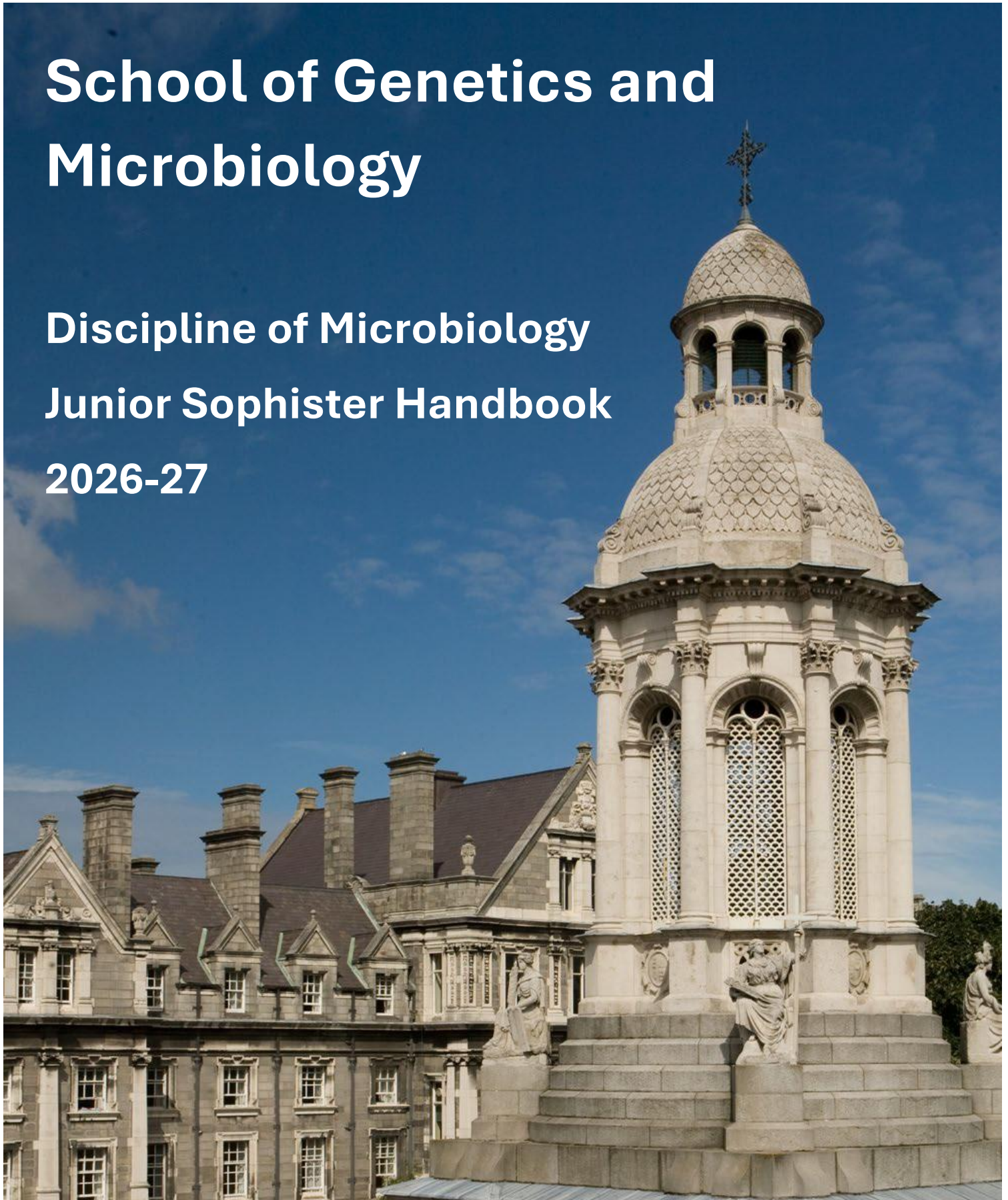




School of Genetics and Microbiology

Discipline of Microbiology
Junior Sophister Handbook
2026-27





MICROBIOLOGY: Introduction

Table 1: Junior Sophister Year Details

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At Trinity College, aspects of microbiology are taught as part of the biology curriculum in the Junior and Senior Fresh years in Natural Sciences. Suitably qualified students may specialize in Microbiology in the Sophister years. Microbiology is a two-year moderatorship course delivered by the School of Genetics and Microbiology. It encompasses microbial & molecular genetics, microbial genomics, cellular & molecular biology, microbial pathogenesis, medical microbiology, immunology, virology, antimicrobial chemotherapy, vaccinology, applied microbiology and biotechnology. Senior Sophister students study in specialized areas of modern microbiology and carry out a full-time, nine-week research project in their final year. Microbiology graduates find employment in research laboratories, universities, industry, hospitals, the scientific civil service, police forensic labs, public health labs, quality control labs in the food, dairy, beverage and pharmaceutical industries, as well as in education, scientific publishing, technical sales and services, marketing and in management.

The JS year consists of a diverse programme of lectures, laboratory practicals and tutorials. The JS year is a 60 ECTS course composed of six core modules (40 ECTS) consisting of lectures, tutorials, group work and laboratory practicals. Students also take 20 ECTS of Open Modules and Trinity Electives. The final mark achieved in the Junior Sophister will constitute 30% of the moderatorship mark. Table 2.1 gives an overview of important dates in this Academic Year and Table 2.2 outlines the organisation and composition of the modules that make up the Junior Sophister Microbiology year. Each module is weighted at 5 ECTS. Detailed descriptions of the lecture and laboratory components are provided below. The information in this booklet may be subject to change depending on staff availability and unforeseen circumstance.

This handbook applies to students taking the Moderatorship in Microbiology. It is available to download from the Departmental website <https://www.tcd.ie/microbiology/>. Please retain it for future reference. The information provided in this handbook is accurate at the time of preparation. Any necessary revisions will be notified to students via email. Please note that although every effort has been made to ensure the accuracy of the contents of this handbook, it is not a legally binding document and the Department of Microbiology reserves the right to modify any element, subject to the normal regulations of the University. In the event of any conflict or inconsistency between the General Regulations published in the University of Dublin Calendar <http://www.tcd.ie/calendar/> and this handbook, the provisions of the General Regulations will prevail.



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1. Learning Outcomes

Upon successful completion of the Microbiology Programme, students will be able to:

- Demonstrate in written and oral form a foundation level of knowledge and understanding of the biological, physical and quantitative sciences underpinning microbiology.
- Demonstrate in written and oral form an advanced level of knowledge and understanding of the principles of microbiology, including:
 - the nature and diversity of microorganisms and the methods of studying them
 - the genetic, biochemical and physiological processes occurring in some of the best-characterised microorganisms
 - the interactions between some of the best-characterised pathogenic microorganisms and their hosts
 - the roles, uses and manipulation of microorganisms in health and disease, agriculture, biotechnology and the environment
 - the roles of microorganisms as model systems in related fields
 - the scientific method of investigation and testing of hypotheses and the distinction between scientific and unscientific arguments
- Demonstrate in written and oral form a detailed, critical knowledge and understanding, supported by using advanced textbooks, journal articles and data sets, of one or more specialist areas, some of it at the current boundaries of the field.
- Apply the knowledge and understanding gained to the critical analysis of experimental data, to sustaining evidence-based arguments on microbiological hypotheses, to solving microbiological problems and to designing microbiological experiments.
- Pursue with a degree of independence an original microbiological research project including project planning; identification, appraisal and safe application of the appropriate experimental techniques; accurate recording and presentation of data; identification of the limitations of and sources of error in experiments; analysis and interpretation of complex data; formulation of logical conclusions; and appraisal of the project outcome in the context of related, published work.
- Demonstrate proficiency in the application of computers to such problems as the searching of literature databases, analysis of biological sequence data, visualisation of biological macromolecules and analysis of experimentally acquired data.
- Demonstrate recognition of the value of scientific inquiry and an understanding of the ethical responsibilities of scientists.
- Demonstrate the capacity to apply international standards and practices within the discipline.
- Act effectively, under the guidance of senior scientists as necessary, as an individual, as part of a team, and/or in a multidisciplinary environment.
- Communicate information and ideas at a high level to both specialist and non-specialist audiences.



- Show that they have acquired the learning skills necessary to update their knowledge and to undertake further study with a high degree of autonomy.

2. YEAR STRUCTURE

Table 2.1: The Academic Year 2026-27

Start Date	Week 3 (14 th September 2026)
Study/Review Week	Week 9 (26 th October 2026)
Revision Week Semester 1	Week 15 (7 th December 2026)
Scholarship Examinations	Week 19 (4 th January 2027)
Semester 2 begins	Week 21 (18 th January 2027)
Study/Review Week	Week 27 (1 st March 2027)
Revision Week Semester 2	Week 33 (12 th April 2027)
Semester 2 Assessment	Week 34 (19 th April 2027)
Trinity Week	Week 35 (26 th April 2027)

Please note that some in-course assessments may take place during Study/Review or Revision weeks.

Please note that the dates of formal assessment weeks may extend to begin earlier or run later – examination schedules have not yet been finalised.



Table 2.2: The JS Year Microbiology Course Overview

MICROBIOLOGY	
Semester 1 (S1)	Semester 2 (S2)
Core Modules	
MIU33011 Microbial Physiology	MIU33012 Microbial Pathogenicity
MIU33016 Applied Microbiology & Antimicrobial Agents	MIU33020 Experimental Microbiology II
MIU33019 Experimental Microbiology I	GEU33301 Bioinformatics
MIU33302 Molecular Genetics I: Regulation of Gene Expression	GEU33303 Molecular Genetics II: Genome Structure and Dynamics
Open Modules Scenario I	
BIU33150 Biochemistry for Biological Sciences	BIU33250 Introduction to Immunology and Immunometabolism
Trinity Elective	ZOU33006 Ecology and Evolution of Infectious Diseases
Open Modules Scenario II	
BIU33150 Biochemistry for Biological Sciences	BIU33250 Introduction to Immunology and Immunometabolism
GEU33045 Genomes and Systems Biology	Trinity Elective
Open Modules Scenario III	
BIU33150 Biochemistry for Biological Sciences	BIU33250 Introduction to Immunology and Immunometabolism
Trinity Elective	Trinity Elective



3. Microbial Physiology

Module Code	MIU33011
Module Co-ordinator	Alastair Fleming
Credits	5 ECTS
Module Personnel	Alastair Fleming (AF), Siobhán O'Brien (SOB)
Taught in	Semester 1
Contact Hours	21

3.1 MIU33011 Alastair Fleming and Siobhán O'Brien

This course considers various aspects of microbial physiology. The best understood bacterial and yeast systems are used as examples throughout. The lectures deal with specialized bacterial and fungal cell wall components, nutrient uptake mechanisms and regulation, microbial metabolism (glycolysis, aerobic and anaerobic respiration, fermentation), adaptation to nutrient depletion, and cell death. The aim is to give an overview of how microbial cells take up and utilise nutrients, and how cells cope with nutrient exhaustion. Indeed, how microbes contend with low nutrient conditions is arguably the most relevant physiological condition yet is the least studied.

The lectures on bacterial cell structure aim to provide a comprehensive overview of the structure and function of bacterial envelope components, surface proteins and polysaccharides. The contribution of each component to bacterial survival, biofilm formation and pathogenesis is examined. Biosynthesis, post-translational modification and export of protein and polysaccharide structures are described. The potential for cell envelope structures to evolve and adapt to external stressors is also discussed. The potential to use bacterial surface structures as vaccine antigens and to exploit our knowledge of biosynthetic pathways to discover new antimicrobial drug targets is also discussed throughout the course.

Recommended Reading List:

- Silhavy TJ, Kahne D, Walker S. The bacterial cell envelope. Cold Spring Harb Perspect Biol. 2010 May;2(5):a000414. doi: 10.1101/cshperspect.a000414. 2010 Apr 14.
 - PMID: 20452953; PMCID: PMC2857177.

Learning outcomes:

At the end of this module, students should:

- Have a detailed knowledge of the microbial cell envelope structure and function.
- Understand the principles of sugar transport mechanisms and their regulation.
- Have gained understanding of the microbial metabolism (fermentation, cellular respiration).
- Know how microorganisms respond to nutrient depletion.

Assessment Details: One 1.5-hour exam paper at the end of semester 1.



Table 3.1: MIU33011 – Programme of Lectures

Week	Day	Time	Lecture Topic & Lecturer
3	Tue	14:00-15:00	Protein secretion in bacteria (SO'B)
3	Wed	11:00-12:00	The Bacterial Cell Wall (SO'B)
3	Thu	10:00-11:00	Gram-positive bacteria — Teichoic Acids 1 (SO'B)
3	Thu	14:00-15:00	Gram-positive bacteria — Teichoic Acids 2 (SO'B)
3	Fri	14:00-15:00	Gram-positive bacteria — Cell wall anchored proteins and pili (SO'B)
4	Wed	12:00-13:00	Gram-negative bacteria — outer membrane proteins (SO'B)
4	Wed	14:00-15:00	Gram-negative bacteria – lipopolysaccharide (SO'B)
4	Thu	10:00-11:00	Outermost Layers of Protection – Capsules and S-layers (SO'B)
4	Thu	14:00-15:00	Outermost Layers of Protection – EPS and Biofilms (SO'B)
4	Fri	11:00-12:00	Cell envelopes under stress (SO'B)
4	Fri	12:00-13:00	Recap and Q&A (SO'B)
5	Wed	14:00-15:00	Specialised cell wall structures in bacteria (AF)
5	Thu	09:00-10:00	Specialised cell wall structures in yeast (AF)
6	Tue	14:00-15:00	Microbial membranes (AF)
6	Wed	12:00-13:00	Microbial sugar transport systems (AF)
6	Thu	10:00-11:00	Regulation of bacterial sugar uptake (AF)
6	Thu	14:00-15:00	Glucose signalling in yeast (AF)
6	Fri	11:00-12:00	Microbial metabolism I (AF)
7	Wed	12:00-13:00	Microbial metabolism II (AF)
7	Wed	14:00-15:00	Microbial sporulation (AF)
7	Thu	10:00-11:00	Quiescence and apoptosis in yeast (AF)



4. Antimicrobial Agents

Module Code	MIU33016
Module Co-ordinator	Marta Martins
Credits	5 ECTS
Module Personnel	Marta Martins (MM), Anna Ershova (AE), Gary Moran (GM)
Taught in	Semester 1
Contact Hours	24

4.1 MIU33016 Marta Martins, Gary Moran and Anna Ershova

The aim of this module is to introduce students to fundamental concepts in Applied Microbiology and Antimicrobial Agents.

Applied microbiology (AE): Lectures will discuss the essential features of microbiology relevant to the environment, agriculture, food, pharmaceutical industries and clinical settings. While food and medicinal applications are a big portion of applied microbiology, the study of microorganisms has led to commercial industries which are involved and affect almost all aspects of human life. The production of specific products, such as monoclonal antibodies and the use of new sequencing technologies, will also be the subject of these lectures. The course includes lectures that will cover main areas in (i) Air and Water quality; (ii) Agricultural microbiology; (iii) Food microbiology; (iv) Biotechnology and Pharmaceutical. During the lectures, we will discuss how OMICS technologies can be used in Applied Microbiology.

Antimicrobial Agents (MM, GM): Antimicrobial Agents are one of the most important molecules that have been discovered and developed to treat from animal to human infections, among other relevant applications. In these lectures we will discuss the antimicrobial resistance crisis and factors that can continue to aggravate it. We will then focus on the general properties of the major antimicrobial agents in use, their cellular targets and mechanisms of action of current drugs. We will also discuss the mechanisms of drug resistance in microbial pathogens, from fungi to bacteria. During the lectures, we will also learn about the sources and approaches that are being explored nowadays to discover new antibiotics.

Recommended Reading List:

- Talaro. Foundations in Microbiology. Sixth Edition. Chapter 26. Environmental and Applied Microbiology.
- Further reading on specialist topics will be provided during the module.

Learning outcomes:

At the end of this module, students should:

- Be able to discuss the different types of microorganisms in different environments as well as their roles in the production of important medical and pharmaceutical products.



- Be able to discuss several aspects of the production of bio-pharmaceuticals in industrial settings and norms.
- Be familiar with the different classes of antibiotics in clinical practice and their modes of action, as well as mechanisms associated to the development of resistance to these agents.
- Be familiar with sources of new antibiotics and new approaches to treat multi-drug resistant infections.

Assessment Details: One 1.5-hour exam paper at the end of semester 1.

Table 4.1: Module content: Programme of lectures

Week	Day	Time	Lecture Topic & Lecturer
10	Thu	14:00-15:00	Introduction to Applied Microbiology. (AE)
10	Fri	12:00-13:00	Agricultural Microbiology: how microorganisms and their products can be used to improve soil quality and protect plants from pathogens. (AE)
10	Fri	16:00-17:00	Food Microbiology: Good and bad microbes that affect food. (AE)
11	Wed	12:00-13:00	Food Spoilage Pathogens: how to prevent food waste. (AE)
11	Wed	14:00-15:00	Foodborne pathogens and foodborne outbreak investigation. (AE)
11	Thu	9:00-10:00	Safe food production standards. (AE)
11	Thu	14:00-15:00	Microbial Biotech I. Microbial biotechnology, the use of microorganisms for pathogen detection, and therapeutic products. (AE)
11	Fri	12:00-13:00	Microbial Biotech II. Microbial biotechnology, including microbial forensics, improving crop quality, solutions for industrial and environmental problems. (AE)
11	Fri	15:00-16:00	Pharmaceutical Microbiology. Biopharmaceuticals, vaccines and the effect of vaccines on pathogen evolution. (AE)
12	Wed	12:00-13:00	Biotherapy - the use of microorganisms in therapy, including cancer therapy. (AE)
12	Thu	09:00-10:00	Bacteriophages (bacterial viruses) can be used to cure antimicrobial-resistant bacteria. Perspectives and limitations of phage therapy and other possible applications of bacteriophages. (AE)
12	Thu	14:00-15:00	Bioinformatics for applied microbiology: the current state and future challenges. (AE)
12	Fri	12:00-13:00	Antimicrobial Agents and the AMR crisis – An overview (MM)
12	Fri	14:00-15:00	The discovery of new antibiotics (MM)
13	Wed	12:00-13:00	Efflux pumps (MM)
13	Wed	14:00-15:00	Heavy Metals and Biocides (MM)
13	Thu	14:00-15:00	Cell wall targeting antibiotics - Beta-lactams (MM)
13	Fri	12:00-13:00	Resistance to beta-lactam antibiotics (MM)
13	Fri	14:00-15:00	Glycopeptides (MM)
14	Wed	12:00-13:00	Polymyxins (MM)



14	Wed	14:00-15:00	Ribosome targeting antibiotics I - Quinolones (MM)
14	Thu	14:00-15:00	Ribosome targeting antibiotics II - Macrolides (MM)
14	Fri	14:00-15:00	Tetracyclines, Aminoglycosides and other antibiotics (MM)
14	Fri	15:00-16:00	Anti-fungal drugs (GM)



5. Mol. Gen. I: Regulation of Gene Expression

Module Code	MIU33302
Module Co-ordinator	Carsten Kröger & Kevin Mitchell
Credits	5 ECTS
Module Personnel	Carsten Kröger (CK), Kevin Mitchell (KM), Adrian Bracken (AB), Mani Ramaswami (MR)
Taught in	Semester 1
Contact Hours	29

5.1 MIU33302 Carsten Kröger, Kevin Mitchell, Adrian Bracken, and Mani Ramaswami

This module will examine the principles and processes of regulation of gene expression, in Prokaryotes and Eukaryotes. It will be anchored around the problems that organisms must solve to survive. These include modulating the cellular economy and maintaining homeostasis in response to dynamically changing internal and external states. This is crucial in microbes for adapting to environmental change and in multicellular organisms for coordinating cellular differentiation and development and regulating cellular, tissue-level and organismal physiology. The module will cover mechanisms and principles of regulation of transcription, chromatin regulation, gene regulatory motifs and networks, epigenetics, mRNA splicing, mRNA turnover, translation, non-coding RNA functions, and protein folding and localisation.

Learning outcomes:

At the end of this module, students should:

- Have a working knowledge of the mechanisms of regulation of gene expression in Pro- and Eukaryotes.
- Understand the principles underpinning cellular cognition, homeostasis, regulation of the cellular economy, and multi-cellular development.
- Be able to deploy this knowledge and understanding to address novel problems involving these topics.
- Know how to independently research a topic in the scientific literature.
- Have experienced and reflected on the dynamics of a group project and presentation.

Recommended Reading List:

- Anthony J.F. Griffiths et al. Introduction to Genetic Analysis. 12th edition. New York, NY:W.H. Freeman & Company, 2020.
- Further reading on specialist topics will be provided during the presentation of the module.



Assessment Details: 50% continuous assessment (group project (50%) – presentation).
50% end of semester exam (1.5-hour exam paper at the end of semester 1).

End of semester exam: The students will be asked to answer 1 essay-type question and 8 short answer questions (3-5 sentences).

Group project: Students will be placed into groups of four or five and given a topic related to the principles of the module. They will be expected to research the literature on this topic and prepare a short presentation to the class, using PowerPoint or similar software. The goal is for students to learn how to independently explore and assess the scientific literature, to work in a group towards a common goal, to get some experience in communicating effectively, and to deepen their understanding of the principles of the module by exploring a particular topic in detail. The group exercise will be assessed based on the presentation.

Table 5.1: Module content: Programme of lectures

Week	Day	Time	Lecture Topic & Lecturer
3	Tue	12:00-13:00	Cellular cognition (regulating the cellular economy) (CK & KM)
3	Thu	15:00-16:00	Regulation of transcription in prokaryotes I (CK)
3	Fri	10:00-11:00	Regulation of transcription in prokaryotes II (CK)
4	Tue	12:00-13:00	Regulation of transcription in prokaryotes III (CK)
4	Thu	15:00-16:00	Group project discussion (CK & KM)
4	Fri	10:00-11:00	Gene regulatory motifs (KM)
5	Tue	12:00-13:00	Gene regulatory networks (KM)
5	Thu	15:00-16:00	Regulation of transcription in eukaryotes I (MR)
5	Fri	10:00-11:00	Regulation of transcription in eukaryotes II (MR)
6	Tue	12:00-13:00	Splicing as regulatory mechanism (MR)
6	Thu	15:00-16:00	RNA quality control (NMD) and mRNA turnover (MR)
6	Fri	10:00-11:00	Dynamical systems and landscapes (KM)
7	Tue	12:00-13:00	Tips on presentations (KM)
7	Thu	15:00-16:00	Group project meetings (CK & KM & AB & MR)
7	Fri	10:00-11:00	Group project meetings (CK & KM & AB & MR)
8	Tue	12:00-13:00	Chromatin biology I (AB)
8	Thu	15:00-16:00	Chromatin biology II (AB)
8	Fri	10:00-11:00	Chromatin biology III (AB)
9	Review week		
10	Tue	14:00-15:00	Non-coding RNAs I (CK)
10	Thu	15:00-16:00	Regulation of translation I (CK)
10	Fri	10:00-11:00	Non-coding RNAs II (KM)
11	Tue	14:00-15:00	Regulation of translation II (KM)
11	Thu	15:00-15:00	Protein folding and posttranslational modifications (KM)



11	Fri	10:00-11:00	Protein localization (KM)
12	Tue	14:00-15:00	Review / discussion (CK & KM)
13	Tue	11:00-12:00	Group Presentations (CK & KM & AB & MR)
13	Tue	14:00-15:00	Group Presentations (CK & KM & AB & MR)
13	Thu	15:00-16:00	Group Presentations (CK & KM & AB & MR)
13	Fri	10:00-11:00	Group Presentations (CK & KM & AB & MR - if needed)

6. Experimental Microbiology I

Module Code	MIU33019
Module Personnel	Alastair Fleming (AF), Marta Martins (MM), Kim Roberts (KR), Derek Nolan (DN)
Credits	5 ECTS
Taught in	Semester 1
Contact Hours	ca. 40

6.1 MIU33019 Alastair Fleming, Marta Martins, Kim Roberts and Derek Nolan

This module offers students an opportunity to explore concepts described in the microbiology lectures through a series of laboratory-based practical classes and tutorials. The classes and activities aim to deepen understanding of the curriculum, inspire broader thinking across modules and encourage numerical, reasoning and problem-solving skills. Students are encouraged to develop the technical and experimental skills required to work in a modern microbiology or molecular biology lab and to become competent, independent bench-lab scientists. This module allows students to put into practice key concepts of the discipline of microbiology.

Lab Skills Sessions. These sessions provide students at the very beginning of term with the fundamental skills and knowledge required to undertake research in a microbiology lab. An introduction to general lab safety and departmental health & safety protocols is provided, and the concept of biosafety levels covered. Students will develop and improve lab-based skills including operation of micro-pipettes, knowledge and operation of departmental equipment in addition to characterising a lab-strain of *Escherichia coli*.

Molecular Genetics (MM). This laboratory course introduces students to a variety of techniques used in microbial genetics, molecular biology and biotechnology. Students will develop an understanding of commonly used techniques in microbial genetics such as plasmid transformation, DNA amplification by polymerase chain reaction, plasmid isolation and DNA separation by gel electrophoresis. Students will gain experience in recombinant protein purification and protein separation by gel electrophoresis.



Table 6.1: MIU33019 – Module content

Semester	Laboratory Practical Semester 1	ECTS
1	Molecular Genetics (MM)	30%
1	Scientific Writing (KR)	30%
1	Biomembranes (AF)	30%
1	Tutorial in Cell Imaging (DN)	10%

Laboratory course in Biomembranes (AF): This laboratory course deals with preparation of inner and outer membranes of *Escherichia coli*, analytical techniques for bacterial membranes including Lowry protein assay, SDS-PAGE, Western blotting and numeracy exercises. The course is designed to maximize hands-on experience and to teach data handling, presentation and interpretation.

Tutorials in Cell Imaging (DN): These tutorials will introduce students to imaging of cells in the broadest sense from high resolution electron microscopy to imaging of cells and organelles with advanced light microscopy. It will cover transmission and scanning electron microscopy, and light, fluorescence, epifluorescence and confocal microscopy. The tutorials will focus on illustrating the techniques with worked examples and will highlight the applications and limitations of the various approaches.

Scientific Writing (KR): This material will be delivered through weekly self-directed tutorials on Blackboard. Students will develop an understanding of different aspects of scientific writing including searching for journal articles, creating diagrams and figures, writing an abstract, the importance of avoiding plagiarism, software to format a bibliography, as well as self and peer critique. These skills will be practised initially by submitting and then self-critiquing short exercises and then by writing a 1500 word review essay.

Assessment Details: The module is assessed in semester 1 through different modalities. Refer to “Examination Structure” Section of this document. Students must achieve a mark of at least 40% in each component to pass the module.



7. Microbial Pathogenicity

Module Code	MIU33012
Module Co-ordinator	Kim Roberts
Credits	5 ECTS
Module Personnel	Kim Roberts and Nicky O'Boyle
Taught in	Semester 2
Contact Hours	22

7.1 MIU33012 – Kim Roberts and Nicky O'Boyle

This module covers two topics: Bacterial Pathogenicity and Virology. The bacterial pathogenicity section covers the molecular basis of bacterial pathogenesis including adhesion of bacteria to host cells and tissue, invasion of mammalian cells, evasion of innate immune responses, regulation of virulence genes and damage to host tissue. The major bacterial protein toxins will be covered (cholera toxin, clostridial neurotoxins, membrane damaging cytolysins (e.g., α -toxin of *Staphylococcus aureus*). Several important bacterial pathogens will be discussed including *Escherichia coli*, *Listeria monocytogenes*, *Staphylococcus aureus*, *Streptococcus pneumoniae*, *Pseudomonas aeruginosa* and *Vibrio cholerae*. The lecture material on *S. aureus* and *E. coli* provides important background information for the laboratory practical course for Microbiology students.

The virology component of this course will compare and contrast the diversity of viral genomes and virus replication strategies. We will discuss how virus replication and evasion of host immune responses contribute to disease. Several important viruses are used to illustrate the core concepts including SARS-CoV-2, Mpox, influenza A viruses, and HIV. Emerging viruses, virus evolution, virus transmission and methods for interrupting virus replication, including vaccines, antiviral drugs and non-pharmaceutical interventions, will also be discussed

Learning outcomes: Upon successful completion of this module, students will be able to discuss different ways that bacterial replication and interactions with the host contributes to disease. They will be able to describe the replication cycles of several important virus species and the diseases these viruses can cause. Students will understand how viruses manipulate host cellular process, including gene transcription and translation, during replication. Students will also have acquired knowledge of antibacterial and antiviral therapies, and ways in which microbes evolve resistance to these drugs.

Recommended Reading List:

- Brenda A Wilson, et al. Bacterial Pathogenesis - A Molecular Approach. American Society for Microbiology Press
- Flint *et al.* Principles of Virology. American Society for Microbiology Press OR Collier *et al.* Human Virology. Oxford University Press



- Further reading on specialist topics will be provided during the lectures.

Table 7.1: Module content: Programme of lectures

Week	Day	Time	Lecture Topic & Lecturer
21	Mon	09:00-10:00	Diversity of viruses (Kim Roberts)
21	Mon	10:00-11:00	Poliovirus – positive sense single stranded RNA (+ssRNA) genome (Kim Roberts)
21	Thu	14:00-15:00	SARS-CoV-2 – a virus with a +ssRNA genome but with a more complicated replication strategy (Kim Roberts)
21	Fri	10:00-11:00	Influenza viruses – negative sense single stranded RNA (-ssRNA) genome (Kim Roberts)
22	Tue	11:00-12:00	Poxviruses – double stranded DNA (dsDNA) genome, cytoplasmic viral factory (Kim Roberts)
22	Tue	15:00-16:00	Introduction to Bacterial pathogenicity (Nicky O'Boyle)
22	Fri	10:00-11:00	Herpesviruses and papillomavirus – dsDNA genomes, replication in the nucleus
22	Fri	11:00-12:00	HIV - +ssRNA with reverse transcriptase (Kim Roberts)
23	Tue	15:00-16:00	The host-pathogen interface – <i>Streptococcus pneumoniae</i> (Nicky O'Boyle)
23	Thu	14:00-15:00	Viruses that cause hepatitis (Kim Roberts)
24	Tue	14:00-15:00	Adhesion & Colonization 1 – Uropathogenic <i>Escherichia coli</i> (Nicky O'Boyle)
24	Wed	15:00-16:00	Adhesion & Colonization 2 – <i>Staphylococcus aeruginosa</i> , <i>Staphylococcus aureus</i> (Nicky O'Boyle)
24	Fri	10:00-11:00	Emerging viruses – zoonotic transmission, outbreaks and pandemic potential (Kim Roberts)
24	Fri	11:00-12:00	Viral evolution and host adaptation Anti-viral vaccines - preventing virus infections (Kim Roberts)
25	Mon	09:00-10:00	Anti-viral therapies - treating virus infections (Kim Roberts)
25	Mon	10:00-11:00	Anti-viral vaccines - preventing virus infections (Kim Roberts)
25	Tue	11:00-12:00	Biofilms and Quorum Sensing – <i>Pseudomonas aeruginosa</i> , <i>Staphylococcus aureus</i> (Nicky O'Boyle)
25	Wed	14:00-15:00	Cellular Invasion – <i>Listeria monocytogenes</i> , <i>Salmonella enterica</i> (Nicky O'Boyle)
26	Mon	14:00-15:00	Bacterial Protein Secretion Systems (Nicky O'Boyle)
26	Mon	15:00-16:00	Microbial Toxins – <i>Staphylococcus aureus</i> , <i>Clostridium botulinum</i> , <i>Vibrio cholerae</i> (Nicky O'Boyle)
26	Tue	11:00-12:00	Regulation of Bacterial Pathogenicity – Enterohaemorrhagic <i>E. coli</i> (Nicky O'Boyle)
26	Wed	14:00-15:00	Vaccines, Therapeutics and Future Directions (Nicky O'Boyle)



Assessment Details: Assessment consists of one hour multi-type question exam during the semester worth 20% and one 1.5-hour essay exam paper at the end of semester 2 worth 80%.



8. Experimental Microbiology II

Module Code	MIU33020
Module Personnel	Kim Roberts (KR), Nicky O'Boyle (NOB), Carsten Kröger (CK)
Credits	5 ECTS
Taught in	Semester 2
Contact Hours	ca. 40

8.1 MIU33020 – Kim Roberts, Carsten Kröger and Nicky O'Boyle

This module offers students an opportunity to explore concepts described in the Microbiology lectures through a series of laboratory-based practical classes and tutorials. The classes and activities aim to deepen understanding of the curriculum, inspire broader thinking across modules and encourage numerical, reasoning and problem-solving skills. Students are encouraged to develop the technical and experimental skills required to work in a modern microbiology or molecular biology lab and to become competent, independent bench-lab scientists. This module allows students put into practice key concepts of the discipline of Microbiology.

Table 8.1: MIU33020 – Module content

Semester	Laboratory Practical	Semester 2	ECTS
2	Bacterial Pathogenicity	(NO'B)	33%
2	Virology	(KR)	33%
2	Bacterial Genetics	(CK)	34%

Laboratory course in Bacterial Pathogenicity (NOB): Building on concepts covered in lectures, this series of labs will demonstrate characteristics and features of bacterial pathogens that enable them to cause disease. The practical series will focus on *Staphylococcus aureus* and *Escherichia coli*; two species associated with a wide diversity of human infections. Using clinical and non-clinical isolates, the roles of bacterial adhesive factors, biofilm formation, and secreted enzymes and toxins will be explored. Finally, a tissue culture based infection experiment will be performed to directly analyse host-pathogen interaction and virulence factor function.

Laboratory course in Virology (KR): During the virology laboratory classes students will learn how to safely manipulate viruses, specifically bacteriophage and influenza virus, for experiments. Concepts covered during this part of the module include aseptic technique, mammalian cell culture, safe use of Microbiological Safety Cabinets, methods used to quantify viruses, and viral RNA extraction and amplification. Students will practise integrating theory from lectures with experimental design and data analysis. The assessment for this part of the module is an open book, short answer test.

Laboratory practicals in bacterial genetics (CK): Students will learn how to perform experiments in bacterial genetics and to interpret the results. They will learn how to relate the practical aspects of their work to the theory covered in the lectures and in the pre-



practical briefings. They will understand the importance of sample sizes when searching for rare genetic events, the importance of experimental accuracy if statistically-reliable data are to emerge from their experiments. They will learn the importance of genotype when selecting bacterial strains for experiments and how to overexpress genes for functional study. Specifically, students will generate random mutant libraries and using those libraries to screen for biological phenotypes. Transposon capture will identify the location of random insertion using molecular cloning. Overexpression of bacterial phospholipases will be functionally assessed by confirming protein overproduction and measuring haemolysis of erythrocytes.

Learning Outcomes:

- Develop essential practical skills in Microbiology
- Learn numerical and computation skills essential for the practice of Microbiology
- Design and execute Microbiology experiments
- Practise the interpretation of data generated from experimental approaches
- Practise problem solving skills
- Understand the basis for experimental design and execution.

Assessment Details: The module is assessed in Semester 2 through different modalities. Refer to “Examination Structure” section of this document. Students must achieve a mark of at least 40% in each component to pass the module.



9. Bioinformatics

Module Code	GEU33301
Module Co-ordinator	Máire Ní Leathlobhair, Karsten Hokamp
Credits	5 ECTS
Module Personnel	Fiona Roche (FR), Karsten Hokamp (KH), Carsten Kröger (CK), Máire Ni Leathlobhair (MNL)
Taught in	Semester 2
Contact Hours	39

9.1 GEU33301 – Fiona Roche, Karsten Hokamp, Carsten Kröger & Máire Ní Leathlobhair

This module is taught in combination with the Genetics department and covers web-based bioinformatics, Python programming and a data handling component. Lectures will be held in computer labs to enable a hands-on approach. The bioinformatics component provides a practical introduction to the use of commonly used bioinformatic databases and tools with a focus on web-based applications. Students will become familiar with accessing biological sequence databases and exploring various sequence analysis tools to understand evolutionary relationships and how this can help to draw protein functional and structural inferences. The Python programming component introduces students to computer programming in Python using bioinformatics-related examples and exercises. It will be carried out within an internal JupyterLab environment. The data handling part contains a biolab component in which samples will be prepared for whole-genome sequencing (WGS). The combined lectures and practicals cover basic techniques for data processing and working with the statistical software R. This module runs for 14 x 2 hours (combined lecture and practical sessions) plus a 5-hour lab practical and 3 x 2-hour in-class assessments in Semester 2.

Students are required to bring their own laptop for the practical sessions. Please bring your lab coat to the Biolab session.

As learning aims of this module students will:

- learn how to search a range of biological databases
- understand how proteins are annotated and classified
- get to know which tools can be used to explore unknown sequences of interest
- master the concept of sequence alignment and homology searching
- understand the process of programming
- acquire basic Python programming skills
- gain a thorough understanding of next-generation sequencing data
- be familiar with the steps and tools required to process, map and visualise NGS data
- become familiar with the specifics of NGS data analysis
- understand how to enhance NGS results with annotation data



- isolate genomic DNA from *E. coli* bacteria
- prepare a DNA library for Nanopore sequencing
- carry out WGS analysis of a bacterial genome

Table 9.1: Module content: Programme of lectures

Week	Day	Time	Lecture Topic & Lecturer
21	Mon	14:00-16:00	Bioinformatics 1 – Biological Databases (FR, 2 hours)
21	Fri	11:00-13:00	Bioinformatics 2 – Protein Resources & Function Prediction (FR, 2 hours)
22	Mon	14:00-16:00	Bioinformatics 3 – Pairwise and Multiple Sequence Alignments (FR, 2 hours)
22	Fri	14:00-16:00	Bioinformatics 4 – Homology Searching using BLAST (FR, 2 hours)
23	Fri	14:00-16:00	Programming 1 – Variables and Loops (KH, 2 hours)
24	Mon	14:00-16:00	Programming 2 – Input/Output, Branching (KH, 2 hours)
24	Fri	14:00-16:00	Programming 3 – Lists, Tuples, Sets (KH, 2 hours)
25	Mon	11:00-13:00	Bioinformatics Assessment (FR, 2 hours)
25	Mon	14:00-16:00	Programming 4 – Dictionaries (KH, 2 hours)
25	Fri	11:00-13:00	Programming 5 – Functions, System Commands (KH, 2 hours)
27			Reading Week
28	Tue	11:00-12:00, 14:00-18:00	Biolab Practical (CK)**Venue: Biolab 1
28	Thu	09:00-11:00	NGS Data Analysis 1 – Using R for bioinformatics I (MNL, 2 hours)
28	Fri	11:00-13:00	Programming Assessment (KH, 2 hours)
29	Thu	11:00-13:00	NGS Data Analysis 2 – Using R for bioinformatics II (MNL, 2 hours)
29	Fri	11:00-13:00	NGS Data Analysis 3 – Graphs & Data Visualization in R (MNL, 2 hours)
30	Thu	11:00-13:00	NGS Data Analysis 4 – Markdown Notebooks in R (MNL, 2 hours)
31	Thu	11:00-13:00	NGS Data Analysis 5 – Introduction to Machine Learning in R (MNL, 2 hours)
32	Fri	11:00-13:00	R Assessment (MNL, 2 hours)

NOTE: Venue LTEE3 and MAC Lab.

**Biolab 1 Carsten Kröger session on Tue 9th March.

Description of each Lecture:

Bioinformatics 1 - Biological Databases (FR, 2 hours): This lecture covers how bioinformatics data are stored and organised with a focus on resources provided at NCBI and EBI. Students will learn about the different types of data and tools found within these resources, specifically the retrieval of gene/transcript information and approaches to interactively explore biological data in the context of the genome.



Bioinformatics 2 - Protein Resources and Function Prediction (FR, 2 hours): This lecture describes how protein sequence data are stored, annotated and classified. Students will learn about computational methods used for predicting protein function and be introduced to protein resources, such as UniProt and InterPro.

Bioinformatics 3 - Sequence Alignment (FR, 2 hour): This lecture introduces the concept of sequence alignment, the process of comparing two sequences to determine if they are evolutionarily related to one another. Students will gain an understanding of both pairwise and multiple sequence alignment and learn of its many applications including its role in inferring function and structure and the identification of genetic variants from sequence comparison.

Bioinformatics 4 - Multiple Sequence Alignment & Genome Browsers (FR, 2 hours): This lecture will explore the concept of homology searching using the BLAST algorithm, which compares single sequences against a database of sequences to search for significantly similar sequences. PSI-BLAST will also be introduced for the identification of more distant homologs.

Programming 1 – Variables and Loops (KH, 2 hours): This lecture covers string variables, string formatting, as well as built-in functions and methods for strings. This is followed by the use of ‘while’ and ‘for’ loops for repeated application of programming steps.

Programming 2 – Input/Output, Branching (KH, 2 hours): This lecture deals with ways of reading experimental data from files into a Python script and how to store results generated by a script in a file. It also introduces ways of making decisions in a Python script through branching. With this additional skill set students will be able to write more elaborate scripts and tackle processing of sequence data in Fasta format.

Programming 3 – Lists, Tuples, Sets (KH, 2 hours): Lists are a very common feature in data science. They are represented in Python through various types of iterable variables, which are covered in this lecture together with their built-in functions and methods.

Programming 4 – Dictionaries (KH, 2 hours): This lecture is dedicated to dictionaries, a collection of key-value pairs, which enables students to implement a DNA translation script.

Programming 5 – Functions, System Commands (KH, 2 hours): With the introduction of functions, the repertoire of programming skills is expanded so that scripts can be written more efficiently. System commands will enable the execution of external programs from within script.

Practical – Isolation of gDNA and Nanopore Sequencing (CK, 5 hours): In this practical, the students will learn how to isolate genomic DNA from *Escherichia coli* bacteria and how to quality-control the DNA integrity to be suitable for whole genome sequencing. One DNA library will be prepared for Oxford Nanopore sequencing. The practical is not assessed.



NGS Data Analysis 1 – Using R for Bioinformatics I (MNL, 2 hours): The last part of the module deals with the analysis of Next-Generation Sequencing (NGS) data. This lecture will introduce students to how the statistical software R can be used to manipulate and analyse NGS and other data. Students will learn about data structures, data manipulation and subsetting, as well as functions and packages in R.

NGS Data Analysis 2 – Using R for Bioinformatics II (MNL, 2 hours): Building on Part I, this lecture will continue to explore how we can use R for the analysis of NGS data. Students will explore more complex data manipulation methods and learn about specialized bioinformatics packages in R. The session will also cover statistical analysis, enabling students to apply these skills to their own research projects.

NGS Data Analysis 3 - Graphs & Data Visualization in R (MNL, 2 hours): This lecture will cover basic plotting in base R, data visualization with ggplot2 and introductory data visualization theory.

NGS Data Analysis 4 - Markdown Notebooks in R (MNL, 2 hours): This lecture covers the use of R Markdown Notebooks as an integrated way to carry out and share data analysis. Students will learn about the structure of R Notebooks, how to use Markdown to format text, and how to create and customize code blocks within Notebooks.

NGS Data Analysis 5 - Introduction to Machine Learning in R (MNL, 2 hours): This lecture will introduce students to the basics of machine learning using R. Students will learn about key machine learning concepts and techniques, including supervised and unsupervised learning.

Learning Outcomes: On successful completion of the module, students should be able to:

- MLO1. Query a range of bioinformatic databases
- MLO2. Apply tools to investigate unknown sequences
- MLO3. Carry out sequence alignment and homology searching
- MLO4. Visualise biological data through a genome browser
- MLO5. Approach programming tasks in a structured way
- MLO6. Write Python scripts following good coding practice
- MLO7. Integrate external programs and use functions within Python scripts
- MLO8. Solve entry-level bioinformatics problems using Python scripts
- MLO9. Assess the quality of NGS data
- MLO10. Apply bioinformatics tools for processing NGS data
- MLO11. Visualise NGS data through genome browser resources
- MLO12. Carry out core NGS downstream analyses resulting in genome assemblies
- MLO13. Integrate external annotation data with analysis results through Python scripts
- MLO14. Competency to isolate bacterial DNA and to prepare a Nanopore sequencing reaction



Recommended Reading List:

- The Biostar Handbook, 2nd Edition (<https://www.biostarhandbook.com/>)
- Bioinformatics, 4th Edition, John Wiley and Sons Ltd, by Andreas D. Baxevanis, Gary Bader, David Wishart
- Bioinformatics and Functional Genomics, 3rd Edition, 2015, Wiley Blackwell, Jonathan Pevsner
- A Critical Guide to BLAST, TK Attwood (<https://www.mygoblet.org/about-us/publication/critical-guide-blast>)
- How to Think Like a Computer Scientist, Learning with Python 3 (RLE), 2012 edition, by Peter Wentworth, Jeffrey Elkner, Allen B. Downey, and Chris Meyers (<https://openbookproject.net/thinkcs/python/english3e/>)

Assessment Details:

- (1) A bioinformatics exam (33%),
- (2) a Python programming exam (33%),
- (3) R homework and an R programming exam (34%).

In case of an overall fail mark for this module, the failed components need to be repeated during the reassessment period.



10. Mol. Gen. II: Genome Structure and Dynamics

Module Code	GEU33303
Module Personnel	Frank Wellmer, Matthew Dorman
Credits	5 ECTS
Module Personnel	Frank Wellmer (FW), Matthew J. Dorman (MJD)
Taught in	Semester 2
Contact Hours	23

10.1 GEU33303 – Frank Wellmer and Matthew J. Dorman

The aim of this module is to introduce students to fundamental concepts in Molecular Genetics. By focusing on plant and microbial genetics, we want to highlight the overlap between these seemingly disparate biological systems. The microbial genetics component will focus on critical regulatory aspects of the gene expression machinery (transcription and translation), and genome replication (DNA replication, homologous recombination, mutagenesis and DNA repair). In relation to plant genetics, students will be introduced to major topics such as the structure and evolution of the nuclear genome, the importance of model plants, including *Arabidopsis thaliana*, light-regulated gene expression, hormone receptors and signal transduction systems. The evolutionary origins of plant cell organelles (chloroplasts and mitochondria) via endosymbiosis involving ancestral microbes will also be explored as will be the many facets of plant-microbe interactions including plant immunity and symbiosis.

Learning outcome: Upon successful completion of this module, students will be able to describe the critical regulatory features of the gene expression systems in prokaryotic microbes and eukaryotic cell organelles (chloroplasts and mitochondria). They will understand how DNA is replicated, how it can be recombined via homologous recombination, altered by mutagenic processes, and repaired. Students will also have acquired knowledge of key topics in plant genetics, such as light-regulated gene expression, hormone receptors and signal transduction, and the genetic basis of plant immunity.

Recommended Reading List:

- Anthony J.F. Griffiths et al. Introduction To Genetic Analysis. 12th edition. New York, NY: W.H. Freeman & Company, 2020
- Further reading on specialist topics will be provided during the presentation of the module

Assessment Details: One 1.5-hour exam paper at the end of semester 2.

Module Coordinators: Frank Wellmer (wellmerf@tcd.ie)

Matthew Dorman (dormanmj@tcd.ie)



Table 10.1: Module content: Programme of lectures

Week	Day	Time	Lecture Topic & Lecturer
21	Tue	11:00-12:00	DNA replication I: Linear and circular genomes; replication strategies; origins of replication (Dorman)
21	Tue	14:00-15:00	DNA replication II: regulation of initiation at oriC; role of DnaA and hemimethylation (Dorman)
21	Thu	15:00-16:00	Homologous recombination I: Holliday, Meselson-Radding and Szostak models (Dorman)
22	Tue	14:00-15:00	Homologous recombination II: RecA, SSB, RecBCD, RuvA, B, C; Horizontal gene transfer (Dorman)
22	Thu	15:00-16:00	DNA Mutagenesis: chemical, deamination, base-analogues, chromosomal integration through homologous DNA, transposons (Dorman)
23	Tue	11:00-12:00	DNA Repair systems: Mismatch base repair; Base excision repair; nucleotide excision repair; SOS response; Non-homologous end-joining; Error Prone DNA Polymerases (Dorman)
23	Tue	14:00-15:00	Tutorial: revision of material, discussion and answering student questions (MJD)
23	Thu	15:00-16:00	Introduction: why plant research is important (FW)
24	Tue	11:00-12:00	Models for plant research and nuclear genome structure (FW)
24	Thu	15:00-16:00	Evolution of the nuclear genome and sex determination in plants (FW)
25	Thu	15:00-16:00	Discovery and mutagenic potential of transposable elements (FW)
27			Reading Week
28	Wed	16:00-17:00	Regulation of transposon activity (FW)
28	Thu	14:00-15:00	The plastid genome and plastid evolution (FW)
29	Thu	14:00-15:00	The genetic toolbox for analyzing plant biology: the making of transgenic plants (FW)
29	Thu	15:00-16:00	Tutorial: revision of material, discussion and answering student questions (FW)
30	Wed	16:00-17:00	The genetic toolbox for analyzing plant biology: genetic screens (FW)
30	Thu	14:00-15:00	The genetic toolbox for analyzing plant biology: mutant analyses (FW)
30	Thu	15:00-15:00	Understanding signal transduction in plants (FW)
31	Wed	16:00-17:00	Understanding the response pathway for light (FW)
31	Thu	14:00-15:00	Understanding the response pathway for the hormone ethylene (FW)
31	Thu	15:00-16:00	Plant-microbe interactions (FW)
32	Thu	14:00-15:00	Plant-pathogen interactions: an evolutionary arms race (FW)
32	Thu	15:00-16:00	Tutorial: revision of material, discussion and answering student questions (FW)



11. Open Modules

Module Code	BIU33150
Module Co-ordinator	Derek Nolan
Credits	5 ECTS
Module Personnel	Amir Khan (AK), Kenneth Hun Mok (KHM), Vincent Kelly (VK), Martin Caffrey (MC), Emma Creagh (EC), Aisling Dunne (AD), Derek Nolan (DN)
Taught in	Semester 1
Contact Hours	21

11.1 BIU33150 Biochemistry for Biosciences

This module follows on from the biochemistry/cell biology component of the “Molecules to Cells” BIU22201 module of year 2. The aim is to provide Junior Sophister students of other disciplines with the grounding in biochemistry necessary to (i) understand biology at a molecular level, (ii) form a mechanistic view of biological processes and (iii) appreciate the pathobiochemical basis of disease. The module covers four major themes in biochemistry: Proteins and Nucleic Acids, Membranes, Cytoskeleton and Signalling. The module will be assessed through a combination of in course assessment and an individual end of term exam.

All lectures will be delivered online as follows with the accompanying lecture notes on Blackboard.

Assessment Details: 60% End of year examination, 40% in-course assessed.

Table 11.1: Module content: Programme of lectures

Week	Upload to BB by	Lecture Topic & Lecturer
Protein and Nucleic Acids		
3	14/09	Amino acids and peptide bond (AK)
3		Structures and folds (AK)
4	21/09	Structure and specific motifs (AK)
4		Spectrophotometry of biomolecules (KHM)
5	28/09	Protein folding and pathologies (KHM)
5		The proteome (KHM)
6	5/10	DNA, chromatin & the nucleus (VK)
6		RNA structure, folds & function (VK)
Membranes		
7	12/10	An introduction to cellular and model membranes (MC)
7		Membrane composition and therapeutic approaches (MC)
8	19/10	The structure, organisation and properties of membranes (DN) (in two parts A & B)



8		Membrane Targeting of Proteins and transport of molecules across membranes (DN)
9		Review Week
Cytoskeleton		
10	2/11	Structure of tubulin and microtubules and the assembly/disassembly of microtubular structures (EC)
10		Microtubular motors, types, mechanism of movement, regulation, physiological roles (EC)
11	9/11	Introduction to actin and the actin cytoskeleton (DN)
11		F-actin nucleation & pathologies associated with actin cytoskeleton (DN)
Signalling		
12	16/11	Signalling 1: Introduction to cell signalling & GPCRs (EC)
12		Signalling 2: G-Protein coupled Receptor (GPCR) regulation (EC)
13	23/11	Signalling 3: Receptor tyrosine kinases (RTKs)-PDGF and EGF (AD)
13		Signalling 4: RTK signalling – PKB and PDK1 (AD)
14		Plus: in person tutorial for Q&A for lectures 13-20, at a time to be confirmed (3-13 week of teaching term)

Lectures schedule and timetable

All lectures will be delivered online as follows with the accompanying lecture notes on blackboard: Module BIU33150. Lectures will be released 2 per week starting on week 1 of the teaching term. Subsequent lectures will be released 2 per week each following Monday. Lectures are sometimes subdivided into part A, B, C, etc., on BB. These can vary in length but combined will give 50 min overall for the lecture topic. So, these are not multiple lectures, they are smaller parts of the same lectures.

There will be two tutorial sessions to allow for in person Q&A these will be in week 6 and week 11 of teaching term.

In addition, there will be an online open forum on in the module on BB in which students can post questions or seek clarifications. Lecturer replies will appear in the forum.

Nominally these lectures are timetables at 19.00 on Monday and Wednesday of each week but both lecture videos will be release at the start of the week as listed below.

Sample MCQs and exam Qs are available online in BB.



Learning Outcomes:

On completion of this module, the student will be able to:

- Recall and comprehend key knowledge and concepts of the hierarchy of polypeptide structure and the forces that stabilize the three-dimensional shape of proteins.
- Explain the link between a protein structure and its biological activity, and with appropriate examples, how human diseases arise from a deviation in structure
- Appreciate the principles of spectrophotometry and its applications to biomolecules.
- Understand the concept of the proteome and its importance in disease Integrate key concepts about nucleic acid structure and function.
- Demonstrate an understanding of the biochemical processes of nucleic acids in the cell.
- Recall and integrate key knowledge and concepts concerning the role of lipids in membrane structure and function.
- Describe how model membranes are formed and their applications.
- Describe how an understanding of membrane composition and structure can be used in the design of vaccines, antibiotics and beta-blockers.
- Demonstrate a knowledge of the biosynthesis of membrane proteins, including the mechanisms of insertion and transport to their various locations.
- Explain the types of membrane transport and how this process is coupled to energy and assayed.
- Describe the structure of microtubules, their assembly and disassembly and their polarity.
- Describe the structure of microtubule motors and the processes of directed vesicle transport and cytoplasmic streaming.
- Describe the structure of monomeric actin and how it is assembled into filaments Explain how actin nucleation is linked to pathological states.
- Describe the general principles of G-protein coupled receptor (GPCR) signalling and its regulation, the initial discovery of G-proteins linked to cyclase, the functional effects of cAMP and the activation of GPCR-linked signal-activated phospholipases.
- Discuss Receptor Tyrosine Kinase (RTK) signalling and details of MAP kinase cascades, using PDGF and EGF as examples. Explain RTK and PI3K pathways in the context of PKB (Akt) and PDK1 signalling.
- Describe the principles of steroid hormone receptor signalling mechanisms.

Recommended Reading List:

A reading list will be given out by lecturers during the module.



Assessment Details:

60% End of year examination, 40% in course assessed.

In course assessment: Two online MCQ assessments.

The MCQs will be structured as follows:

There will be two MCQs per lecture, giving 40 MCQs for the course.

The first MCQ will open online the week after reading week and will cover the first 12 lectures (so 24 MCQs) representing 24% of the marks for the module.

The second MCQ will open online week 12, i.e., the last week of the term and will cover the material contained in the eight lectures after reading week. There will be 16 MCQs representing 16% of the marks for the course.

The two MCQs will be structured as follows:

Important features of this assessment

1. The assessment will be by MCQ and there will be two MCQs related to the content of each lecture, giving 40 MCQs for the course.
2. The first MCQ will cover lectures 1-12 (24 MCQs), the second will cover lectures 13-20 (16 MCQs).
3. You can choose when to take the assessment during the time that the exam is open, which will be for three days (details will be posted in BB)
4. The assessment will be a “take home” online MCQ. It is important that you are ready for the test before you commence.
5. The MCQ is time limited so once you start, you will have to complete the assessment in the allotted time. You will be allowed 2 min per MCQ. The test will automatically shut down when the time allowed ends. So, the first MCQ containing 24 Qs will have an allocated time of 48 min, the second will have an allocated time of 16 min. There will be pro rata extended times for those students who qualify for this accommodation.
6. The online assessment does not allow backtracking. Changes to an answer after submission are not allowed.
7. Note the questions will be selected at random from a bank of questions available for each lecture and the order of appearance will also be randomise, so Q1 may not necessarily be related to content of lecture 1. Similarly, the questions will vary from session to session, so the questions will be related to each of the lectures but may not be the same for every student.

Sample MCQs and a sample paper will be available online.



The end of term assessment will consist of an in-person exam (60%).

You will have to answer 3 essay type questions. Time allowed 90 min.

There will be four sections on the paper reflecting the 4 main topics of the module.

Section 1: Proteins and Nucleic Acids

Section 2: Membranes

Section 3 Cytoskeleton

Section 4 Signalling

Each section will contain two questions. You must answer 3 Qs from 3 different sections.

Section 1 is compulsory: one must come from section 1: Proteins and Nucleic Acids. The other two questions can be a choice from the remaining three sections.

You cannot answer two questions from the same section.

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Module Code	BIU33250
Module Co-ordinator	Aisling Dunne
Credits	5 ECTS
Module Personnel	Aisling Dunne (AD), Jean Fletcher (JF), Michael Carty (MC), Ed Lavelle (EL), Luke O'Neill (LON), Sinead O'Rourke (SOR)
Taught in	Semester 2
Contact Hours	17

11.2 BIU33250 Introduction to Immunology & Immunometabolism

This module introduces to the basic components and function of the immune system – the molecules, cells, tissues and organs that make up the immune system. It will illustrate the immune responses to infection. Additionally, it will introduce students to the principles of integrated metabolism and bioenergetics before considering how they are dysregulated in inflammatory diseases and also how we can harness this knowledge for new immunotherapies.

Assessment Details:

60% End of year examination, 40% in course assessed.

In course assessment: In-class end of module MCQ exam covering lecture material

End of year exam; 3 essay questions, answer 2 – specific instructions will be given on paper.

Table 12.1: Module content: Programme of lectures

Lecture	Lecture Topic & Lecturer
1	Innate Immunity 1- Introduction to the Immune System (AD)
2	Innate Immunity 2 – Innate Defences
3	Innate Immunity 3 – Cellular Response to infection
4	Innate Immunity 4 – PRR Signalling
5	Innate Immunity 5 – Cytokines
6	Innate Immunity 6 – DCs & Antigen Presentation
7	Adaptive Immunity & Infection 1 – T-cell Receptor
8	Adaptive Immunity & Infection 2 – T-cell Signalling
9	Adaptive Immunity & Infection 3 – T Effector T-cells
Revision Tutorial: Innate Immunity	
10	Adaptive Immunity & Infection 4 - B-lymphocytes & Plasma Cells (MC)
11	Adaptive Immunity & Infection 5 – Antibodies (MC)
12	Adaptive Immunity & Infection 6 – Infection & Covid-19 (EL)
13	Adaptive Immunity & Infection 7 – Vaccination (EL)



14	Immunometabolism 1 - Metabolites as Signalling Molecules (LON)
15	Immunometabolism 2 – Applied Immunometabolism (LON)
16	Immunometabolism 3 – Immunometabolism & disease (SOR)
TBC	Revision Tutorial: Adaptive Immunity

Learning Outcomes:

On successful completion of this module students will be able to:

- Identify cells, receptors and soluble component of the innate immune system and how they function to eliminate pathogen.
- Define how an adaptive immune response is initiated and how different types of adaptive immune responses are used to eliminate particular pathogens.
- Identify how the immune system can cause disease and how it can be exploited therapeutically.
- Recall the principals of central energy and intermediary metabolic pathways and appreciate their importance in cellular function.
- Apply knowledge on cellular metabolism to diseases including cancer and inflammation.

Recommended Reading List:

The recommended text for this module is Janeway's Immunobiology published by Norton's Books, currently in its 10th Edition. Further reading will be given out by lecturers during the module.

Delivery

This Open module consists of 16 scheduled lectures (plus 2 tutorials) which will be delivered either online through Panopto (pre-recorded) or face to face. Any recordings will be released online in Blackboard and students will be notified beforehand. The in-class MCQ will be made available on the Blackboard after Reading/revision Week 1 at a flexible slot. The end of Semester exam will be an in-person, written exam paper.

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Module Code	GEU33045
Module Co-ordinator	Mike Dolan
Credits	5 ECTS
Module Personnel	Mike Dolan (MD), Adrian Bracken (AB), Matthew J. Dorman (MJD), Kenneth Hun Mok (KHM)
Taught in	Semester 1
Contact Hours	24

11.3 GEU33045 Genomics and Systems Biology

Learning Aims: The aim of this module is to equip students with a comprehensive understanding of the methods used in the fields of genomics, proteomics and metabolomics and how these methods are used for basic research, biotechnology, agriculture and medicine. To this end, several applications from work in diverse organisms (bacteria, fungi, plants, animals including humans) in addition to specific diseases and disorders (Schizophrenia and Cancer) will be presented. The module further introduces students to the field of systems biology and outlines how systems biology differs from the classic reductionist approach used in biology.

Table 13:1 Module content: Programme of lectures

Week	Day	Time	Lecture Topic & Lecturer
3	Mon	17:00-18:00	Introduction to Genomics and Systems Biology (MD)
3	Tue	17:00-18:00	History of DNA Sequencing I (MD)
4	Mon	17:00-18:00	History of DNA Sequencing II: The Human Genome Project (MD)
4	Tue	17:00-18:00	Modern Day DNA sequencing I: 2nd Generation Sequencing Technologies (MD)
5	Mon	17:00-18:00	Modern Day DNA sequencing II: 3rd Generation Sequencing Technologies (MD)
5	Tue	17:00-18:00	Reference Sequences and Alignment (MD)
6	Mon	17:00-18:00	Population Genomics (MD)
6	Tue	17:00-18:00	Transcriptomics: Revealing Gene Expression (MD)
6	Wed	17:00-18:00	How to Find Genes (MD)
7	Mon	17:00-18:00	Functional Genomics: Regulatory Genome and non-coding DNA (MD)
7	Tue	17:00-18:00	Single-cell and spatial Transcriptomics I (MD)
8	Mon	17:00-18:00	Single-cell and spatial Transcriptomics II (MD)
8	Tue	17:00-18:00	Revision of material, discussion and answering student questions (MD) – Tutorial
9	Review Week		
10	Mon	17:00-18:00	Bacterial genomes and comparative genomics (MJD)
10	Tue	17:00-18:00	Introduction into the epigenome: histone and DNA modifications (AB)



10	Wed 17:00-18:00	Proteomics: Identify/characterise/quantify; Mass Spec and other technologies (KHM)
11	Mon 17:00-18:00	Functional genomics in bacteria (MJD)
11	Wed 17:00-18:00	Quantitative proteomics; clinical proteomics (Mok)
12	Mon 17:00-18:00	Methods to analyse the epigenome; the ENCODE project 1 (AB)
12	Wed 17:00-18:00	Interaction/affinity proteomics; metabolomics introduction (KM)
13	Mon 17:00-18:00	Methods to analyse the epigenome; the ENCODE project 2 (AB)
13	Wed 17:00-18:00	Metabolomics technologies (KM)
14	Mon 17:00-18:00	Cancer profiling and classification of tumour types (AB)
14	Tue 17:00-18:00	Revision of material, discussion and answering student questions (all lecturing staff)
15	Review Week	
16	Assessment	

NOTE: Venue LTEE3

Learning Outcomes: Upon successful completion of this module, students will be able to describe experimental approaches used in the fields of genomics, proteomics and metabolomics. They will understand how to leverage these methods to analyze complex biological systems and questions. Students will be able to evaluate the applications of these techniques in biological sciences and discuss case studies involving specific diseases and disorders. Finally, they will be able to differentiate between systems biology and traditional reductionist approaches in biology.

Recommended Reading List: None

Assessment Details: One 1.5-hour exam paper at the end of semester 1

Module Coordinator: Mike Dolan MJDOLAN@tcd.ie



Module Code	ZOU33006
Module Co-ordinator	Pepijn Luijckx
Credits	5 ECTS
Module Personnel	Pepijn Luijckx (PL), Greg Albery (GA)
Taught in	Semester 2
Contact Hours	28-31

11.4: Ecology and Evolution of Infectious Diseases

Module content: The recent pandemic reminds us that diseases and parasites can do great harm to their hosts and thereby affect human health, food security and biodiversity. This course provides students with an understanding of the ecological and evolutionary principles that underly disease symptoms, emergence, and outbreak. Through a series of lectures, supplemented with practicals we will explore how natural selection acts on hosts and their pathogens, what factors facilitate disease outbreaks, and how we might prevent pathogens from escaping our control. Using examples in human medicine, animals, and plants we will explore. 1) why we get sick, 2) how diseases emerge, 3) super spreaders, individuals who generate many infections, 4) How global warming can alter the interaction between diseases and their hosts, 5) the evolution of antibiotic resistance and the evolution of virulence, 6) evolution proofing our drugs, and 7) many other concepts in evolutionary medicine, ecology, and evolution.

Learning outcomes:

1. Explain evolutionary medicine and its applications.
2. Understand why and how diseases harm their host.
3. Understand how pathogens respond to vaccines and drugs and how we minimize or avoid evolution of drug resistance.
4. Identify environmental, ecological, and evolutionary factors that contribute to disease outbreaks and influence disease dynamics. Work in a team and present the features of a chosen disease to the class.

Assessment Details: 40% Continuous Assessment, 60% Examination.



12. Examination, Progression and Appeals

Progression, reassessment and appeals regulations can be obtained from the College Calendar.

12.1 Non Satisfactory Attendance and Course

All students must fulfil the course requirements of the school or department, as appropriate, with regard to attendance and course work. All laboratory sessions are compulsory. Where specific requirements are not stated, students may be deemed non-satisfactory if they miss more than a third of their course of study or fail to submit a third of the required course work in any term. At the end of the teaching term, students who have not satisfied the School's or Department's requirements may be reported as non-satisfactory for that term. Students reported as non-satisfactory for the Michaelmas and Hilary terms of a given year may be refused permission to take their Semester Two assessment/examinations and may be required by the Senior Lecturer to repeat their year.

Reassessment and publication of results

The reassessment session usually occurs at the end of August. Students will receive provisional results after Semester 1 assessment. The Courts of Examiners will convene after Semester 2 and consider the results from both semesters.

12.2 Feedback and exam script viewing

Exam scripts can be viewed shortly after publication of results. Typically, shortly after publication. Please contact microbiology@tcd.ie to arrange script viewing with a member of staff.

13. Examination Structure: General

Two components will contribute towards the final Junior Sophister Microbiology mark:

1. Marks from Core Module assessment (40 ECTS)
2. Marks from Open modules and Trinity Electives (20 ECTS)

13.1 Assessment and Examination Procedures

The lecture component of Core Modules in Microbiology will be predominantly examined by a formal written examination at the end of the semester in which the module is taught. Additional continuous assessment is carried out in a few select modules.

Laboratory practical components are assessed in-course by laboratory practical reports, practical tests, written tests or other assignments.

The final mark for the Microbiology and Open modules will form the JS Microbiology mark that is carried forward to Moderatorship.

The final Junior Sophister mark for Microbiology accounts for 30% of the Moderatorship mark.



14. Prizes in Junior Sophister Microbiology

14.1 Lesley White Memorial Prize

This prize was founded in 1989 by subscription from family, friends and colleagues, in memory of Dr Lesley White (née Baxter) who was a graduate in biochemistry (1973). The prize is awarded annually, in biochemistry and microbiology alternately, to the best candidate in the Junior Sophister year honour examination in biochemistry (even years) or in microbiology (odd years, best performance in experimental microbiology modules MIU33019 and MIU33020). The appropriate Head of School or Department makes the recommendation for awarding the prize. Value, €70.

14.2 Microbiology Society Prize

This prize was first awarded in 2003 to the student who performed best in the Junior Sophister examinations. The prize includes a certificate, a voucher (€100), and a year's free undergraduate membership of the society. Nomination for the Microbiology Society prize is based on the results of the main examination phase from the core microbiology modules (40 ECTS) only.

14.3 The Larry O'Hara Scholarship:

This scholarship will facilitate JS Microbiology students to work in a laboratory in Ireland or internationally for the summer in between JS and SS years. The student should contact a laboratory that would be willing to host them and then send details of the laboratory and the proposed project to microbiology@tcd.ie. A committee chaired by the Head of Discipline will then review all applications and award the scholarship(s) accordingly. Applications must be submitted by the end of February 2027.

Note: The prizes are based on the results of the annual exams.

15. Teaching & Administrative Staff

Administrative	Position	Ext	Email
Noreen O'Sullivan	Executive Officer Microbiology	1199	microbiology@tcd.ie
Jayne Vance	Executive Officer Microbiology	1190	magoverj@tcd.ie
Alicia Vega	Executive Officer Genetics	1140	avega@tcd.ie
Laoise Quinn	School Manager	2873	Laoise.Quinn@tcd.ie



Microbiology	Position	Ext	Email
Alastair Fleming	Associate Professor in Microbiology	3112	alastair.fleming@tcd.ie
Kim Roberts	Assistant Professor in Microbiology	4451	kroberts@tcd.ie
Carsten Kröger	Assistant Professor in Microbiology	1414	carsten.kroeger@tcd.ie
Marta Martins	Assistant Professor in Microbiology	1194	mmartins@tcd.ie
Siobhán O'Brien	Assistant Professor in Microbiology	1135	siobhan.o-brien@tcd.ie
Nicky O'Boyle	Assistant Professor in Microbiology	1195	oboylen1@tcd.ie
Matthew Dorman	Assistant Professor in Microbiology	2014	dormanmj@tcd.ie
Anna Ershova	Teaching Fellow in Microbiology	1191	ershovaa@tcd.ie

Genetics & Other	Position	Ext	College Email
Jane Farrar	Head of School	3695	jane.farrar@tcd.ie
Kevin Mitchell	Associate Professor in Genetics	3067	kevin.mitchell@tcd.ie
Mani Ramaswami	Professor of Neurogenetics	8400	ramaswam@tcd.ie
Adrian Bracken	Professor of Genetics	4121	adrian.bracken@tcd.ie
Derek Nolan	Professor in Biochemistry	2455	denolan@tcd.ie
Karsten Hokamp	Senior Experimental Officer	2719	kahokamp@tcd.ie
Fiona Roche	Bioinformatics Research Officer	2719	fmroche@tcd.ie
Frank Wellmer	Professor in Genetics	3729	wellmerf@tcd.ie
Mike Dolan	Assistant Professor in Genetics Director Teaching & Learning (Undergraduate)	1872	mjdolan@tcd.ie
Máire Ní Leathlobhair	Assistant Professor in Genetics	-	nleathlm@tcd.ie



16. Appendices A-H

16.1 A - Academic Integrity

All students are required to access the online central repository in which all information and resources on Academic Integrity have been consolidated. This facility explains what plagiarism is, and how it can be avoided. The central repository is being hosted by the Library and is located at **Academic Integrity** (<https://libguides.tcd.ie/academic-integrity>).

It includes the following:

The matrix explaining the different levels of plagiarism outlined in the Calendar entry and the sanctions applied.

1. Information on what plagiarism is and how to avoid it
2. “Ready, Steady, Write”, an online tutorial on plagiarism which must be completed by all students
3. The text of a declaration which must be inserted into all cover sheets accompanying all assessed course work
4. Details of software packages that can detect plagiarism, e.g. Turnitin
5. All students must complete the online tutorial on avoiding plagiarism “Ready, Steady, Write”, located at <https://libguides.tcd.ie/academic-integrity/ready-steady-write>.

All students must complete the cover sheets containing the following declaration, when submitting assessed work: I have read and I understand the plagiarism provisions in the General Regulations of the University Calendar for the current year, found at: <https://libguides.tcd.ie/academic-integrity/declaration>.

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

For the rules governing academic integrity please see www.tcd.ie/calendar. The relevant outcome following the assessment of the level of plagiarism can be found here: <https://libguides.tcd.ie/academic-integrity/consequences>.

16.2 B - The European Credit Transfer and Accumulation System (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.

Provided by the Bologna Desk (Senior Lecturer's Office, TCD), June 2008.

16.3 C–Guidelines on Awarding Grades for Course Work & Examination Answers in the Sophister Years

Note that these guidelines are for use as a general reference (Table 16.1). Differences may occur between disciplines.

16.4 D–Student Information System (SITS) – Access via my.tcd.ie

The student information system is accessible to all staff and students via the web portal **my.tcd.ie**.

All communications from College will be sent to you via your online portal which will give you access to an 'inray' of your messages. You will also be able to view your timetables online, both for your teaching and for your examinations. All fee invoices/payments, student levies and commencement fees will be issued online, and all payments will be carried out online. You will be able to view your personal details in the new system – some sections of which you will be able to edit yourself. It is important that you check this information and keep it up to date. Your examination results will also now be communicated to you via the online portal.

For help with the system contact Academic Registry:

<https://www.tcd.ie/academicregistry/contact/>

Monday to Friday 9.00am – 5pm

Email: academic.registry@tcd.ie

Tel: +353 (0) 1 896 4500



16.5 E – Blackboard

The Microbiology Department is using Blackboard to deliver student notes, reading lists and online assignments.

Go to: <https://tcd.blackboard.com/webapps/login/>

16.6 F – Disability Service Student Handbook

Please go to the link below to access the Disability Service Student Handbook:

<https://www.tcd.ie/students/orientation/add-dis/>

16.7 G – Examination Appeals Process

Please see the College Appeals Policy at:

<https://www.tcd.ie/teaching-learning/ug-regulations/Appeals.php>

16.8 H – School of Genetics and Microbiology information

Head of School: Prof. Jane Farrar (jane.farrar@tcd.ie)

Head of Department and Microbiology Discipline: Prof. Marta Martins (martins@tcd.ie)

School Manager: Laoise Quinn (laoise.quinn@tcd.ie)

Director of Teaching and Learning (Undergraduate): Dr Mike Dolan (mjdolan@tcd.ie)

16.9 I – The Use and Referencing of Generative AI

Aligned with the College Statement on Artificial Intelligence and Generative AI in Teaching, Learning, Assessment & Research (2024), the use of GenAI is permitted unless otherwise stated. Where the output of GenAI is used to inform a student's document or work output, this usage should be acknowledged and appropriately cited, as per **Library guidelines on acknowledging and reference GenAI**. From an academic integrity perspective, if a student generates content from a GenAI tool and submits it as their own work, it is considered plagiarism, which is defined as academic misconduct in accordance with College Academic Integrity Policy.



Table 16.1: Guidelines on Awarding Grades

	Mark Range	Criteria
I	90-100	IDEAL ANSWER: showing insight and originality and wide knowledge. Logical, accurate and concise presentation. Evidence of reading and thought beyond course content. Contains particularly apt examples. Links materials from lectures, practicals and seminars where appropriate.
	80-89	OUTSTANDING ANSWER; falls short of the 'ideal' answer either on aspects of presentation or on evidence of reading and thought beyond the course. Examples, layout and details are all sound.
	70-79	MAINLY OUTSTANDING ANSWER; falls short on presentation and reading or thought beyond the course but retains insight and originality typical of first class work.
II-1	65-69	VERY COMPREHENSIVE ANSWER; good understanding of concepts supported by broad knowledge of subject. Notable for synthesis of information rather than originality. Sometimes with evidence of outside reading. Mostly accurate and logical with appropriate examples. Occasionally a lapse in detail.
	60-64	LESS COMPREHENSIVE ANSWER; mostly confined to good recall of coursework. Some synthesis of information or ideas. Accurate and logical within a limited scope. Some lapses in detail tolerated.
	55-59	SOUND BUT INCOMPLETE ANSWER; based on coursework alone but suffers from a significant omission, error or misunderstanding. Usually lacks synthesis of information or ideas. Mainly logical and accurate within its limited scope and with lapses in detail.
II-2	50-54	INCOMPLETE ANSWER; suffers from significant omissions, errors and misunderstandings, but still with understanding of main concepts and showing sound knowledge. Several lapses in detail.
	45-49	WEAK ANSWER; limited understanding and knowledge of subject. Serious omissions, errors and misunderstandings, so that answer is no more than adequate.
	40-44	VERY WEAK ANSWER; a poor answer, lacking substance but giving some relevant information. Information given may not be in context or well explained, but will contain passages and words, which indicate a marginally adequate understanding.
F-1	35-39	MARGINAL FAIL; inadequate answer, with no substance or understanding, but with a vague knowledge relevant to the question.
	30-34	CLEAR FAILURE; some attempt made to write something relevant to the question. Errors serious but not absurd. Could also be a sound answer to the misinterpretation of a question
F-2	0-29	UTTER FAILURE; with little hint of knowledge. Errors serious and absurd. Could also be a trivial response to the misinterpretation of a question.
UG		Ungraded



Table 16.2: Appendix

Item	Reference Source
General Regulations	TCD Calendar https://www.tcd.ie/calendar/
Student Support	Student Supports & Services: https://www.tcd.ie/students/supports-services/ Student Services Booklet https://www.tcd.ie/students/assets Senior Tutor Services https://www.tcd.ie/seniortutor/ Graduate Studies, https://www.tcd.ie/graduatestudies/ Mature Student Office, https://www.tcd.ie/maturestudents/ Student Counselling https://www.tcd.ie/studentcounselling/
Co-curricular Activities	Central Societies Committee https://www.trinitysocieties.ie/
Information on the TCDSU	TCD Students' Union https://www.tcdsu.org/
Emergency Procedure	In the event of an emergency, dial Security Services on extension 1999 . Security Services provide a 24-hour service to the college community, 365 days a year. They are the liaison to the Fire, Garda and Ambulance services and all staff and students are advised to always telephone extension 1999 (+353 1 896 1999) in case of an emergency. Should you require any emergency or rescue services on campus, you must contact Security Services. This includes chemical spills, personal injury or first aid assistance. It is recommended that all students save at least one emergency contact in their phone under ICE (In Case of Emergency).
Date Protection	Data Protection for Student Data https://www.tcd.ie/dataprotection/
Timetable	My TCD https://my.tcd.ie/urd/sits.urd/run/siw_lgn
Key Locations	Blackboard https://tcd.blackboard.com/webapps/login/ Academic Registry https://www.tcd.ie/academicregistry/
Academic Integrity Progression Regulations	Academic Integrity https://libguides.tcd.ie/academic-integrity TCD Calendar https://www.tcd.ie/calendar/
Professional and Statutory Body Accreditation	Provided in School/Discipline Handbook
Attendance Requirements	TCD Calendar https://www.tcd.ie/calendar/
Absence from Examinations	Calendar, Part II, General Regulations and Information, Section II Item 35 Calendar, Part III Section 10