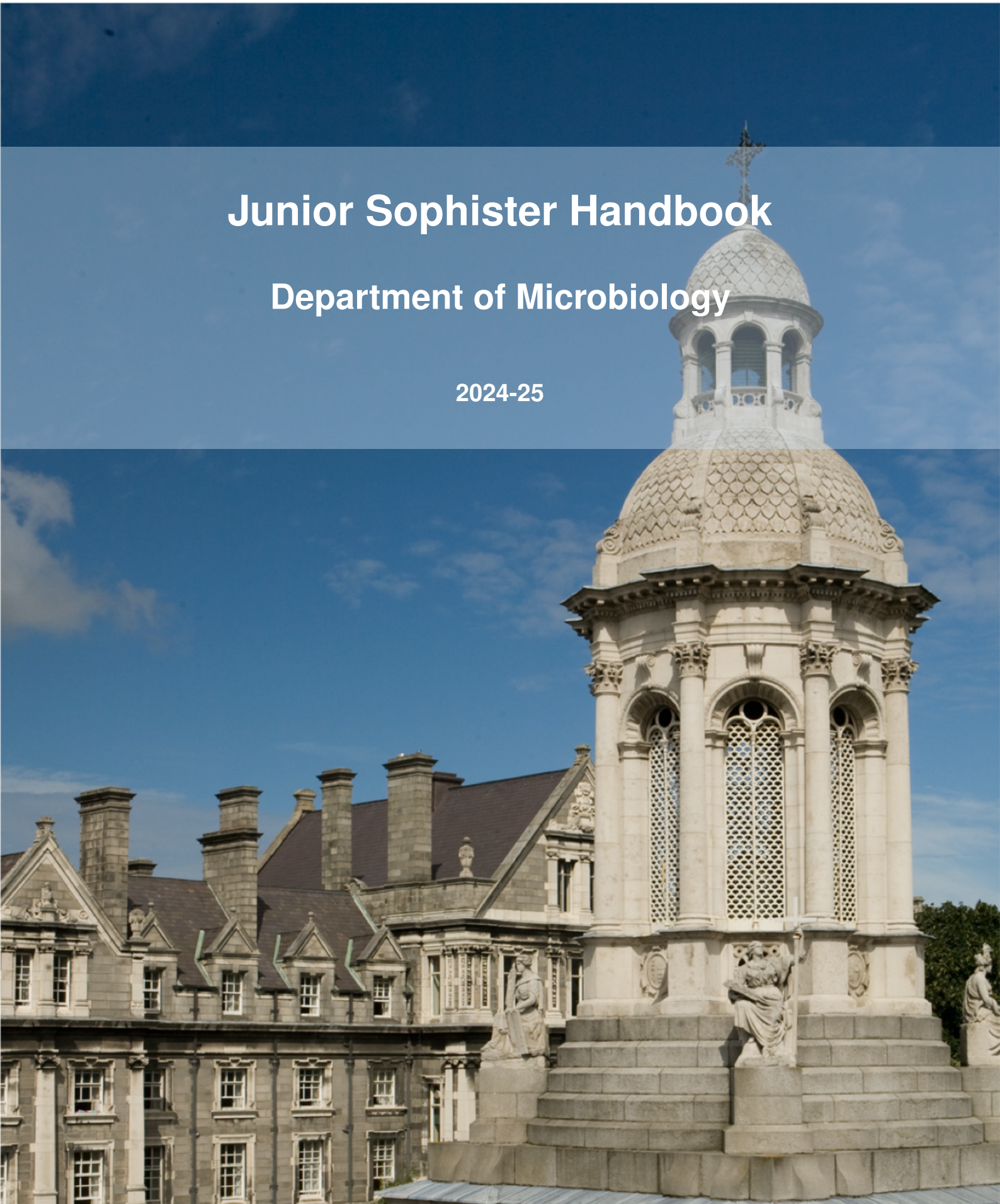
Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

Junior Sophister Handbook

Department of Microbiology

2024-25



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.

Contents

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 occuring 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 the use of 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 2024-25 – Key Dates

Table 2.1: The Academic Year 2024-25

Start Date:	Week 3 (9th September 2024)
Study/Review Week	Week 9 (21st-25th October 2024)
Revision Week Semester 1	Week 15 (2nd-6th December 2024)
Semester 1 Assessment	Week 16 (9th-13th December 2024)
Scholarship Examinations	Week 20 (6th-10th January 2025)
Semester 2 begins	Week 22 (20th January 2025)
Study/Review Week	Week 28 (3rd-7th March 2025)
Revision Week Semester 2	Week 34 (14th-18th April 2025)
Semester 2 Assessment	Week 35 (21st-25th April 2025)
Trinity Week	Week 36 (28th April-2nd May 2025)

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 Pathogenesis
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 Module Scenario I	
BIU33150 Biochemistry for Biological Sciences	BIU33250 Introduction to Immunology and Immunometabolism
Trinity Elective	ZOU33006 Ecology and evolution of infectious disease
Open Module Scenario II	
BIU33150 Biochemistry for Biological Sciences	BIUI33250 Introduction to Immunology and Immunometabolism
GEU33045 Genomes and Systems Biology	Trinity Elective
Open Module 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, Fergal Hamrock
Taught in	Semester 1
Contact Hours	20

3.1 MIU33011 – Alastair Fleming and Fergal Hamrock

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 to use bacterial surface structures as vaccine antigens and to exploit our knowledge of biosynthetic pathways to discover new antimicrobial drug targets are discussed.

Learning outcomes:

A 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
Week 3	Tue 14:00-15:00	Protein secretion in bacteria (FH)
Week 3	Wed 12:00-13:00	Specialised cell wall structures in bacteria (AF)
Week 3	Thu 14:00-15:00	Specialised cell wall structures in yeast (AF)
Week 3	Thu 10:00-11:00	Gram-positive bacteria — Teichoic Acids 1 (FH)
Week 3	Fri 11:00-12:00	Gram-positive bacteria — Teichoic Acids 2 (FH)
Week 4	Tue 14:00-15:00	Gram-positive bacteria — Cell wall anchored proteins & pili (FH)
Week 4	Wed 12:00-13:00	Microbial membranes (AF)
Week 4	Thu 14:00-15:00	Microbial sugar transport systems (AF)
Week 4	Fri 11:00-12:00	Gram-negative bacteria — Outer membrane proteins (FH)
Week 5	Tue 14:00-15:00	Gram-negative bacteria — lipopolysaccharide (FH)
Week 5	Wed 12:00-13:00	Regulation of bacterial sugar uptake (AF)
Week 5	Thu 10:00-11:00	Outermost Layers of Protection – Capsules and S-layers (FH)
Week 5	Fri 11:00-12:00	Outermost Layers of Protection – EPS and Biofilms (FH)
Week 6	Tue 14:00-15:00	Cell envelopes under stress (FH)
Week 6	Wed 12:00-13:00	Glucose signalling in yeast (AF)
Week 6	Thu 10:00-11:00	Recap and Q&A (FH)
Week 6	Thu 14:00-15:00	Microbial metabolism I (AF)
Week 7	Wed 12:00-13:00	Microbial metabolism II (AF)
Week 8	Wed 12:00-13:00	Microbial sporulation (AF)
Week 8	Thu 12:00-13:00	Quiescence and apoptosis in yeast (AF)

4. Applied Microbiology & Antimicrobial Agents

Module Code	MIU33016
Module Co-ordinator	Marta Martins
Credits	5 ECTS
Module Personnel	Marta Martins, Anna Ershova, Gary Moran
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, amond other relevant applications. In these lectures we will 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.

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:

A 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: MIU33016: Programme of Lectures

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

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

Module Code	MIU33302
Module Co-ordinators	Carsten Kröger & Kevin Mitchell
Credits	5 ECTS
Module Personnel	Carsten Kröger, Kevin Mitchell, Adrian Bracken, Mani Ramaswami
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 have to solve in order 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:

A 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).

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 on the basis of the presentation.

End of semester exam: The students will be asked to answer 1 essay-type question and 10 short answer questions (3-5 sentences).

Table 5.1: Module content: Programme of lectures

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

6. Experimental Microbiology I

Module Code	MIU33019
Credits	5 ECTS
Module Personnel	Alastair Fleming, Marta Martins, Kim Roberts, Derek Nolan
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 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)	1.5
1	Scientific Writing (KR)	1.5
1	Biomembranes (AF)	1.5
1	Tutorial in Cell Imaging (DN)	0.5

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-ordinators	Kim Roberts
Credits	5 ECTS
Module Personnel	Kim Roberts and Tim Foster
Taught in	Semester 2
Contact Hours	20

7.1 MIU33012 – Kim Roberts and Tim Foster

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 and damage to host tissue. The major bacterial protein toxins will be covered (cholera enterotoxin, clostridial neurotoxins, membrane damaging cytolysins (e.g., α-toxin of *Staphylococcus aureus*). Several important bacterial pathogens will be discussed including *Listeria monocytogenes*, *Shigella flexneri*, *Staphylococcus aureus*, *Streptococcus pneumoniae*, *Pseudomonas aeruginosa* and *Vibrio cholerae*. The lecture on *S. aureus* 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	Lecture Topic & Lecturer
	Bacterial pathogenicity (Tim Foster)
Week 22-27	Course Overview. Fundamental concepts.
Week 22-27	Clostridial neurotoxins. Tetanus and Botulism. Classical toxinoses
Week 22-27	*Vibrio cholerae*. Cholera. An environmental saprophyte with human infection as part of its life cycle.
Week 22-27	*Shigella* species. Bacillary dysentery. Important Intracellular pathogens.
Week 22-27	*Pseudomonas aeruginosa*. The ultimate opportunist. Nosocomial infections and cystic fibrosis.
Week 22-27	*Staphylococcus aureus*. Commensal and invasive nosocomial pathogen. MRSA.
Week 22-27	*Streptococcus pneumoniae*. Upper respiratory tract commensal with ability to cause pneumonia and sepsis.
Week 22-27	*Listeria monocytogenes*. Food-borne pathogen. Dangerous to the immunocompromised and pregnant women.
Week 22-27	**Virology (Kim Roberts)**
Week 22-27	Diversity of viruses
Week 22-27	Poliovirus – positive sense single stranded RNA (+ssRNA) genome
Week 22-27	SARS-CoV-2 – a virus with a +ssRNA genome but with a more complicated replication strategy
Week 22-27	Influenza viruses – negative sense single stranded RNA (-ssRNA) genome
Week 22-27	Poxviruses – double stranded DNA (dsDNA) genome, cytoplasmic viral factory
Week 22-27	Herpesviruses and papillomavirus – dsDNA genomes, replication in the nucleus
Week 22-27	Virus evolution and interventions (KR)
Week 22-27	HIV - +ssRNA with reverse transcriptase
Week 22-27	Viruses that cause hepatitis
Week 22-27	Emerging viruses – zoonotic transmission, outbreaks and pandemic potential
Week 22-27	Viral evolution and host adaptation
Week 22-27	Anti-viral vaccines - preventing virus infections
Week 22-27	Anti-viral therapies - treating virus infections

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

8. Experimental Microbiology II

Module Code	MIU33020
Credits	5 ECTS
Module Personnel	Kim Roberts, Carsten Kröger, Fergal Hamrock
Taught in	Semester 2
Contact Hours	ca. 40

8.1 MIU33020 – Kim Roberts, Carsten Kröger and Fergal Hamrock

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 1	ECTS
2	Bacterial Pathogenicity (FH)	1.666
2	Virology (KR)	1.666
2	Bacterial Genetics (CK)	1.666

Laboratory course in Bacterial Pathogenicity (FH): Concepts and bacterial characteristics which contribute to pathogenicity and virulence discussed throughout the lecture series will be demonstrated in these labs through comparison of clinical and non-clinical strains of *Staphylococcus aureus*. Specifically these labs will demonstrate the importance of bacterial adhesive factors to promote attachment to host cells and tissues, biofilm formation, secretion of

bacterial enzymes and toxins which promote virulence and pathogenicity, detection of bacterial antigens and host antibodies.

Laboratory course in Virology (KR): These laboratory classes cover aseptic technique, cell culture, safe use of Microbiological Safety Cabinets, methods used to quantify viruses, and RNA extraction and amplification. In addition, students use Blackboard to create a short blog post about a virus of their choice. Assessment for this part of the module is split evenly between an open book, short answer test and the blog post created using Blackboard.

Laboratory practicals in bacterial genetics (CK): Students learn how to perform experiments in bacterial genetics and to interpret the results. They learn how to relate the practical aspects of their work to the theory covered in the lectures and in the pre-practical briefings. They understand the importance of large sample sizes when searching for rare genetic events, the importance of experimental accuracy if statistically-reliable data are to emerge from their experiments, they learn to distinguish genetic selection from genetic screening, the importance of genotype when selecting bacterial strains for experiments, how to construct a genetic map and the vital importance of hypothesis testing using genetic marker rescue.

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-ordinators	Máire Ní Leathlobhair, Karsten Hokamp
Credits	5 ECTS
Module Personnel	Fiona Roche, Karsten Hokamp, Carsten Kröger, Máire Ní Leathlobhair
Taught in	Semester 2
Contact Hours	39

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

This module is taught in combination with the Genetics Department and contains 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 processing next-generation sequencing data and working with the statistical software R.

This module runs for 15 x 2 hours (combined lecture and practical sessions) plus a 5-hour lab practical and 2 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
Week 22	Mon 14:00-16:00	Bioinformatics 1 – Biological Databases (FR)
Week 22	Fri 11:00-13:00	Bioinformatics 2 – Protein Resources & Function Prediction (FR)
Week 23	Mon 14:00-16:00	Bioinformatics 3 – Sequence Alignments (FR)
Week 23	Fri 14:00-16:00	Bioinformatics 4 – Multiple Alignments & Genome Broswers (FR)
Week 24	Fri 14:00-16:00	Programming 1 – Variables and Loops (KH)
Week 25	Mon 14:00-16:00	Programming 2 – Input/Output, Branching (KH)
Week 25	Fri 14:00-16:00	Programming 3 – Lists, Tuples, Sets (KH)
Week 26	Mon 11:00-13:00	**Bioinformatics Assessment (FR)**
Week 26	Mon 14:00-16:00	Programming 4 – Dictionaries (KH)
Week 26	Fri 11:00-13:00	Programming 5 – Functions, System Commands (KH)
Week 28		**Reading Week**
Week 29	Tue 11:00-12:00, 14:00-18:00	Biolab Practical (CK)**
Week 29	Thu 10:00-12:00	**Programming Assessment (KH)**
Week 29	Fri 11:00-13:00	NGS Data Analysis 1 – Using R for bioinformatics I (MNL)
Week 30	Thu 11:00-13:00	NGS Data Analysis 2 – Using R for bioinformatics II (MNL)
Week 30	Fri 11:00-13:00	NGS Data Analysis 3 – Graphs & Data Visualization in R (MNL)
Week 31	Thu 11:00-13:00	NGS Data Analysis 4 – Markdown Notebooks in R (MNL)
Week 32	Thu 11:00-13:00	NGS Data Analysis 5 – Introduction to Machine Learning in R (MNL)
Week 33	Thu 11:00-13:00	R Assessment (MNL)

NOTE: Venue LTEE3 and MAC Lab.
**Biolab 3 Carsten Kröger session on Tue 11th 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 the EBI.

Students will learn about the different types of data and tools found within these resources, delving deeper into the Gene and Ensembl databases.

Bioinformatics 2 - Protein Resources and Function Prediction (FR, 2 hours): This lecture describes how protein sequence data are stored, annotated and classified. Students will also 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 pairwise sequence alignment, the process of comparing two sequences to determine if they are evolutionarily related to one another. The lecture will also explore the BLAST algorithm, which compares single sequences against a database of sequences to search for significantly similar sequences.

Bioinformatics 4 - Multiple Sequence Alignment & Genome Browsers (FR, 2 hours): This lecture extends alignment approaches to the alignment of multiple sequences and discusses its many applications including its role in inferring function and structure and identifying genetic variants from sequence comparison. Students will also be introduced to genome browsers and learn how to interactively explore and visualise biological data in the context of the genome with a specific focus on comparative genomics.

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 perform and report analysis of data. 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:

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

Recommended Reading List:

- The Biostar Handbook, 2ndEdition (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%) and (3) R homeworks 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 Coordinator	Frank Wellmer
Credits	5 ECTS
Module personnel	Frank Wellmer, Fergal Hamrock
Taught in	Semester 2
Contact Hours	23

10.1 GEU33303 – Frank Wellmer and Fergal Hamrock

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.

Table 10.1: Module content: Programme of lectures

Week	Day&Time	Lecture Topic & Lecturer
Week 22	Tue 11:00-12:00	DNA replication I: Linear and circular genomes; replication strategies; origins of replication (FH)
Week 22	Tue 14:00-15:00	DNA replication II: regulation of initiation at oriC; role of DnaA and hemimethylation (FH)
Week 22	Thu 15:00-16:00	Homologous recombination I: Holliday, Meselson-Radding and Szostak models (FH)
Week 22	Fri 16:00-17:00	Homologous recombination II: RecA, SSB, RecBCD, RuvA, B, C; Horizontal gene transfer (FH)
Week 23	Tue 14:00-15:00	DNA Mutagenesis: chemical, deamination, base-analogues, chromosomal integration through homologous DNA, transposons (FH)
Week 23	Thu 15:00-16:00	DNA Repair systems: Mismatch base repair; Base excision repair; nucleotide excision repair; SOS response; Non-homologous end-joining; Error Prone DNA Polymerases (FH)
Week 24	Tue 11:00-12:00	Tutorial: revision of material, discussion and answering student questions (FH)
Week 24	Tue 14:00-15:00	Introduction: why plant research is important (FW)
Week 24	Thu 15:00-16:00	Models for plant research and nuclear genome structure (FW)
Week 25	Tue 11:00-12:00	Evolution of the nuclear genome and sex determination in plants (FW)
Week 25	Thu 15:00-16:00	Discovery and mutagenic potential of transposable elements (FW)
Week 26	Fri 14:00-15:00	Regulation of transposon activity (FW)
Week 28		**Reading Week**
Week 29	Wed 16:00-17:00	The plastid genome and plastid evolution (FW)
Week 29	Thu 14:00-15:00	The genetic toolbox for analyzing plant biology: the making of transgenic plants (FW)
Week 29	Fri 14:00-15:00	Tutorial: revision of material, discussion and answering student questions (FW)
Week 30	Wed 16:00-17:00	The genetic toolbox for analyzing plant biology: genetic screens (FW)
Week 30	Thu 14:00-15:00	The genetic toolbox for analyzing plant biology: mutant analyses (FW)
Week 30	Thu 15:00-16:00	Understanding signal transduction in plants (FW)
Week 30	Fri 14:00-15:00	Understanding the response pathway for light (FW)
Week 31	Wed 16:00-17:00	Understanding the response pathway for the hormone ethylene (FW)
Week 31	Thu 14:00-15:00	Plant-microbe interactions (FW)
Week 31	Thu 15:00-16:00	Plant-pathogen interactions: an evolutionary arms race (FW)
Week 33	Thu 14:00-15:00	Tutorial: revision of material, discussion and answering student questions (FW)

11. Open Modules

11.1 Biochemistry for Biological Sciences (Semester 1) – 5 ECTS

i BIU33150: A Kahn, K Mok, J Murray, M Caffery, D Nolan and A Dunne.

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 topics covered will include: the biochemistry of protein structure, enzymes and their role in metabolism, membranes and transport, signalling and the cytoskeleton and related cell biology. The module will be assessed through a combination of in course assessment and an individual end of term exam. **This module will be delivered online.**

11.2 Introduction to Immunology and Immunometabolism (Semester 2) – 5 ECTS

i BIU33250: A Dunne, C O'Farrelly, J Fletcher, R Porter, F Sheedy

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 importance of central energy and intermediary metabolic pathways before considering how they are dysregulated in diseases like cancer and to fuel immune function. The module will be assessed by in course continuous assessment and an individual end of term exam paper.

11.3 Genomics and Systems Biology (Semester 1) – 5 ECTS

i GEU33045: M Dolan (Module Co-ordinator), K Mok, A Bracken, C Kröger

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.

Lecture Venue: LTEE3.

Table 11.1: GEU33045 Module content: Programme of lectures

Week	Time & Day	Lecture Topic & Lecturer
Week 3	Tue 17:00-18:00	Introduction to Genomics and Systems Biology (MD)
Week 3	Wed 17:00-18:00	History of DNA Sequencing I (MD)
Week 4	Mon 17:00 18:00	History of DNA Sequencing II: The Human Genome Project (MD)
Week 4	Tue 17:00-18:00	Modern Day DNA sequencing I: 2nd Generation Sequencing Technologies (MD)
Week 5	Mon 17:00-18:00	Modern Day DNA sequencing II: 3rd Generation Sequencing Technologies (MD)
Week 5	Tue 17:00-18:00	Structural and Comparative Genomics (MD)
Week 6	Mon 17:00-18:00	Genomic Architecture of Schizophrenia (MD)
Week 6	Tue 17:00-18:00	Transcriptomics: Revealing Gene Expression (MD)
Week 7	Mon 17:00-18:00	Profiling RNA expression in the Schizophrenic Brain (MD)
Week 7	Tue 17:00-18:00	Regulation of Gene Expression (MD)
Week 7	Wed 17:00-18:00	Single-cell and spatial Transcriptomics (MD)
Week 8	Mon 17:00-18:00	Single-cell dissection of the human brain in health and disease (MD)
Week 8	Tue 17:00-18:00	Revision of material, discussion and answering student questions (MD)
Week 9		**Study/Review week**
Week 10	Tue 17:00-18:00	Bacterial genomes and comparative genomics (CK)
Week 11	Mon 17:00-18:00	Functional genomics in bacteria (CK)
Week 11	Tue 16:00-17:00	Introduction into the epigenome: histone and DNA modifications (AB)
Week 11	Tue 17:00-18:00	Methods to analyse the epigenome; the ENCODE project (AB)
Week 12	Mon 17:00-18:00	Cancer profiling and classification of tumour types (AB)
Week 12	Tue 17:00-18:00	Using genomic information for the development of cancer therapies (AB)
Week 13	Mon 17:00-18:00	Proteomics: Identify/characterise/quantify; Mass Spec and other technologies (KM)
Week 13	Tue 17:00-18:00	Quantitative proteomics; clinical proteomics (KM)
Week 14	Mon 17:00-18:00	Interaction/affinity proteomics; metabolomics introduction (KM)
Week 14	Tue 16:00-17:00	Metabolomics technologies (KM)
Week 14	Tue 17:00-18:00	Revision of material, discussion and answering student questions (all lecturing staff)
Week 15		**Revision Week**
Week 16		**Assessment Week**

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. Lecture venue: LTEE3.

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

11.4 Ecology and evolution of infectious disease (Semester 2) – 5 ECTS

i ZOU33006 – Pepijn Luijckx

Module Learning Outcomes with reference to the Graduate Attributes and how they are developed in discipline: On successful completion of this module, you should be able to:

- LO1: Explain evolutionary medicine and its applications.
- LO2: Understand why and how diseases harm their host.
- LO3: Understand how pathogens respond to vaccines and drugs and how we minimize or avoid evolution of drug resistance.
- LO4: Identify environmental, ecological, and evolutionary factors that contribute to disease outbreaks and influence disease dynamics.
- LO5: Work in a team and present the features of a chosen disease to the class.

Graduate Attributes: levels of attainment

- To act responsibly - Enhanced
- To think independently - Attained
- To develop continuously - Enhanced
- To communicate effectively - Attained

Module content: The recent us pandemic reminds 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. Though a series of lectures, supplemented with practical's 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 virulence, 6) evolution proofing our drugs, and 7) many other concepts in evolutionary medicine, ecology, and evolution.

Teaching and Learning Methods. The module is taught through:

- 15 lectures
- 4 interactive lectures using TCDpolls.
- Practicals (9 hours)
- Presentations (3-6 hours depending on number of students)

Assessment Details:

- Assessment Component: Practical 1 worksheet
  - Assessment Description: Explore various diseases, worms and other parasites.
  - LO Addressed: LO2
  - 5% of total
  - Week due: 23
- Assessment Component: Individual or group presentation
  - Assessment Description: Presentation on a disease or parasite of your choice. Alternative assignments available for those with anxiety speaking in public.
  - LO Addressed: LO5
  - 25% of total
  - Week due: 30
- Assessment Component: Wet lab report
  - Assessment Description: Report on behaviour manipulating parasites or fungi practical.

  - LO Addressed: LO2/LO4
  - 20% of total
  - Week due: 33
- Assessment Component: Exam
  - Assessment Description: Short essay + short answer questions.
  - LO Addressed: LO1-LO4
  - 50% of total
  - Week due: End of semester

Contact Hours and Indicative Student Workload:
- Contact hours: 28-31
  - Lectures: 19 hours
  - Practicals: 9 hours
  - Presentations: 3-6 hours
- Independent Study (preparation for course and review of materials):
  - 30 hours
- Independent Study (preparation for assessment, incl. completion of assessment):
  - 40 hours

Recommended Reading List:
- A list of readings, videos and podcasts will be made available on Blackboard.

Module Pre-requisite:
- Modules that confer: Basic knowledge of ecology and evolution

12. Examination, Progression and Appeals

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

12.1 Non-Satisfactory Attendance and Coursework

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.

12.2 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.

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. Examination Structure: Core Modules

14.1 Assessment Modalities

14.2 Semester 1 – The Modules

i MIU33011: Microbial Physiology (5 ECTS)

Assessment will be by a written exam with essay-type questions and/or short answers. The exam papers will be in three sections A, B and C. Rubric: Answer THREE questions, ONE question from each of Sections A, B and C. OR Answer two questions, ONE question from each of Sections A and B and answer short questions in Section C.

ii MIU33016: Applied Microbiology & Antimicrobial Agents (5 ECTS)

Assessment will be by a written exam with essay-type questions and/or short answers. The exam papers will be in three sections A, B and C. Rubric: Answer THREE questions, ONE question from each of Sections A, B and C. OR Answer two questions, ONE question from each of Sections A and B and answer short questions in Section C.

iii MIU33302: Molecular Genetics I: Regulation of Gene Expression (5 ECTS)

50% continuous assessment (group project, presentation). 50% end of semester exam (1.5 hours, one essay-type question plus 10 short answer questions.

iv MIU33019: Experimental Microbiology I (5 ECTS)

Assessment of practical work can take various forms including MCQ, short answers, laboratory notebooks, essays, problem solving and interpretation of data. The form may vary from year to year.

Molecular Genetics. Assessed at the end of the laboratory course. The assessment will include a written exam and a take-home assignment.

Scientific Writing: The assessment will be a 1500 word essay. Students are also expected to submit a short assignment each week for 6 weeks, and failure to do so will incur a 1% penalty per assignment to the essay mark.

Laboratory course in Biomembranes. Assessed at the end of the laboratory course through written exam. Tutorials in Cell Imaging. Assessed by continuous assessment during

the course.

Note: Students must achieve a mark of at least 40% in each component to pass the module.

N.B. Some in-course assessments may take place during Study/Review and Revision Weeks.

14.3 Semester 2 – The Modules

i MIU33012: Microbial Pathogenicity (5 ECTS)

Assessment will be in the form of a written 1.5 hour exam at the end of semester 2. The paper may be comprised of essay-type questions and/or short answer questions. There will be two sections to the paper, A and B. Students will be asked to answer THREE questions, ONE question from each of sections A and B, AND an additional question from either section.

ii GEU33301: Bioinformatics (5 ECTS)

(1) A bioinformatics exam (33%), (2) a Python programming exam (33%) and (3) a report based on NGS data analysis with an R programming component (34%). Submission deadline for the report is Wednesday, April 24th, 5 pm. The wetlab component will not be assessed.

iii GEU33303: Molecular Genetics II: Genome Structure and Dynamics (5 ECTS)

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

iv MIU33020: Experimental Microbiology II (5 ECTS)

Assessment of practical work can take various forms including MCQ, short answers, laboratory notebooks, essays, problem solving and interpretation of data. The form may vary from year to year.

Laboratory course in Bacterial Pathogenicity. The practical is assessed at the end of the laboratory course. The assessment takes the form of MCQ/Short Answer/Data handling or interpretation paper.

Laboratory course in Virology. The practical is assessed at the end of the laboratory course through an open book short answer question test and a short presentation to the class.

Bacterial Genetics. The practical material is assessed in a written exam (short answer questions and MCQs) in the week following the end of the classes (duration: one hour).

N.B. Some in-course assessments may take place during Study/Review and Revision Weeks.

Note: Students must achieve a mark of at least 40% in each component to pass the module.

Marking guidelines. Faculty guidelines on awarding grades for essays and examination answers in the Sophister years can be found in Appendix in this booklet.

14.4 Viewing scripts: A time to view scripts will be published closer to the exam periods.

15. Prizes in Junior Sophister Microbiology

15.1 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 honor examination in biochemistry (even years) or in microbiology (odd years). The appropriate Head of School or Department makes the recommendation for awarding the prize. Value: €70.

15.2 Microbiology Society Prize

This prize was first awarded in 2003 to the student who performed best in the JS examinations. The prize includes a certificate, voucher and a year's free Undergraduate Membership of the Society. Nomination for the Microbiology Society prize is based on the results from the core Microbiology modules (40 ECTS) only.

16. Teaching & Administrative Staff

Microbiology	Position	Ext	College Email
Dr Alastair Fleming	Associate Professor in Microbiology	3112	alastair.fleming@tcd.ie
Dr Kim Roberts	Assistant Professor in Microbiology	4451	kroberts@tcd.ie
Dr Carsten Kröger	Assistant Professor in Microbiology	1414	carsten.kroeger@tcd.ie
Dr Marta Martins	Assistant Professor in Microbiology	1194	mmartins@tcd.ie
Dr Tim Foster	Professor (Emeritus) of Microbiology	-	tfoster@tcd.ie
Dr Máire Ní Leathlobhair	Assistant Professor in Microbiology	2013	nleathlm@tcd.ie
Dr Anna Ershova	Teaching Fellow in Microbiology	1191	ershovaa@tcd.ie
Mr Fergal Hamrock	Teaching Fellow in Microbiology	-	hamrockf@tcd.ie
Dr Nicky O'Boyle	Assistant Professor in Microbiology	-	-

Genetics & Other	Position	Ext	College Email
Dr Kevin Mitchell	Associate Professor in Genetics	3067	kevin.mitchell@tcd.ie
Dr Mani Ramaswami	Professor of Neurogenetics	8400	ramaswam@tcd.ie
Dr Adrian Bracken	Professor in Genetics	4121	adrian.bracken@tcd.ie
Dr Derek Nolan	Professor in Biochemistry	2455	denolan@tcd.ie
Dr Karsten Hokamp	Senior Experimental Officer	2719	kahokamp@tcd.ie
Dr Fiona Roche	Bioinformatics Research Officer	2719	fmroche@tcd.ie
Dr Frank Wellmer	Professor in Genetics	3729	wellmerf@tcd.ie
Dr Mike Dolan	Assistant Professor in Genetics	-	mjdolan@tcd.ie

Administrative	Position	Ext	College 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

17. Appendices A-H

17.1 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**.

It includes the following:

1. The matrix explaining the different levels of plagiarism outlined in the Calendar entry and the sanctions applied
2. Information on what plagiarism is and how to avoid it
3. 'Ready, Steady, Write', an online tutorial on plagiarism which must be completed by all students
4. The text of a declaration which must be inserted into all cover sheets accompanying all assessed course work
5. Details of software packages that can detect plagiarism, e.g. Turnitin

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.

17.2 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

17.3 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 17.1). Differences may occur between disciplines.

17.4 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 'intray' 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 the 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

17.5 E – Blackboard

The Microbiology Department is using Blackboard to deliver student notes, reading lists and online assignments. Simply follow these steps:

1. Go to https://tcd.blackboard.com/webapps/login/
2. Click TCD Student and Staff login
3. Enter your student name and password.
4. Click on modules for relevant student notes.

17.6 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/

17.7 G – Examination Appeals Process

Please see the College Appeals Policy at:
https://www.tcd.ie/teaching-learning/ug-regulations/Appeals.php

17.8 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 (mmartins@tcd.ie)
- School Manager: Laoise Quinn (laoise.quinn@tcd.ie)
- Director of Teaching and Learning (Undergraduate): Dr Pablo Labrador (labradoj@tcd.ie)

Table 17.1: 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.
II-2	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.
	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.
III	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.
U.G.		Ungraded

Table 17.2: Appendix

Item	Reference/Source
General Regulations	TCD Calendar
Student Support	Student Supports & Services, Student Services Booklet, Senior Tutor Services, Graduate Studies, Mature Student Office, Student Counselling
Co-curricular Activities	Central Societies Committee
Information on the TCDSU	TCD Students' Union
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).
Data Protection	Data Protection for Student Data
Timetable	My TCD
Key Locations	Blackboard, Academic Registry
Academic Integrity	Academic Integrity
Progression Regulations	TCD Calendar
Professional and Statutory Body Accreditation	Provided in School/Discipline Handbook.
Attendance Requirements	TCD Calendar
Absence from Examinations	Calendar, Part II, General Regulations and Information, Section II, Item 35 Calendar, Part III Section 10
Reference to Relevant University Regulations	Student Complaints Procedure