosuppression to prevent organ transplant rejection (DKF) Detailing the current strategies for preventing organ transplant rejection, focusing on the mechanism of action of the potent immunosuppressant’srapamycin and cyclosporin A.
Lectures 3: Infectious disease vaccines and adjuvants - innate immune activators (AD) Current vaccination strategies, vaccine subtypes, adjuvant requirements, vaccine benefits versus risks, safety.


Bacterial and Viral Evasion (5 lectures) Rachel McLoughlin and Andrew Bowie

Lecture 1: Immune response to bacterial infection (RMcL)
Characterise a pathogen, introduce the concept of virulence and virulence factors, discuss extra-cellular vs. intracellular bacterial infections, Mechanisms of host immunity to different types of bacterial infection: Anti-microbial peptides, complement, phagocytes, antibodies, T-helper cells, cytotoxic T-cells.

Lecture 2: Immune evasion by bacteria (RMcL)

Lecture 3: Viral evasion of innate immunity I (AB)
Overview of viral life cycle, the innate immune response to viruses, antiviral pattern recognition receptors (PRRs) for sensing viral nucleic acid, induction of type I interferons, the interferon effector response involving interferon stimulated genes (ISGs).

Lecture 4: Viral evasion of innate immunity II (AB)
Key concepts in viral evasion, what viruses have taught us about innate immunity, how viruses evade detection by the innate immune response.

Lecture 5: Viral evasion of innate immunity III (AB)
Poxviral mechanisms of innate immune evasion, specific examples of manipulation of innate immune signalling by vaccinia virus proteins with a Bcl-2-like fold, structural insights into viral protein: host protein interactions.

Reading list for lectures 1-2:
Finlay B et al. Anti-Immunology: Evasion of the Host Immune System by Bacterial and Viral Pathogens. 2006 Cell 124, 767-782
Krzyszof G et al. Friendly fire against neutrophils: Proteolytic enzymes confuse the recognition of apoptotic cells by macrophages. 2008 Biochimie 90, 405-415


Faherty C.S et al. Staying alive: bacterial inhibition of apoptosis during infection. 2008 Trends in Microbiology Vol 16 No.4


**Reading list for lectures 3-5:**

**General**

**Pattern Recognition Receptors:**
Carty and Bowie. 2010. Recent Insights into the role of Toll-like receptors in viral infection. *Clinical & Experimental Immunology* 161, 397-406.

**Poxviruses (e.g. Vaccinia Virus):**

*essential reading, specifically referred to in lecture course.*

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**BI4015 DATA HANDLING (5 ECTS)**

**SEQUENCE ANALYSIS**

**Sequence Analysis Jerard Hayes**

The course will provide an introduction into Bioinformatics. Part I of the course consists of three lectures and three exercise sessions. Topics covered include:

- DNA (including genomic) and protein databases
Accessing sequence information from databases using the Internet
- Sequence similarity searches (i.e. BLAST, FASTA)
- Identification of homologous proteins
- Multiple sequence alignments (i.e. Clustal W)
- Searches for protein motifs, domain, patterns

Students will carry out three exercises (marked as problems):

**Exercise 1:** Accessing databases from the Internet, retrieval of sequences (DNA and protein), extracting relevant sequence information, presentation and annotation of a chosen sequence

**Exercise 2:** Sequence similarity search (BLAST), identification of homologous proteins, multiple sequence alignment (Clustal W)

**Exercise 3:** Sequence analysis of membrane proteins, hydrophobicity plots, identification of transmembrane helices and signal peptides

**Reading list:**

*essential reading
# recommended


#Kyte, J. and Doolittle, R. F. 1982. A simple method for displaying the 

#Persson, B. and Argos, P. 1994. Prediction of transmembrane segments in 

#Rost, B. et al. 1995. Transmembrane helices predicted at 95% accuracy. 
Protein Science, 4: 521-533.


transmembrane helices in protein sequences. In J. Glasgow et al. (eds.) Proc. 
Sixth Int. Conf. On Intelligent Systems for Molecular Biology, 175-182. AAAI Press.

sites. Nucleic Acid Research, 14: 4683-90.

peptides and prediction of their cleavage sites. Protein Engineering, 10:1-6.

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**Comparative Medicine Introductory Animal Course  Peter Nowlan**

The Purpose of this lecture course is to introduce Students to the basic 
requirements for working with animals. This is necessary if a full appreciation 
of animal related work is to be got from the projects. It is also a legal 
requirement that anybody involved in the use of animals for scientific purposes 
has appropriate training (*EC directive 86/609*)

This module is not intended to be a comprehensive training course. To do 
this would require a much more detailed and extensive series of talks. Most 
of the training which will be required by students will be obtained by working 
in close contact with a technician and with experienced supervisors.
The golden rule should be always *'if you don't know ask somebody'*. 
The welfare of the animal and often the success of your Project will 
depend on using a correct approach to animals involved in your project.
Even if you do not intend choosing a project, which involves live animals, you may do so in your future career. **It will not be possible for anybody who does not pass the assessment to choose a project involving animals.**

- Introduction to Laboratory Animal Science
- The Law and Application for a licence
- Animal House Design; Its effect on Research
- Characteristics of Individual species
- Experimental design Choice of species
- Injections and tissue sampling
- Health Considerations
- Alternatives to live animal experimentation
- Handling Video, Safety, Local arrangements
- Video and discussion 'Ethics of Animal research'
- The Scientists Viewpoint
- Assessment

**Reading List:**

- Laboratory animals an introduction for new experimenters
  A. A. Tuffery
- Handbook of laboratory animal management and care
  S. Woelfensohn, M. Lloyd
- Introduction to laboratory animal science and technology
  J. Inglis
- Humane experimental technique
  W. Russell, R. Burch
- Experimental and surgical technique in the rat
  H. Wayneforth, P. Flecknell
- Animals and alternatives in toxicology; present and future prospects
M. Balls, J. Bridges, J. Southee
In vitro toxicology
S. Cox Gad
UFAW handbook on the care & management of laboratory animals
T. Poole
Laboratory animals anaesthesia P. Flecknell
Handbook of rodent and rabbit medicine K Laber-Laird,
M. Swindle, P. Flecknell
The biology and medicine of rabbits and rodents J. Harkness J. Wagner
The laboratory animals, principles and practice W. Lane-Petter,
A. Pearson
Man and mouse, animals in medical research W. Paton
Lives in the balance; J. Smith, K. Boyd
The ethics of using animals in biomedical research
Vivisection in historical prospective R. Rupke