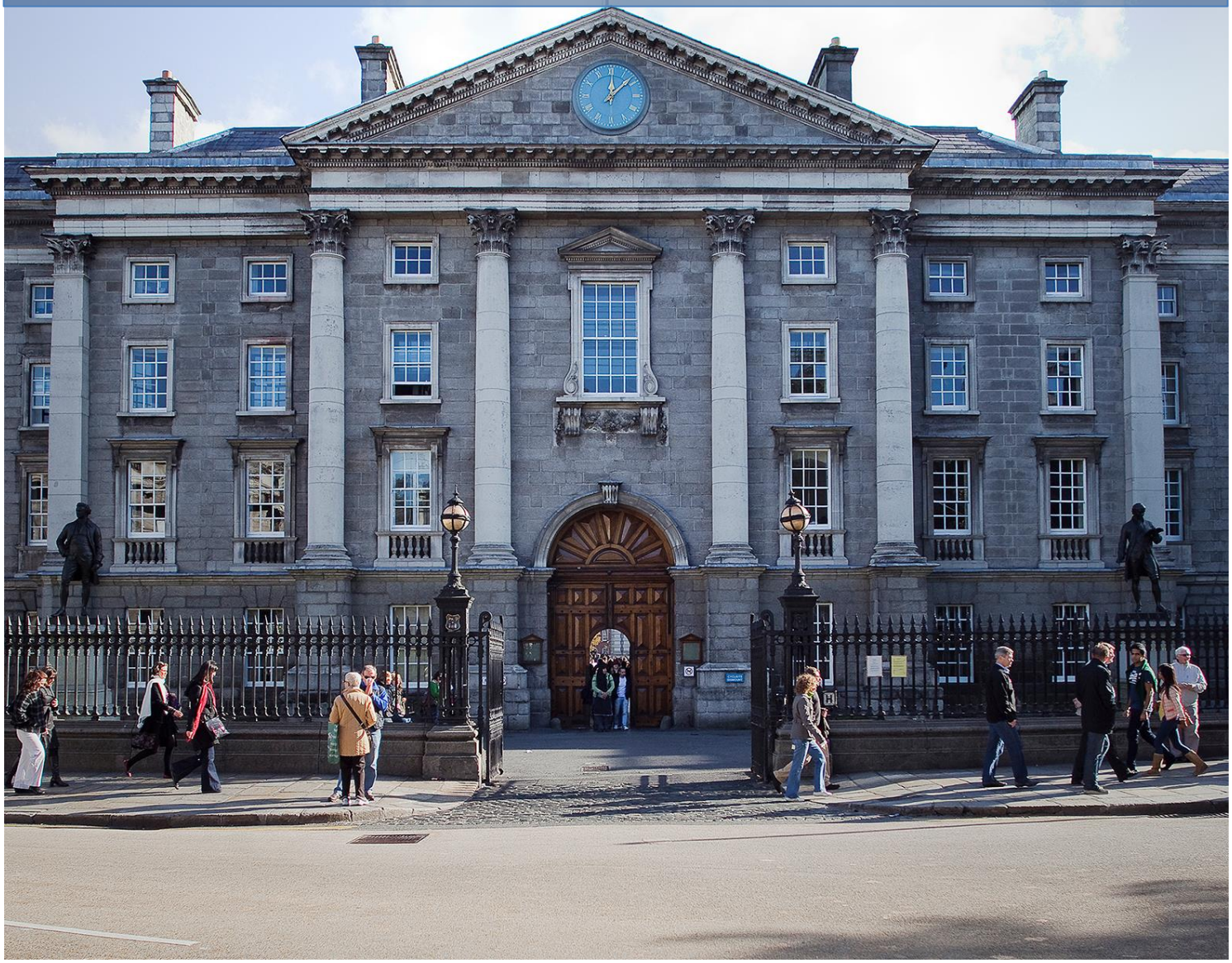
Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

Neuroscience Moderatorship

Junior Sophister Handbook

2023–2024



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INTRODUCTION

Welcome to the Neuroscience Program at Trinity College. Neuroscience is a discipline that is devoted to the scientific study of the nervous system and is at the interface between biology and psychology. It includes study of the nature and functioning of the nervous system at all levels, from the molecules that make up individual nerve cells, to the complexities of how behaviour, thoughts and emotions are produced. Neuroscience is unique in that it makes use of a variety of methods and investigations from a wide range of traditional disciplines. Understanding the functioning of the nervous system requires an integrated knowledge of anatomy, physiology, biochemistry, molecular biology, pharmacology, and psychology. Consequently, although the degree is housed within the School of Biochemistry and Immunology, the Sophister Neuroscience program is comprised of courses from all of these disciplines and is the only degree in Trinity to be taught by lecturers from all three faculties.

In the Junior Sophister year, our aim is to lay a solid foundation in the various disciplines that make up Neuroscience, but it will also begin to really delve into the integration of circuits in the brain and to examine how the brain generates behaviour. In addition, the Junior Sophister year will give you experience in data handling, biostatistics, experimental design, computing, written and oral communication skills, and interpretation and critical analysis of scientific research papers. The 'open modules' in *Cell Physiology and Pharmacology*, in *Biochemistry for Biosciences* and in *Human Neuropsychology* are essential underpinning for the core Neuroscience curriculum and these three are strongly recommended. Thus, you will be well prepared for the Senior Sophister year. **It is also important to remember that your Junior Sophister marks contribute 30% to your final degree.** The Senior Sophister year will take you deeper into some of the areas you explored in the Junior Sophister year, but also will take on new areas like glial biology, neuroimmunology and neurodegenerative & neuropsychiatric conditions, as well as undertaking a major capstone project in one of the many research labs that make up the neuroscience community in Trinity.

This *Handbook* has been prepared as a guide to the Junior Sophister year, and contains information regarding the course content, course assessment, reading lists, plagiarism and basic laboratory information. Due to the multidisciplinary nature of Neuroscience, the Junior Sophister year will be demanding and will require you to be committed to your course. Students are expected to work hard and to take responsibility for their learning. However, you should always feel free to seek advice and guidance from members of teaching staff, who may be contacted in their respective departments, or in the TCIN building.

In addition to learning within the context of formal lecture and practical sessions, I encourage co-operation with your fellow students so as you can learn from each other along the way. You should not consider helping one of your classmates as a waste of your time, but rather as revision for yourself!

I wish you every success over the next two years.

Dr Eva Jimenez-Mateos

JS Course coordinator: Dr. Eva Jimenez-Mateos jimeneze@tcd.ie

SS Course coordinator: Dr. Colm Cunningham cunninco@tcd.ie

Course Administrator: Gabrielle McCabe, email gamccabe@tcd.ie

Trinity Biomedical Sciences Institute

September 2023

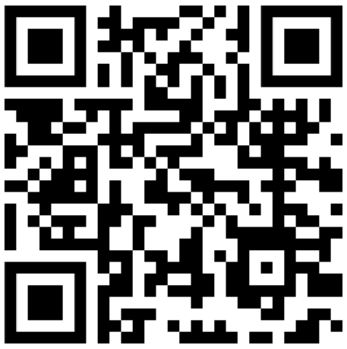
Note: The Information in this handbook is subject to change during the course of the year.

Students will be informed by email if this occurs.

Need support? Reach out to Student Counselling Service

Student Counselling Service (SCS) provides a compassionate, inclusive and student-centred service, embedding high quality social integration, academic development and mental health services.

What does SCS actually do? SCS offer free, confidential and non-judgemental support to registered students of Trinity who are experiencing personal and/or academic concerns. The SCS team of qualified counsellors and learning strategists are committed to promoting and protecting wellbeing and success throughout a diverse student body. No matter who you are, no matter what your situation is, the Student Counselling Service is here to support you through your difficulties. The SCS strive to help all Trinity students irrespective of age, disability, sexual orientation, socioeconomic background, gender identity and expression, marital or family status, religion, ethnicity or culture.



SNAP (Support & Needs Assessment Planning)
A SNAP session is a student's first meeting with SCS. During a SNAP appointment you will meet with one of our clinicians for a conversation about what you are experiencing and to identify what resources might be helpful to meet your current needs. The goal of this appointment is to get you connected with the most effective and least time/energy intensive option to get your needs met. You can get assigned an individual counsellor after a SNAP session.

Sign up for a SNAP session at student-counselling@tcd.ie

Workshops
SCS offer workshops free of charge on topics relevant to student mental health and wellbeing.

- Minding our Mental Health in College
- Managing Stress and Anxiety
- Shyness and Social Anxiety
- Self-Esteem and the Inner Critic
- How to Support a Friend Who is Struggling
- Cultivating Mindfulness and Compassion
- Building Empathy Skills
- Suicide Awareness Skills

Please email student-counselling@tcd.ie to request a workshop or talk.

Need Urgent Support?
In the event of an emergency that cannot wait, the Student Counselling Service has emergency appointments available every weekday. Email at student-counselling@tcd.ie to book in with the duty counsellor. You can also reach ***Niteline***, which is run by students at:

https://www.tcd.ie/Student_Counselling/support-services/niteline/

Additional off-campus support is available at Samaritans (www.dublinsamaritans.ie) and Peita House (http://www.pieta.ie/).

As a reminder, you can always contact your **College Tutor** for personal and academic support.

COURSE STRUCTURE

Neuroscience	
Semester 1 (S1)	**Semester 2 (S2)**
Core Modules	
BIU33485 Research Skills (5 credits)	ANU33001 Neuroanatomy (5 credit s)
BIU33465 Integrative Neuroscience (5 credits)	BIU33445 Neurochemistry I (5 credits)
	GEU33035 Genetic Analysis of the Nervous System (5 credits)
NSU33PH1 General Principles of Pharmacology (5 credits)	PGU33009: Neurophysiology I (5 credits)
	BIU33495 Nucleic Acids & Molecular Biology Techniques (5 credits)
Open Modules Scenario I	
PGU33905 Cell Physiology and Pharmacology (5 credits)	Human Neuropsychology * (5 credits) For 2023-24* PSU34830 Advances in Neurotherapy
BIU33150 Biochemistry for Biosciences (5 credits)	
Trinity Elective (5 credits)	
Open Modules Scenario II	
PGU33905 Cell Physiology and Pharmacology (5 credits)	Trinity Elective (5 credits)
BIU33150 Biochemistry for Biosciences (5 credits)	
GEU33045 Genomes and Systems Biology (5 credits)	
Open Modules Scenario III	
PGU33905 Cell Physiology and Pharmacology (5 credits)	Trinity Elective (5 credits)
BIU33150 Biochemistry for Biosciences (5 credits)	
Trinity Elective (5 credits)	

ELECTIVES

It is part of College's education strategy that all students should be given the opportunity to experience knowledge and ideas outside their main subject area as Group III courses. Elective courses consist of 5 ECT credits spread over Semester 1 or 2. Details of the Elective courses, including timetables can be found at https://www.tcd.ie/trinity-electives/electives/

Elective courses are assessed as Group III courses, i.e. they count towards the overall JS mark.

Teaching staff on the Neuroscience Moderatorship:

Teaching Staff	Contact details	School
Dr. Eva Jimenez-Mateos	jimeneze@tcd.ie	Medicine
Prof. Andrew Harkin	aharkin@tcd.ie	Pharmacy
Dr. Pablo Labrador	labradoj@tcd.ie	Genetics and Microbiology
Prof. Kevin Mitchell	kevin.mitchell@tcd.ie	Genetics and Microbiology
Prof. Andrew Bowie	agbowie@tcd.ie	Biochemistry and Immunology
Dr. Colm Cunningham	colm.cunningham@tcd.ie	Biochemistry and Immunology
Dr. Gavin Davey	gavin.davey@tcd.ie	Biochemistry and Immunology
Dr. Aisling Dunne	aidunne@tcd.ie	Biochemistry and Immunology
Dr. David Finlay	finlayd@tcd.ie	Biochemistry and Immunology
Dr. Jean Fletcher	fletchj@tcd.ie	Biochemistry and Immunology
Dr. Jerrard Hayes	jehayes@tcd.ie	Biochemistry and Immunology
Dr. Vincent Kelly	kellyvp@tcd.ie	Biochemistry and Immunology
Dr. Derek Nolan	denolan@tcd.ie	Biochemistry and Immunology
Prof. Cliona O'Farrelly	ofarrecl@tcd.ie	Biochemistry and Immunology
Dr. Tomás Ryan	tomas.ryan@tcd.ie	Biochemistry and Immunology
Dr. Daniela Zisterer	dzistrer@tcd.ie	Biochemistry and Immunology
Prof. Shane O'Mara	Shane.OMara@tcd.ie	Psychology

REQUESTING ACADEMIC REFERENCES

If a student would like to request a reference, they should send an email to make the request and provide the staff member with the following:

- details of the course, job, internship, PhD/MSc application etc. for which they are applying.
- details of the type of reference (letter, completion of section on application form etc) required and the mode of submission (upload to website, email etc).
- a copy of their current *Curriculum Vitae.*
- a copy of their personal statement or application letter where appropriate.
- a minimum of **2 weeks notice** for provision of the reference.

BIU33485: RESEARCH SKILLS

Module coordinator: Dr. Eva Jimenez-Mateos (4 Lectures, 2 Workshop, 4 Tutorials)

MODULE DESCRIPTION

The first part of the module (**data handling, statistics and experimental design**) gives an introduction to experimental design, data handling and statistical analysis of data, data interpretation and presentation. In block I and II, students will use computer software (a) to perform a range of commonly used statistical tests, (b) to graphically represent data and (c) to apply what they have learnt in problem-solving exercises. In block III, Journal Club is designed to provide students with an opportunity to read individual scientific articles and to develop the necessary skills to critically evaluate them.

MODULE DETAILS

Block 1

Lecture 1- Introduction to data representation and Interpretation. Dr Jimenez-Mateos.

Lecture 2- Data representation and Interpretation. Dr Jimenez-Mateos.

3 hours session on Computer lab (PAC room)

Block 2

Lecture 4- Quantitative and computational Neurosciences (MATLAB)- Prof. Nasseroleslami

Lecture 5- Quantitative and computational Neurosciences (MATLAB)- Prof. Nasseroleslami

Workshop- Quantitative and computational Neuroscience.

Block 3

Tutorial 1- Journal Club (2-3hr)- Dr Sarah McComish

Tutorial 2- Journal Club (2-3hr)- Dr Jimenez-Mateos

Tutorial 3- Journal Club (2-3hr)- Dr Jimenez-Mateos

Tutorial 4- Journal Club (2-3h) – Dr Jimenez Mateos

Tutorial 5- Journal Club (2-3hr)- Oral presentation (10%)- Dr Jimenez-Mateos

Reading/Learning Resources:

Primer of Biostatistics. 5th Ed. by S.A. Glantz. McGraw-Hill. ISBN 0-07-024268-2, 1997
Biomedical Research: How to plan, publish and present it. 2nd Ed. by W.F. Whimster. Springer-Verlag Berlin and Heidelberg GmbH & Co. KG. ISBN 3540198768, 1997.
Medical Statistics at a Glance. by A. Petrie and C. Sabin. Blackwell Science, Oxford. ISBN 0632050756, 2000.

LEARNING OUTCOMES

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

- critically read and interpret scientific journal papers.
- critically assess experimental design and interpretation of data.

- evaluate statistical methods.
- present scientific data via powerpoint to a scientific audience.

ASSESSMENT: All assessment for this module is in-course. **Block I** – MCQ, 30%. **Block II** – ICA, 20%. **Block III** - Oral presentation, 10%. Written exam critical analysis of scientific manuscript, 40% (Take home exam, 24hr)

BIU33465: INTEGRATIVE NEUROSCIENCE

Module coordinator: Dr. Tomás Ryan (14 lectures and 6 tutorials)

MODULE DESCRIPTION

The intention of this course is firstly to provide students with a firm grounding in the sub-fields of neuroscience that are conventionally referred to as systems neuroscience, cognitive neuroscience, and behavioral neuroscience; and secondly to introduce students to integrative frameworks for synthesizing existing neuroscience literature from different fields and for orientating to hypothesis driven and explanatory research. Students will learn how to approach any brain function (e.g. learning and memory) from a functional and evolutionary standpoint, and will apply heuristic conceptual and computational approaches for developing frameworks within which hypotheses can be developed. They will learn how such hypotheses can be tested through multi-disciplinary research projects that combine behavioral, cognitive, physiological, and molecular investigations of brain function using cutting edge experimental methods. They will learn how to assess the validity and quality of such research with the utmost skepticism. They will learn how outcomes of progressive experimental investigations can develop and refine theories that aim to explain the brain and behavior. This Junior Sophister module is designed to be comprehensive, in order to provide all students with a firm and holistic platform that can be applied to students' interpretation of other courses and/or of their own independent reading and research.

LEARNING OUTCOMES

- understand the historical origins of the scientific study of behavior in ethology and experimental psychology.
- appreciate different cognitive and computational frameworks in which to explain behavior.
- develop a working knowledge of neural circuit organization and function.
- understand the methodology and interpretation of data from widely used technology and methods of modern neuroscience research.
- understand core concepts and current topics in the neuroscience of movement.
- understand core concepts and current topics in the neuroscience of perception.
- understand core concepts and current topics in the neuroscience of emotion and motivation.
- understand core concepts and current topics in the neuroscience of learning and memory.

- understand core concepts and current topics in the neuroscience of decision making.
- understand core concepts and current topics in the neuroscience of organismic homeostasis.
- appreciate different empirical approaches to the neuroscience of consciousness.
- appreciate the role of evolutionary biology in explaining neuroscience and behavior, and have knowledge of evolutionary neuroscience and psychology.

At the end of the problem-based learning element of the course the student will:

- have developed a theory-orientated perspective for understanding cognitive and behavioral functions at multiple levels.
- be able to critically assess and integrate multiple sources from different fields and develop and synthetic framework for describing current knowledge of any neuroscience topic.
- be able to identify and articulate novel scientific questions at the frontier of systems, cognitive, and behavioral neuroscience.
- have demonstrated the ability to community the above outcomes through an extensive written essay
- have demonstrated the ability to community the above outcomes through oral presentations
- have demonstrated the ability to work in a team

ASSESSMENT: All assessment of this module is in-course. In-course assessment comprises of oral presentation following group work, essay, and examination.

NSU33PH1: GENERAL PRINCIPLES OF PHARMACOLOGY

Module coordinator: Prof. Andrew Harkin (26 Lectures; 5 Practicals; 1 revision class)

MODULE DESCRIPTION

Targets of drug action; receptor pharmacology and cell signalling; pharmacodynamics (drug action, agonism and antagonism; specificity and side-effects); Dose-response; basic pharmacokinetics (drug absorption, distribution, metabolism and excretion); general ANS pharmacology - sympathetic and para-sympathetic nervous transmission; cholinergic drugs, anticholinesterases; direct and indirect acting sympathomimetics; non-adrenergic and non-cholinergic transmitters; neuromuscular transmission and neuromuscular blocking agents; central neurotransmission and the biochemical basis of neuropharmacology; excitatory and inhibitory transmitters; neuromodulatory transmitters: biogenic amines and acetylcholine; application of basic principles in selected examples of drug use; overview of drug development and testing. ***Practical classes include***: 1 Drug targets and receptor transduction - computer simulated programme with assignment, 2. Dose response in the Guinea Pig Ileum preparation: agonists - computer simulated experiments and data analysis with assignment , 3. Water Maze – computer simulated programme with data analysis and

assignment, 4. Basic Pharmacokinetics, computer simulated programme with data analysis and assignment, 5. Drug development and testing – clinical trials; computer simulated programme with assignment.

LEARNING OUTCOMES

On completion of this course the student will be able to:

- state the variety of targets to which drugs bind in the body and illustrate their transduction and cell signalling mechanisms.
- define agonist (full, partial and inverse), antagonist (competitive and non-competitive) and recall selected examples of each.
- describe receptor binding experiments and define the receptor binding parameters B_{MAX} and K_D.
- to construct dose response curves and calculate drug potency of both agonists and antagonists.
- to illustrate the principles of drug absorption, distribution, metabolism and excretion and define the terms, pKa, bioavailability, volume of distribution, clearance, half-life and Kel.
- to illustrate the organisation and mode of neurotransmission within the sympathetic, para sympathetic, enteric and somatic nervous systems.
- to recall the mechanisms of action and clinical uses of cholinergic and adrenergic drugs within the peripheral nervous system.
- to define the key steps associated with excitatory and inhibitory neurotransmission in the brain and provide selected examples of drugs which influence these steps.
- to report on the various stages of drug discovery, development and the clinical trials process.

ASSESSMENT: Examination (60%) & in-course assessment (40%).

Reading/Learning Resources:

Rang and Dale's Pharmacology (9th Ed.) by James Ritter Rod Flower Graeme Henderson Yoon Kong Loke David MacEwan Humphrey Rang. Elsevier (2020)
Brody's Human Pharmacology. Mechanism-Based Therapeutics (6th Ed.) by Lynn Wecker Elsevier (2018)
The Biochemical Basis of Neuropharmacology. (8th Ed) by J.R. Cooper, F.E. Bloom and R.H. Roth. (2003) Oxford University Press. ISBN 0-19-514008-7.

PGU33009: NEUROPHYSIOLOGY I

Module coordinator: Dr Eva Jimenez-Mateos (23 lectures; 4 Practicals)

MODULE DESCRIPTION

The lectures in this module focus on how the nervous system works. Lectures will describe the structure and function of neurons, how they communicate and how they are arranged to form the nervous system. Topics include electrical properties of neurons, properties and physiological functions of ion channels, synaptic excitability, transmission and plasticity and the delivery and interpretation of sensory information into the central nervous system. Part of the course is also devoted to describing methods to record both cellular and brain activity. Practical classes focus on computer-simulated recordings of individual nerves to understand features of neuronal activity, recording brain function via electroencephalogram and sensory-evoked potentials. This module is designed to provide understanding of how the brain functions at a cellular and systems level.

DETAILS OF THE MODULE

Semester 1

Lectures:
Membrane excitability
Neurophysiology I
Neurophysiology II
Somatic Sense Organs
Proprioception, Taste and Olfaction
Hearing and Equilibrium

Practicals:
Nerve stimulation
Electroencephalogram
Visual Evoked Potentials
Receptor modulation

Semester 2

Lectures:
1. Neurotransmitters, ion channels and synaptic transmission I
2. Neurotransmitters, ion channels and synaptic transmission II
3. Neurotransmitters, ion channels and synaptic transmission III
4. Magnetic resonance Imaging
5. Electroencephalogram
6. Neurophysiology of Sleep
7. Somatosensation
8. Nociception
9. Visual System I
10. Visual System II
11. Visual System III
12. Motor System – primary motor areas
13. Motor System – Basal ganglia
14. Motor System – cerebellum
15. Electrophysiological techniques
16. Learning and memory
17. Reward circuits and addiction

LEARNING OUTCOMES

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

- describe the neurophysiological activity of peripheral and central neurons involved in sensory information processing.
- define the physiological roles of the brain regions and pathways involved in the planning, initiation and control of movement.

- identify the brain activity patterns associated with distinct sleep states and describe the neurophysiological basis of sleep and wakefulness.
- relate cellular and synaptic neuronal activity to the coordinated brain oscillations recorded by electroencephalography (EEG).
- interpret neurophysiological activity recorded using in vitro and in vivo electrophysiological techniques and recognise the clinical uses of neurophysiological recordings including EEG and sensory-evoked potentials.
- relate how synaptic plasticity at cellular and network levels underlies long-term alterations in behaviour associated with learning and memory, addiction.

ASSESSMENT: Laboratory reports & in-class test (30%) and Examination (70%).

ANU33001: NEUROANATOMY

*Module coordinator: Dr. Daniel Johnston (*18 Lectures; 1 Lab. introduction; 7 practical sessions)

LEARNING OUTCOMES

Neuroanatomy is the anatomic study of the CNS and PNS, with emphasis on pathways and nuclei associated with sensory input integration and motor output. This module will combine theoretical learning with cadaveric brain inspection and on successful completion you will be expected to:

- recognize and describe the major subdivisions and anatomic features of the central nervous system (CNS), including the cerebral hemispheres, brainstem, cerebellum, and spinal cord.
- describe the ventricular system and the production, circulation, absorption, and function of the cerebrospinal fluid.
- name the major vessels visible and outline the blood supply of the CNS.
- identify CNS structures associated with major sensory and motor systems, their connections, and outline their pathways outside the CNS.
- locate and functionally describe the nuclei and pathways associated with the special senses.
- name and classify the cranial nerves and list their major connections.
- list the deeper cortical nuclei associated with the limbic system and basal ganglia and their function where known.
- apply anatomical knowledge to explain the normal function of CNS regions in activities of daily life.
- use anatomical knowledge to explain the pathogenesis and natural history of common clinical disorders of the CNS.

ASSESSMENT: Examination (50% multiple choice questions) AND Practical Examination, comprising 40%, end of module, and 10%, in course continuous assessment, (after practical 3) (totally 50%).

Please note that the neuroanatomy practical examination is usually held outside of Semester 2 term prior to the annual examination period.

Reading/Learning Resources:

Clinical Neuroanatomy and related Neuroscience: FitzGerald and Folan-Curran: W B Saunders
Very detailed and integrates neuroanatomy, neurophysiology, neuropharmacology and clinical considerations.

Grays anatomy for students. Drake, Vogel, Mitchel.
Excellent textbook with detailed schematic and clear explanatory text.

Blackboard
This contains all announcements relating to curricular content, explanatory videos, sample questions, lectures slides and practical manuals and the Wiegert's presentation.

BIU33495: NUCLEIC ACIDS & MOLECULAR BIOLOGY TECHNIQUES

Module personal: Daniela Zisterer, Marcin Baran, Fred Sheedy, David Finlay, Colm Cunningham, David Loane

(17 Lectures; 2 practical (15 contact hours))

MODULE DESCRIPTOR

This module covers the structure and function of nucleic acids in a eukaryotic context. The basis of gene transcriptional regulation and mRNA translation are described at a mechanistic and structural level in addition to the processes involved in DNA replication and repair. The lectures of this module (17h) are accompanied by a set of practical sessions (15 contact hours) that include (i) pKA and preparation of buffers and (ii) analysis of plasmid DNA, digestion and cloning, transformation and selection of bacteria; laboratory and tutorial sessions.

Learning Outcomes:

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

- Recall and integrate key knowledge and concepts about DNA structure, function and process and assess the importance of DNA replication.
- Describe the molecular and structural features of transcription initiation, transfer RNA charging and ribosomal translation.
- Recall and integrate key knowledge and concepts about how gene expression is regulated and demonstrate an understanding of the processes and importance of transcription and translation.
- Relate the theory behind techniques used in recombinant DNA technology and evaluate how these techniques can be applied to biological problems.
- Understand the different types of DNA damage, how they occur and implications for genome stability.
- Exhibit knowledge of the signal transduction pathways that sense DNA damage and the different repair pathways that exist to deal with the range of types of DNA damage.

Recommended Reading List:
A reading list will be given out by lecturers during the module.

Assessment Details:

80% End of year examination, 20% in-course assessed.

In course assessment: Pre- and post-practical homework assignments (20% of course)

BIU33445: NEUROCHEMISTRY I

*Module coordinator: Prof. Gavin Davey (*12 Lectures; 5 practical sessions)

MODULE DESCRIPTOR

This module focuses on chemical transmission between neurons, how neurotransmitters are classified and identified and describes typical and atypical neurotransmitters and their functions in the brain. Practical classes are devoted to the following topics: subcellular fractionation of brain tissue, assessment of protein expression in brain tissue, assessment of enzyme markers, measurement of neurotransmitters, analysis of brain lipids, neurotransmitter receptor binding.

Learning Outcomes:

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

- Describe the cell types in the brain and common techniques that enable chemicals with neurotransmitter-like properties to be identified
- Understand the criteria that need to be satisfied in order for a chemical to be classified as a neurotransmitter
- Develop a knowledge of the biogenic amines (acetylcholine, dopamine, noradrenaline, adrenaline, serotonin) and the properties that allow them to be classified as neurotransmitters
- Develop a knowledge of glutamate and GABA and the properties that allow them to be classified as neurotransmitters
- Develop a knowledge of atypical neurotransmitters (NO, CO, D-serine, neuropeptides, purines) and the properties that allow them to be classified as neurotransmitters
- Develop a knowledge of how dysfunctional neurotransmitter systems give rise to common brain disorders
- Set up and manage standard laboratory equipment correctly, safely and in the appropriate context.
- Outline the theory behind the techniques used in practical classes.
- Construct a clear scientific record of experiments and the data generated in experiments in a laboratory notebook and critically assess the data.
- Explain the importance of experimental controls and multiple determinations.
- Work independently and in a team and exercise initiative and personal responsibility.

- Participate in group discussions with peers and with teachers. Select and apply appropriate statistical tests to their own experimental data and evaluate the results of these tests.

Recommended Reading List:

Basic Neurochemistry (Siegal, Albers, Brady, Price) Academic Press, 7th Edition. (6th Edition is online free at https://www.ncbi.nlm.nih.gov/books/NBK20385/?term=basic%20neurochemistry)

Principles of Neural Science by Eric Kandel , James Schwartz , Thomas Jessell , Steven Siegelbaum , A.J. Hudspeth

Assessment Details: Examination (80%); Laboratory practicals (20%).

GEU33035: GENETIC ANALYSIS OF THE NERVOUS SYSTEM

*Module coordinator: Dr Juan Pablo Labrador (*19 Lectures; 3 tutorials)

MODULE DESCRIPTOR

The module is focused on understanding how experimental genetics are used to manipulate genes in organisms to address problems in biology. Areas covered are 1) Experimental Genetics: structure and conservation of genes, nature of mutations and their effects on protein structure and function, model organisms in genetic research and experimental manipulation of animal genomes. 2) Developmental Neurogenetics: the purpose and design of genetic screens, genetic analysis of neurogenesis and genetic analysis of axon guidance 3) Behavioural Genetics: cell organization and methods of cell biology, cell biology of neurons and synapses, creation and use of molecular reporters of specific gene or cell activity, methods to study nervous systems, sensory circuits, sensation; transduction; perception; coding; behaviour, learning and memory, sleep and circadian rhythms.

Learning Outcomes

Upon successful completion of this module, students will be able to understand and describe how model organisms are used in genetic research and common technologies and methods employed to genetically modify organisms. Students should also understand the basis of genetic screens and mapping. They will be able to explain epistasis through the analysis of different genetic interactions in neurogenesis and axon guidance. Students will become familiar with the cell biology of neurons and synapse as well as methods to probe synaptic activity. Students will also learn about circuitry underlying perception.

Recommended Reading List: Anthony J.F. Griffiths; Susan R. Wessler; Sean B. Carroll; John Doebley. Introduction To Genetic Analysis. New York, NY :W.H. Freeman & Company, 2015

Assessment Details: Final exam/or assignment

Open Modules

PGU33905: CELL PHYSIOLOGY AND PHARMACOLOTY

Credit Value (S1)

Module coordinator: Dr T Boto

The lectures in this module focus on (i) membrane structure, proteins and properties; (ii) receptors and neurotransmitters, (iii) the principles of drug action, drug development and drug targets. The module is designed to consider the structure of the membrane, the changes that occur in the membrane under different biological circumstances using age as an example, and role of membrane proteins. Cell functions, for example, the control of intracellular calcium by cells and transmitter release will be considered in the context of the membrane proteins that impact on these functions. There is a problem-based learning element to this course that will be a team-based exercise. An overall theme will be chosen and groups of 3 or 4 students will be assigned specific aspects of the theme. The objective is to undertake research on the theme and prepare a presentation that is cohesive across the topic. Each team member will contribute to the presentation.

BIU33150: BIOCHEMISTRY FOR BIOSCIENCES

Module personnel: Profs A Kahn, K Mok, M Caffery, D Nolan and A Dunne.

This module follows on from the biochemistry/cell biology component of the “Molecules to Cells” BIU22201 module of year 2. The aim is to provide Junior Sophister students of other disciplines with the grounding in biochemistry necessary to (i) understand biology at a molecular level, (ii) form a mechanistic view of biological processes and (iii) appreciate the pathobiochemical basis of disease. The topics covered will include: the biochemistry of protein structure, enzymes and their role in metabolism, membranes and transport, signalling and the cytoskeleton and related cell biology. The module will be assessed through a combination of in course assessment and an individual end of term exam.

PSU34830: Advances in Neurotherapy: From Molecules to Prosthetics for Neuropsychiatric & Neurological Disorders

Module personnel: TBC

Academic Matters

1. Attendance

All students are expected to attend lectures, workshops, practical classes, in-course assessments and examinations. Scheduled classes play an important role in supporting progress through the academic year in particular course assignment work. Students are therefore expected to keep up a consistent rate of good attendance so that performance later in the year will not be adversely affected. In the event of not being able to attend classes due to illness, **please inform the Course Advisor.** Medical certificates are required for absences of more than a few days OR if the absence means a deadline or an assessment will be missed. Details of medical certificates and other personal information will be treated confidentially. Students who miss classes are responsible for updating themselves on any information provided during those classes.

The Department operates the College procedure in relation to 'Non-satisfactory attendance and course work' (Calendar). That is, any student who misses more than a third of a course in any term or fails to complete assignments may be declared 'non-satisfactory'. Non-satisfactory returns are made to the Senior Lecturer; such students may be refused permission to take the annual examination and may be required by the Senior Lecturer to repeat the year.

> *'Extract from University of Dublin Calendar 2012-13, General Regulations, page H6.*
>
> *Non-satisfactory attendance and course work*
>
> *§24 All students must fulfil the requirements of the school or department, as appropriate, with regard to attendance and course work. Where specific requirements are not stated, students may be deemed non-satisfactory if they miss more than a third of their course of study or fail to submit a third of the required course work in any term.*
>
> *§25 At the end of the teaching term, students who have not satisfied the school or department requirements, as set out in §§18, 22 and 23 above, may be reported as non-satisfactory for that term. Students reported as non-satisfactory for the Michaelmas and Hilary terms of a given year may be refused permission to take their annual examinations and may be required by the Senior Lecturer to repeat their year.'*

Please see https://www.tcd.ie/undergraduate-studies/academic-progress/attendance-course-work.php for regulations regarding student attendance.

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

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

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

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

2. Assessment and examinations

Courses are assessed by in-course assessment and/or by examination. Your grade at the end of the Junior Sophister year is compiled from the results of annual examinations and continuous assessment marks for the year. Ten marks are allocated per ECTS credit, towards the possible 600 marks for Junior Sophister year. Please note that, as per College Calendar, **student attendance at all examinations is mandatory**. Should a student miss an exam (without medical cert or appropriate supporting documentation submitted to College Tutor and Student Cases) they will be returned as '*ABSENT NO PERMISSION*' which results in automatic exclusion from college. Please see https://www.tcd.ie/Senior_Tutor/faq/ for further information regarding college regulations.

Please note that examination timetables are compiled by Academic Registry/Exams Office and all examination information is made available to students via **my.tcd.ie**. Course advisors and administrative staff **cannot** provide details of examination dates and venues.

Below are the exam paper structures for each module based on previous years. Please note that these may be subject to change and are **given as a guideline only**. Each module coordinator will provide definitive information about exam paper structure.

Exam	Question style	Format
ANU33001 Neuroanatomy	Short answer and multiple choice questions	Answer all questions
BIU33495 Nucleic Acids & Molecular Biology Techniques	3 essay questions	1 question each from Section I, II and III; choice of 2 questions per Section
BIU33445 Neurochemistry I	2 essay questions	1 question each from Section I, and II; choice of 2 questions per Section
BIU33465 Integrative Neuroscience	All in-course assessed	
GEU33035 Genetic Analysis of the Nervous System	Final exam	
NSU33PH1 General Principles of Pharmacology	2 essay questions	Choice of 3 questions
PGU33009	3 essay questions	Choice 2 questions from 3

In-Course Assessment

The nature of the assessments will vary from one course to another. Individual members of teaching staff will give more details of assessment procedures at the beginning of each module. Students are encouraged to develop their word-processing skills and computer skills in general in the Junior Sophister year.

Submission deadlines

For each item of course work there will be a submission deadline. Meeting deadlines is regarded as an important part of the course and is valued by employers. Apart from maintaining equity between students, deadlines enable students to demonstrate their ability to schedule their work properly. Students are expected to meet all deadlines. **A case for special circumstances may be made via the College Tutor. Extension of deadlines will only be given in exceptional circumstances.**

Word limitations

All course assessments must comply with the stated word limit (± 10%). Students are required to write the number of words at the end of the assessment. Students may exceed the word limit only by 10%, e.g. if the word limit is 2,500 words, a word count of 2,750 will be accepted.

Class Descriptors: These Science Faculty Descriptors are given as a guide to the qualities that assessors are seeking in relation to the grades usually awarded. A grade is the anticipated degree class based on consistent performance at the level indicated by an individual answer. In addition to the criteria, listed the Department's examiners will also give credit for evidence of critical discussion of facts or evidence.

Guidelines on Grades for Sophisters' Essays and Examination Answers

Class	Range	Criteria
I	90-100	IDEAL ANSWER; showing insight and originality and wide knowledge. Logical, accurate and concise presentation. Evidence of reading and thought beyond course content. Contains particularly apt examples. Links materials from lectures, practicals and seminars where appropriate.
	80-89	OUTSTANDING ANSWER; falls short of the 'ideal' answer either on aspects of presentation or on evidence of reading and thought beyond the course. Examples, layout and details are all sound.
	70-79	MAINLY OUTSTANDING ANSWER; falls short on presentation and reading or thought beyond the course, but retains insight and originality typical of first class work.
II-1	65-69	VERY COMPREHENSIVE ANSWER; good understanding of concepts supported by broad knowledge of subject. Notable for synthesis of information rather than originality. Sometimes with evidence of outside reading. Mostly accurate and logical with appropriate examples. Occasionally a lapse in detail.
	60-64	LESS COMPREHENSIVE ANSWER; mostly confined to good recall of coursework. Some synthesis of information or ideas. Accurate and logical within a limited scope. Some lapses in detail tolerated.
II-2	55-59	SOUND BUT INCOMPLETE ANSWER; based on coursework alone but suffers from a significant omission, error or misunderstanding. Usually lacks synthesis of information or ideas. Mainly logical and accurate within its limited scope and with lapses in detail.
	50-54	INCOMPLETE ANSWER; suffers from significant omissions, errors and misunderstandings, but still with understanding of main concepts and showing sound knowledge. Several lapses in detail.
III	45-49	WEAK ANSWER; limited understanding and knowledge of subject. Serious omissions, errors and misunderstandings, so that answer is no more than adequate.
	40-44	VERY WEAK ANSWER; a poor answer, lacking substance but giving some relevant information. Information given may not be in context or well explained, but will contain passages and words which indicate a marginally adequate understanding.
F-1	35-39	MARGINAL FAIL; inadequate answer, with no substance or understanding, but with a vague knowledge relevant to the question.
F-2	30-34	CLEAR FAILURE; some attempt made to write something relevant to the question. Errors serious but not absurd. Could also be a sound answer to the misinterpretation of a question.
F-3	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.

3. Plagiarism

Each student is responsible for ensuring that their work is actually the result of his/her own efforts, skills and knowledge, and has not been produced by means that will give an unfair advantage over other students. You are urged to read very carefully the following extract from the College Calendar 2006/07 on plagiarism — the improper use of others' work. Plagiarism is a very serious offence and is against the spirit of proper academic and scientific enquiry. The risk of inadvertent plagiarism is greater in Sophister years because of the increasing use of primary sources (research papers). It is therefore essential to develop good practice immediately.

§53 Plagiarism is interpreted by the University as the act of presenting the work of others as one's own work, without acknowledgement.

Plagiarism is considered as academically fraudulent, and an offence against University discipline. The University considers plagiarism to be a major offence, and subject to the disciplinary procedures of the University.

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

Plagiarism can arise from actions such as:

(a) copying another student's work;

(b) enlisting another person or persons to complete an assignment on the student's behalf.

(c) quoting directly, without acknowledgement, from books, articles or other sources, either in printed, recorded or electronic format;

(d) paraphrasing, without acknowledgement, the writings of other authors.

Examples (c) and (d) in particular can arise through careless thinking and/or methodology where students:

(i) fail to distinguish between their own ideas and those of others.

(ii) fail to take proper notes during preliminary research and therefore lose track of the sources from which the notes were drawn;

(iii) fail to distinguish between information which needs no acknowledgement because it is firmly in the public domain, and information which might be widely known, but which nevertheless requires some sort of acknowledgement;

(iv) come across a distinctive methodology or idea and fail to record its source.

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

Students should submit work done in co-operation with other students only when it is done with the full knowledge and permission of the lecturer concerned. Without this, work submitted which is the product of collusion with other students may be considered to be plagiarism.

§55 It is clearly understood that all members of the academic community use and build on the work of others. It is commonly accepted also, however, that we build on the work of others in an open and explicit manner, and with due acknowledgement. Many cases of plagiarism that arise could be avoided by following some simple guidelines:

(i) Any material used in a piece of work, of any form, that is not the original thought of the author should be fully referenced in the work and attributed to its source. The material should either be quoted directly or paraphrased. Either way, an explicit citation of the work referred to should be provided, in the text, in a footnote, or both. Not to do so is to commit plagiarism.

(ii) When taking notes from any source it is very important to record the precise words or ideas that are being used and their precise sources.

(iii) While the Internet often offers a wider range of possibilities for researching particular themes, it also requires particular attention to be paid to the distinction between one's own work and the work of others. Particular care should be taken to keep track of the source of the electronic information obtained from the Internet or other electronic sources and ensure that it is explicitly and correctly acknowledged.

§56 It is the responsibility of the author of any work to ensure that he/she does not commit plagiarism.

§57 Students should ensure the integrity of their work by seeking advice from their lecturers, tutor or supervisor on avoiding plagiarism. All departments should include, in their handbooks or other literature given to students, advice on the appropriate methodology for the kind of work that students will be expected to undertake.

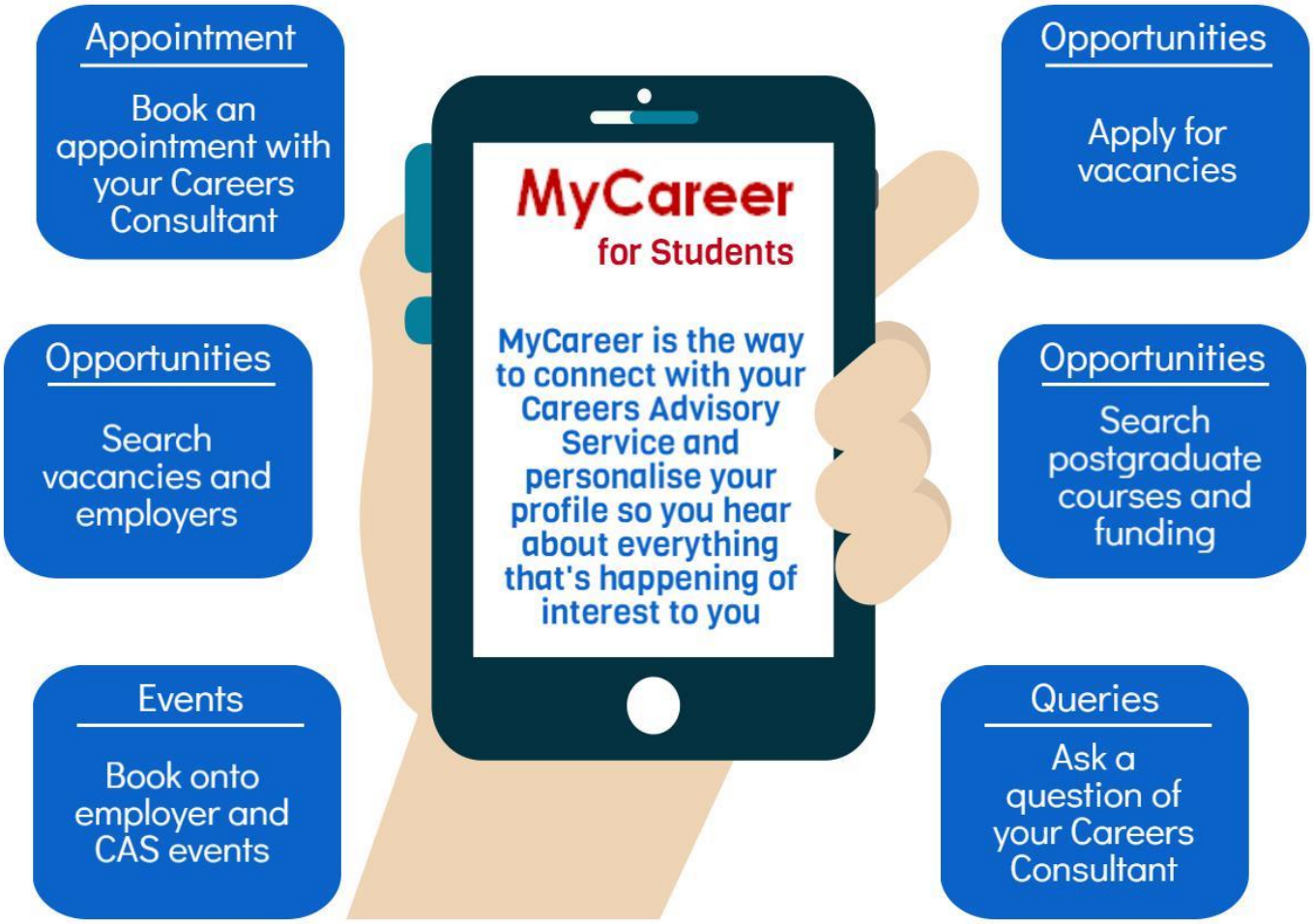
§58 If plagiarism as referred to in §34 above is suspected, the Head of Department will arrange an informal meeting with the student, the student's tutor*, and the lecturer concerned, to put their suspicions to the student and give the student the opportunity to respond.

§59 If the Head of Department forms the view that plagiarism has taken place, he/she must notify the Senior Lecturer in writing of the facts of the case and suggested remedies, who will then advise the Junior Dean. The Junior Dean will interview the student if the facts of the case are in dispute. Whether or not the facts of the case are in dispute, the Junior Dean may implement the procedures set out in Conduct and College Regulations §2.

*As an alternative, students nominate a representative from the Students' Union to accompany them to the meeting.

Student Feedback

From time to time you may be asked to evaluate parts of the course. Your comments on all aspects of the Neuroscience program are welcome and will be treated in confidence. Student feedback is extremely important, particularly in the early years of a new course, as it provides a means for us to assess the course and will enable us to improve aspects of the course in the coming years.



Login. Only two steps - it's easy! Find us on tcd.ie/careers or MyDayApp

STEP 1 Login to MyCareer (using your Trinity username and password)

STEP 2 Update your profile with your email preferences, job and study areas of interest and your career readiness

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

Careers Advisory Service

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An online service that you can use to:

- Apply for opportunities which match your preferences - vacancies including research options
- Search opportunities- postgraduate courses and funding
- View and book onto employer and CAS events
- Submit your career queries to the CAS team
- Book an appointment with your Careers Consultant

Simply login to MyCareer using your Trinity username and password and personalise your profile.

Careers Advisory Service

Trinity College Dublin, 7-9 South Leinster Street, Dublin 2

01 896 1705/1721 | Submit a career query through MyCareer

MyCareer: mycareerconnect.tcd.ie

TCD.Careers.Service

TCDCareers

www.tcd.ie/Careers/students/postgraduate/

@TCDCareers

tinyurl.com/LinkedIn-TCD-Connecting

Opening Hours

During term: 9.30am - 5.00pm, Monday - Friday

Out of Term: 9.30am - 12.30pm & 2.15 - 5.00pm, Monday - Friday

Appendices

Appendix 1: Instructions for citing references

Referencing a book:

Name of author(s)/editor(s), give surname first followed by initial(s) as given on title page.

Year of publication, this should be placed in brackets.

Title of book this should be underlined or put in brackets.

Edition number, if not first edition.

Publisher

Place of publication.

The standard layout for citation is as follows:

Surname initials (date). Title: subtitle. Edition statement. Place of publication, publisher.

e.g. Leonard, B.E. (1997). Fundamentals of Psychopharmacology, 2nd Ed., pp 110-111, Wiley, Chichester.

Referencing a journal:

Example

Surname initials (date). Article title. Journal title, Volume (part), pages.

e.g. McNair, H. (1980): Basic considerations in HPLC. J. Chromatog. 8: 53-59.

Referencing authors

1. *Single author*

" Recent research (Jones, 1999) has demonstrated that…"

2. *Two authors*

(Connor and Leonard, 1998)

Connor, T.J. and Leonard, B.E. (1998) Depression, stress and immunological activation: the role of cytokines in depressive disorders. Life Sci. 62, 583-606.

3. *Multi-authorship (2 or more authors)*

(Yoo et al., 1995)

Yoo, S.D., Holladay, J.W., Fincher, T.K., and Dewey, M.J. (1995) Rapid microsample analysis of imipramine and desipramine by reversed phase high performance liquid chromatography with ultraviolet detection. J. Chromatog. 668, 338-342.

Dissertation or Thesis

It is necessary to provide details of the level of degree etc. and awarding institution in the full details.

e.g. (Dredge, 1998)

Dredge, K. (1998) A preclinical assessment of the effects of antidepressant drugs on the immune system. Ph.D Thesis, Dept. of Pharmacology, NUI, Galway.

The most important thing to remember when citing references is to be consistent.

Appendix 2: Useful Neuroscience textbooks

Neuroscience: Exploring the Brain (2nd Ed) by M.F. Bear, B.W. Connors, M.A. Paradiso (2007)
Lippincott Williams and Wilkins; ISBN: 0781732557.
A good basic text

Neuroscience by D. Purves et al. (2012) Sinauer Associates Incorporated; ISBN: 0878937420.
A good basic text

Fundamental Neuroscience by M.J. Zigmond, F.E. Bloom, S.C. Landis, J. Roberts, L. Squire (2013) Academic Press; ISBN: 0127808701
A very comprehensive reference text

Principles of Neural Science (3rd. Ed) by E.R. Kandel, J.R. Schwartz & T.M. Jessel (2000) McGraw-Hill; ISBN: 0071120009
A good reference text

Basic Neurochemistry by G.J. Siegel et al. (1999). Raven Press, New York, ISBN: 039751820X.
A good reference text

Proteins, Transmitters and Synapses by D.G. Nicholls (1994) Blackwell, Oxford, ISBN: 0632036613.
Very detailed in parts, but contains some useful diagrams

Color Atlas of Neuroscience by B. Greenstein and A. Greenstein (2000) Thieme, Stuttgart. ISBN: 3-13-108171-6.
Contains useful diagrams and will enhance understanding of neuroanatomy and neurophysiology.

Neuroanatomy: An illustrated colour text (2^{nd} Ed.) by A.R. Crossman and D. Neary (2000) Churchill Livingstone, Edinburgh. ISBN 0-443-06216-1
Recommended text for Neuroanatomy

Neuroscience at a Glance by R. Barker, S. Barasi, M. J. Neal (1999) Blackwell Science (UK);
ISBN: 08654286
Contains useful diagrams and will enhance understanding of neuroanatomy and neurophysiology.

Molecular Neuropharmacology: A foundation in clinical Neuroscience by E.J. Nestler, S.E. Hyman and R.C. Malenka (2001) McGraw-Hill, New York, ISBN: 0071120653.
Deals with many aspects of neuroscience in a very user-friendly manner.

The Biochemical Basis of Neuropharmacology. (7^{th} Ed) by J.R. Cooper, F.E. Bloom and R.H. Roth.
(1996) Oxford University Press. ISBN 0-19-510399-8.
A useful textbook for basic neurochemistry and neuropharmacology

Appendix 3: Useful Websites

Pubmed

Pubmed is a database of journals kept in the National Library of Medicine in the USA. It contains journals from the 1960's up to the present day. It gives abstracts for almost all articles, and it also contains links to many full text articles.

http://ncbi.nlm.nih.gov/pubmed/

Science Direct

Science direct is a web-based database of Elsevier Science journals. It contains 1200 scientific journals and access to full-text articles. You can download full text articles from 1995 onwards within TCD, however from outside the college only abstracts are available.

http://sciencedirect.com

Neuroscience Web Sites

A useful tour of the brain, and a description of brain disorders

http://www.brainexplorer.org

A useful site that deals with neurotransmitter function and drug action within the brain

http://www2.onu.edu/~ksehlhor/drugs.html

Neuroscience for kids, but well worth looking at.

http://faculty.washington.edu/chudler/neurok.html

Brain model tutorial – Useful for Neuroanatomy

http://pegasus.cc.ucf.edu/~Brainmd1/brain.html

Basic Biochemistry of neurotransmitters

http://web.indstate.edu/thcme/mwking/nerves.html

Neuroscience Web Search

http://www.acsiom.org/nsr/neuro.html

Neurological disorders resource - Lots of links to websites dealing with neurological disorders

http://www.univ.trieste.it/~brain/NeuroBiol/Neuroscienze%20per%20tutti/disorders.html

The whole brain atlas

http://www.med.harvard.edu/AANLIB/home.html

Appendix 4: Useful information in the Laboratory

Multiplication Factors and their prefixes

Multiplication factor	Prefix	Symbol
$1\ 000\ 000\ 000\ 000 = 10^{12}$	tera	T
$1\ 000\ 000\ 000 = 10^{9}$	giga	G
$1\ 000\ 000 = 10^{6}$	mega	M
$1\ 000 = 10^{3}$	kilo	k
$100 = 10^{2}$	hecto	h
$10 = 10^{1}$	deca	da
$0.1 = 10^{-1}$	deci	d
$0.01 = 10^{-2}$	centi	c
$0.001 = 10^{-3}$	milli	m
$0.000\ 001 = 10^{-6}$	micro	μ
$0.000\ 000\ 001 = 10^{-9}$	nano	n
$0.000\ 000\ 000\ 001 = 10^{-12}$	pico	p
$0.000\ 000\ 000\ 000\ 001 = 10^{-15}$	femto	f
$0.000\ 000\ 000\ 000\ 000\ 001 = 10^{-18}$	atto	a

SI Units

Physical Quantities	Symbols	Units
Length	l	metre (m) micrometre (⊠m)
Wavelength of light	λ	nanometre (nm)
Area	A	square metre (m^2)
Volume	V	cubic metre (m^3)
Capacity	V	millilitre (ml)
Time	t	second (s)
Frequency	f	hertz (Hz)
Velocity	v	metre per sec (m/s)
Gravitational acceleration	g	metre per sec squared (m/s^2)
Mass	m	kilogramme (kg)
Density	ρ	kg per metre squared (kg/m^2)
Pressure	p	Newton per square metre (N/m^2)
Thermodynamic temperature	T	Kelvin (K)

Preparation of solutions

1. **Percent solutions**

Example 1 (w/v)

How much of a 0.9% NaCl solution can be made with 2.5g NaCl

0.9% NaCl solution = 0.9g NaCl in 100mls solution

Thus 2.5g = 100/0.9x2.5 = 278ml.

Example 2 (v/v)

How much ethanol is in 50 ml of a 5% solution of ethanol in water?

5% ethanol solution = 5 mls ethanol in 100mls of final solution

Hence 50 mls = 5/2 = 2.5 mls ethanol

2. Molarity

Mole: The number grams equal to the atomic or molecular weight of the substance.

Molecular weight of NaCl = Na(23) + Cl(35.5) = 58.5g

A 1 Molar (1M) solution contains 1 mole of solute per litre of solution.

Molarity (M) number that expresses the number of moles of substance in 1 litre of solution.

3. Normality

Normality and molarity are based on the same principles, with one major change. Molarity is based on molecular weight (mol wt.); normality is based on equivalent weight.

A gram equivalent weight of an element or compound is the mass that will combine with or replace 1 mole of hydrogen.

Example: KOH dissociates into one K^+ ion and one OH^- ion. One mole of K+ will replace one mole of H+ in a chemical reaction; hence KOH has an equivalent weight equal to one mole KOH

Example: H_2SO_4 dissociates into two H^+ ions and one SO_4^- ion. One mole of this ion will combine with 2 moles of hydrogen. Hence 1 gram equivalent weight of H_2SO_4 equals 0.5 mol, because two H^+ ions will combine with one SO_4^- ion

Example 1

Make 1000 ml 0.5 M NaCl. Molecular weight of NaCl is 58.5

Mol wt. x M = g/L

58.5 x 0.5 = 29.25 g/L

- 29.25g NaCl made up to 1000 ml gives 1000 ml 0.5M NaCl

Example 2

$\frac{\text{Density x Purity}}{100} = \text{g/ml}$ $\frac{\text{molecular weight}}{\text{g/ml}} = \text{no. of ml required to make up 1L}$

Given that for H_2SO_4: Specific gravity = 1.84, purity = 98%, MW= 98.07

(a) How would you prepare a 3.4M solution?

$\frac{1.84 \times 98}{100} = 1.80$ $\frac{98.07}{1.8} = 54.5$

54.5 = 1M solution hence 3.4 M solution requires 185.24 ml in 1L of solution.

(b) How would you prepare a 2 N solution?

1 gram equivalent weight of H_2SO_4 equals 0.5 mol, thus 54.5/2=27.25 x 2N= 54.5ml in 1L solution.

Example 3

How would you prepare a 0.02 M solution of Acetic Acid from a stock solution of concentration 1.7 M?

$\frac{1.7}{0.02} = 85$

Hence use a 1 in 85 dilution – 1ml of Acetic Acid solution and add 84ml distilled water.