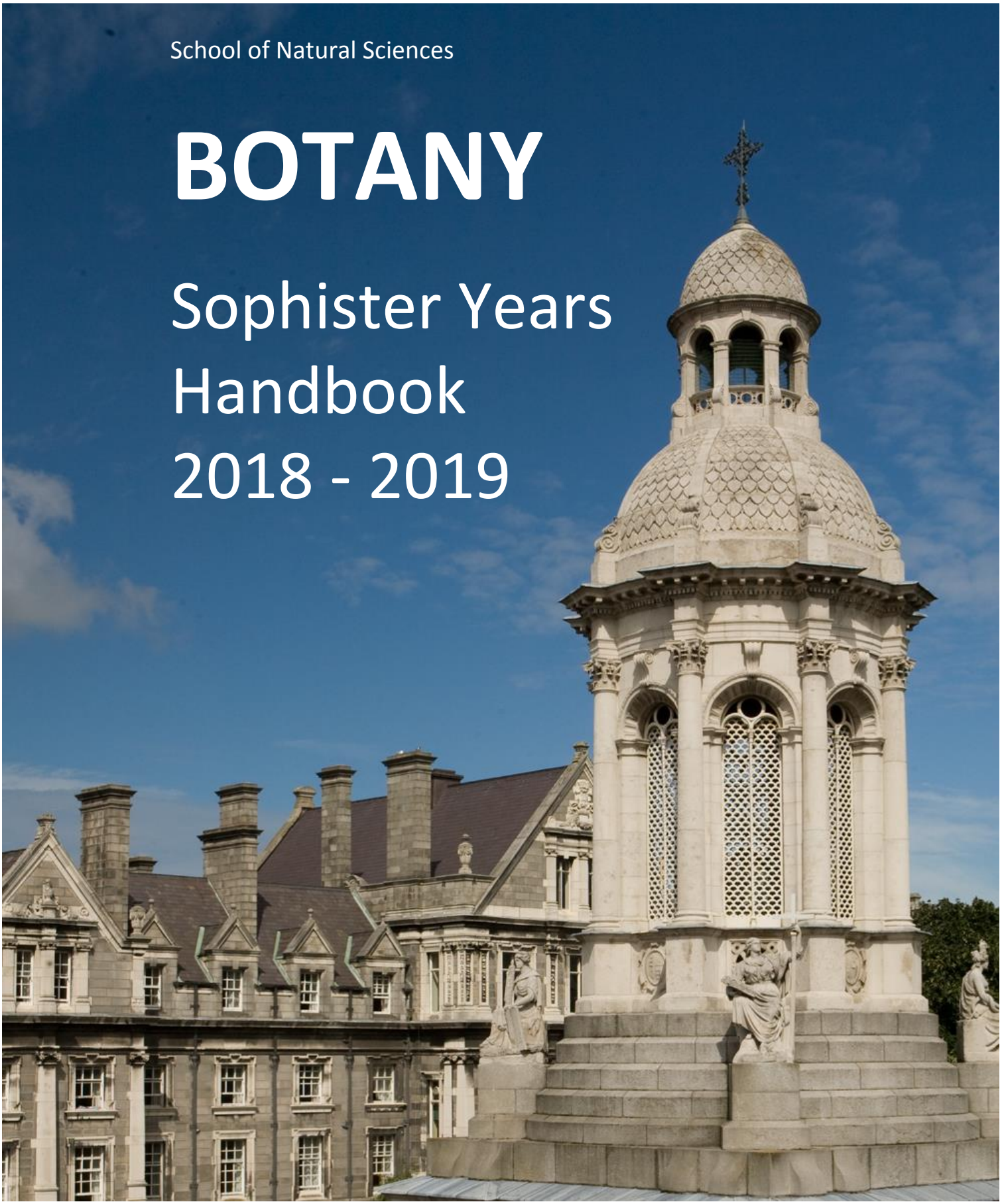
Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

School of Natural Sciences

BOTANY

Sophister Years Handbook 2018 - 2019



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A note on this Handbook

This handbook applies to all students taking the Botany (Plant Sciences) Programme taught by the School of Natural Sciences. It provides a guide to what is expected of you on this programme, and the academic and personal support available to you. Please download and retain a copy for future reference.

The information provided in this handbook is accurate at time of preparation. Any necessary revisions will be notified to students via email.

Your attention is drawn to the University Calendar Part 1 (the relevant parts of which are available at registration, or from your tutor) and, in particular, sections G & P that outline general rules governing all students progression through College and the Faculty of Science; in addition your attention is drawn to Sections H5/H6 regarding attendance. In the event of any conflict or inconsistency between the General Regulations published in the University Calendar and information contained in course/departmental handbooks, the provisions of the General Regulations will prevail.

INTRODUCTION

A Welcome to Botany at Trinity

Welcome to the Botany Discipline, a leading centre of teaching and research in plant sciences. Our interests range over the areas of plant systematics, plant community ecology, and environment and sustainability. We study plants because they are of vital importance; as the source of all our food, the oxygen we breathe and most of the medicines we use. They are central to the processes of global climate change and to the provision of food and energy for an expanding human population. In the face of such change their conservation is increasingly vital.

This booklet has been prepared as a guide to your Sophister (3rd and 4th) years in Plant Sciences. It provides details of the core teaching staff, their research interests, the modules on offer and how your work will be assessed and examined as well as details of departmental procedures. As Sophister students you are an integral part of the Botany Discipline - which operates as a teaching and research unit within the School of Natural Sciences. In order to function efficiently we have adopted working procedures with which you are expected to conform, especially with regard to health and safety and security.

Plant Sciences encompass a broad range of subject areas, including:

Ecology & Conservation
Plant Biochemistry
Plant Molecular Biology
Classical and Molecular Taxonomy
Quaternary Ecology
Soil Science
Biogeography
Plant Physiology
Ecophysiology
Genetics
Plant Animal Interactions

Your Sophister years are also designed to offer you the learning opportunities to gain skills in communication, numeracy and scientific problem solving. In addition, we are fully committed to the Broad Curriculum initiative and we will allow you to participate in the opportunities that this initiative presents. You will also have the opportunity, particularly in your final year, to choose certain topics for in-depth investigation.

The Botany Discipline's Web page (http://www.tcd.ie/Botany) is a very useful source of information, particularly on research and teaching, which is not duplicated in this booklet.

We believe that our School offers you a friendly and stimulating working environment, and we trust that your two years with us will be both enjoyable and rewarding.

Professor Michael Williams
Course Coordinator
September 2018

STAFF – HOW TO CONTACT US

Teaching Staff

Professor Yvonne Buckley (YB)	Zoology Building
Professor Ian Donohue (ID)	Zoology Building
Professor Trevor Hodkinson (TH)	First Floor, Botany Building
Professor Celia Holland (CH)	Zoology Building
Professor Andrew Jackson (AD)	Zoology Building
Professor Jennifer McElwain (JMcE), Head of Discipline	First Floor, Botany Building
Professor Fraser Mitchell (FM)	First Floor, Botany Building
Professor John Parnell, Course Coordinator (JP)	Ground Floor, Botany Building
Professor John Rochford (JR)	Zoology Building
Professor Matthew Saunders (MS)	Ground Floor, Botany Building
Professor Jane Stout (JCS)	Ground Floor, Botany Building
Dr Marcus Collier (MC)	First Floor, Anatomy Building
Professor Stephen Waldren (SW)	Trinity Botanic Gardens, Dartry & Centre for the Environment
Professor Michael Williams (MW)	Ground Floor, Botany Building

Emeritus Staff

Dr Paul Dowding (PD)	Watts Building
Professor David Jeffrey (DJ)	Watts Building
Professor Daniel Kelly (DLK)	Ground Floor, Botany Building
Professor Nick Gray (NG)	Centre for the Environment

Technical Staff

Ms Siobhán McNamee	Ground Floor, Botany Building
Ms Jacqueline Stone Murphy	Old Anatomy Building
Ms Patricia Coughlan	Old Anatomy Building
Mr Mark Kavanagh	Centre for the Environment

Executive Officer

Ms Mandy Lockhart	Ground Floor, Botany Building

Trinity College Botanical Garden Staff

Ground Staff

Ms Elizabeth Bird	Botanic Garden, Dartry
Mr Michael McCann	Botanic Garden, Dartry

STAFF RESEARCH INTERESTS

We run a tutorial programme with small group teaching in three key research areas:

Systematics: This research group's activities are unique in Ireland and focus on discovering and describing the Earth's plant life, understanding how it evolved and devising conservation measures for it. Our work is global, involves both wild and crop plants and has resulted in the discovery of many species and genera new to science.

Ecology: Ecology is all about interactions between organisms and the environment. We research the natural environment and agricultural systems throughout Ireland, Europe and in the tropics. Our research into forest ecology, palaeoecology and pollination informs government policy, maintains biodiversity and facilitates sustainable production.

Ecosystems, Environment & Sustainability: Research at TCD focuses on the sustainable management of our natural resources. This includes the management of land-based production systems and their potential to mitigate and adapt to global climate change, the management of waste waters and the maintenance of ecosystem service provision by natural ecosystems. This research is conducted throughout Ireland but also across Europe, America and sub-Saharan Africa.

TEACHING AND LEARNING TERM DATES 2018-19

Teaching and Learning Term Dates 2018/2019			
Michaelmas Term Teaching & Learning Dates Monday 10 September 2018 – Friday 30 November 2018		**Hilary Term Teaching & Learning Dates** Monday 21 January 2019 – Friday 12 April 2019	
Week 03	10 Sept – 14 Sept	Week 22	21 Jan – 25 Jan
Week 04	17 Sept – 21 Sept	Week 23	28 Jan – 01 Feb
Week 05	24 Sept – 28 Sept	Week 24	04 Feb – 08 Feb
Week 06	01 Oct – 05 Oct	Week 25	11 Feb – 15 Feb
Week 07	08 Oct – 12 Oct	Week 26	18 Feb – 22 Feb
Week 08	15 Oct – 19 Oct	Week 27	25 Feb – 01 Mar
Week 09	22 Oct – 26 Oct (Study / Review)	Week 28	04 Mar – 08 Mar (Study / Review)
Week 10	29 Oct – 02 Nov *	Week 29	11 Mar – 15 Mar
Week 11	05 Nov – 09 Nov	Week 30	18 Mar – 22 Mar*
Week 12	12 Nov – 16 Nov	Week 31	25 Mar – 29 Mar
Week 13	19 Nov – 23 Nov	Week 32	01 Apr – 05 Apr
Week 14	26 Nov – 30 Nov	Week 33	08 Apr – 12 Apr
			*Bank/Public Holidays in the week

A full listing of the Academic Year Calendar 2018/2019 can be viewed on this website page
https://www.tcd.ie/calendar/academic-year-structure/academic-year-structure.pdf

Assessment Dates

- Semester 1 assessment dates commence the week beginning Monday 10th December 2018.
- Semester 2 assessment dates commence the week beginning Monday 22nd April 2019 *Easter Monday Bank Holiday.

PLANT SCIENCES MODERATORSHIP LEARNING OUTCOMES

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

- Demonstrate in written, oral and visual form a foundation level of knowledge and understanding of the biological, physical and quantitative sciences underpinning Plant Sciences.
- Demonstrate awareness, particularly in relation to the contributions that plant science makes to society, such as maintaining biodiversity, assessing the impacts of global change, reducing environmental pollution and ensuring sustainable food and energy production, taking into account scientific, social, political, moral and ethical considerations.
- Articulate the fundamental concepts in plant science.
- Discuss current research developments in plant science.
- Review and criticise published scientific information.
- Utilise innovative techniques and modern research facilities to develop combined theoretical and technical competence so enabling the development of high-quality independent research and of the ability to work accurately, efficiently and safely in both field and laboratory environments.

- Demonstrate numerical competency and the ability to analyse quantitative data by appropriate statistical tests, using spreadsheets and other software.

- Collaborate effectively in teams and work independently.

- Communicate accurately, clearly, persuasively and imaginatively, in both oral and written form.

DESCRIPTION OF THE EUROPEAN CREDIT TRANSFER SYSTEM (Credits)

The European Credit Transfer and Accumulation System (Credits) 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 Credits are the recommended credit system for higher education in Ireland and across the European Higher Education Area.

The Credits 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 Credit represents 20-25 hours estimated student input, so a 5-Credit module will be designed to require approximately 125 hours of student input including class contact time and assessments.

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 modules. Exceptions to this rule are one-year and part-year visiting students, who are awarded Credits for individual modules successfully completed.

MODERATORSHIP COURSE STRUCTURE
JUNIOR SOPHISTERS (Year 3)

The JS year consists of a diverse programme of lectures, laboratory practicals, field trips, tutorials and seminars, totalling 55 mandatory credits. In addition to core Plant Sciences modules, students take a Broad Curriculum module (5 credits). These modules are indicated in greater detail in the pages below:

MANDATORY MODULES:

Modules	Credits	Semester/Weeks
BOU33100 Plant Physiology	5	S1 Pt2 / Wk 10-14
ZOU33010 Fundamentals of Ecology	5	S1 Pt1 / Wk 4-08
BOU33107 Plant Molecular Biology	5	S2 Pt1 / Wk 22-26
BOU33108 Plants and the Irish Environment	5	S1 Pt1 / Wk 4-08
BOU33109 General Botanical Science	5	S1+S2 / Wk 4-33
BOU33111 Angiosperm Diversity and Systematics	5	S2 Pt 2 / Wk 29-33
BOU33120 Environmental Dynamics	5	S1 Pt1 / Wk 4-08
BOU33121 Field Skills in Plant and Environmental Science (Canary Islands)	5	S2 Pt1 / Wk 22-26
BOU33123 Soil Science	5	S1 Pt2 / Wk 10-14
BOU33125 Diversity of Plant Morphology	5	S2 Pt2 / Wk 29-33
ZOU33070 Experimental Design & Analysis	5	S2 / Wk 22-33
TOTAL CREDITS	**55**	

OPTIONAL MODULES:

Module	Credits	Semester/Weeks
BOU33122 Entomology	5	S2 Pt 2 / Wk 29-33
BOU33124 Economic Botany	5	S1 Pt1 / Wk 04-08
Broad Curriculum Module	5	
TOTAL CREDITS AVAILABLE	**5**	

Broad Curriculum Information is available at: http://www.tcd.ie/Broad_Curriculum/cfc/index.php
Lectures for these modules are timed to coincide with free slots in your timetable. Most modules are scheduled to run at lunchtimes so that space is available in our timetable to allow you to take one of these modules.
Assessment criteria are outlined at: http://www.tcd.ie/Broad_Curriculum/administration/assessment.php

SENIOR SOPHISTERS (Year 4)

In the Senior Sophister year, students attend a series of lectures, laboratory practicals, field work, seminars, tutorials and workshops. In addition, they are required to undertake a 20 credit research project which culminates in the submission of a dissertation. The year consists of a total of 50 mandatory credits and 10 optional credits for one module taken from outside the Plant Sciences course. These modules are indicated in greater detail in the following pages.

MANDATORY MODULES

Modules	Credits	Semester/Weeks
BOU44103 Plant Conservation and Biodiversity	5	S2 Pt1 / Wk 22-26
ZOU44030 Data Handling	5	S1 / Wk 04-14
BOU44106 Tutorials in Botany	5	S1+S2 / Wk 4-33
BOU44108 Plant-Environment Interactions	5	S1 Pt2 / Wk 10-14
BOU44109 Vegetation Description and Analysis	5	S1 Pt1 / Wk 4-08
BOU44110 The Evolution of Plants and Plant Atmosphere Interactions	5	S2 Pt1 / Wk 22-26
FBU44000 Research Project	20	S1+S2 / Wk 4-33
TOTAL CREDITS	**50**	

SCHOOL OPTIONAL SCIENCE MODULES:

(students choose **two** of the following optional modules)

Modules	Credits	Semester/Weeks
BOU44107 Plant-Animal Interactions	5	S2 Pt 2 / Wk 29-33
BOU44111 Restoration Ecology and Re-Wilding	5	S2 Pt 1 / Wk 22-26
BOU44105 Global Environmental Change	5	S2 Pt2 Wk 29-33
ZOU44017 Tropical Ecology Field Trip	5	S1 / Wk 4-08
FBU44060 Plant Breeding & Biotechnology	5	S2 Pt 2 / Wk 29-33
TOTAL CREDITS AVAILABLE	**10**	


SCHOOL OF BOTANY
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SOPHISTER MODULE DESCRIPTIONS

The modules listed below offer you a high-quality, broad-based learning experience, which we hope you will find interesting, exciting and technically challenging.

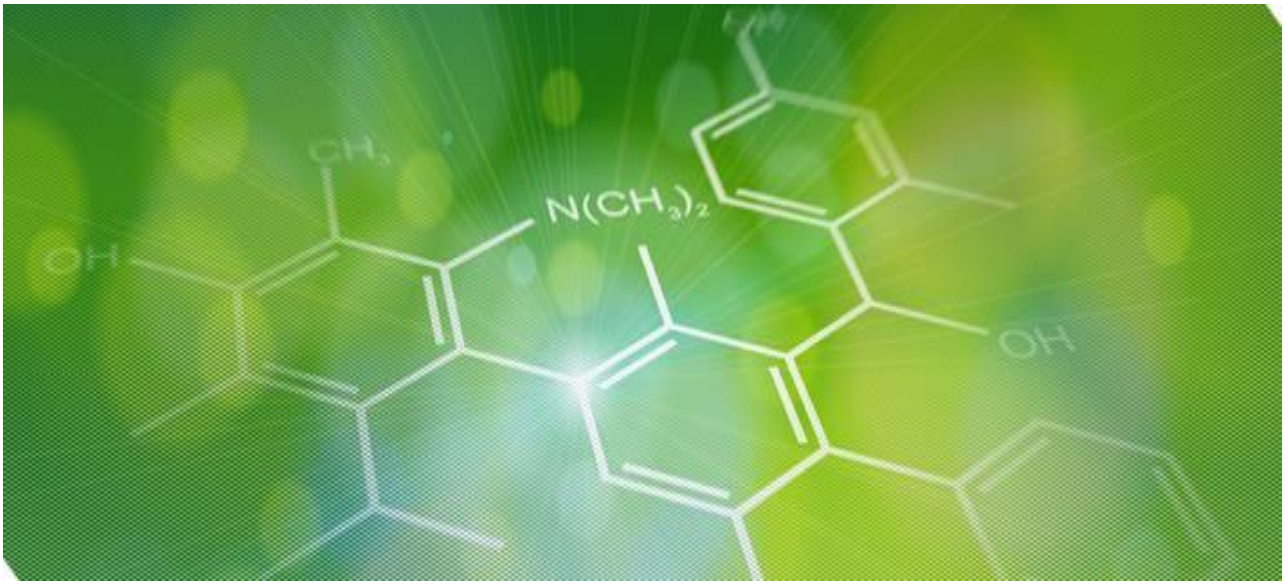
All modules directly reflect, and build-on, the research interests and activities of the Department's staff.

The staff member responsible for coordinating each module is indicated by their initials after the heading 'Lecturer(s)' and other staff members who contribute to the module are indicated immediately afterwards in brackets.

Some modules have indicative readings lists (books) associated with them.. Copies of some of these books are kept in the Botany Library on Shelves K7, 8 & 9. These – and other books marked with a red spot - must not be borrowed and must be read in the Library. Multiple copies of most are in the Hamilton library (codes given for some of these). **N.B. Additional reading will be recommended by lecturers for ALL modules.**

Student Contact Hours

In addition to the specified contact hours indicated under each module, you are expected to engage in work associated with the module to bring your input up to a total of approximately 125 hours for a 5 Credit module and 250 hours for a 10 Credit module.



JUNIOR SOPHISTER MANDATORY MODULES
MANDATORY MODULES

BOU33100: Plant Physiology

Co-ordinator:	**Professor Michael Williams**
Module Type:	Mandatory (Plant Sciences)
Assessment:	50% Examination, 50% Continual Assessment
ECTS:	5 credits
Prerequisites:	None
Lectures:	20 hours
Tutorials:	4 hours
Practicals:	24 hours
Total	48 hours

Description:

This module covers major biochemical and physiological aspects of photosynthesis, respiration, resource capture and growth at both the cell and whole plant level. Supporting practicals are designed to examine both the light and stromal reactions of photosynthesis and to investigate the role of light in seed germination and plant development. Continual assessment will be through a programme of practicals, tutorials and student presentations.

Learning outcomes:

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

- Describe how plants perceive light.
- Explain how plants use light as both a source of energy and an environmental signal.
- Describe the various pathways of photosynthesis at the level of the cell and the whole plant.
- Describe the interplay between photosynthesis and respiration in a plant cell.
- Describe the role of light in controlling germination, growth and flowering in higher plants.

- Use up-to-date methodology for measuring photosynthesis in chloroplasts and intact leaves.

Indicative reading:

Taiz, L. & Zeiger, L. (2010). *Plant Physiology.* (5th Edition). Sinauer Associates, Massachusetts. 581.1 N12*4

ZOU33010: Fundamentals of Ecology

Co-ordinator:	**Professor Ian Donohue**
Other Lecturers	Fraser Mitchell
Module Type:	Mandatory (Plant Sciences, Environmental Sciences & Zoology)
Assessment:	50% Examination, 50% Continual Assessment
ECTS:	5 credits
Prerequisites:	None
Lectures:	16 hours
Practicals:	12 hours
Field Trip	3 hours
Mini Project:	20 hours
Total	51 hours

Description:

This module examines the factors that affect the distribution, growth and survival of plant and animal communities. It describes how organisms interact with their environment and the role that they have in ecosystem and community structure. There is an introduction to the concepts and models that help to explain and predict organism distributions and interactions. The module comprises interrelated components of lectures, practical sessions and fieldwork. It has been designed to provide a foundation to ecological theory and its application.

Learning outcomes:

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

- Define what we mean by ecology and describe its principles and practice.
- Show a firm methodological and theoretical understanding of the study of the distribution and abundance of species.
- Describe and evaluate unifying concepts of distributions and ecological processes (e.g. feeding strategies, interspecific interactions, etc.).
- Show, through practical exercises, a good approach to project work.
- Show enhanced communication skills through a variety of techniques.

BOU33107: Plant Molecular Biology

Co-ordinator:	**Professor Trevor Hodkinson**
Module Type:	Mandatory (Plant Sciences)
Assessment:	50% Examination, 50% Continual Assessment

ECTS:	5 credits
Prerequisites:	None
Lectures:	16 hours
Practicals:	18 hours
Total	34 hours

Description:

Plant Molecular Biology plays a major part in most fields of botanical research including ecology, systematics and physiology. The aim of this module is to cover the fundamentals of plant molecular biology and to explore applied aspects, including molecular systematics, molecular ecology, conservation genetics and genetic engineering.

Learning outcomes:

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

- Demonstrate an understanding of the core elements within the field of Plant Molecular Biology that will enable them to build upon this knowledge and help them better understand other modules.
- Work competently in a molecular biology research laboratory. Although the module is not vocational, it provides a large amount of hands-on laboratory experience.

Indicative reading:

Avise, J.C. (1994). *Molecular Markers, Natural History and Evolution*. Chapman & Hall.

Chrispeels M.J. & Sadava D.E. (2003). *Plants, genes and crop biotechnology*. (2nd Edition). Jones and Bartlett.

Judd W.S., Campbell C.S, Kellogg E.A. & Stevens P.F. (2007). *Plant Systematics: a phylogenetic Approach.* (4th edition). Sinauer Associates, Inc. Publishers Sunderland, Massachusetts, USA.

Li, W-H. (1997). *Molecular evolution*. Sinauer Associates.

Ridley, M. (1996, 2004). *Evolution*. 3rd edition. Blackwell Science.

BOU33108: Plants and the Irish Environment

Co-ordinator:	**Professor Fraser Mitchell**
Other Lecturers:	Fraser Mitchell, Ian Donohue, Trevor Hodkinson, Jenny McElwain, Matthew Saunders, Jane Stout & Michael Williams
Module Type:	Mandatory (Plant Sciences & Environmental Sciences)
Assessment:	100% Continual Assessment
ECTS:	5 credits
Prerequisites:	None
Lectures:	4 hours
Practicals:	40 hours
Total	44 hours

Description:

This module combines an introduction to the Plant Sciences and Environmental Sciences moderatorships with a series of field-based activities including a residential field-trip during the first week of the teaching term (Week 3). There will also be a lecture given during the field trip and three following it on specific aspects of the Irish flora.

Learning outcomes:

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

- Collect and accurately record various types of data from a range of local habitats using several different methods.
- Identify native species.
- Interpret relationships between plants, and between plants and the physical environment.
- Contrast ecological sampling techniques and assess their relative merits.
- Analyse in detail the natural and cultural landscape.

BOU33109: General Botanical Science

Co-ordinator:	**Professor Matthew Saunders**
Other Lecturers:	All
Module Type:	Mandatory
Assessment:	100% Continual Assessment
ECTS:	5 credits
Prerequisites:	None
Lectures:	6 hours
Tutorials:	24 hours
Seminars:	16 hours
Essays & Exercises:	14 hours
Total	60 hours

Description:

The aim of the seminars is to introduce undergraduate students to current research topics on key issues related to the Plant Science curriculum. The aim of tutorials and workshops is to develop skills in communication and analysis of scientific information. The module is divided into a series of interactive tutorials and workshops with themes such as, essay writing, problem solving, graphics, thesis writing, journal article analysis.

Seminars: The Ecology, Evolution and the Environment seminars run throughout the academic year where invited speakers from institutes across Europe present their research. The topics of these seminars are aligned to the content of the moderatorships offered tin the School of Natural Sciences but are broad in their scope.

Tutorials: Students will have the opportunity, in small groups, to discuss the research interests of faculty members within the Botany department and to evaluate the wider literature in these areas.

Workshops: The workshops are designed to offer key transferrable skills to students and are provided by various staff members from across the university.

Learning outcomes:

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

- Demonstrate an understanding of the basics of a wide range of research issues from within and outside the Plant Science curriculum and be able to critically assess the information presented to them.
- Describe and discuss how work being carried out in Botany contributes to both national and international research activates and how these are used to address problems of global importance.
- To develop key transferrable skills.
- To appraise and critique research outputs and to communicate this work in both academic and non-academic written or oral format.

BOU33111: Angiosperm Diversity and Systematics

Co-ordinator:	**Professor John Parnell**
Other Lecturer:	Trevor Hodkinson
Module Type:	Mandatory
Assessment:	100% Continual Assessment
ECTS:	5 credits
Prerequisites:	None
Lectures:	15 hours
Practicals:	22 hours
Peer group marking:	1 hour
Presentation:	3 hours
Total	41 hours

Description:

By undertaking this module you will become acquainted with the most important group of plants on Earth – the Flowering Plants or Angiosperms. In it we discuss the origin of the Angiosperms, move on to various systems for their classification, compare and contrast molecular and morphological phylogenetic signals and discuss various large groups of Angiosperms: concentrating on those that occur in Europe.

Learning outcomes:

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

1. Describe and discuss higher plant classification, identification and evolution at family and order level worldwide.
2. Describe and discuss higher plant classification, identification and evolution at generic and specific level in Ireland.

3. Know the key characteristics of some of the most commonly encountered Angiosperms in Ireland.
4. Know about the phylogenetic signals produced by molecular and morphological data.
5. Develop team-working and team-assessment skills. Develop an in-depth knowledge of a selected plant family.

Indicative Reading:

Heywood, V.H., Brummitt, R.K., Culham, A., & Seberg, O. (2007). *Flowering Plant Families of the World*. Royal Botanic Gardens, Kew. 424 pp. S-LEN 582.13 P7;2; S-LEN 582.13 P7;3; 582.13 +P7;1

Willis, K.J. & McElwain, J.C. (2014). *The Evolution of Plants* (2nd edition). Oxford. 424 pp. Located in Botany Library

BOU33120: Environmental Dynamics

Co-ordinator:	**Professor Fraser Mitchell**
Module Type:	Mandatory (Plant Sciences), Optional (Environmental Sciences)
Assessment:	50% Examination, 50% Continual Assessment
Credits:	5
Prerequisites:	None
Lectures:	24 hours
Total	24 hours

Description:

The last 2.6 million years of Earth history have witnessed dramatic climatic and environmental changes. This module provides an overview of these major environmental changes, their causes, and their significance for human development. It contrasts 'glacial' and 'interglacial' worlds, examines the nature of the transitions between them, explores some potential causes of change, and illustrates their environmental impacts. In the process, a range of key environmental records are considered, along with the "proxies" used to develop them.

Learning Outcomes:

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

- Explain why global climates have varied dramatically over the last 2.6 million years.
- Describe the spatial and temporal variation in past climate change.
- Describe the long term impact of climate change on ecosystems.
- Describe the techniques used to reconstruct past climates.
- Describe the techniques used to reconstruct past ecosystems.
- Evaluate the contribution of climate and human activity to ecosystem dynamics.
- Relate the relevance to past ecosystem change to current and future ecosystem function.

Indicative reading:

Bradshaw, R.H.W. & Sykes, M. (2014). *Ecosystem Dynamics: From the Past to the Future.* Wiley Blackwell. 334pp. Located in Botany Library.

Roberts, N. (2014). *The Holocene. An Environmental history.* (3rd Edition). Wiley Blackwell. 376pp. Located in Botany Library.

BOU33121: Field Skills in Plant and Environmental Science (Canary Islands)

Co-ordinator:	**Professor Jane Stout** (Spring Field Course leader**)**
Other Lecturers:	Jane Stout, Trevor Hodkinson, John Parnell, Stephen Waldren, Matt Saunders & Michael Williams
Module Type:	Mandatory (Plant Sciences), Optional (Environmental Sciences)
Assessment:	100% Continual Assessment
ECTS:	5 credits
Prerequisites:	None
Lectures:	8 hours
Practicals:	8-day residential field course
Reading:	20 hours
Total	125 hours

Description:

This module combines a lecture series with a residential field trip to the Canary Islands. The Canary Islands represent very different environments to Ireland: they have different ecology, different threats and pressures. They also contain highly variable landscapes and there are lots of different types of habitats in small area. In addition, they are home to many endemic species, particularly plants, which are not found anywhere else in the world, and face many man-made environmental challenges. The lecture series explores the geography, flora and fauna of the Canary Islands, as well as the history of the islands, and the impacts that humans have and continue to have on its ecosystems.

Learning outcomes:

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

- Describe the link between environmental conditions and vegetation community composition and structure (i.e. understand why certain plants grow in different places – what morphological, physiological and ecological traits have evolved for live in particular environments and how are plants affected by human activities?).
- Sample vegetation in the field accurately and representatively in a diversity of natural and anthropogenic ecosystems (i.e. be able to design appropriate sampling according to different habitat types to make ecological assessments).
- Outline what should be in an Environmental Impact Assessment Scoping report and conduct a scoping exercise for a hypothetical development in the Canary islands.
- Design, conduct and analyse a field experiment and present the results in both written and oral format.
- Demonstrate transferrable field skills including making accurate and appropriate field notes, team work and risk assessment

There are four main aims of this module:

1. To introduce students to highly diverse subtropical island flora, with complex biogeographical composition;

2. To record the plant communities across a range of environments, differing in rainfall, altitude, degree of disturbance, etc. and to investigate the ecophysiology of the native flora over the range of habitats studied;

3. To assess the threat to biodiversity posed by human activities;

4. To develop students' knowledge of field-based plant and animal identification, and how to conduct field research. To do this, a series of 8 lectures will be given prior to going on an 8-day residential fieldcourse in Gran Canaria.

BOU33123: Soil Science

Co-ordinator:	**Professor Matthew Saunders**
Other Lecturer(s):	Jay Piggott, Paul Dowding & Gary Lanigan
Module Type:	Mandatory (Plant Sciences) Optional (All other moderatorships in the School of Natural Sciences)
Assessment:	50% Examination, 50% Continual Assessment
ECTS:	5 credits
Prerequisites:	None
Lectures:	10 hours
Tutorials:	5 hours
Practicals:	20 hours
Total	35 hours

Description:

Soils are important for plants as they provide the key resources required for growth and also essential structural support. This module will provide an overview of the fundamental concepts of soil formation and characterisation; how soil characteristics influence plant distribution and productivity through water and nutrient availability; how soil organisms (bacteria, fungi) interact with plants and how soils influence global biogeochemical cycles (carbon and nitrogen). Particular focus will be given to the role of soils in the production of food, fuel and fibre and how sustainable land management practices are required to ensure the long-term health and fertility of soil systems.

Learning outcomes:

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

- Describe the nature of soil and the terms used to describe the major physical and chemical characteristics of soil.
- Understand how soils are formed and how they are influenced by natural and anthropogenic processes.
- Compare and contrast the role of soils in plant productivity such as through plant water relations and mineral nutrition.
- Appraise the issues of sustainable soil management and the impacts of intensive land use on soil quality and fertility.

- Demonstrate an understanding of biogeochemical cycling within soil systems and the role of soils in the mitigation of climate change.

Indicative Reading:

- Foth, HD. (1990). Fundamentals of soil science. Wiley, Chichester.
- Hartlemink, AE., McBratney, AB., White, RE. (Eds) (2009). Soil Science, Earthscan, London.
- Lal, R. (2006). Encyclopedia of soil science. Taylor and Francis. Oxford.
- McLaren, RG., Cameron, KC. (1996). Soil science: sustainable production and environmental protection. Oxford University Press, Oxford.
- Weil, RR., Brady, NC. (2016). The nature and properties of soil. Pearson, London.

White, RE. (2006). Principles and practice of soil science: the soil as a natural resource. Blackwell Science, Oxford

BOU33124: Economic Botany

Co-ordinator:	**Professor Michael Williams**
Module Type:	Optional (Plant Sciences) Optional (Environmental Sciences)
Assessment:	100% CA
ECTS:	5 credits
Prerequisites:	None
Lectures:	12 hours
Tutorials:	4 hours
Practicals:	8 hours
Total	24 hours

Description:

This module represents a review of the economic importance of plants, ranging from the commercial use of algae in the food and biofuel industry, agriculturally important crops, plants as sources of pharmaceuticals to the use of non-food crops in industry. Continual assessment will be in the form of a desk-based study using FAO data on global food production, student talks on key economic crops from around the globe to practicals on brewing and tissue culture.

Learning outcomes:

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

- Understand the importance of plants in a wide range industries
- Describe the major food crops of the world and their cultivation
- Use meta-analysis to answer key questions on sustainability of food production
- Have a working knowledge of brewing and the use of botanicals in beer making
- Produce plants from callus tissue.

BOU33125: Diversity of Plant Morphology

Co-ordinator:	**Professor Jennifer McElwain**
Module Type:	Mandatory (Plant Sciences)
Assessment:	50% Examination, 50% Continual Assessment
ECTS:	5 credits

Pre-requisites: None
Lectures: 12 hours
Practicals: 21 hours
Total: 33 hours

Description:

The Earth's vegetation is replete with a diversity of plant forms from 40 meter high trees to aquatics to parasites and climbers. Different plant forms are adapted for different functions. This course aims to provide students with the basic tools necessary to understand describe and appreciate a diversity of plant form and think critically about the likely functional role of different plant structures. Students will be introduced to the morphology of land plants (embryophytes) in the context of current understanding on plant phylogeny (based on molecular data), taxonomy and systematics. Major evolutionary trends in plant form, function and life cycles will be discussed.

Learning outcomes:

- Be familiar with the phylogeny, taxonomy and systematics of land plants
- Understand basic botanical nomenclature needed to describe plant morphology and use taxonomic keys
- Be capable of identifying various plant species in the Irish flora using taxonomic keys in standard works of reference
- Describe the evolution of plant life cycles and understand the evolutionary advantages and limitations of gametophyte dominant versus sporophyte dominant strategies
- Describe the key morphological differences and similarities among all major land plants groups including bryophytes, monilophytes, lycophytes and spermatophytes (gymnosperms and angiosperms).

Interactive Reading:

Crane, P. (2013) Ginkgo. Yale University Press.
Kress W.J. and Shjerwood, S.. (2009). *The Holocene. An Environmental history.* (3rd Edition). Kew. 320pp.
Judd W.S et al. (2008) Plant Systematics. A phylogenetivc approach. Sinauer.
Simpson, M.G. (2006). *Plant Systematics.* Wiley Elsevier Acdemic Pres. 580pp. Located in Botany Library.
Also, various papers posted on blackboard

ZOU33070: Experimental Design and Analysis

Co-ordinator: **Professor Celia Holland**
Module Type: Mandatory (Plant Sciences, Environmental Sciences, Zoology & Functional Biology)
Assessment: 100% Continual Assessment
ECTS: 5 credits
Prerequisites: None
Lectures: 14 hours
Practicals: 10 hours
Workshops: 6 hours
Total 30 hours

Description:

This module will aim to put data collection and analysis in the context of research design and will be an important foundation for the Senior Sophister research project. The module consists of two parts. The emphasis will be practical with a more 'hands on' approach rather than the theory of statistics. Initially students will be taught about experimental design, data collection and sampling and the use of spreadsheets for data entry. This will lead on to preliminary data exploration and issues of normality. Emphasis will be placed upon the importance of visually exploring the data prior to the use of statistical tests. Summary statistics, including measures of centre and spread, skewness, kurtosis, percentiles and boxplots, will be covered. Then the module will move on to explore the concept of hypothesis testing and the need to compare two or more means. This will involve the use of t-tests and analysis of variance. Other types of data will also be introduced including the analysis of frequencies. The relationship between two variables in the context of regression analysis will also be explored. Finally a data set will be used to bring the entire process together starting with simple data exploration through summary statistics to more complex analyses. The aim of the second part of the module is to address, in more detail, the fundamentals of experimental design and to explore how previous projects were conducted. In addition, students will learn how to write a moderatorship project proposal.

Learning outcomes:

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

- address the fundamentals of experimental design and use hypothesis testing to answer biological questions.
- appreciate instruments for data collection, and how to explore and analyse data within the context of research design.
- code data using an Excel spreadsheet and explore these data using graphical and summary techniques.
- outline the requirements of parametric statistical tests and recognize the applicability of four such tests.
- calculate statistical tests by hand and use the statistical package R to explore and analyse data.
- write a moderatorship project proposal, design an experiment and analyse the findings of a scientific paper in a group setting.

Indicative Reading:

Ruxton, G.D. and Colegrave, N. 2011. *Experimental design for the life sciences.* (3rd edition) Oxford University Press, Oxford (ISBN 9780199569120).

Optional Modules:

BC**: Broad Curriculum**

Any of the offered BC modules may be taken as long as they can be accommodated in the timetable.

BOU33122: Entomology

Co-ordinator:	**Professor Jane Stout**
Module Type:	Optional (Plant Sciences), Optional (Environmental Sciences), Mandatory (Zoology)
Assessment:	50% Continual Assessment 50% Examination
ECTS:	5 credits
Prerequisites:	None
Lectures:	13 hours
Practicals:	12 hours
Independent Learning:	100 hours
Total	125 hours

Description:

There are more species of insects on Earth than any other group of organisms and they are of massive ecological and economic importance. This module will address behavioural, social, ecological and applied aspects of entomology, including their role in delivering ecosystem services (such as biocontrol and pollination), invasive species (such as fire ants and harlequin ladybirds) and conservation (both in Ireland and internationally). The practicals will provide students with the skills for sampling and identification of insects, which will be further enhanced through an individual project.

Learning outcomes:

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

- Categorise insects according to their key features into the main order groups; know the distinction between insects and other arthropods
- Describe some of the range of behaviours employed by insects for foraging, defending and reproducing
- Develop understanding of the role of insects in ecosystem processes and their interactions with other organisms
- Explain their value as providers of ecosystem services
- Quantify the economic importance of insects (both positive and negative) to humans
- Evaluate the conservation biology of insects at national and international levels

Indicative Reading:

Price PW, Denno RF, Eubanks MD, Finke DL, Kaplan I (2011). *Insect Ecology: Behavior, Populations and Communities*. Cambridge University Press.

SENIOR SOPHISTER MANDATORY MODULES
MANDATORY MODULES

BOU44103: Plant Conservation and Biodiversity

Co-ordinator:	**Professor Stephen Waldren**
Other Lecturers:	Trevor Hodkinson, John Parnell
Module Type:	Mandatory (Plant Sciences) Optional (Environmental Sciences)
Assessment:	50% Examination, 50% Continual Assessment
ECTS:	5 credits
Prerequisites:	None
Lectures:	16 hours
Practical Computer:	12 hours
Themed Discussions:	3 hours
Total	41 hours

Description:

Loss of biodiversity is one of the major problems facing humanity. The theoretical background to the evolution of plant diversity is firstly developed, and the principles of conservation are then used to develop approaches to conserve plant diversity. The module is taught through lectures and practical workshops.

Learning outcomes:

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

- Identify key processes that lead to the development of higher plant diversity.
- Explain how patterns of plant diversity have arisen.
- Assemble, manipulate and critically analyse experimental data related to plant diversity.
- Describe the processes that threaten plant diversity, and evaluate the degree of threat.
- Evaluate national legislation and policy related to plant diversity and its conservation.
- Evaluate global and national initiatives to conserve plant diversity.

Indicative Reading:

Cox, C.B. & Moore, P.D. (2005). *Biogeography: An Ecological and Evolutionary Approach.* Blackwell. S-LEN 574.9 P5*7;2. 498pp.

Groom, MJ, Meffe, GK & Carroll, CR. (2006). *Principles of Conservation Biology*. (3rd Edition). Sinauer Associates. S-LEN 574.5 N499*2. 498pp

BOU44105: Global Environmental Change

Co-ordinator:	**Professor Michael Williams**
Module Type:	Optional (Plant Sciences), Mandatory (Environmental Sciences)
Assessment:	50% Examination, 50% Continual Assessment
ECTS:	5 credits
Prerequisites:	None
Lectures:	21 hours
Tutorials:	2 hours
Practicals:	12 hours
Total	35 hours

Description:

The global environment is changing more rapidly at present than at any time during the human occupancy of the planet. This module reviews the existence of the changing environment and the predictions for the future.

Learning outcomes:

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

- Understand the various elements of current global environmental change and the contribution of the major drivers of these changes.
- Understand the prevailing hypotheses as to the mechanisms and ultimate causes of global environmental change and the extent to which processes operate at different temporal and spatial scales.
- Appreciate the nature of the interactions between environmental change and ecosystem processes.
- Use analytical procedures in the laboratory and field to investigate the impacts of global change.

BOU44106: Tutorials in Botany

Co-ordinator:	**Professor Matthew Saunders**
Other Lecturers:	All academic and research staff in the School of Natural Sciences, Botany and Zoology disciplines.
Module Type:	Mandatory
Assessment:	50% Examination, 50% Continual Assessment
ECTS:	5 credits
Prerequisites:	None
Lectures:	6 hours
Tutorials:	24 hours
Presentations:	10 hours
Seminars:	16 hours
Essays & Exercises	14 hours
Total	70 hours

Description:

The aim of the seminars is to introduce undergraduate students to current research topics on key issues related to the Plant Science curriculum. The aim of tutorials and workshops is to develop skills in communication and analysis of scientific information. The module is divided into a series of interactive tutorials and workshops with themes such as, essay writing, problem solving, graphics, thesis writing, journal article analysis.

Learning outcomes:

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

- Demonstrate an understanding of the basics of a wide range of research issues from within and outside the Plant Science curriculum and be able to critically assess the information presented to them.
- Describe and discuss how work being carried out in Botany contributes to both national and international research activates and how these are used to address problems of global importance.
- To develop key transferrable skills such as teamwork.
- To appraise and critique research outputs and to communicate this work in both academic and non-academic written or oral format.

Indicative Content and Learning Activities (Key Words):

Seminars: The Ecology, Evolution and the Environment seminars run throughout the academic year where invited speakers from institutes across Europe present their research. The topics of these seminars are aligned to the content of the moderatorships offered tin the School of Natural Sciences but are broad in their scope.

Tutorials: Students will have the opportunity, in small groups, to discuss the research interests of faculty members within the Botany department and to evaluate the wider literature in these areas.

Workshops: The workshops are designed to offer key transferrable skills to students and are

provided by various staff members from across the university.

BOU44108: Plant-Environment Interactions

Co-ordinator:	**Professor Matthew Saunders**
Module Type:	Mandatory (Plant Sciences), Optional (Environmental Sciences & Functional Biology)
Assessment:	50% Examination, 50% Continual Assessment
ECTS:	5 credits
Prerequisites:	None
Lectures:	15 hours
Practicals:	20 hours
Tutorials:	5 hours
Total	40 hours

Description:

Plant growth is significantly influenced by the surrounding physical, chemical and biological environment. This module will address the key inter-related concepts of carbon assimilation and sequestration, plant water relations and energy balance components across the soil-plant-atmosphere continuum. The physiological response of plants to respond to a broad range of environmental conditions including abiotic and biotic extreme events will be explored, and the implications for natural and production based systems will be assessed.

Learning outcomes:

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

- Demonstrate an understanding of how environmental factors influence the physiological performance of plants at various stages of growth and across multiple spatial and temporal scales (leaf, whole plant, and ecosystem).
- Investigate using suitable methodological approaches how to monitor and quantify the impacts of key environmental drivers on physiological processes.
- Compare and contrast how plant systems respond to eternal drivers such as future climatic variability and land-use pressures.
- Distinguish how these concepts can be implemented and utilised to address key issues in the sustainable management of land and the provision of food, fuel and fibre.

Indicative Reading:

- Hall, D.O., Scurlock, J.M.O., Bolhar-Nordenkampf, H.R., Leegood, R.C. & Long, S.P. (eds) (1993). Photosynthesis and Production in a Changing Environment - A Field and Laboratory Manual, Chapman and Hall, London.
- Jones, H.G. (2014) Plants and Microclimate - A Quantitative Approach to Environmental Plant Physiology. Cambridge University Press, Cambridge.
- Lambers, H., Chapin, F.S., Pons, T.L. (2006). Plant physiological ecology. Springer, New York, USA.

- Nobel, P.N. (2005). Physiochemical and environmental plant physiology. Elsevier Academic Press, Burlington, MA, USA.
- Taiz, L., Zeiger, E. (2010). Plant Physiology. Sinauer Associates Inc., Sunderland, Massachusetts U.S.A.

BOU44109: Vegetation Description and Analysis

Lecturer:	**Professor Stephen Waldren**
Other Lecturer(s):	Professor John Parnell, Dr Jean Wilson
Module Type	Mandatory (Plant Sciences) Optional (Environmental Sciences)
Assessment	100% Continual Assessment
Credits	5
Lectures:	7-8 Hours
Practical Computer Workshops:	18 Hours
Field Work:	20 Hours
GIS Computer Sessions	9 Hours
Total	55 Hours

Description:

This module will describe how to sample, record and lead up to detailed multivariate analyses to help define vegetation communities. Though some theoretical and historical framework will be given in lectures, the emphasis will be on practical collection, analysis and interpretation of vegetation data. Various data sets will be utilised in computer-based sessions, and field work will be used to generate a novel data set, the analysis and interpretation of which will form part of the continuous assessment for this module.

Learning Outcomes:

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

- Employ effective methods to collect vegetation data
- Understand the theory and practice of vegetation description
- Employ a variety of measures to describe plant diversity in sampled vegetation
- Use multivariate statistical techniques to develop hypotheses about vegetation communities
- Utilise remotely sensed data and GPS in the field to map vegetation communities

BOU44110: The Evolution of Plants and Plant-Atmosphere Interaction

Lecturer:	**Professor Jennifer McElwain**
Module Type:	Mandatory (Plant Sciences), Optional (Environmental Sciences)
Assessment:	70% Examination, 30% Continual Assessment
Credits:	5
Prerequisites:	None
Lectures:	15 hours (3 per week)

Tutorials: 10 hours (1 x 2hour per week)

Total 25 Hours

Description:

We are currently experiencing major changes in our climatic and atmospheric environment. Conservative estimates project that the concentration of greenhouse gas carbon dioxide will double by the end of this century and global temperatures are expected to rise by 1 to 4 degrees C. A major issue facing the scientific and political community is understanding how these projected changes will influence natural ecosystems, plant and animal ecology and biodiversity. This module will explore the evolution of plants in the context of long-term changes in climate and atmospheric composition. Examples of plant-atmosphere and plant-climate interactions in the deep geological past will be examined in addition to modern experimental studies. The course will provide a framework for understanding the nature and scale of evolution, adaptation and ecophysiological responses of plants to their atmospheric and climatic environment over the past 500 million years of Earth history. Continual assessment will be through a programme of tutorials and student reviews of primary research papers linked to lectures.

Learning outcomes:

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

- To describe plant evolution over the past 3,700 million years (with specific emphasis on land plant evolution over the past 500 million years based on the fossil plant record)
- To evaluate fossil plant responses to environmental extremes associated with mass extinction events in Earth history
- To describe how plant evolution influences the long-term carbon cycle, climate and atmospheric composition
- To understand global, regional, local and individual level plant responses to past changes in climate and atmospheric composition
- To use knowledge of plant-atmosphere responses in the deep geological past to evaluate the threat of ongoing anthropogenic global change

BOU44111: Restoration Ecology and Re-wilding

Co-ordinator: **Dr Marcus Collier**

Other Lecturers Guest Lecturers

Module Type: Optional (School of Natural Sciences)

Assessment: 100% Continual Assessment

ECTS: 5 credits

Prerequisites: None

Lectures: 15 hours

Practicals: 10 hour (field trip)

Total 25 hours

Description:

Restoration ecology, like conservation biology, is a 'crisis' discipline, having emerged as a scientific response to the ecological damage caused by human activities. Restoration ecology has many positive outcomes but has also a lot of controversy. Re-wilding and novel ecosystems are new, daring and controversial areas within restoration ecology making it difficult to know how and when to intervene. This

module will introduce you to the challenges and opportunities, failings and fallacies of the complex world of restoration ecology and the work of restoration ecologists. It will look at how re-wilding could be the best nature-based solution and how novel ecosystems could be the worst. As the discipline struggles to include social sciences, politics and economics, this module will draw on case studies of restoration globally to will challenge students to rethink ecology and ecosystems in the Anthropocene. Students will also visit an abandoned industrial landscape and look at the after-use and restoration processes.

Learning Outcomes:

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

- Understand the principals of restoration ecology as they apply in a modern context
- Comprehend the nuanced nature of restoring ecosystems and habitats as well as re-introducing species in practice
- Carry out restoration case study analysis
- Understand the complex relationship between ecology, social values and policies
- Evaluate the success of restored ecosystems and species

Indicative Reading:

Aronson, J, Milton, S.J., & Blignaut, J. Eds. (2007) *Restoring Natural Capital*. Island Press
Hobbs, R. J., Higgs, E. S. & Hall, C. M. Eds. (2013) *Novel Ecosystems*. Wiley
Marris, E. (2011) *Rambunctious Garden*. Bloomsbury
Monbiot, G.(2015) *Feral*. Penguin

FBU44000: Research Project
(20 credits – Michaelmas and Hilary Terms)

Module Personnel:	**Professor Yvonne Buckley** All Zoology & Botany Staff
Module Type:	Mandatory
Assessment:	100% Continual Assessment:

Description:

The project provides an important opportunity for students to plan and carry out a detailed and original piece of scientific research and communicate the results. It culminates in the production of a thesis and communication of the results through a poster presentation at an undergraduate research conference. Students will be assigned to a member of staff who will support an appropriate topic and will supervise the work. They will submit a research proposal before the practical work begins as part of the Junior Sophister ZOU33070 Experimental Design & Analysis module, submit a thesis and present a poster on the results. For the project, they will be expected to outline clearly a scientific problem, review the associated literature, design and execute an appropriate research programme, analyse and present the results and draw clear conclusions, **all the time recording progress in a notebook, which must be made available to the project supervisor together with original data.** Detailed guidance notes on writing and submitting the thesis and poster may be found on the FBU44000 Blackboard site.

Learning outcomes:

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

- Formulate scientific questions, apply a scientific approach to problem solving
- Plan an investigation and utilise the principles of good experimental, observational or computational design
- Conduct an in-depth scientific review of a subject
- Organise desktop, computational, field or laboratory based research including: logistics, recording, archiving, qualitative or numerical analysis and presentation and interpretation of data
- Manage a project through continuous assessment of progress and improvement of skills
- Effectively work with a team including their supervisor and other members of the research team
- Demonstrate technical competence in the handling of research facilities and operate safely in a computational, laboratory and/or field environment, both individually and as part of a team
- Present and communicate results in the form of a dissertation and presentation

Module ZOU44030: Data Handling

Co-ordinator:	**Professor Andrew Jackson**
Module Type:	Mandatory (Environmental Sciences & Plant Sciences)
Assessment:	100% Continual Assessment
ECTS:	5 credits
Prerequisites:	None
Lectures:	18 hours
Practicals:	33 hours
Total	51 hours

Description:

This module will develop hypothesis testing with a revision of t-tests and explore general linear models, using ANOVA, product-moment correlation and regression. Experimental design will also be covered using ANOVA examples. Equivalent non-parametric approaches will be described. The module will go on to cover chi-squared and goodness of fit, and end with a brief introduction to multivariate statistics with a focus on ordination and classification. The module will be delivered by lectures, demonstration and discussion sessions, and by hands on use of various software packages.

Learning outcomes:

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

- Design experiments effectively.
- Understand how various processes contribute to data variation.
- Use statistical software packages to analyse experimental data effectively.
- Apply commonly used statistical tests with discrimination and use these tests to draw valid conclusions from data.
- Present data in effective formats.
- Critically interpret and appraise commonly used methods of data analysis published in scientific literature.

FBU44060: Plant Breeding and Biotechnology

Co-ordinator:	**Professor Trevor Hodkinson**
Other Lecturer:	Professor Trevor Hodkinson
Module Type:	Optional (Plant Sciences)
Assessment:	50% Examination, 50% Continual Assessment
ECTS:	5 credits
Prerequisites:	None
Lectures:	12 hours
Practicals:	15 hours
Total	27 hours

Description:
The module covers the principles and practice of plant breeding and biotechnology. Lectures cover key topics such as the origins of agriculture, genetic resources, disease resistance, conventional breeding, modern breeding, genetic engineering, and case studies in breeding and biotechnology. Practicals cover crop diversity, polyploid estimation and at least one site visit to a Teagasc Research Centre (e.g Ashtown Dublin).

Learning outcomes:

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

- Discuss core elements within the field of plant breeding and biotechnology.
- Show laboratory skills in plant breeding.
- Demonstrate knowledge of plant breeding techniques.

Indicative Reading List:

Jones, R., Ougham, H., Thomas, H. & Waaland, S. (2012). *The Molecular Life of Plants*. Wiley-Blackwell. 766pp. Located in Botany Library.

OPTIONAL MODULES

BOU44107: Plant-Animal Interactions

Co-ordinator:	**Professor Jane Stout**
Other Lecturers:	Professor Ruth Kelly
Module Type:	Optional (Plant Sciences), Optional (Environmental Sciences & Zoology)
Assessment:	50% Examination, 50% Continual Assessment
ECTS:	5 credits
Prerequisites:	None
Lectures:	12 hours
Practicals:	9 hours
Presentation:	3 hours
Independent Study:	100 hours
Total	124 hours

Description:

In The Origin of Species (1859) Darwin emphasized that "plants and animals, most remote in the scale of nature, are bound together by a web of complex relations". Plant-animal interactions have become increasingly recognized as drivers of evolutionary change and important components of ecological communities. This module will focus on pollination (the transfer of pollen between male and female reproductive structures in flowers) and herbivory (the consumption of plants by animals). The first half of the module will focus on plant-pollinator interactions, including pollinator-mediated evolution of floral traits, community level interactions, pollinator decline and conservation. The second part of the module will focus on antagonistic interactions between plants and herbivores, and explore plant and animal adaptations to herbivory, plant-herbivore dynamics and applications of interactions to ecosystem management. Practicals will investigate floral characteristics and adaptations for pollination, pollinator networks and plant and animal adaptations to herbivory.

The aims of the module are:

1. To promote your understanding of pure and applied ecology and evolution of plant-animal interactions

2. To equip you with the basic skills for carrying out laboratory and field experiments to examine plant-animal interactions.

Learning outcomes:

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

- Synthesise and summarise aspects of the ecology and evolution of mutualistic and antagonistic plant-animal interactions, from individuals to communities, interactions between native and alien species, and applied issues.
- Carry out laboratory work investigating pollination syndromes, plant-pollinator interaction networks and plant and animal adaptations to herbivory, and analyse and interpret data collected.
- Work as a team to obtain, organise and present material on current topics in the field.

Indicative Reading List:

Herrera CM, Pellmyr O (2002). *Plant animal interactions: an evolutionary approach.* Blackwell Science, Oxford.

ZOU44017: Tropical Ecology Field Course

Lecturer:	**Professor Ian Donohue**
Other Lecturer(s):	Andrew Jackson & John Rochford
Module Type	Optional (Plant Sciences, Environmental Sciences & Zoology)
Assessment	50% Examination and 50% Continual Assessment
Credits	5
Lectures:	25 Hours
Practicals:	70 Hours
Total	95 Hours

Description:

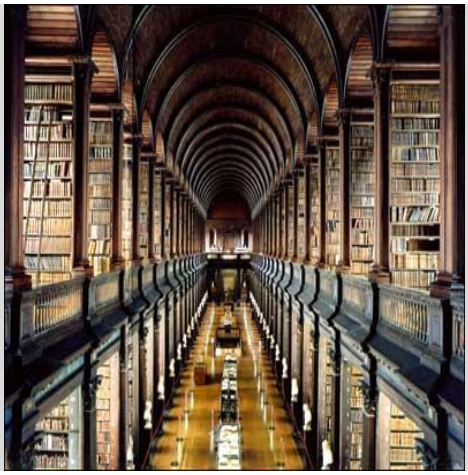
This module aims to provide students with a thorough understanding of the principles underpinning the ecology of tropical ecosystems. The module comprises a ten-day residential field course in East Africa that will run during the first two weeks of November. The course will focus on the ecology and biodiversity of a range of ecosystems and habitats (including tropical montaine forest and alpine communities, aquatic ecosystems [freshwater rivers and lakes, wetlands and saline lakes] and grasslands) and the connectivities among them. Issues and problems to do with human impacts and the conservation and management of these diverse habitats will also comprise an important element of the course.

- Quantifying biodiversity and the factors that underpin biodiversity in the tropics.
- Invasive species.
- Sustainable development of tropical ecosystems.

Learning Outcomes:

By the end of the module, typical students should be able to:

- Demonstrate holistic knowledge of East African geology, landscapes and ecosystems and the extent and nature of human interactions within them.
- Understand the principles underpinning the ecology of tropical grasslands, forests, freshwaters and alkaline waters and be able to explain these to a layperson.
- Evaluate the importance of natural background environmental fluctuations compared to those caused by human impact.
- Synthesise and reconcile the conflicting arguments for the future of each of the ecosystems visited.
- Integrate these arguments into sustainable management plans, which incorporate indigenous livelihoods.
- Design a group research project, conduct the research and analyse and synthesise results.
- Make a competent oral presentation of their research project.



EQUIPMENT

All students taking Plant Sciences or Environmental Sciences modules should acquire dissection kits for laboratory work: these must include a fine forceps (blunt forceps are of little use); also a couple of mounted needles.

All field courses participants will require:

- Weatherproof clothing (protection against soaking and/or chilling may be required at any season!).
- Stout footwear (suitable for both rough and wet terrain - mountaineering boots are the most generally suitable, but rubber boots may be preferred for wet lowlands).
- Handlens (x 10 or x 8 are the most generally useful; x 15 or x 20 are valuable for finer details, *e.g.* for bryophytes).
- Notebook (waterproof is recommended).
- Relevant plant identification books.
- Sun protection lotion.
- If you have a mobile phone it is very useful to bring that too.

FINANCE

The Department makes every effort to keep down expenditure on field courses. It is necessary, however, that students should budget appropriately. For information on financial assistance, contact: Senior Tutor's Office, No. 27, College, or your tutor.

Note:
Students will be required to pay the full amount before the start of the Field Courses.

LABORATORY AND FIELDWORK SAFETY

Legal Background

The University must exercise a "duty of care" to employees and those they supervise. This duty of care is recognised in both criminal and civil law. There is also a duty on everybody to take reasonable care for their own safety and the safety of those around them.

The Laboratory

In formal laboratory exercises you will be under supervision in a controlled environment where all reasonable safety precautions have been considered and all hazards identified. For that reason laboratory safety is reasonably taken care of provided you follow the instructions of those in control of the laboratory. However, you have a duty of care for yourselves and those who may be affected by your actions. This means that your behaviour in the laboratory must be such that you do nothing to place either yourself or other laboratory users at risk. There is only so much we can do and you have a legal obligation to follow instructions, look out for yourself and do nothing to put either yourself or others at risk.

Instrumentation in a laboratory is one area where this can be a problem. If you have never used an instrument before you will not know the potential danger it may pose. Do not interfere with any piece of equipment. You may muddle through with it but you might also cause injury to yourself or others. The staff, both academic and technical, along with the demonstrators, are available to instruct you, so always ask to be taken through the use and dangers of any piece of equipment which you have to use.

Fieldwork

Fieldwork is defined as any practical work carried out in the field by staff or students of the University for the purpose of teaching and/or research. By definition it occurs in places which are not under the control of the University, but where the University is responsible for the safety of its staff and students.

Please note: Voluntary and Leisure activities are excluded.

Outside of Voluntary and Leisure activities, the Head of Discipline has overall responsibility for health and safety in their area. They are required to ensure that the risk assessment of the fieldwork is made and to ensure that a safe system of work has been established for all staff and students. This duty is frequently delegated to the member of staff organising the fieldwork. The Head of Discipline must ensure that the fieldwork meets the safety criteria of the School, and that accidents are reported and investigated. There is a Department Safety Officer, who is responsible for day-to-day safety matters.

There is a duty on the fieldwork participants to take reasonable care for their own safety and the safety of those affected by them.

Some staff and students may be unable to carry out certain types of fieldwork due to any number of physical or medical conditions and early identification of such problems is essential.

There are a number of forms that must be completed before Laboratory or Fieldwork is begun. Please note that it is compulsory for each student to fill these forms in prior to beginning fieldwork. The forms must be returned to Discipline Safety Officer.

Relevant and suitable protective equipment must be worn. Participants must dress appropriately especially in cold and wet conditions. When the activity involves the use of boats other than registered ferries appropriate life jackets must be worn.

The School of Natural Sciences has prepared a detailed set of instructions relating to fieldwork. These will be issued prior to the first field course.

FIRE

Fire Prevention
Copies of the College General Fire Notice are displayed in the Department. Familiarise yourself with the instructions in case of fire. Individuals are responsible for checking the fire precautions in their own work areas. Any defect or potential fire hazards should be reported to the building Fire Warden.

Note the position of fire extinguishers in your working area. Familiarise yourself with the operating sequence for each extinguisher It is a criminal offence to misuse a fire extinguisher.

Before leaving offices or laboratories:-

- ensure that all litter bins do not contain any smouldering materials.
- do not leave litterbins under or near to any combustible items *e.g.* desks, tables, shelving, *etc*.
- close all filing cabinets and presses.
- switch off and unplug electrical equipment not in use.

In Case of Fire
There is a fire alarm system in the buildings controlled by Botany. If the alarm bells ring or someone shouts 'fire', all persons in the building must exit as rapidly as possible and assemble at the east end of the rugby pitch.

For emergency exit from the Old Anatomy Building laboratories, unlock the exit doors using keys stored behind glass in a key box beside the doors.

At the assembly point organise yourselves into laboratory or functional groups and the senior person present must take a roll-call. Missing persons must be reported immediately so that a search can be instituted quickly.

If possible, before exiting from the building, turn off all bunsens, electrical equipment *etc*.

CLOSE ALL WINDOWS AND DOORS IN YOUR LABORATORY AND IMMEDIATE WORK AREAS.
If possible inform the Front Gate Security Officer, emergency no. ext: 1999 or the 24 hour security no. ext: 1317, who will call the fire brigade. Then inform the Chief Steward, ext: 1144.

There is an emergency phone on the ground floor of the Botany Building for this purpose. Warn firemen of possible missing persons and potential hazards in the area of the fire – hazardous chemicals, pathogens, gas cylinders, *etc*.

BOMBS/HOAX BOMB CALLS/BOMB WARNINGS

Keep an eye out for suspicious packages at all times. If one is observed report it to the Chief Technician or another staff member. If a bomb is thought to be in the building, procedures essentially follow those employed in the case of fire except that report is made to College authorities on ext: 1999/1317 (Front Gate Security Officer & 24 hour Security) who will call the Gardai.

FIRST AID

First Aid boxes are placed in every laboratory. These boxes contain a range of dressings and bandages for treatment of minor cuts and burns. Placed on top of each box there should be an eye-wash bottle containing Sterile Saline solution. DO NOT USE AN ITEM WITHOUT SUBSEQUENTLY INFORMING A TECHNICIAN. This ensures the incident is recorded and the items used are replaced. A list of trained First Aiders is displayed on each first aid cabinet.

REPORT ANY DEFICIENCY OF THE ITEMS IN OR ON THE BOX TO THE CHIEF TECHNICIAN.

All accidents must be reported to the Safety Officer and entered in the accident book which is kept in the Chief Technician's office. An accident report form will be completed. Dangerous occurrences must also be reported on the appropriate form.

In the event of serious accident or medical emergency, quickly report it to the Chief Technician (Main Building) or the senior person present and call the Front Gate Security Officer ext: 1999/1317 who will notify the Emergency Services, or if off Campus call the ambulance service at no. 999 or 6778221 (Tara Street) if necessary. In the event of eye injuries, the victim should be taken directly to the Royal Victoria Eye & Ear Hospital, Adelaide Road. During office hours medical assistance can be obtained from the Student Health Service ext: 1556/1591.

In cases involving poisoning call the Poisons Information Centre, Beaumont Hospital no. 837 9964/ 837 9966 or contact the Pharmacology Department ext: 1563.

Familiarise yourself with the standard first aid procedures to be followed in the event of acid and alkali contact with the body, reagent ingestion, cuts, electrical shock, burns, etc.

In the field, all staff and demonstrators carry an individual first aid kit. Departmental vehicles carry a more extensive kit. Report all field injuries or illness immediately to the leader of the field trip. You must always adhere to the instructions and directions of the field-leader.

Health and safety issues for laboratory and field projects must be discussed in detail with supervisors.

SOPHISTER ASSESSMENT AND EXAMINATIONS

Assessment Dates
Junior Sophister and Senior Sophister

- Semester 1 assessment dates commence the week of Monday 10th December 2018.
- Semester 2 assessment dates commence the week of Monday 22nd April 2019 *Easter Monday Bank Holiday.

External Examiner
An external examiner, currently Professor Colin Osborne, University of Sheffield, UK, moderates the Junior and Senior Sophister examination. It is common practice for external examiners to viva some students following the completion of their final examinations. The viva timetable will be available during the examinations.

Module Assessment
Junior Sophister modules are assessed by in-course continuous assessment and/or examination. Please note that twenty per cent of the Senior Sophister overall mark is carried forward from the Junior Sophister year.

Senior Sophister modules are also assessed by in-course continuous assessment and/or examination. Your final degree classification is based on a combination of marks; continuous assessment; research project including submission of a thesis, examinations, and twenty per cent of the Senior Sophister overall mark is carried forward from the Junior Sophister year.

You should take care not to engage in plagiarism when completing exercises: for instance colluding with others to complete a word-processed practical report would be plagiarism unless approval had been sought in advance from the relevant lecturer. [see section below on College policy dealing with plagiarism.]

You must indicate on any practical write-ups the name of your Partner(s) and his/her ID number(s).

Written submitted exercises will be scanned by plagiarism-detecting software ('Blackboard'). Again you must display your own and your partner's names and IDs on any submitted work.

The penalties and procedures applied by the College are given at http://tcd-ie.libguides.com/plagiarism/levels-and-consequences
Please see below for your information, the deduction of marks for plagiarised submissions within the Discipline:

Deduction of Marks for Plagiarism

% of Plagiarism	% Marks Deducted
61% or higher	No mark, referred to Course Coordinator
51 - 60%	40%
41 - 50%	30%
31 - 40%	20%
Up to 30%	10%

Submission of Continuous Assessment Material

To avoid any misunderstandings arising in relation to submitting continuous assessments please adhere to the following points **as they are absolute**:

- Please submit your continuous assessment either electronically or by hand, as directed by the module coordinator. By hand submissions are to be put into the appropriate post-boxes in the entrance hall of the Department before 4.00pm on the day of the submission deadline.

- Electronic submissions are to be made through Blackboard**.** Please note that the Blackboard web-site rejects any submission up-loaded after 5pm. These deadlines are absolute! The only exception to this is when assessments are taken in at the end of a practical by the staff member providing the session. The Blackboard software detects the percentage of plagiarised material and marks will be deducted as a result.

- **Assessments left in staff pigeonholes, or handed to other members of staff will not be marked.**

- For late submissions there will be a deduction of 5% per day, (including weekends). Submissions received more than three days late, without a medical certificate, will not be marked. ALL LATE SUBMISSIONS MUST BE HANDED IN DIRECTLY TO THE BOTANY OFFICE TO THE EXECUTIVE OFFICER TO BE DATE STAMPED.

- Any alternative arrangements must be approved by the staff member responsible for the assessment, and the Departmental Executive Officer notified.

Please remember it is important to keep all Continuous Assessment exercises when returned to you, until the Court of Examiners has awarded your final mark.

Sophister Essay & Examination Marking Guide

Class	Mark Range	Criteria
I	**90-100**	EXCEPTIONAL ANSWER; This answer will show original thought and a sophisticated insight into the subject, and mastery of the available information on the subject. It should make compelling arguments for any case it is putting forward, and show a rounded view of all sides of the argument. In exam questions, important examples will be supported by attribution to relevant authors, and while not necessarily giving the exact date, should show an awareness of the approximate period. In essays, the referencing will be comprehensive and accurate.
	80-89	OUTSTANDING ANSWER; This answer will show frequent originality of thought and make new connections between pieces of evidence beyond those presented in lectures. There will be evidence of awareness of the background behind the subject area discussed, with evidence of deep understanding of more than one view on any debatable points. It will be written clearly in a style which is easy to follow. In exams, authors of important examples may be provided. In essays all important examples will be referenced accurately.
	70-79	INSIGHTFUL ANSWER; showing a grasp of the full relevance of all module material discussed, and will include one or two examples from wider reading to extend the arguments presented. It should show some original connections of concepts. There will be only minor errors in examples given. All arguments will be entirely logical, and well written. Referencing in exams will be sporadic but referencing should be present and accurate in essays.
II-1	**65-69**	VERY COMPREHENSIVE ANSWER; good understanding of concepts supported by broad knowledge of subject. Notable for independent synthesis of information rather than originality. Evidence of relevant reading outside lecture notes and module work. Mostly accurate and logical with appropriate examples. Occasionally a lapse in detail.
	60-64	LESS COMPREHENSIVE ANSWER; mostly confined to good recall of module work. Some independent synthesis of information or ideas. Accurate and logical within a limited scope. Some lapses in detail tolerated. Evidence of reading assigned module literature.
II-2	**55-59**	SOUND BUT INCOMPLETE ANSWER; based on module work 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. The content is sensible and relates a reasonable narrative, if limited in synthesis and sophistication. There is reasonably good citation practice and a well presented reference list in essays.
	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. Content may be disjointed and lacking good structure. Poor citation practice and reference list in essays.
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	**30-39**	MARGINAL FAIL; inadequate answer, with no substance or understanding, but with a vague knowledge relevant to the 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

Sophister Project & Thesis Marking Guide

Class	Mark Range	Criteria
I	**85-100**	Exceptional project report showing broad understanding of the project area and excellent knowledge of the relevant literature. Exemplary presentation and analysis of results, logical organisation and ability to critically evaluate and discuss results coupled with insight and originality.
	70-84	A very good project report showing evidence of wide reading, with clear presentation and thorough analysis or results and an ability to critically evaluate and discuss research findings. Clear indication of some insight and originality. A very competent and well presented report overall but falling short of excellence in each and every aspect.
II-1	**60-69**	A good project report which shows a reasonably good understanding of the problem and some knowledge of the relevant literature. Mostly sound presentation and analysis of results but with occasional lapses. Some relevant interpretation and critical evaluation of results, though somewhat limited in scope. General standard of presentation and organisation adequate to good.
II-2	**50-59**	A moderately good project report which shows some understanding of the problem but limited knowledge and appreciation of the relevant literature. Presentation, analysis and interpretation of the results at a basic level and showing little or no originality or critical evaluation. Insufficient attention to organisation and presentation of the report.
III	**40-49**	A weak project report showing only limited understanding of the problem and superficial knowledge of the relevant literature. Results presented in a confused or inappropriate manner and incomplete or erroneous analysis. Discussion and interpretation of result severely limited, including some basic misapprehensions, and lacking any originality or critical evaluation. General standard of presentation poor.
Fail	**20-39**	An unsatisfactory project containing substantial errors and omissions. Very limited understanding, or in some cases misunderstanding of the problem and very restricted and superficial appreciation of the relevant literature. Very poor, confused and, in some cases, incomplete presentation of the results and limited analysis of the results including some serious errors. Severely limited discussion and interpretation of the results revealing little or no ability to relate experimental results to the existing literature. Very poor overall standard of presentation.
Fail	**0-19**	A very poor project report containing every conceivable error and fault. Showing virtually no real understanding or appreciation of the problem and of the literature pertaining to it. Chaotic presentation of results, and in some cases incompletely presented and virtually non-existent or inappropriate or plainly wrong analysis. Discussion and interpretation seriously confused or wholly erroneous revealing basic misapprehensions.

PLAGIARISM

To ensure that you have a clear understanding of what plagiarism is, how Trinity deals with cases of plagiarism and how to avoid it, you will find a repository of information at http://tcd-ie.libguides.com/plagiarism.

We ask you to take the following steps:

(i) Visit the online resources to inform yourself about how Trinity deals with plagiarism and how you can avoid it at http://tcd-ie.libguides.com/plagiarism. You should also familiarize yourself with the 2015-16 Calendar entry on plagiarism located on this website and the sanctions which are applied.

(ii) Complete the 'Ready, Steady, Write' online tutorial on plagiarism at http://tcd-ie.libguides.com/plagiarism/ready-steady-write. Completing the tutorial is compulsory for all students.

(iii) Familiarise yourself with the declaration that you will be asked to sign when submitting course work at http://tcd-ie.libguides.com/plagiarism/declaration.

(iv) Contact your College Tutor, your Course Director, or your Lecturer if you are unsure about any aspect of plagiarism.

ETHICS

In line with Trinity College Dublin's Policy on Good Research Practice, all research in the School of Natural Sciences (SNS) should be conducted according to the overarching ethical principles of "respect for the individual subject or population, beneficence and the absence of maleficence (research should have the maximum benefit with minimal harm) and justice (all research subjects and populations should be treated fairly and equally)."

All individuals involved in research should facilitate and ensure research is conducted ethically. Ethical conduct in research is a shared responsibility. Primary responsibility rests with the Principal Investigator(s). Ethical responsibilities and legal obligations may overlap. All staff and students conducting research are required to ensure that their research is carried out in compliance with this policy. Ethical review is required before any studies involving human subjects, other living organisms and natural or man-made habitats commence. This requirement applies to staff, postgraduate and undergraduate students and volunteers/interns. Field- and laboratory work cannot commence until review has been completed and/or approval has been gained. STUDENTS PLANNING TO UNDERTAKE RESEARCH SHOULD COMPLETE THE SNS Research Ethics Application.

For further details please follow this link: www.naturalscience.tcd.ie/research/ethics

FINAL YEAR PROJECT MODERATORSHIP THESES

Aims and Objectives

The project provides an important opportunity for students to plan and carry out a detailed and original piece of scientific research and communicate the results. It culminates in the production of a thesis and communication of the results through a poster presentation at an undergraduate research conference.

Learning outcomes:

1. Formulation of scientific questions, application of a scientific approach to problem solving.
2. Planning an investigation and utilization of the principles of good experimental, observational or computational design.
3. In-depth scientific review of a subject.
4. Organisation of desktop, computational, field or laboratory based research including: logistics, recording, archiving, appropriate quantitative and/or qualitative analysis and presentation and interpretation of results.
5. Project management expertise through continuous assessment of progress and improvement of skills.
6. Effective team work with supervisor and other members of the research team.
7. Demonstrate technical competence in the handling of modern research facilities and operate safely in a laboratory, office and/or field environment, both individually and as part of a team.
8. Presentation and communication of results in the form of a dissertation and presentation.

As part of your project you are required to produce a project proposal, risk assessment and ethics form in JS year. Full details of what is expected in this plan are provided in the Junior Sophister "Experimental Design & Analysis" module ZOU33070 [Research Project]. The proposal helps you to develop important skills in summarising a research area, understanding your research objectives, and pitching your ideas to would-be funders and/or stakeholders.

Assessment of the Project

The allocation of marks for the Project is as follows:

<u>Poster presentation - 1 Credit</u>

The poster will be presented by the student verbally at a poster presentation event and marked by the supervisor and a second marker on both scientific content and the communication of the work.

<u>Thesis - 14 Credits</u>

The thesis is marked by the supervisor and a second marker. It may also be marked by a 3rd marker. The supervisor will complete a student engagement form which assesses the student's contributions to the project, the complexity and difficulty of the project and the student's engagement with the topic. The engagement form will not be marked directly but will be made available to other markers and examiners.

Role of Supervisors

The role of supervisor includes:

- Discussing the project plan and suggesting changes if necessary
- Advising on the appropriate materials and methods to use
- Offering advice on sources of information for your thesis
- Discussing problems with data collection should they arise
- Advising on issues relating to writing up your thesis
- Reading & providing guidance on one draft of your thesis

Please remember, supervisors are there to help you. You will not lose marks if you consult them on a regular basis. You should arrange to meet with your supervisor at mutually agreed times. You should make appointments to meet with your supervisor as you cannot expect them to see you whenever you call to their office. In addition, you must allow adequate time for your supervisor to read the draft you give them. Each supervisor is free to organize meetings as suits them, their students and the material to be covered. As a rule of thumb you can expect one hour per week as a group of undergraduate students with your supervisor. Prepare for these meetings carefully and make sure you ask the questions you need answered.

Planning your project

Plan your project carefully taking into account the constraints of available expertise, materials and facilities and also taking into account the risks involved and ethical considerations. A well designed study is efficient, producing sufficient data to answer the research questions/hypotheses posed using resources as effectively as possible given the constraints. Do not plan experiments/observations/analyses which are large and cumbersome and which try to solve half a dozen problems simultaneously.

Decide on the statistical treatment of your data before you start your observations, experiments, desktop study, modeling and data collection. Analysis of data from poorly designed data collection is extremely difficult. Consult your supervisor for advice with statistical analysis and refer to the modules ZOU33070 Experimental Design & Analysis and ZOU44030 Data Handling. You will not be penalised for consulting your supervisor, but you will penalise yourself if you devise inadequate data collection through lack of consultation. Do not accumulate large amounts of data in the hope that you can analyse them later. Analyse them as you go along to inform your research.

Thesis (maximum 8,000 words. References, abstract, cover page, table of contents, figure legends, tables, table legends, acknowledgements and appendices (if used) are not included in the word count)

Writing your thesis is a key part of your training as a scientist. The structure and conventions that we ask you to follow are those used in many reports for industry and by most biological science journals. The thesis must be coherently organised, clearly written, edited and carefully proof-read. Note that a long thesis is not necessarily a good thesis, you do not have to use all 8,000 words available and should present a succinct thesis while not excluding important information. A thesis longer than the word limit would indicate a lack of concise writing style and will be penalized accordingly.

You will receive guidance in thesis writing and presentation during the semester. Additional resources will be posted on the FBU44000 Blackboard site.

Poster submission, presentation & format

The presentation will be as a poster, which will be presented in a conference style format where presenters are expected to interpret their poster for markers & answer questions. The poster must be printed and brought to the poster presentation session and must also be submitted on Blackboard as a pdf by the poster submission date.

The poster will be in standard A1 format (841 x 594 mm) and you will need to arrange to have it printed in advance of the presentation date (e.g. https://www.reads.ie/product/a0-poster-printing-dublin.php). It can be useful to print the poster out (on A4, A3 etc.) to proof read it and assess the design before you send it for printing. Posters are usually printed in colour but that is at the discretion of the presenter. The poster submission and presentation will be after the thesis is submitted.

Thesis submission & format

Your thesis must be typed and must be submitted by the specified date in hard copy and electronically via Blackboard. The deadline for submission is absolute and theses handed in after the submission date will be penalized.

A pdf version of your thesis should be submitted through Blackboard by the submission deadline, time/date of submission will be determined from the Blackboard submission record. This file will be submitted through the plagiarism detection software and the plagiarism report made available to markers.

Two paper copies of the thesis (identical to the electronic copy) must be submitted to the Botany and Zoology teaching office (Zoology Building) by the submission deadline. The thesis should be printed double sided and stapled in the top left corner, there is no need to get it bound. Printing should be in black and white; colour printing should only be used for figures where colour is essential for comprehension.

Format

- Text should be typed double-sided on A4 paper, using a consistent 12 point font (e.g. Calibri, Times New Roman) and 1.5 line spacing. Convert to a pdf and proof read the pdf before submission.
- Margins should be 2 cm all round.
- All pages must be numbered.
- Please ensure you retain an electronic copy of your thesis for your own records. If there are differences between electronic and hard copies of your thesis the electronic copy will be treated as the primary source.
- The thesis must include sections (1)-(5) & (10). The thesis should normally include sections (6)-(9):

The thesis should consist of:

(1) *A **title page*** containing the following information: a concise and informative title for the project; your name; B.A. (Mod) Thesis 2016 (depending on the year); School of Natural Sciences, University of Dublin, Trinity College. See examples from theses posted on Blackboard. (not included in word count).

(2) *A **signed declaration*** stating 'I (name) declare that this thesis is my own work except where stated through references or in the Acknowledgements and that it is (number) words in

length'. (not included in word count).

(3) *An **Abstract**.* This is usually written at the very end, but comes at the beginning! The abstract should not exceed 250 words in length and should be a concise summary of the entire project. (not included in word count).

(4) ***Acknowledgements***. Note, briefly, the help you received from others. (not included in word count).

(5) ***Table of contents*** *and* ***list of figures*** should be included, together with relevant page numbers. (not included in word count).

(6) ***Introduction***. This should give background to the topic, indicating its relevance and importance and should include within the text a literature review. A critical part of this section will be in the form of a literature review – a comprehensive and critical account of what has been published on a topic and is likely to be read by a research worker in that field who wants an up-to-date statement of what is known. Essentially this review involves you finding all the potentially relevant material in its primary source, i.e. the journal or book where it was first published. You should do this using databases (e.g. Web of Science, Biological abstracts, Google Scholar) and searching/browsing relevant scientific journals.

You need to read the major articles, abstracts of more peripheral material, and to note any parts of them that are relevant to the topic. This information then has to be collated and presented in a readable and logically structured way, citing all sources of the information. Our intention is not that you should write a definitive, exhaustive review that could involve hundreds of references. The scope of the review will be limited by restricting it to a narrow topic related to your project. You should show that you are familiar with previous research associated with your project, assess this critically, and clearly indicate how it relates to your proposed work.

The aims/hypotheses and null hypotheses should be given at the end of the introduction and should flow logically from the background material presented in the literature review.

(7) ***Materials and Methods***. This should provide sufficient details to allow the work to be repeated. Where you are using already published methods, simply refer to the relevant paper(s) stating only modifications. As with all sections, sub-section headings will be useful where distinct sets of experiments or measurements were undertaken. Methods of statistical analysis should be detailed in this section.

(8) ***Results***. Present and describe your processed data, with reference to the results of appropriate statistical analysis, in tables, graphs and figures with clear legends, labels and titles. These should describe, as efficiently as possible, the results that you obtained; typically as a series of graphs, histograms, tables, as appropriate. A concise text commentating on the tables and figures is essential. Think carefully about the most effective way to present your data. Avoid large uncondensed tables (these may be put in appendices if necessary). Make sure though that evidence of statistical analysis is clear.

(9) ***Discussion***. This should highlight the significance of your findings in the context of other work (it should not repeat the results section) and should also note the limitations on your findings and alternative interpretations.

The discussion could start with a short summary of your main findings (but do not repeat the Results section, and do not refer to figures/tables in the Discussion section); as a rule of thumb each paragraph should refer to your own findings as well as those of others (published and/or unpublished. The discussion should answer the question of "so what?" – it's an opportunity for you to take a step back and comment on the general

significance of your findings; don't be tempted to draw sweeping generalizations or lofty conclusions from your work – recognize the limitations and make suggestions for what could be done in the future.

(10) ***References****.* Any points made in the text must be supported by evidence, either your results or the published findings of others. The sources are identified by citation. This has the form of only the surname of the author(s) followed by the year of publication, nothing more, *e.g.* 'Graedel and Crutzen (1993) found that ...' if the authors are the subject or object. If the citation is simply to back up a statement, then the whole citation is in parenthesis, *e.g.* 'Acclimation has been observed in wheat (Graedel and Crutzen, 1993)'. If the number of authors exceeds two, give the name of the first and follow this with *et al*. (which means 'and others'), *e.g*. 'Halverson *et al.* (1993)' rather than 'Halverson, Clayton and Handelsman (1993)'. The full references for the citations are then given in the Reference list that follows the Discussion. Full references should be of the following forms, depending on the type of publication:

Thesis:
Lensen, G.M. (1993). *Responses of C3 and C4 species from Dutch salt marshes to atmospheric CO2 enrichment*. DS thesis, Vrije Universiteit, Amsterdam. 113 pp.

***Journal Article*:**
Halverson, L.J., Clayton, M.K, and Handelsman, J. (1993). Variable stability of antibiotic-resistance markers in *Bacillus cereus* UW85 in the soybean rhizosphere in the field. *Molecular Ecology,* **2**: 65-78.

***Edited book containing a series of articles by different authors*:**
Lewis, R.L. (1992). Satellite ocean colour observations of global biogeochemical cycles. In: Falkowski, P.G. & Woodhead, A.D. (eds) *Primary Productivity and Biogeochemical Cycles in the Sea*. Plenum Press, New York, pp. 139-154.

***Book with all chapters written by the same authors*:**
Graedel, T.E. and Crutzen, P.J. (1993). *Atmospheric Change: An Earth System Perspective*. Freeman, Oxford, 446 pp.

Web page: *Ni Sheoin, Department of Botany, Trinity College Dublin, Plant systematics Flora of Thailand and surrounding countries, 5th March 2015 http://www.tcd.ie/Botany/research/systematics/florathailand.php. Visited: 27th June 2014* [Make sure that you state the authors name, title of the page, date page was created or last updated, full web address and date you visited the web page].

(11) ***Figures.*** These should be numbered consecutively and positioned within the text, close to the point of first mention. Do not crowd figures with unnecessary text or lines, or shading. Each figure must be accompanied by a legend that is placed below it (not included in the word count), and explains the figure, giving enough detail so that the figure can be understood without reference to the text. The legend should not describe the results or include any discussion.

(12) ***Tables.*** These should be numbered consecutively and positioned within the text, close to the point of first mention. Each table must be accompanied by a legend, which is placed

above it, and explains the table, giving enough detail so that the table can be understood without reference to the text (not included in the word count). The legend should not describe the results or include any discussion.

(13) ***Scientific Names.*** Please note that all species have a generic name followed by a specific name followed, in the case of plants, by the name(s) of the taxonomists involved in giving the name to them. For example, the common Primrose is called *Primula vulgaris* Huds. This name tells us that Hudson (abbreviated Huds.) was the first person to validly publish the name *Primula vulgaris*. Often the generic name is abbreviated after being given once in full (*e.g*. *Primula vulgaris* could be shortened to *P. vulgaris*). Obviously this can only be done if one hasn't mentioned any other genus beginning with a P - e.g. *Prunella*. Note that the first letter of the genus name is always a capital (upper case) while the species name is always in lower case and both are in italics. Note that the rules vary slightly for animals in that the name of the naming taxonomist is often not abbreviated and the year of publication follows the name of the taxonomist – e.g. the Giraffe - *Giraffa camelopardalis* Linnaeus, 1758 or Dyeing poison frog - *Dendrobates tinctorius* (Schneider, 1799): brackets being used where the genus has changed

(14) ***Appendices.*** Appendices are not usually necessary but can be included if agreed in advance with the supervisor. Appendices may contain any other items (*e.g.* technical details, equation derivations, *etc*) that are unnecessary in the main text. Appendices should be numbered and referred to in the main text where appropriate. Guidance from the supervisor should be sought in relation to material that is appropriate for inclusion in Appendices. Appendices are not included in word count.

(15) ***Data.*** Your data should be submitted to your supervisor separately if requested.

(16) ***Security.*** **ALWAYS** keep at least **TWO recent** back-ups of your thesis on appropriate media, such as memory sticks, hard drives and your student file storage space or other online storage. We cannot make allowances for corrupted files or lost data on submission day.

Bioavailability of Phosphorus Inputs to Lough Leane, Killarney

Your Name

B.A. (Mod) Plant Sciences Thesis 2016

School of Natural Sciences

University of Dublin

Trinity College

Supervisor: Professor Their Name

GENERAL INFORMATION

Academic Issues

If you experience any academic problems, below are some sources of assistance:

- Course Lecturer
- Course Director
- Class representatives
- Head of Discipline
- Personal tutor (or any other tutor if you cannot find yours)
- Senior Tutor
- Head of School
- Director of Teaching and Learning (Undergraduate)
- Class representatives
- Students' Union Education Officer, (01) 646 8439,
  Email: education@tcdsu.org

Personal Issues

If you experience any personal problems, below are some sources of assistance:

- Personal tutor (or any other tutor if you cannot find yours)
- Senior Tutor
- Student Counselling Service, 199/200 Pearse Street, College, Email: student-counselling@tcd.ie; (01) 896 1407
- Niteline: (Thursdays to Sundays during term only, 9pm - 2.30am) at 1800 793 793
- Student Health Service, House 47 - Medical Director: Dr David McGrath 01 896 1556; Doctor: Dr David Thomas 896 1556; Health Promotion Officer, Ms Aileen McGloin 01 896 1556; Physiotherapist: Ms Karita Cullen 01 896 1591;
- Welfare Officer, Students' Union, House 6, College (01) 646 8437, mailto: welfare@tcdsu.org
- Chaplains; House 27, College: Paddy Gleeson (Roman Catholic) 896 1260; Darren

McCallig (Church of Ireland) 01 896 1402; Julian Hamilton (Presbyterian) 896 1901; Kieran Dunne (Roman Catholic) 01 896 1260

- Disability Services, Mr Declan Treanor, Room 3055, Arts Building (01 896 3111), Email: disab@tcd.ie
- Any student, member of staff or other person with whom you feel able to discuss your problems.

Student 2 Student

From the moment you arrive in College right the way through to your end of year exams Student 2 Student (S2S) is here to make sure your first year is fun, engaging and a great foundation for the rest of your time in Trinity. You'll meet your two S2S mentors in Freshers' Week and they'll make sure you know other people in your course before your classes even start. They'll keep in regular touch with you throughout your first year and invite you to events on and off campus. They'll also give you useful information about your course and what to look out for. Mentors are students who have been through first year and know exactly what it feels like, so you never have to worry about asking them a question or talking to them about anything that's worrying you.

S2S also offers trained Peer Supporters if you want to talk confidentially to another student or just to meet a friendly face for a coffee and a chat. S2S is supported by the Senior Tutor's Office and the Student Counselling Service.

Website: http://student2student.tcd.ie

E-mail: student2student@tcd.ie

Phone: 896 2438

General Information

Central Societies Committee http://trinitysocieties.ie/

Dublin University Central Athletics Club DUCAC http://www.tcd.ie/Sport/student-sport/ducac/?nodeId=94&title=Sports_Clubs

Trinity College Students Union https://www.tcdsu.org/

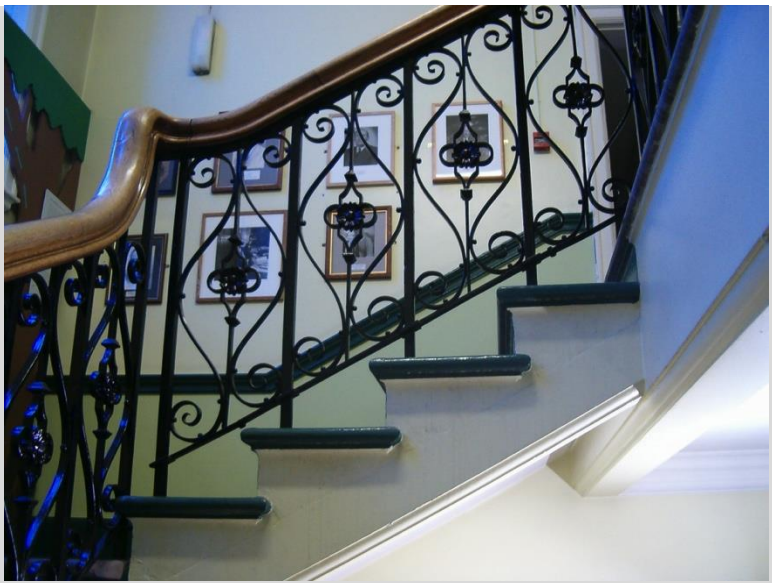
Trinity College Graduate Students Union https://www.tcdgsu.ie/

Key Locations

Academic Registry https://www.tcd.ie/academicregistry/

TCD Portal my.tcd.ie

Blackboard https://tcd.blackboard.com/webapps/login/



Departmental Office
The Executive Officers are responsible for the management of the Departmental Office. All queries regarding the Department are initially dealt with by the Executive Officers.

Chief Technician's Office
The Chief Technician is directly responsible for all the services provided by the technical staff. They are as follows:
1. Support for teaching classes and field courses.
2. Stores and purchase of consumables/equipment.

Please note:
(i) The day-to-day running of the stores is the responsibility of the Technicians. All orders sent to an outside firm or College Department must be must be placed by the Preparer using the Colleges Financial Information System with the correct code authorised by the Head of Botany or the Research Account Holder. No responsibility can be accepted for orders processed in any other manner.
(ii) *Undergraduates working on their research projects are expected to wash the glassware they use and return it to where it is stored.*
(iii) Any experimental material in laboratories or greenhouses must be removed at the conclusion of the practical work. Consult your supervisor or a technician regarding disposal.
(iv) The Departmental photocopier is available *only* for the copying of articles in Library journals and books that cannot be removed from the Department. The Departmental library is an extension of the College Library and therefore Copyright restrictions are identical.

Instrumentation

New Users
All new and potential users of equipment and instruments in the building must declare their intention of using such apparatus on the first occasion to a technician or a member of staff who will then arrange appropriate familiarisation briefings about the particular apparatus.

This requirement does not apply to organised practical classes where alternative arrangements will ordinarily be made (*i.e.* by demonstrators supervising use of instrument, *etc.*).

Booking of Instruments and Apparatus
Booking calendars are supplied with some of the instruments in the building. *Irrespective of whether you actually require to advance book an instrument or not, you must sign on to show that you were a user of that particular instrument.*

Borrowing of Equipment
No equipment may be loaned by undergraduates.

LIBRARY

The Botany Library rules *must* be adhered to. They are as follows:

(i) Books may be borrowed by:
- (a) Members of academic staff.
- (b) Research students in Botany.
- (c) Sophister students attending Plant Sciences classes.

Other members of the College may read in the Library but may not borrow books without the written permission of the departmental librarian.

(ii) Periodicals *may not* be borrowed from the library by *anyone.* Articles may be photocopied in the Library by arrangement with the relevant course lecturer or research supervisor.

(iii) Books on loan from the College library may not be borrowed, except by members of the academic staff, who may borrow them on the same terms as from the College library.

(iv) Books marked with a red seal and books on shelves K7, 8 & 9 *must not be borrowed by anyone.*

(v) Books borrowed must be entered in the loan book in an orderly and legible form.

(vi) No more than three books may be on loan to an under-graduate student at one time.

(vii) Books borrowed must be returned within *three* weeks and may not be borrowed again by the same person until three days have elapsed since their return.

(viii) Books and periodicals should be returned to their correct shelf.

(ix) Books in the Herbarium Library may be borrowed only at the discretion of the Herbarium librarian (Prof. J. Parnell). Borrowings *must* be entered into the Herbarium library loan book.

(x) Missing books or periodicals should be reported to the Librarian in writing.

(xi) *PERSISTENT OFFENDERS AGAINST THE RULES WILL BE EXCLUDED FROM THE LIBRARY.*

Please Note: The Library is used for morning coffee (11.00 - 11.30 a.m.), lunch (1 – 2p.m.) and afternoon tea (4.00 - 4.20 p.m.) by the Botany staff and research students. It is also used outside these times for meetings.

BOTANIC GARDENS

Main Function of the Garden
Support of botanical teaching and research in TCD by providing living plant material, controlled growth environments, glasshouses and other experimental facilities. The Garden also houses the Irish Rare and Threatened Plant Genebank.

Main Research of the Garden
Conservation biology, taxonomy, physiological ecology, plant response to climate change.

The garden produces an Index Seminum for exchange with other gardens, arboreta and bona fide individuals every two years.

Facilities
Four heated glasshouses, three unheated glasshouses, one poly-tunnel, walk-in controlled environment chambers, seed processing facility, deep-freeze seed genebank, low temperature growth facilities, experimental plots including open top chambers, growing beds including systematic garden and arboretum, potting shed and ancillary facilities. The diverse plant collection reflects teaching and research needs.

Director:

Professor John Parnell

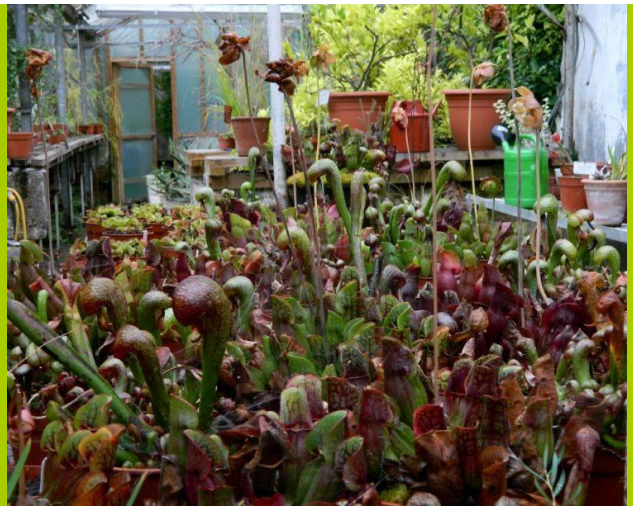
Curator/Administrator:

Professor Stephen Waldren

Ground Staff:

Mr Michael McCann
Ms Elizabeth Bird

For further information, please see the Botanic Gardens web pages at:
http://www.tcd.ie/Botany/botanic-garden/



HERBARIUM

Main Function of the Herbarium
Support of botanical teaching and research in systematics, ecology and physiology by providing a comprehensive reference collection of preserved plant material. The herbarium houses very large numbers of plant specimens from overseas including very many type specimens. It is of international importance.

Main Research of the Herbarium
Systematics of selected plant groups, especially from SE Asia, Europe and Central America.

Facilities
About 300,000 preserved plant specimens and an associated library of many thousand books and journals.

Herbarium Curator:
Professor John Parnell

Deputy Curator:
Professor Trevor Hodkinson

Curator Hepatic Collection:
Emeritus Professor Daniel Kelly

Herbarium Assistant:
Ms. Marcella Campbell

For further information, please see the Herbarium's web pages at:
http://www.tcd.ie/Botany/herbarium/about.php