MSP Course Catalogue 2018-2019

Version 13.11.2018

Disclaimer

The course and skills descriptions provided herein are for the guidance of prospective students of the Maastricht Science Programme (MSP) and every effort is made to ensure their accuracy. However, the MSP reserves the right to make variations to the content and pre- and co-requisites, to discontinue courses and to merge or combine courses without prior notice.

Overview of Courses and Skills for the Academic Year 2018-2019 (Version November, 2018) – colours for colour-blind people!!!

	Biology	Chemistry	Mathematics and Computer Sciences	Physics	Neuroscience	Interdisciplinary
Core Courses	BIO1001 Introduction to Natural Sciences: Biology	CHE1001 Introduction to Natural Sciences: Chemistry		PHY1002 Introduction to Natural Sciences: Mathematical Foundations of Physics		INT1001 Introduction to Liberal Arts and Sciences
100 Level Courses			MAT1006 Applied Statistics MAT1007 Mathematical Tools for Scientists	PHY1001 Elements of Physics	NEU1001 Introduction to Neuroscience NEU1002 Biological Foundations of Behavior	INT1002 Basic Principles of Pharmacology INT1003 Introduction to Biomedical Engineering INT1005 Commercializing Science and Technology INT1006 Sustainable Development
200 Level Courses	BIO2001 Cell Biology BIO2002 Ecology BIO2003 General Botany BIO2004 General Zoology BIO2005 Evolutionary Biology BIO2006 Biotechnology BIO2007 Genetics BIO2010 Human Anatomy and Physiology	CHE2001 Organic Chemistry CHE2002 Inorganic Chemistry CHE2003 Physical Chemistry CHE2004 Spectroscopy CHE2005 Chemistry for the Future: Generation and Storage of Alternative Energy CHE2006 Biochemistry	MAT2002 Optimization MAT2004 Linear Algebra MAT2005 Statistics MAT2006 Calculus MAT2007 Introduction to Programming MAT2008 Differential Equations MAT2009 Multivariable Calculus	PHY2001 Classical Mechanics PHY2002 Thermodynamics and Statistical Physics PHY2003 Vibrations and Waves PHY2004 Electromagnetism PHY2005 Quantum Theory PHY2006 Electronics PHY2007 Optics PHY2008 Solar System Astronomy	NEU2001 From Sensation to Perception NEU2002 Neuropsychopharmacology	INT2001 Nanomaterials Science and Technology INT2007 Science-in-Action INT2008 Molecular Toxicology
300 Level Courses	BIO3001 Molecular Biology BIO3002 Ecophysiology* BIO3003 Microbiology BIO3004 Animal Behavior BIO3007 Tropical Ecology BIO3010 Genomics and Proteomics	CHE3001 Organic Reactions CHE3002 Transition Metal Chemistry CHE3004 Modern Catalytic Chemistry CHE3005 Industrial Chemistry CHE3006 Quantum Chemistry CHE3007 Advanced Physical Chemistry CHE3008 Analytical Science and Technology	MAT3003 Game Theory MAT3005 Numerical Mathematics	PHY3001 Quantum Mechanics PHY3002 Theory of Relativity PHY3004 Nuclear and Elementary Particle Physics PHY3005 Relativistic Electrodynamics PHY3006 General Relativity	NEU3001 Neuroscience of Action	INT3001 Philosophy of Technology INT3002 Advanced Microscopy: Theory and Applications INT3003 Biomaterials INT3005 Biobased Materials and Technology INT3006 Creativity and Concept Development for New Business INT3007 Systems Biology INT3008 Regenerative Medicine INT3009 Chemical Ecology* INT3010 Science and the Visual Arts: Conservation and its Histories

All courses are 5 ECTS

** Modules with asterisk are offered once every other year*

Period 1 Period 2 Period 4 Period 5 **not offered in 2018-2019**

	Biology	Chemistry	Mathematics and Computer Sciences	Physics	Neuroscience	Interdisciplinary
Core Skills						PRA1001 Research Methods PRA1002 Research, Data Analysis and Presentation Academic Skills
100 Level Skills				PRA1003 Basic Physics Laboratory	PRA1005 Data Collection Techniques in the Neurosciences	
200 Level Skills	PRA2009 Field Skills PRA2011 Exploring the World of Plants PRA2013 Practical Zoology PRA2014 Genetics	PRA2002 Chemical Synthesis PRA2004 Inorganic Synthesis PRA2008 Physical Chemistry	PRA2003 Programming	PRA2006 Electronics PRA2007 Physics Laboratory		PRA2005 Advanced Molecular Laboratory Skills PRA2010 Synthetic Biology PRA2015 Advanced Academic Skills
300 Level Skills	PRA3003 Molecular Biology PRA3010 Microbiology Skills PRA3011 The Limburg Landscape PRA3017 Applied Cell Biology PRA3019 Plant Breeding and Physiology	PRA3001 Advanced Organic Synthesis PRA3008 Transition Metal Chemistry PRA3013 Bioinorganic Chemistry PRA3014 Spectroscopic Methods PRA3018 Molecular Modelling PRA3020 Analytical Chemistry in the Art World	PRA3021 Topics in Scientific Computing	PRA3002 Advanced Physics Laboratory PRA3012 Advanced Electronics		PRA3005 Polymer Processing PRA3006 Programming in the Life Sciences

All skills are 2.5 ECTS

Period 1 Period 2 Period 4 Period 5

BIO1001 Introduction to Natural Sciences: Biology

Course coordinator

Linnea van Griethuijsen, Faculty of Science and Engineering, Maastricht Science Programme

Contact: l.vangriethuijsen@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Pre-requisites

- ✓ PRA1001 Research Methods

Objectives

This course is an introduction to the field of biology, builds on the previous high-school knowledge of the students and aims to develop a deeper understanding of:

- the basic characteristics of life: metabolism, growth, reproduction, response to stimuli + communication
- the relation between structure and function of bio-molecules in living organisms
- the cell as the unit of living organisms
- biodiversity, evolution & taxonomy
- the basics of metabolism and photosynthesis
- the principles and mechanisms underlying classical genetics
- the basic principles of ecology
- population dynamic and how populations respond to environmental changes

Description of the course

This course aims at introducing the students to the most fundamental biological principles of life. The cell as the basic unit of life will be studied as well as classification of organisms in order to understand the basic principles of the diversity of species.

A basic understanding of photosynthesis and cellular respiration will be provided in this course. The ability to replicate, to multiply and produce offspring is studied in the field of genetics, and the basic Mendelean genetics will be studied. The basic principles of evolution will be introduced. How living organisms relate to each other will be explained and basic principles of ecology are presented.

Literature

Campbell, Reece et al. (2017). Biology, A Global Approach (11th edition, global edition). Pearson (ISBN10: 1-292- 170433 ISBN13: 978-1-292- 170435, Ebook: ISBN-10: 1292170441 ISBN-13: 9781292170442) There is also a version with access to online study material (MasteringBiology), which is NOT required for this course. The 10th global edition is also acceptable.

Instructional format

Two-hour lecture by MSP Biology lecturers and 2 two-hour PBL tutorials per week. Students will have to prepare a short essay on a biological subject of their choice.

Assessment

Evaluation of student performance will be based on 1) a final exam at the end of the course period; 2) the essay on a biological subject of choice; 3) peer review reports on several essays; 4) the student's contribution to the discussion during the meetings (tutor evaluation).

BIO2001 Cell Biology

Course coordinators

Dr Vanessa LaPointe and Dr Aart van Apeldoorn: MERLN Institute for Technology-Inspired Regenerative Medicine; Faculty of Health, Medicine and Life Sciences

Contact (Period 1): v.lapointe@maastrichtuniversity.nl
Contact (Period 4): a.vanapeldoorn@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ None

Objectives

- To present the structure of prokaryote (bacteria) and eukaryote cells (animal, plant, fungal).
- To comprehend the structure/function relationship of the plasma membrane.
- To understand the functions of cell organelles and sub-cellular structures.
- To deepen the knowledge about transport of material in- and out of the cell
- To understand communication between the cell interior and exterior of the cell (cell signalling).
- To understand the principles of transport between the different cell organelles and how molecules and proteins are reliably transported to the different organelles.
- To create understanding of cell motility and how the cell controls its shape (cytoskeleton).

Description of the course

This course aims to develop a detailed understanding of the cell as the basic unit of life. The cell can be seen as an organism that can perform a wide range of functions. In eukaryotes, these functions are linked to the different compartments/organelles in the cell: nucleus, mitochondria, chloroplasts, endoplasmatic reticulum, lysosomes, endosomes, *etc*. There is a continuous transport between the different organelles (intracellular vesicular transport) and between the cell interior and the extracellular environment (endocytosis & exocytosis). All these cellular transport mechanisms will be studied in detail. Additionally, the cell contains intracellular structures that regulate shape, strength, and motility, *i.e.* the cytoskeleton. The cytoskeleton is a highly dynamic structure and the different components of the cytoskeleton (microtubules, F-actin, intermediate filaments) and their assembly and disassembly will be explained. Finally the basic principles of signal transduction will be studied, *i.e.* how does the cell react to signals from the environment, how are these signals detected and how are these processed into a primary cellular response?

Literature

"Molecular Biology of the cell" 6th edition (2014). B. Alberts, A. Johnson, J. Lewis, D. Morgan, M. Raff, K. Roberts, P. Walter; Garland Science: Taylor and Francis Group, New York, NY10017, USA (ISBN: 978 0 8153 44643)

Instructional format

The course will be divided into tasks (two per week) which will be introduced, explained and discussed in the lecture. A more detailed study will take place in tutorial groups using PBL.

Assessment

Evaluation of student performance will be based on 1) a written midterm exam; 2) a final exam at the end of the course period (open book); 3) a poster or a presentation (depending on the group size) made in a small group that will be presented in a public session at the end of the course.

BIO2002 Ecology

Course coordinator

Dr. John Sloggett: Faculty of Science and Engineering, Maastricht Science Programme

Contact: j.sloggett@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ None

Objectives

- To understand what ecology as a discipline encompasses and its relevance for humanity
- To understand the different levels of organisation that ecology is studied at from the level of the organism up to the level of the entire planet, and how studies at these different levels interact
- To understand concepts, theories, and evidence about the ecological processes that determine the distribution and abundance of organisms
- To understand the impact that humans exert on natural processes and the ecological consequences of anthropogenic activity

Description of the course

Ecology is the study of the interactions of organisms with each other and with the abiotic environment. It covers many levels, including individuals, populations, communities and ecosystems. In this course we will examine the ecological patterns and processes that operate at these various levels and how they interact. Particular focus will be placed on the role that humankind plays in ecology today and on how factors such as deforestation, eutrophication and invasive species have affected natural systems.

Literature

Smith, T.M. & Smith, R.L. *Elements of Ecology*, most recent edition (details closer to course)

Instructional format

One lecture plus 2 tutorials per week

Assessment

Tutorial grade, debate, exam

BIO2003 General Botany

Course coordinator

Dr. Roy Erkens: Faculty of Science and Engineering, Maastricht Science Programme
Contact: roy.erkens@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ None

Objectives

In this course, you will gain an insight to the magnificent diversity of plant structures and physiological functions as part of their clever adaptation to the environment. The course will illustrate all major parts of basic plant body architecture from the perspective of anatomy, development, and physiology throughout the life cycle.

Description of the course

The magnificent diversity of plant size and form is not something foreign to us. If you take a stroll down a park, you will see plants ranging from less than 1 cm to greater than 100 m tall. In addition to that, plants also appear in various shapes and morphologies. At the first glance, a tiny dandelion may appear to have little or nothing in common with a conifer tree. Interestingly, all plants perform fundamentally similar processes based on the same architectural body plan regardless of their different adaptations to their own niches. In this course, you will get to explore the morphological diversity to the basic plant body plan: leaf, stem, and root. In this exploration, you will obtain an in-depth knowledge about the basic anatomy and structure of plants from the organ level to the cellular organelles. The course will also provide you with a greater understanding of the formation and functions of these structures developmentally and physiologically throughout the plant life cycle.

Literature

To be determined

Instructional format

Two-hour interactive lecture followed by two two-hour tutorials per week.

Assessment

There will be three points of assessment: a) quizzes b) final exam, and c) questions-of-the-day session

BIO2004 General Zoology

Course coordinator

Dr. John Sloggett: Faculty of Science and Engineering, Maastricht Science Programme

Contact: j.sloggett@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ None

Objectives

- To characterise the defining biological features of the animal kingdom
- To provide an overview of the characteristics of the major animal groups
- To explain the systematics and phylogenetics of major groups within the animal kingdom
- To place the morphological, anatomical and behavioural aspects of animal groups in an evolutionary context
- To examine in more detail particular biological adaptations using specific animal groups as examples

Description of the course

Animals are everywhere, on land, in water and in the air. They comprise an extremely diverse kingdom, with all species being a mixture of shared and unique biological characteristics. These characteristics are a product of evolutionary history and adaptation to particular features of the abiotic and biotic environment. In this course you will focus on the major groups within the animal kingdom, what defines them, how they are organised and how they are related to each other; you will also examine the specific adaptations of certain animals in more depth. The question "What is an animal?" will be considered as will the issue of how animals are grouped and related to each other. This will be done in the context of the major phyla, their defining morphological, anatomical and physiological features and the sorts of adaptations and behaviours that they exhibit. You will also examine certain adaptations such as bright colouration, feeding or parental care in greater depth, using particular animal groups as a source of examples.

Literature

Miller, S.A & Harvey, J.P. *Zoology*, most recent edition (more details closer to course)

Instructional format

One lecture, one PBL tutorial, one interactive lecture/tutorial

Assessment

Tutorial performance, poster, exam

BIO2005 Evolutionary Biology

Course coordinator

Dr. Roy Erkens: Faculty of Science and Engineering, Maastricht Science Programme

Contact: roy.erkens@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Recommended

- ✓ BIO2007 Genetics

Objectives

During this course you will gain insight in the most important patterns and processes of evolution. Furthermore, you will be able to explain and illustrate the synthetic character of evolutionary theory with examples (i.e. you understand and can explain why evolutionary theory is a unifying concept for all biological sciences and an important foundation for the "human sciences" of medicine, psychology and sociology).

Description of the course

Evolution is the most important principle in biology. It is the only scientific biologically theory that unifies all phenomena of life from the level of (macro)molecules to ecosystems. Ever since the Modern Synthesis early last century (when Darwin's insights were combined with modern genetics), evolutionary research has expanded enormously. Subsequent developments – the birth of molecular biology, the ever increasing power of computers and the development of phylogenetics - have led to an enormous increase in our understanding of the processes and patterns of evolution. This course emphasizes the general principles of evolution, the hypotheses on the causes of evolutionary change (relevant for most organisms), and the large patterns which are visible in the history of the earth. This course is an excellent opportunity to obtain a base in evolutionary knowledge, regardless of the field you will work in (biology or elsewhere).

The course zooms in from macro-evolutionary patterns to micro-evolutionary processes. You will look at the geological and paleontological history of the earth and how biologists use phylogeny to reconstruct deep past (the tree of life) using genetic data. A fundamental unit within biology is the species and therefore also theories of species and speciation will be discussed. Furthermore, how random changes in populations (genetic drift) and natural selection influence evolution will be investigated using simulation models. In relation to this you will look beyond alleles into quantitative genetics and the evolution of phenotypes, and also at the process of adaptation. Finally, evolution is used to 1) explain life history characters (e.g. how many children does an organism produce) and obtain a different view on human medicine, and 2) understand co-evolution between species.

Literature

- Evolution, making sense of life. C. Zimmer and D.J. Emlen, 2nd ed. 2016. Roberts & Company Publishers.
- One module of Simbio's evobeaker package (http:// http://simbio.com/products-college/EvoBeaker) for evolutionary simulations (will be provided by MSP).

Instructional format

You will focus on key fields in evolutionary biology and solve a problems attached to these fields each week during two two-hour (standing) tutorial sessions. During interactive two-hour meetings we will discuss the solutions to the problems you came up with. However, next to this two assignments have to be carried out.

Assessment

Three grades will be awarded during this course: a) two assignment grades, b) an exam grade.

BIO2006 Biotechnology

Course coordinators
Dr. FeiYian Yoong; Faculty of Science and Engineering, Maastricht Science Programme

Contact: feiyian.yoong@maastrichtuniversity.nl

Pre-requisites
None

Co-requisites
None

Objectives
You will gain a better understanding of the progress of the biotechnology field and how it has impacted our daily lives in various ways. The course challenges you to generate your own biotechnological ideas and how to commercialize it, resembling the real commercial setting.

Description of the course
Biotechnology is one of the most cutting-edge fields in the scientific world. The technological application of biological systems has led to the advancement of various products for the benefits of mankind. This course invites you to further explore the world of biotechnology. In this course, you will discover different types of biotechnology and their applications. You will be informed the latest discovery in the field from guest lecturers and readings. You will learn how biotechnological applications have impacted our daily lives with or without our realization. You will also obtain hands-on experiences in generating your own biotechnological ideas in various fields including agriculture, health and medicine, food science, and environment. You will then expand upon your ideas for a commercial purpose. The journey from brainstorming an idea to delivering an elevator pitch on your product will be one of the main focuses in the course. You will get to experience the process of commercializing an idea as practiced in the real commercial setting. This course offers an interdisciplinary perspective of scientific research (in biology, chemistry, or physics) and industrial approach which may potentially lead to an entrepreneurship.

Literature
A variety of articles, videos, and/or book chapters which will be made available online on a weekly basis.

Instructional format
Two-hour lecture weekly and two two-hour of advanced PBL style.

Assessment
To be determined.

BIO2007 Genetics

Course coordinators

Prof. dr. Leon de Windt: Faculty of Health, Medicine and Life Sciences, Maastricht University.
Contact: l.dewindt@maastrichtuniversity.nl

Pre-requisites

- ✓ BIO2001 Cell Biology

Co-requisites

- ✓ PRA2014 Skills Genetics

Objectives

- To understand the chemical structure of DNA and the molecular mechanisms of DNA replication.
- To get familiar with the basic principles how information stored in genes is converted to a (cellular) phenotype in the form of RNA and protein.
- To get familiar with the mechanisms how organisms (eukaryotes, prokaryotes) extract information from their genome.
- To comprehend and be able to apply the concepts of genome structure, comparative genomics, and functional genomics.
- To understand the molecular basis of single gene inheritance (Mendel's first law), sex-linked single gene inheritance and to interpret human pedigrees.
- To have sufficient background for advanced courses in biochemistry and the life sciences.

Description of the course

The course discusses the principles of genetics with application to the study of biological function at the level of molecules, cells, and multicellular organisms, including humans. The topics include: structure and function of genes; chromosomes and genomes; biological variation resulting from replication and recombination, mutation and selection; DNA repair and the genetic basis of disease inheritance.

Literature

"Introduction to Genetic Analysis" by Griffiths, Wessler, Carrol, Doebley (Palgrave Macmillan, 11th edition, 2015. ISBN-13: 9781464109485).

Instructional format

Lectures and tutorial group meetings

Assessment

- A midterm theoretical examination on all lectures and theoretical content of weeks 1-3 is scored and will count 20% towards the final grade.
- A final theoretical examination on all lectures and theoretical content of BIO2007 consists of ± 30 questions of which about half in multiple-choice format and half as open questions. This final examination factor weighs in 70% to the final grade.
- A final evaluation on tutorial attendance and active participation during the complete course is scored and will count 10% towards the final grade.

BIO2010 Human Anatomy and Physiology

Course coordinator

Dr. Andries Gilde: Faculty of Health, Medicine and Life Sciences, Department of Biochemistry

Contact: a.gilde@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ None

Objectives

- Membrane and Electrophysiology
- Cardiovascular function
- Hormonal and neuronal control of Blood Pressure
- Organ function in energy balance and volume control
- Integrative Physiology of the Circulatory System

Description of the course

Anatomy describes the form of (all subunits of) a living being. Physiology comprehends the physical and chemical processes that are responsible for the origin, development, and progression of life (Arthur Guyton). As form and function are closely interrelated, we will study anatomy and physiology in this course hand in hand.

We will start with the smallest living subunit of the human body – the cell – and will subsequently learn about the different organ systems. Finally, we will integrate all information to the level of the complete human body.

As the circulation is the central part of the human body by maintaining the condition for all cells constant ("homeostasis"), and as this course is too short to discuss all items of anatomy and physiology in detail, we will especially focus on the cardiovascular system. Also, cardiovascular physiology is an important basis for understanding cardiovascular disease, one of the two most common causes of death in the Western society. This further enhances the importance of understanding the cardiovascular system.

This course will provide a solid fundament for those who pursue an academic career in Life Sciences, Biometrics, Biomaterials, Biochemistry, or even Medicine.

Literature

Online library accessmedicine.mhmedical.com

Instructional format

Lectures and tutorials

Assessment

Professional Conduct, Collaboration, Paper, Written Test

BIO3001 Molecular Biology

Course coordinators

Dr. Paula da Costa Martins, Faculty of Health, Medicine and Life Sciences, Maastricht University.
Contact: p.dacostamartins@maastrichtuniversity.nl

Pre-requisites

- ✓ BIO2001 Cell Biology
- ✓ BIO2007 Genetics

Co-requisites

- ✓ PRA3003 Molecular Biology

Objectives

- To get acquainted with the best-characterized cell signaling mechanisms in eukaryotic cells.
- To understand gene structure/function and different gene regulatory mechanisms (chromatin remodeling and (post)transcriptional regulation) in prokaryotes and eukaryotes.
- To understand how molecular biology, when used in combination with other biological disciplines (e.g. biochemistry, genetics, imaging), can provide tools to understand (diagnostics) and intervene (therapy) in the cellular complexity of human disease.

Description of the course

The general aim of this course is to obtain detailed knowledge about the molecular processes in cell signalling and control of gene expression. Topics include intracellular signalling pathways; chromatin structure and remodelling; recruitment and assembly of transcription factors; eukaryote mRNA synthesis, processing, modification, stability and translation; stem cells and reprogramming; and the culmination of the above factors that drive common complex human disease. The tutorials will be partially in Problem Based Learning (PBL) and multiple-choice format, with exercises designed to provide a perspective of how cutting edge molecular biological techniques are applied to tackle major research questions in modern biomedical research.

Literature

A reader is provided at the start of the course. Other recommended literature will be announced later.

Instructional format

Lectures and tutorial group meetings

Assessment

1. A midterm theoretical examination (multiple choice and open questions) on all lectures and theoretical content of weeks 1-3 is scored and will count 30% towards the final grade.
2. A final examination on all lectures and theoretical content of BIO3001 consists of ±30 questions (multiple-choice and open questions) and weighs 60% of the final grade.
3. A final evaluation on tutorial attendance and active participation is scored and will count 10% towards the final grade.

BIO3002 Ecophysiology

PLEASE NOTE: this course alternates with INT3009 Chemical Ecology, and will next run in ***P2, 2019-2020***

Course coordinator

Dr. John Sloggett: Faculty of Science and Engineering, Maastricht Science Programme
Contact: j.sloggett@maastrichtuniversity.nl

Pre-requisites

- ✓ BIO2001 Cell Biology

Co-requisites

- ✓ None

Objectives

- To understand what ecophysiology is and the role in plays in an academic and applied context.
- To gain a basic knowledge of the physiology of certain non-human organismic groups
- To understand in detail the characteristics of different abiotic environments that impose strong adaptive pressures on organismal physiology
- To understand specific direct physiological adaptations evolved in response to these environmental pressures
- To gain an insight into physiological adaptations to the biotic environment
- To understand the principle of convergent evolution and how different groups may have evolved different physiological solutions to the same evolutionary pressures

Description of the course

Ecophysiology is the study of physiological adaptations of organisms in relation to the environments in which they live. It has become an increasingly important science, because an understanding of the relationship between organism and environment is essential in order to predict the effects of man-made environmental change. The physiology of an organism incorporates many of its most important adaptations to the environment in which it lives. In this course you will consider the variety of environmental pressures imposed on organismal physiology. You will examine the often ingenious solutions that evolve in response to these pressures, and how different organisms and groups of organisms have evolved different physiological means of dealing with the same problem. The course will focus both on the abiotic environment (e.g. issues related to climate, gas exchange) and the biotic environment (e.g. how digestive physiology is adapted to plant toxins). Towards the end of the course you will look at Conservation Physiology, one of the practical applications of ecophysiology. There is a particular focus on the physiological adaptations of animals.
Although BIO2004 General Zoology is not a prerequisite for this course, the course is recommended before you take Ecophysiology.

Literature

Scientific papers

Instructional format

Lectures, tutorial sessions and seminar.

Assessment

Tutorial grade based on quality of contribution, seminar presentation, final (open) exam

BIO3003 Microbiology

Course coordinator

Frank Stassen, Faculty of Health, Medicine and Life Sciences

Contact: f.stassen@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ PRA3010 Microbiology

Objectives

- To obtain basic knowledge of medical microbiology, i.e. of bacteriology, virology and genetically modification of microorganisms.
- To study the characteristics of a selection of micro-organisms in relation to their related infectious diseases, more specific pathogenesis, epidemiology, diagnosis and therapy.

Description of the course

The 7 weeks course will start with two introduction lectures on Bacteriology and Virology. The general principles of replication, classification, metabolism and antibiotic resistance of bacteria as well as the presence of bacteria in several organ systems and the composition of the indigenous flora will be discussed in week 1. The general priciples of replication, classification and pathogenesis of viruses will be discussed in the introduction lecture of week 2. Several aspects of bacteriology and virology will be further discussed in the expert and tutorial group meetings, which will include topics as HIV, Tuberculosis and ESBL.

The knowledge you have obtained in the first two weeks will serve the basis for the following three weeks, where Infectious diseases, Outbreaks & resistance and Microbiological diagnostics will be discussed in the lectures as well as in the tutorial groups. In these topics, both the bacterial and viral aspects will be discussed.

The last part of this course will deal with genetically modified microorganisms, in which you gain inside in the purposes of modification and the tools that are available. In the PBL tutorial group linked to this part of the course (Case: The Experiment), you will design your own experiment on paper; genetically modification of viral genes.

Literature

- Murray. *Medical Microbiology*. (7th ed.), Elsevier Mosby.

Instructional format

Lectures, expert meetings and tutorial group meetings.

Assessment

1. A final examination, which consists of open questions.
2. A PowerPoint presentation on a selected topic in microbiology
3. Active participation in the expert meetings and tutorial groups.

BIO3004 Animal Behaviour

Course coordinator

Dr. Linnea van Griethuijsen: Faculty of Science and Engineering, Maastricht Science Programme

Contact: l.vangriethuijsen@maastrichtuniversity.nl

Pre-requisites

- ✓ BIO2004 General Zoology*
- ✓ BIO2005 Evolutionary biology

Co-requisites

- ✓ none

Objectives

- Gain an understanding of how animal behaviour is studied
- Recognize ultimate and proximate causes of behaviour and understand how they are related
- Understand what triggers behaviour and the importance of behaviour in an animal's chances of survival and reproductive success
- Gain a general knowledge of the development of the field of animal behaviour and how it is linked to related fields such as neurobiology and behavioural ecology

Description of the course

This course will introduce you to how behaviour of animals is studied and the (relatively young) history of this field. We will look at the origins (ultimate cause) of behaviour; the function of behaviour in an animal's survival and reproduction, and how behaviours evolve over evolutionary time. In particular we will study the evolution of altruism, reproductive behaviour, mating systems, communication and parental care. We will also discuss how animals decide on foraging strategies, how they avoid predators, find suitable territories or decide to migrate. We will also look at the proximate causes of behaviour; what triggers behaviours and what is the role of ontogeny (organismal development)? Although the basis of behaviour lies in neurobiology and the brain, these will not be discussed in detail in this course. We will discuss the role of memory and learning in relation to animal behaviour.

* Students who have not done BIO2004 General Zoology, but with sufficient biology background *may* be able to take this course with a waiver. Contact the coordinator.

Literature

Alcock, J. (2013). *Animal Behavior, an evolutionary approach* (10th edition). Sinauer. (ISBN 978-0-87893-966-4). Scientific articles which can be obtained online via UM library.

Instructional format

Two-hour lecture and 2 two-hour tutorials per week

Assessment

Final exam + presentation on relevant research article

BIO3007 Tropical ecology

Course coordinator

Dr. Roy Erkens: Faculty of Science and Engineering, Maastricht Science Programme

Contact: roy.erkens@maastrichtuniversity.nl

Pre-requisites

- ✓ BIO2002 Ecology

Objectives

In this course you will get an overview of the characteristics, functioning, and importance of tropical rain forests, study their history and think about their future. You will be also introduced into the IUCN Redlist and learn how to assess conservation proposals for the protection of threatened species.

Description of the course

Tropical forests are amongst the most species-rich biomes of the world. Yet, our understanding of their evolution, functioning and development are far from complete. Rain forests on different continents have fundamentally different characteristics that make each of them unique. Also within continents, regions, or overall zones the differences might be quite large. There are three main tropical rainforest areas, the Neotropics (Central and South America), Africa and Asia, but for this course you will mainly focus on the Neotropics. You will look at what defines the tropical region, the differences and similarities between the three large blocks of rainforest, and investigate the structure and biodiversity of tropical rain forests. Also, you will look at the development of tropical forests, how biodiversity changes over time (ecologically and evolutionarily) and how trophic levels work within these forests. Furthermore, the role of tropical forests in relation to climate change and global carbon cycling will be investigated, and a link will be made to tropical savannas and dry tropical forests. Finally, you will investigate the IUCN Red list and will experience the practices of nature conservation in tropical areas.

Literature

This skill will use solely primary literature as a basis for the tasks. No text book is required.

Instructional format

Each week is devoted to a major topic in tropical rain forest ecology that will be studied using (standing) PBL tutorials. A mandatory guest lecture is part of this course. Also, an assignment called "Gallery of Endangered Tropical Biodiversity" has to be completed (consisting of two written texts, two presentations and a general final session in which you decide on the best proposals).

Assessment

The assessment will consist of several parts:

1) group grade for final exam assignment (50% of final grade).
2) individual fact sheet grade (including the presentation; 25% of final grade).
3) individual counter-proposal grade (including the presentation; 25% of final grade).

BIO3010 Genomics and Proteomics

Course coordinator

Prof. Dr. E.C.M. Mariman, Faculty of Health, Medicine and Life Sciences, Human Biology, Maastricht University.
Contact: e.mariman@maastrichtuniversity.nl

Pre-requisites

- ✓ BIO2007 Genetics

Recommended

- ✓ Knowledge at the level of iGenetics by Peter J. Russell

Co-requisites

- ✓ none

Objectives

- To understand how genomics applications are used to unravel the biology of life.
- To understand the basic principles of omics-techniques.
- To gain insight in the advantages and limitations of genomics-based experiments.
- To appreciate the surplus value of combining data from different omics-applications as a systems approach.
- To provide the basis for gaining insight in bioinformatics and computational genomics.

Description of the course

The introduction of genomics applications has added an extra dimension to the understanding of the molecular nature of life. Prerequisites were the unraveling of the genome of humans and other organisms, and the development of high-throughput methods for the simultaneous analysis of the expression levels of as much as possible genes. This course will give students insight in the analytical principles behind omics-technologies such as array-based analysis, in the information that can or cannot be obtained by the different 'omics'-approaches, and in the novel developments of omics-applications such as miRNA arrays, analysis of the epigenome, and next generation sequencing. Specific themes of the course are trancriptomics, proteomics, metabolomics with special attention for the surplus value of combining of data from various omics-approaches as the best way to understand life (Systems Biology). Special areas of attention are Nutrigenomics and Toxicogenomics.

Literature

- Sethi et al. Approaches for targeted proteomics and its potential applications in neuroscience. J. Biosci. 2015.
- Drake et al. Challenges to developing proteomic-based breast cancer diagnostics. OMICS 2011.
- Berna et al. Nutrigenetics and nutrigenomics insights into diabetes etiopathogenesis. Nutrients 2014.
- Malone et al. Microarrays, deep sequencing and the true measure of the transcriptome. BMC Biology 2011.
- Trifonova et al. Postgenomics diagnostics: metabolomics approaches to human blood profiling. OMICS 2013.

Instructional format

Thematic lectures on methodological principles and techniques, with examples of omics-applications. PBL sessions to address in more detail some of the thematic subject of the lectures. Journal club sessions to study and discuss relevant literature on the application of omics-methods in life sciences. An assignment involving the writing of an essay on a specific subject as for instance 'personalized genomics'. There is a visit to laboratories using omics technology. There will be a group discussion on Big Data.

Examination

The final grade will depend on the final examination with a mixture of open and multiple choice questions, and on the score for the essay.

CHE1001 Introduction to Natural Sciences: Chemistry

Course coordinators

Period 1	Dr. Fabrice Birembaut	fabrice.birembaut@maastrichtuniversity.nl
	Dr. Marie C. Correia	marie.correia@maastrichtuniversity.nl
Period 4	Dr. Burgert Blom	burgert.blom@maastrichtuniversity.nl

Faculty of Science and Engineering, Maastricht Science Programme

Pre-requisites

- ✓ None

Co-requisites

- ✓ PRA1001 Research Methods

Objectives

- To gain an understanding of the nature of atoms and their organization in the periodic table.
- To recognize various classes of chemical compounds and to understand their chemical and physical properties.
- To obtain an understanding of the physical chemistry fundamentally important to biological and chemical processes, with an emphasis on thermodynamics and kinetics.
- To use concepts acquired from kinetics, thermodynamics, acid-base chemistry, and electrochemistry, to predict the potential outcome of chemical reactions.
- To acquire sufficient background for more advanced courses in chemistry, biochemistry and the life sciences.

Description of the course

The emphasis of this course will be on a number of essential topics in modern chemistry. The first part of the course will provide an overview of the structure of atoms and their place in the periodic table as well as the properties of various types of chemical bonds and chemical bonding theory. The second part will present an introduction to physical chemistry with important topics such as the characteristics of gases/liquids/solids, thermodynamics and reaction kinetics. In the final part, the course focuses on a selection of important chemical subjects which form the basis of chemical studies in general. Typical topics in this part of the course are based on acid-base chemistry and electrochemistry.

Literature

Silberberg, M. S. *Principles of General Chemistry, 3rd International Edition*; McGraw-Hill: New York, **2013**; ISBN: 9780071317986.

Instructional format

Lectures and tutorial group meetings

Assessment

1. A midterm examination consisting of multiple choice, short answer, calculation and explanation questions
2. Weekly tutorials – attendance and contributions
3. Pop-quizzes (either in lecture or online)
4. A final (cumulative) examination consisting of short answer, calculation and explanation questions

CHE2001 Organic Chemistry

Course coordinator

Dr. Hanne Diliën: Faculty of Science and Engineering, Maastricht Science Programme

Contact: hanne.dilien@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ PRA2002 Chemical Synthesis

Objectives

- To give the ability to recognize and name common organic compounds.
- To know the basic physical and chemical properties of common organic compounds.
- To understand stereochemistry and its impact on the properties and applications of organic molecules.
- To enable you to understand the most important organic reactions and be able to apply these reactions to obtain well defined organic compounds.

Description of the course

This course focuses on the basis of organic chemistry. In the first part of the course, important fundamental topics, such as atomic theory, bonding theory, hybridization, molecular orbital theory and resonance will be discussed. A special topic will be stereochemistry, which is an essential topic in organic chemistry and the life sciences, since stereochemistry often determines the activity of biological compounds or medicines. Subsequently, the course continues with an introduction into reactivity of organic molecules. Focus, will be on a selection of fundamental organic reactions, which form the basis for a wide array of other organic reactions. To this end, a logical review will be provided of the reactivity of the most important functional groups, as applied in organic synthesis.

Literature

Klein; "Organic Chemistry"; 2th edition; 2015; Wiley (ISBN: 9781118452288)

Instructional format

Lectures and tutorial group meetings. The tutorial group meetings will also be used to prepare with tasks for the co-requisite skill in chemical synthesis.

Assessment

1. A midterm examination, which consists of multiple choice questions,
2. A final examination, which consists of open questions,
3. The contributions to the tutorial group meetings.

CHE2002 Inorganic Chemistry

Course coordinator

Dr Burgert Blom, Faculty of Science and Engineering, Maastricht Science Programme

Contact: burgert.blom@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Recommended

- ✓ CHE2001 Organic Chemistry
- ✓ PRA2002 Chemical Synthesis

Co-requisites

- ✓ PRA2004 Inorganic Synthesis

Objectives

- To introduce the student to the general principles of inorganic chemistry
- To provide an understanding of the basic bonding relationships amongst atoms in inorganic compounds
- To introduce the student to d-block chemistry
- To provide a descriptive survey of non-carbon elements and their properties
- To provide the basis for the further studies of inorganic chemistry

Description of the course

This survey course will introduce the students to the world of chemistry beyond carbon. As an introductory course it will focus on the principles of bonding and interaction between atoms, both of the main group and the d-block elements. Topics covered include but are not limited to molecular orbital theory, main group elements, acids and bases, coordination chemistry, and the solid state.

An introduction to group theory and organometallic chemistry is also included.

Literature

To be determined amongst:

Shriver and Atkins: Inorganic Chemistry (Oxford); Huheey, Keiter, Keiter: Inorganic Chemistry (Harper Collins); and Wulfsberg: Inorganic Chemistry (University Science Books)

Instructional format

Lectures and tutorial group meetings.

Assessment

There will be a minimum of two points of assessment. Assessment points may include but may not be limited to any amongst exams, take home problem sets, tutorial group participation, oral presentations, written assignments, and poster presentations.

CHE2003 Physical Chemistry

Course coordinator

Dr. Jules Harings: Faculty of Science and Engineering, Maastricht Science Programme

Dr. Fabrice Birembaut: Faculty of Science and Engineering: Maastricht Science Programme

Contact: jules.harings@maastrichtuniversity.nl

Pre-requisites

- ✓ none

Co-requisites

- ✓ None

Objectives

- To provide a molecular and mathematical understanding of basic concepts in physical chemistry on a more advanced level.
- To explain and describe the behaviour of systems when temperature and pressure is changed.
- To apply the general principles of thermodynamics in understanding and description of chemical and environmental processes like bookkeeping heat by means of enthalpy when solutions mix.
- To demonstrate how molecules interact in terms of electrostatics, from reacting to an existing field to inducing one.
- To present how these interactions apply in known (bio)systems and can predict physical properties of molecules.

Description of the course

This course focuses on advanced aspects in physical chemistry and how it contributes in solving problems encountered in biology, (bio)chemistry and the environment. Thermodynamics and electrostatics are two of the most important tools that can predict the behaviour of molecules, which can then lead to a broad spectrum of topics related to the life and environmental sciences, including (i) (bio)energetics, (ii) phase transitions, (iii) ion and electron transport, (iv) chemical reaction, (v) (bio)macromolecules and self-assembly, and (vi)physical properties. PBL tasks are embedded to create an understanding how to apply general principles of physical chemistry to biological, (bio)chemical and environmental problems. Development of plausible models for physical or chemical mechanisms, incl. numerical analytical methods to solve the models and testing against observations/experimental evidence, are essential throughout the course.

Literature

Atkins, P., De Paula, J. (2009) Physical Chemistry (9th ed.) Oxford University Press.

Instructional format

Tutorial group meetings and lectures.

Assessment

Student performance will be evaluated on the basis of:

1) two written tests, a mid-term examination covering topics of the first 3 weeks, and a test consisting of open questions at the end of the course,
2) student contribution and involvement in the tutorial groups, including presentation of problem solutions, as scored by the attending tutors.

CHE2004 Spectroscopy

Course coordinator

Dr. Hanne Diliën: Faculty of Science and Engineering, Maastricht Science Programme

Contact: hanne.dilien@maastrichtuniversity.nl

Pre-requisites

- ✓ CHE2001 Organic Chemistry

Co-requisites

- ✓ none

Objectives

- To have a basic understanding of the theoretical background of the measurement principles typically used in spectroscopy and spectrometry.
- To learn to read and interpret the diverse types of spectral data obtained from the most common spectroscopic techniques.
- To learn to identify and characterize chemical compounds using a variety of available analytical techniques.
- To be able to develop an analytical strategy to identify an unknown compound.

Description of the course

The emphasis of this course will be on a number of essential topics in the field of spectroscopy. The course will focus on several spectroscopic and chromatographic techniques such as Nuclear Magnetic Resonance (NMR), UV-Vis spectroscopy, FT-IR spectroscopy, gas and liquid chromatography and mass spectrometry. First, the theoretical background and physical basics of the techniques will be discussed. Then, the reading and interpretation of spectral analysis will be covered. The main focus of the course will be on the acquiring of knowledge and practical expertise to characterize chemical compounds. An analytical strategy to get structural information for unknown molecules from experimental data will be developed.

Literature

Spectroscopy; Lampman, Pavia, Kriz, Vyvyan; 4th edition (International Edition): Brooks/Cole

Instructional format

Lectures and tutorial group meetings.

Assessment

1. A midterm examination, which consists of open questions and problems,
2. A final examination, which consists of open questions and problems,
3. The contributions to the tutorial group meetings.

CHE2005 Chemistry for the Future: Generation and Storage of Alternative Energy

Course coordinator
Dr. Marie C. Correia, Faculty of Science and Engineering, Maastricht Science Programme

Contact: marie.correia@maastrichtuniversity.com

Pre-requisites
- ✓ CHE2001 Organic Chemistry
- ✓ CHE2002 Inorganic Chemistry

Objectives
- To become familiar with important sources of alternative energy and the issues relevant to society regarding the implementation of alternative energy sources
- To understand various methods of generation and storage of alternative energy
- To know the chemical principles behind a variety of alternative energy sources and storage methods
- To gain knowledge of the typical materials and catalysts utilized in alternative energy production and storage
- To understand the basic principles of how biomass and greenhouse gases can be utilized as chemical feedstocks

Description of the course
Although current energy is derived from a variety of sources, the majority is from fossil fuels. Since fossil resources are finite, and anthropogenic climate change is evident, alternative sources of energy, and the upgrading of greenhouse gases to chemical feedstocks are of considerable interest to researchers. This course is a survey course exploring the sources and generation of alternative energy from a chemical viewpoint. In addition, energy storage solutions, and greenhouse gas upgrading will also be discussed since the effective storage of energy and the sequestration of greenhouse gases are considerably important. Topics studied are solar energy, biomass to energy conversions, hydrogen generation/storage, fuel cells and greenhouse gas upgrading to chemical feedstocks. Lectures will be followed by tutorial group meetings structured as a journal club (bull session) in which more detailed chemical concepts will be discussed.

Literature
Selected scientific articles

Instructional format
Series of lectures and tutorial group meetings

Assessment
1. A midterm literature review article on a specific topic within the field of alternative energy generation and storage
2. A final comprehensive examination consisting of short-answer and explanation questions
3. Weekly tutorial group meetings – attendance and contributions

CHE2006 Biochemistry

Course coordinators

Prof. dr. C. Reutelingsperger, Faculty of Health, Medicine and Life Sciences, Department of Biochemistry
c.reutelingsperger@maastrichtuniversity.nl

N. Deckers, Faculty of Health, Medicine and Life Sciences, Department of Biochemistry, n.deckers@maastrichtuniversity.nl (corresponding coordinator)

Pre-requisites

- ✓ None.

Co-requisites

- ✓ None.

Objectives

At the end of the course you will be able to:

- communicate fundamental principles governing structure, function and interactions of biological molecules to students encountering biochemistry for the first time.
- appreciate the science of biochemistry and its relevance to Health and Disease .
- recognise the roles of bio-macromolecules like proteins, lipids, polysaccharides and nucleotides in living cells in the context of diseases such as hyperventilation, thrombosis and atherosclerosis.
- identify, explain, and discuss the basic principles of enzyme catalysis and inhibition.
- enter advanced courses that require more detailed biochemistry knowledge, and to enroll into various Master programs in the life sciences.

Description of the course

Biochemistry is considered the mother of all Life Sciences. Understanding Biochemistry will facilitate learning of more specialised Life Sciences such as Molecular and Cell Biology.

This course will present the essentials of Biochemistry during 6 lectures and 10 tutorials. We will cover the structures, functions and interactions of the biomacromolecules, including proteins, lipids, carbohydrates, DNA and RNA, which perform many of the activities associated with life. We will provide insight in the specificity and action of enzymes, the biocatalysts of the cell. Further, we will explain metabolic pathways that result in the generation of ATP, the major energy currency of the cell.
Finally we will present recent biochemical understandings on genome editing that revolutionize treatment of diseases at the level of correcting mutated genes (gene therapy).

Literature

- Berg, J.M., Tymoczko, J.L., Stryer, L. Biochemistry. (8th ed). W.H. Freeman. ISBN-10: 1-4641-2610-0; ISBN-13: 978-1-4641-2610-
- Garrett and Grisham. Biochemistry. (4th ed.). Thomson Brooks/Cole. ISBN101133108792 ISBN13 978-1133108795.

Instructional format

The course is subdivided into contextual topics which are covered during lectures and tutorial groups. Students are expected to participate actively in *Problem-Based-Learning* tutorial groups to acquire conceptual knowledge of Biochemistry in order to understand better the fundamentals of Health and Disease.

Assessment

A written mid-term and final examination (open questions).

CHE3001 Organic Reactions

Course coordinator

Dr. Hanne Diliën: Faculty of Science and Engineering, Maastricht Science Programme

Contact: hanne.dilien@maastrichtuniversity.nl

Pre-requisites

- ✓ CHE2001 Organic Chemistry
- ✓ CHE2004 Spectroscopy

Co-requisites

- ✓ PRA3001 Advanced Organic Synthesis

Objectives

- To provide a comprehensive overview of chemical reactivity.
- To understand the reactivity of most common functional groups.
- To be able to present detailed reaction mechanisms for typical organic reactions.
- To give the ability to design multi-step reaction sequences to obtain a specific organic compound.

Description of the course

This course focuses on chemical reactivity. In this course, a broad review will be presented of the most important functional groups and their reactivity. This review will describe the synthesis and reactivity of molecules, such as alcohols, aldehydes, ketones, carboxylic acids and amines. It will also discuss reactions involving orbitals, the so-called pericyclic reactions. Knowledge of the various types of organic reactions will provide the basic skills to design multistep synthesis sequences to obtain specific organic compounds. Furthermore, the reaction types will be placed in an appropriate context with regard to practical applicability and industrial processing. Finally, also theoretical aspects regarding reaction mechanisms will be presented.

Literature

Klein; "Organic Chemistry"; 2th edition; 2015; Wiley (ISBN: 9781118452288)

Instructional format

Lectures and tutorial group meetings. The tutorial group meetings will also be used to prepare with tasks for the co-requisite skill in advanced organic synthesis.

Assessment

1. Midterm examination, which consists of open questions and problems,
2. Final examination, which consists of open questions and problems,
3. A paper or presentation on multistep synthesis,
4. The contributions to the tutorial group meetings.

CHE3002 Transition Metal Chemistry

Course coordinator

Dr. Burgert Blom: Faculty of Science and Engineering, Maastricht Science Programme
Contact: burgert.blom@maastrichtuniversity.nl

Pre-requisites:

- ✓ CHE2001 Organic Chemistry
- ✓ CHE2002 Inorganic Chemistry

Recommended:

- ✓ CHE3001 Organic Reactions

Co-requisites:

- ✓ PRA3008 Transition Metal Chemistry

Objectives

- To build up on the student's knowledge of d-block elements acquired during Inorganic Chemistry (CHE 2002)
- To allow the student to gain deeper understanding of the electronic structure and properties of d-block elements
- A solid introduction and careful analysis of organometallic chemistry
- A survey of several important classes of compounds in organometallic chemistry
- Introduction and survey of state of the art spectroscopic techniques (for example EPR, ^{57}Fe Moessbauer, SQUID, etc.)
- To give the student a brief introduction to molecular catalysis
- Ultimately, to prepare the student for a Masters program in chemistry

Description of the course

This course is divided into 6 main themes over a 6 week period. Each week a different important class of organometallic compound will be discussed in terms of synthesis, structure, properties, and bonding. In addition the reactivity of each class of compound will be highlighted. Moreover, later in the course, advanced spectroscopic methods will be studied, including state of the art techniques such as EPR, ^{57}Fe Moessbauer, Magnetochemical techniques, such as SQUID, and others. An introduction to very contemporary and cutting edge themes in organometallic chemistry will be provided: innocent and non-innocent ligands, heavy alkene and alkyne monologues, and N-Heterocyclic Ylenes.

Literature

Robert H. Crabtree: The Organometallic Chemistry of the Transition Metals, Wiley (any edition will do)
Christoph Elschenbroich: Organometallics (any edition will do)
(Elschenbroichbook is considered the "Bible" of organometallic chemistry, and is worth investing in a copy.)

Instructional format

This will be a lecture-based course. The students will be expected to attend lecture one time per week and the corresponding tutorial meetings two times per week.

Assessment

Assessment for this course will be determined by the student's performance in a midterm and a final exam exclusively.

CHE3004 Modern Catalytic Chemistry

Course coordinator

Dr. Burgert Blom: Faculty of Science and Engineering, Maastricht Science Programme

Contact: burgert.blom@maastrichtuniversity.nl

Pre-requisites

- ✓ CHE2001 Organic Chemistry

Recommended

- ✓ CHE2002 Inorganic Chemistry
- ✓ CHE3001 Organic Reactions
- ✓ CHE3002 Transition Metal Chemistry

Co-requisites

None

Objectives

- To outline, describe and discuss the essential principles of catalysis.
- To provide a survey of the different types of chemical catalysis, to include transition metals, organocatalysis.
- To introduce the state-of-art in the field, illustrated by appropriate examples.
- To examine case studies of key reactions for the synthesis of fine chemicals.
- To provide the basis for the further studies in this rapidly-moving field, and to link catalysis to other areas of chemistry.

Description of the course

This course will provide a comprehensive introduction to the topic of catalysis, with a focus on homogeneous catalysis mediated by organometallic compounds; and emphasis on modern chemistry and key processes. Each week a different important and relevant catalytic process will be reviewed in detail: Polymerisation and selective oligomerisation; catalytic C-C coupling reactions; Hydroformylation (including the Monsanto process); Hydrosilylation (with modern developments) and other hydrometalation reactions; catalytic metathesis (alkene and alkyne), and their applications in some modern cases studies; etc. It is recommended that this course is taken after CHE 3002, or concurrent, as the key fundamental reaction steps are organometallic in nature.

Literature

To be determined amongst:

Organic Chemistry (Bruice), Inorganic Chemistry (Shriver and Atkins), Organic Chemistry, 2nd ed. (Clayden, Greeves, Warren), Catalysis in Asymmetric Synthesis, 2nd ed. (Caprio, Williams), Applied Organometallic Chemistry and Catalysis (Whyman). Primary scientific and patent literature as appropriate: Crabtree : The Organometallic Chemistry of the Transition Metals": N.B. C. Elschenbroich Organometallics

Instructional format

Lectures and tutorial group meetings.

Assessment

There will be a minimum of two points of assessment. Assessment points may include but may not be limited to any amongst: exams, take home problem sets, tutorial group participation, oral presentations, written assignments, and poster presentations.

CHE3005 Industrial Chemistry

Course coordinator

Dr. Katrien Bernaerts: Faculty of Science and Engineering, Biobased Materials

Contact: katrien.bernaerts@maastrichtuniversity.nl

Pre-requisites

- ✓ CHE2001 Organic Chemistry

Recommended

- ✓ CHE2002 Inorganic Chemistry

Objectives

- make the students familiar with chemical process industry;
- to gain knowledge of the basic industrial processes for basic organic and inorganic products;
- make the students understand the specific challenges industry copes with.

Description of the course

The main purpose of this course is to bring alive the concepts forming the basis of the chemical process industry. The production of chemicals entails specific solutions to problems related to process control, upscaling, energy use, unit operations, etc. which are often governing the choice of certain processes over other alternatives. Some insight in chemical reactors is required in order to fully appreciate industrial aspects of the production of organic as well as inorganic basic chemicals.
If there is an opportunity, the curriculum will be illustrated with a plant visit at Chemelot.

Literature

Recommended: "An introduction to industrial chemistry" by A. Heaton (Springer, 3rd edition, 1996).

Instructional format

Lectures and tutorial group meetings.

Assessment

1. A presentation about the company visit
2. A final examination, which consists of open questions
3. The contributions to the tutorial group meetings

CHE3006 Quantum Chemistry

Course coordinator

Dr. Fabrice Birembaut: Faculty of Science and Engineering, Maastricht Science Programme

Contact: fabrice.birembaut@maastrichtuniversity.nl

Pre-requisites

- ✓ MAT1007 Mathematical Tools for Scientists

Co-requisites

- ✓ none

Objectives

- To apply the quantum model to describe real chemical examples
- To predict some molecular properties by solving quantum chemistry equations
- To recognise and critique the failures of the model

Description of the course

This course will start by focusing on the basics of quantum chemistry and the solving of the Schrödinger equation and utilising it to describe the particle in a box model. We will then move forward and use the model to describe atoms and then diatomic molecules, linking it to the rise of quantum numbers. The course will then move onto valence chemistry and the LCAO model to predict some of the properties of diatomic molecules finishing with Hückel theory to demonstrate organic molecules' reactivity.

Literature

Physical Chemistry by Peter Atkins (please check edition with coordinator)

Molecular Quantum mechanics by Peter Atkins (optional)

Instructional format

Lectures and tutorial group meetings.

Assessment

1. A midterm examination (open book);
2. A final examination, which consists of open questions (oral, depending on the number of participants);
3. The contributions to the tutorial group meetings (50% peer reviewed, 50% assessed by tutor).

CHE3007 Advanced Physical Chemistry

Course coordinators

Dr. Fabrice Birembaut: Faculty of Science and Engineering, Maastricht Science Programme
Contact: fabrice.birembaut@maastrichtuniversity.nl

Pre-requisites

✓ MAT1007 – Mathematical Tools for Scientists

Recommended:

- Knowledge of quantum chemistry (either PHY2005 or CHE3006)
- Physical chemistry (CHE2003)

Co-requisites

✓ none

Objectives

By the end of the course students will be able to:

- Calculate kinetics data (rate, rate constants , activation energy etc)
- Use different methods in order to obtain the data aforementioned (steady state approximation…)
- Analyse the data and draw conclusions about the reaction schemes.
- Understand photochemistry
- Interpret photochemical analysis and conclude about the different processes involved.

Description of the course.

During this course we will further investigate kinetics and you will learn about different ways of working out the rate constant, especially through the steady state approximation. You will also analyse data and draw conclusions about the reaction scheme and the likely pathways that the reaction is taking. The second part of the course, which is also related to kinetics, will investigate photochemistry and you will be introduced to different processes that can emit light (Jablonski diagrams, fluorescence, phosphorescence…). The course will conclude with explaining those processes in terms of quantum chemistry.

Literature

Atkins – Physical chemistry, any edition, OUP.
Hollas – Modern Spectrocopy, any edition, Wiley

Instructional format

The course will be lectures and tutorials based

Assessment

Students will be assessed on participation, and through a midterm and final exams.

CHE3008 Analytical Science and Technology

Course coordinator

Prof. dr. Maarten Honing: Faculty of Health, Medicine & Life Sciences.

Contact: m.honing@maastrichtuniversity.nl

Pre-requisites

- ✓ CHE2001 Organic Chemistry
- ✓ CHE2004 Spectroscopy

Co-requisites

None

Objectives

- To gain an understanding of physical chemical properties of molecules in the liquid-, super critical- and gas-phase.
- To recognize various separation technologies and correlate the "physical chemical properties of molecules to the "mode of action" in gas- and liquid chromatography.
- To obtain an understanding of the physical chemistry fundaments in spectroscopic technologies, including UV/VIS, IR/Raman, MS and NMR.
- Create a fundamental understanding in "sampling, sample storage and sample pre-treatment" together with the basics of statistical methodologies.
- To gain insight in "Process Analytical Technologies" applied by in-, at and on-line detection technologies, regulatory requirements.
- To become familiar with quantification and molecular structure analysis of chemicals, metabolites, bio- and synthetic polymers using hyphenated technologies, e.g. liquid chromatography with flow-NMR.
- Obtain insight into different applications of analytical methodologies and acquire sufficient background for more advanced courses in polymer-, bio-chemistry and life sciences.

Description of the course

The emphasis of this course will be on a number of essential topics in analytical sciences and related to modern bio- and polymer chemistry, chemical- and biotechnological engineering. As a start, the course will touch on the basic physical chemical properties of molecules in different phases. The translation of these properties to the capability of modern separation and detection technologies will be made. In the final part, of the course focuses on the so-called hyphenation of the analytical technologies and their application in chemical and biological sciences, together with the basics of analytical statistics and method development. Typical topics in the course are based on the quantification and molecular structure assessment of chemical, biological relevant metabolites, bio- and synthetic polymers..

Literature

To be announced

Instructional format

Lectures and tutorial group meetings

Assessment

1. A midterm examination consisting of multiple choice, short answer, calculation and explanation questions
2. Weekly tutorials – attendance and contributions
3. A final (cumulative) examination consisting of short answer, calculation and explanation questions

INT1001 Introduction to Liberal Arts and Sciences

Course coordinators
Dr. Kasper Eersels, Dr. Feiyian Yoong and Dr. Marie C. Correia ; Faculty of Science and Engineering, Maastricht Science Programme

Contact:
kasper.eersels@maastrichtuniversity.nl
feiyian.yoong@maastrichtuniversity.nl
marie.correia@maastrichtuniversity.nl

Pre-requisites
- ✓ None

Co-requisites
- ✓ PRA1002 Research, Data Analysis and Presentation Academic Skills

Objectives
The objective of this course is to make you think about the natural sciences from a philosophical perspective: what is science; what is the scientific method? The course also challenges you to develop your intellectual and generic skills further: how to integrate different perspectives; what is ethical in science; how to communicate in/about science? To achieve these, the course has the following sub-objectives:

- To deepen your understanding of natural sciences by introducing you to different perspectives on science and scientific methodologies.
- To make you aware of what is needed to be a 'good' natural scientist. You are introduced to norms and values in scientific environments and challenged to think critically by offering diverging views on the topics discussed in the course.
- To equip you with the skills and knowledge required to communicate your knowledge and ideas effectively. You are stimulated to achieve these goals when working in teams.

Description of the course
Introduction to Liberal Arts & Sciences familiarizes you with the intellectual skills, the generic skills and the development of values and ethics inherent in the liberal arts & sciences tradition. The first part of the course aims at providing you with an understanding of the natural sciences from a philosophical perspective. What is science? What is the scientific methodology? What are the norms and values in a scientific environment? The variety of perspectives that you are introduced to when answering these questions will allow you to develop critical thinking skills and provide you with insight that can be used in your personal development as a scientist. After exploring the philosophy of science in the first part of the course, the second part teaches you to apply and communicate your knowledge and ideas effectively by devoting attention to argumentation and science communication.

Literature
All students are required to read:
Watson, J.D. (Author) & Jones, S. (Introduction), *The Double Helix, A Personal Account of The Discovery of the Structure of DNA,* ISBN: 978-0-7538-2843-4.
In addition, students will study a variety of articles and book chapters which will be made available online on a weekly basis.

Instructional format
This course is structured around 10 PBL assignments with weekly lectures to provide background to the topics discussed.

Assessment
Assessments in this course include an essay assignment, a peer review report, written preparation for a final group debate, tutorial participation, and a final group debate.

INT1002 Basic Principles of Pharmacology

Course coordinators

Dr. Ben Janssen: Faculty of Health, Medicine and Life Sciences, Department of Toxicology

Contact: B.Janssen@maastrichtuniversity.nl

Dr. Eric Vuurman : Faculty of Psychology & Neuroscience

Contact: Eric.Vuurman@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ None

Objectives

- To explain the basic principles of pharmacokinetics and pharmacodynamics of drugs.

Description of the course

Pharmacokinetics (what the body does to a drug) and pharmacodynamics (what a drug does to the body) describe basic principles that are important for predicting and understanding drug effects in the human body. Pharmacokinetics comprise the processes of drug absorption, distribution, metabolism and excretion. These processes are usually monitored by measuring drug concentrations in blood or blood plasma and evaluated in terms of clearance, volume of distribution, and elimination half-life. The kinetic principles are of particular importance for installing optimal drug therapy. The pharmacodynamic effects of a drug on the body depends on many factors such as differential drug actions at receptor sites, intracellular signalling, disease activity, ability of the body to compensate, therapeutics *versus* non therapeutic effects, dosing schedules, and patient adherence. The course will discuss the basic pharmacokinetic and pharmacodynamic principles of drugs that interfere with the autonomic nervous system in relation to blood pressure control. Additionally, the basic principles of drug metabolism and toxicity will be discussed for drugs influencing the central nervous system (antidepressants and antipsychotics).

Literature

Katzung BG et al. Basic and clinical pharmacology. McGraw Hill (13th edition), 2015, e-version via library.

Julien RM et al. A primer of Drug Action. Worth (12th edition).

Goodman and Gillman: The Pharmacological Basis of Therapeutics 12th edition, 2011 (on-line edition)

Instructional format

Lectures, tutorial groups, practical.

Assessment

Mid-term and final exam with multiple choice and essay questions.

INT1003 Introduction to Biomedical Engineering

Course coordinator

Dr. Federico De Martino: Faculty of Psychology & Neuroscience, Department of Experimental Psychology

Contact: f.demartino@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ None

Objectives

To provide an overview of the different fields of biomedical engineering.

Description of the course

Biomedical engineering is a highly interdisciplinary field at the interface between engineering and medicine and biology. In biomedical engineering, principles and methodologies typical of engineering are applied to solve problems from the medical and biological sciences. This course will introduce (some of) the subdisciplines within biomedical engineering, including systems physiology, bio-instrumentation, bio-medical signal analysis and bio-medical imaging. General issues of each of the subdisciplines will be illustrated together with selected examples and neuroscience applications.

Literature

Various book chapters and research articles

Instructional format

Lecture, lab visits and tutorial meeting

Assessment

Participation during tutorials, midterm presentation/report and final written exam.

INT1005 Commercializing Science and Technology

Course coordinator

Chris Sparks, Maastricht Centre for Entrepreneurship

Contact: c.sparks@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ None

Objectives

- Understand how science-based research and technological inventions can be transformed into new business, either in the context of a start-up or in established companies
- To foster an entrepreneurial spirit

Description of the course

The course Commercializing Science & Technology aims to help you understand and master core challenges of turning science into products and ultimately operating businesses. In so doing, we will adopt a strongly entrepreneurial lens. That means, we will look at important technology commercialization activities through the eyes of a potential technology entrepreneur.

One of the most important tasks entrepreneurs have to perform is to understand the full range of potential opportunities that can be created based on their technological competences and to what extent they have freedom to operate (IP) within chosen markets. However, the identification and validation of market opportunities is only the beginning. Successful technology commercialization also requires an understanding of the different business model options and how to structure market entry strategies such that they support moving along the technology learning curve and the diffusion of innovative products. Therefore, this course puts major emphasis on the entrepreneurial competencies, tools, and methodologies, as opposed to technological competences, in early-stage commercialization processes.

The competencies you will acquire throughout this course will be extremely valuable whether you choose an entrepreneurial career or a career in managing technology in an established firm or within a public or private research lab.

Literature

We will provide a reader with suggested academic papers and case materials.

Instructional format

This course is taught through a combination of regular problem based learning, interactive case lectures and a field project that will challenge you to apply your newly acquired knowledge to realistic problem situations of technology entrepreneurs.

Assessment

Your final score will consist of four components*:

1) Participation

2) Field project reports

3) Final presentation on field project

4) Class facilitation & topical presentations on entrepreneurial methodologies, mind sets, and tools.

*Subject to change on an annual basis

INT1006 Sustainable Development

Note: this course replaces INT2002 Science and Sustainable Development. If you have successfully completed INT2002 you may not participate in INT1006.

Course coordinator

Dr. Maud Huynen, ICIS, Faculty of Science and Engineering, Maastricht University.
Contact: m.huynen@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ None

Objectives

- To gain a basic understanding of the (various perspectives on the) concept of sustainable development and some of the main related ideas, concepts and theories.
- To gain insights into (the limits to) our immense global human impact on the earth's systems and the underlying drivers of these unsustainable trends
- To explore ideas about how to achieve a more sustainable society.

Description of the course

Today it is acknowledged that achieving sustainable development at the local, regional and global scale is one of the greatest challenges for the 21st century. But in many cases the term 'sustainable development' functions as little more than a vacuous buzzword. So what does sustainable development actually mean? How unsustainable is our global society at the moment? Are we contributing to irreversible climate change? Are we already passing dangerous global environmental tipping points? Why are humans acting in such unsustainable ways? And, of course, what are sustainable ways forward?

This course aims to enhance student's understanding of 'sustainable development', based on the notion that human development can only be sustainable when environmental boundaries are respected. The course introduces the main concepts, ideas and theories related to the term sustainable development. Students will gain insights into (the limits to) humanity's immense impact on the earth's systems and the underlying drivers of these unsustainable trends. Furthermore, sustainable development requires an understanding that inaction has consequences. Students will explore ideas about how to achieve a more sustainable society. As part of the examination students will link theories/concepts/ideas discussed in the course to a self-selected case study (a promising way forward towards sustainability) in a poster presentation.

Literature

E-Readers.

Instructional format

Tutorial group meetings and lectures.

Assessment

Practical assignment (poster presentation), written exams.

INT2001 Nanomaterial Science and Technology

Course coordinator

Cyriel Mentink PhD: Chemelot Innovation and Learning Labs

Contact: cyriel.mentink@chillabs.nl

Pre-requisites

- ✓ PHY1001 Elements of Physics

Co-requisites

- ✓ none

Objectives

- To have an understanding of the potential of nanotechnology and a keen insight in the latest developments of nanotechology
- To have an understanding of some of the major synthetic routes to obtain nanomaterials
- To obtain an understanding of the analytical methods needed for the analysis and characterisation of nanomaterials
- To have an understanding of potential environmental and human health impacts of nanomaterials
- To be familiar with the use of nanoparticles in the application field of coatings.

Description of the course

This course will start with an overview on the potential use of nanotechnology and materials. Secondly the production of nanomaterials by the so-called bottom-up and top-down method will be discussed. Working with nanomaterials demands a variety of high-end analytical techniques. By looking at the principles of these techniques a better insight will be obtained on their use and restrictions. Nanomaterials are made for specific applications or with specific properties. Two distinct examples will be discussed namely, stimuli responsive materials and anti-reflective coatings. As most nanomaterials will have different physical properties as their bulk counterpart the potential environmental and human health impacts has to be assessed. In this part of the course an overview of the discussion on this impact will be presented.

Literature

Will be based on a collection of relevant scientific papers and textbooks.

Instructional format

Lectures and tutorial group meetings.

Assessment

1. A review paper one of the topics of this course
2. A PowerPoint presentation on one of the topics of this course,
3. The contributions to the tutorial group meetings.

INT2007 Science in Action

Course coordinator

Andreas Mitzschke, Faculty of Arts and Social Sciences, Department of Technology & Society Studies
Contact: andreas.mitzschke@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ None

Objectives

By the end of this course students should be able to:

- describe the contemporary social, economic, political, and cultural dynamics of knowledge production in the sciences.
- Identify the complexities of how scientific knowledge is distributed, communitcated and debated in society
- critically analyze 'common sense' views of the making and use of scientific claims.

Description of the course

This course is situated in the field of Science and Technology Studies (STS) and analyses the social and cultural complexities involved in the production and dissimination of scientific knowledge. Scientific knowledge production and technological developments to not take place in a social, cultural, political, or economic vaccum. On the contrary, this course shows how these forces play inextricable roles in the practice and production of science. As our point of departure we critically engage with notions of progress inherent in much of modern science. We then look begin to look at the organization of knowledge production and its collaborative character from an STS perspective. We also study processes in which credible facts are established and published. Furthermore, this course also pays attention to the integrity of science and in particular its grey areas. Beside the immediate context in which scientific facts are established (i.e. the lab), the course also takes into account the wider socio-economic context in which science operates. This involves not only the commercialization of science, but also the way its promises and expectations are related to our hopes and fears. Finally, you will gain insights into the way the cultural-historical contexts affects the interpretation of facts. Based on discussions and analyses of these topics the course aims to make you reflect critically on 'common sense' views of the making and use of knowledge production, the construction of scientific facts and the notion of objectivity.

Besides tutorial meetings, the course also involves lectures, discussion meetings, video analysis, and a visit to a scientific lab for an interview

Literature

- E-Reader.
- UM library.

Instructional format

Tutorial group meetings, lectures, video analyses, and an interview of a researcher

Assessment

Participation in -and preparation of- discussions and assignments (team/individual), interview report, a final presentation and a final paper are part of the examination.

INT2008 Molecular Toxicology

Course coordinator

Dr Gertjan den Hartog: Faculty of Health, Medicine and Life Sciences Maastricht University

Contact: gj.denhartog@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ None

Objectives

- To gain knowledge on experimental approaches to identify and quantify metabolites, reactive intermediates and their selective interaction with specific cellular target molecules (selective toxicity)
- To get acquainted with the procedures applied to assess the toxicity of drugs and chemicals.
- To understand the role of bioactivation and bio-inactivation in the toxicity of drugs and other xenobiotics.
- To be able to apply strategies used to predict toxicity
- To understand strategies to reduce or prevent toxicity
- To understand risk factors involved in inter-individual susceptibility to xenobiotics, including genetic polymorphisms, drug-drug and food-drug interactions.

Description of the course

Human molecular toxicology studies the molecular mechanisms underlying toxicity of compounds in man. The conversion to reactive intermediates and metabolites is key in the actual toxicity of compounds. Therefore, the role of metabolism in the formation of metabolites and reactive intermediates and the protection against these species is extensively addressed. Moreover, compounds generally display a toxicity that is restricted to a specific organ and type of toxicity. This concept of selective toxicity is elaborated. Focus is on redox-controlled processes in biotransformation and in modulation of cell function. Topics include a survey of the molecular mechanisms determining (selective) toxicity; the versatility of enzymes, such as cytochrome P450 and glutathione S-transferases in the biotranformation of compounds; consequences of genetic polymorphisms of biotransformation enzymes; chemical and biological properties of various classes of reactive intermediates; structure-activity relationships and other approaches applied to predict metabolism; and strategies to reduce toxicity.

Literature

A selection of scientific papers will be provided during the course.

Instructional format

Lectures, short practical and tutorial group meetings.

Assessment

1. A final examination, which consists of open questions and multiple choise questions,
2. A presentation on a selected topic,
3. The contributions to the tutorial group meetings.

INT3001 The Philosophy of Technology

Course coordinator

Dr. Tamar Sharon: Faculty of Arts and Social Sciences

Contact: tamar.sharon@maastrichtuniversity.nl

Pre-requisites

- ✓ PRO1001 Philosophy of Science

Co-requisites

- ✓ None

Objectives

- To teach students to think critically about the social, political and ethical impacts of technology and science on the contemporary world.
- To introduce a number of key thinkers, approaches and themes in the philosophy of technology.
- To grasp the important contribution philosophy can make to understanding technological and scientific developments.
- To further acquaint students, following course PRO1001, with humanistic interpretations and analyses of science and technology.

Description of the course

Technology is everywhere. From care robots to GMOs, from the internet to genome sequencing – it impacts every aspect of our lives, from how we care for each other, to what we eat, what we know and how we age. Technological innovations usually come with a series of bright promises: robots will reduce tedious manual labor; medical innovations will help eliminate disease; the internet will democratize society and foster peace. But history teaches us that well-intentioned scientific and technological developments rarely do only what they set out to do. They often have unforeseen consequences and contribute to far-reaching transformations of our scientific and social worlds. Can we try to anticipate these transformations? Are there recurrent promises and societal impacts that we can identify? Can we steer technological development in a certain direction? What is the relationship between technology, society and the good life? This course offers an overview of the main themes and approaches in the philosophy of technology, to help you learn to reflect critically on how techno-scientific innovations impact society. We will study key classic and modern philosophers of technology and apply their work to new and emerging science and technology, including: the use of genetic screening and psycho-pharmaceuticals for enhancement purposes, the role of artificial intelligence in the automation of work, and the use of the smart technologies in medical and other types of surveillance.

Literature

A list of readings will be provided in the course manual; additional readings to be found by students.

Instructional format

Lectures and tutorial group meetings.

Assessment

1. Preparation of reading material and active participation in group discussions.
2. Participation in a debate that will take place in class.
3. A final written exam on issues, literature and perspectives discussed in the course.

INT3002 Advanced Microscopy: Theory and Applications

Course coordinator

Prof. Dr. Marc van Zandvoort
Contact: mamj.vanzandvoort@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Recommended

- ✓ PHY1001 Elements of Physics

Co-requisites

- ✓ None

Objectives

- To acquaint the student with an understanding of principles of optical microscopy and limiting factors in resolution
- To introduce and detail a number of microscope techniques and the theory behind them
- To discuss the factors that limit contrast, resolution, and penetration depth of these techniques
- To explain sample preparation procedures
- To have hands-on experience with each of the techniques

Description of the course

The use of advanced imaging techniques in light microscopy is wide-spread, particularly in the fields of material science, chemistry, and biomedical imaging. In recent years, the resolution and/or functionality of such tools has been increased due to the development of (confocal) fluorescence microscopy, spectral fluorescence microscopy, two-photon excitation microscopy, and stimulation emission depletion (STED) microscopy [first experimentally shown by the winners of the 2014 Nobel Prize in Chemistry]. Together with rapid developments in aberration correction and in image analysis, this allows users to understand much more about the samples they are investigating. This course will introduce a number of advanced imaging techniques to participants, detailing theoretical aspects as well as practical considerations. There will be ample possibility to work on the discussed microscope equipment. This course is aimed at any student from the programme with an interest in imaging and its principles.

Literature

TBC

Instructional format

This course follows the Problem-Based Learning (PBL) method. Each week of this course, one of the microscope techniques takes central stage, first in a lecture, then in two tutorial meetings. During these tutorial meetings participants will combine hands-on practical experience and PBL to solve problems and case studies in the field of microscopy. This way, optimal understanding of both optical theory and its applications in the natural sciences is achieved. Lectures and PBL are given at the advanced optical microscopy facilities of the Faculty of Health, Medicine, and Lifesciences.

Assessment

Will consist of the combination of

- one resultant grade for all weekly assignments, and
- one grade for a final assignment at the end of the course

INT3003 Biomaterials

Course coordinator

Prof. P. Habibovic, Department of Instructive Biomaterials Engineering, MERLN Institute for Technology-Inspired Regenerative Medicine, Maastricht University;
Contact: p.habibovic@maastrichtuniversity.nl

Pre-requisites

- ✓ CHE2001 Organic Chemistry

Co-requisites

- ✓ None

Objectives

- To provide an overview of all materials that are used in biomedical applications.
- To understand the synthesis and structure of different biomaterials; metals, ceramics, polymers, and composites thereof.
- To introduce the student to the evaluation, characterization, and testing of biomaterials.
- To provide a detailed understanding of the interaction of biomaterials with surrounding tissues and the complete organism.

Description of the course

What makes a material a biomaterial? The overall objective of the course Biomaterials is for the student to gain insight in the role that properties of materials can play in solving biomedical problems. Relevant questions in this context are: which requirements need to be met to render a material suitable for biomedical applications? Which biomedical problem is to be solved, and which material offers the best solution? What is the current state-of-the-art? What are the most promising developments?
A biomaterial is defined as "any substance or combination of substances, other than drugs, synthetic or natural in origin, which can be used for any period of time, which augments or replaces partially or totally any tissue, organ or function of the body, in order to maintain or improve the quality of life of the individual". In this course, the exact structure and physico-chemical characteristics of various biomaterials (metals, ceramics, polymers, composites) will be explained. For instance, the composition, degradation behavior and mechanical properties are important parameters. The techniques that are used to evaluate the physico-chemical characteristics of biomaterials are, consequently, an important subject. Furthermore, the interactions between different biomaterials and the biological environment (cells, extracellular matrix, tissues, organs) will be studied. The concepts of biocompatibility, bioinertness and bioactivity will be introduced, as well as various methods used to determine the biological response to a biomaterial.

Literature

To be determined, will be announced later.

Instructional format

Lectures, tutorial groups meetings and a small research based project using literature resources.

Examination

1) A final examination with open questions; 2) a poster presentation on the short project concerning biomaterials research

INT3005 Biobased Materials and Technology

Course coordinator

Dr. Yvonne van der Meer (Yvonne.vandermeer@maastrichtuniversity.nl)

Dr. Ketie Saralidze (k.saralidze@maastrichtuniversity.nl)

Recommended

- ✓ CHE2001 Organic chemistry (strongly recommended)

Objectives

- To understand what biobased materials are and what their impact is on society
- To create an understanding of sources of biobased intermediates, building blocks and materials
- Get an insight into the synthesis and production methods of intermediates, building blocks and biobased materials
- To deepen understanding of the relation between material composition, properties and material applications
- To study the added value (if any) of biobased materials
- To study the impact of biobased materials and technologies on the environment (biodegradation, sustainability, carbon footprint)

Description of the course

Presently, a transition from petrol-based to a more sustainable and biobased society is taking place. This change is driven by the concern about climate change and the anticipated depletion of fossil-reserves. This creates an opportunity to not only replace currently made plastics and polymers with sustainable biobased alternatives, but also to produce new materials with additional useful functionalities derived from biological renewable sources. This requires a multidisciplinary approach in which production of biological resources, their processing and possible modification are first steps. New technologies may be required to indeed obtain the right methods and synthesis routes to produce the new biobased materials for applications in healthcare, consumer products and other applications. In this course the different aspects of the field of biobased materials will be studied. The aim is to create a critical, but also creative attitude towards biobased materials and technologies in general. The students should be able to recognize the challenges and possibilities with respect to materials in the transition towards a biobased economy and society.

Literature

A list of selected papers will be provided in the course manual.

Instructional format

Lectures, guest lectures and tutorial group meetings.

Assessment

1. A written exam.
2. Presentation + discussion session on a particular Biobased material/technology; (at least 45-60 minutes)
3. Peer review report of assigned presentation.

INT3006 Creativity and Concept Development of New Business

Note: this course replaces PRA3004 Creativity and Concept Development of New Business. If you have successfully completed PRA3004 you may not participate in INT3006.

Course coordinators

Danielle Dols and Irina Burlacu, Faculty of Science and Engineering, Maastricht Science Programme

Contact: danielle.dols@maastrichtuniversity.nl
irina.burlacu@maastrichtuniversity.nl

Pre-requisites

- ✓ INT1005 Commercialising Science and Technology

Co-requisites

- ✓ None

Objectives

- To understand the fundamental steps from a creative academic idea towards a business
- To be able to apply creativity techniques to problem solving
- To understand how creativity can be used to transform technology into product concepts.
- To be able to draft value propositions and business models that result from product ideation.

Description of the course

With a series of guest lectures by external experts, this course will built on the basics covered in INT1005 Commercialising Science and Technology. It is not an ordinary course, but a step by step process in which we present a series of key players we will come across as academics when we try to bring an academic idea to the market. After all, it is often challenging to find commercial promise for new materials and technologies. Currently, we as course coordinators are trying to commercialize our ideas and inventions. We want to share our experiences and the people we met on the way, with you as potential future entrepreneurs.

Novel materials and technologies are typically developed in research labs at universities and companies. A key role of both technology transfer office and corporate R&D-labs is to translate these novel concepts into new products and new business. Customer feedback may also trigger product and business development. Envisioning how novel technology can be used to develop and market new products is an inherently creative process that should not only be mastered by entrepreneurs and business developers, but also by scientists and technologists. Topics covered will be creativity, IP, finances, academic technology transfer, business models and testimonials from actual people who have started commercially viable businesses.

Literature

- None

Instructional format

Lectures, tutorial group meetings and project presentations

Assessment

1. A group based reflection paper halfway during the course
2. A group based PowerPoint presentation summarizing a business plan how the group expects to convert a creative academic idea into a business opportunity
3. A final individual examination

INT3007 Systems Biology

Course coordinator

Martina Summer-Kutmon, Department of Bioinformatics (BiGCat) / Maastricht Centre for Systems Biology (MaCSBio);
Contact: martina.kutmon@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ None

Recommended

- ✓ MAT2004 Linear Algebra
- ✓ MAT2006 Calculus
- ✓ BIO2001 Cell Biology

Objectives

- To give an overview of the relevant areas of Systems Biology
- Studying relevant Mathematical and Computational techniques
- Understanding complex and multiscale Biological processes
- Learning students to apply this knowledge in concrete biomedical contexts
- Integrate mathematical and biological concepts
- To introduce the student to the major Systems Biology tools and software.

Description of the course

With the progress of genome sequencing and other -omics technologies, a wealth of multilevel data on the molecular nature of biological systems has been generated. Although systems are composed of elements, the essence of a system lies in its dynamics and interactions. It is evident that neither the biologist nor the mathematician is capable of integrating their current expertise and knowledge in the required way. That is the gap systems biology has to fill. Systems biology is a new approach to biological and biomedical research based on a more holistic perspective and relying on the use of mathematical and computational models, complementing experiments in the lab.
The goal of this course is to provide an overview of systems biology and its building blocks, experimental approaches, and a variety of mathematical models and tools. Students will be introduced to the mathematical basis of evolution, dynamic systems, networks, and constraint based modelling. We discuss many examples from amongst others cancer metabolism, diabetes, and neuroscience. Practical skills will be trained by carrying out computer experiments. Successful participation at this course is the perfect preparation for a Master in Systems Biology.

Literature

Hand-outs will be distributed during the course. Recommended Literature:
Eberhard O. Voit, A first course in systems biology, 2013, Taylor & Francis Group, ISBN 978-0-8153-4467-4.
Bernhard O. Palsson, Systems Biolog – Constraint-based Reconstruction and Analysis, 2015, Cambridge University Press, ISBN 978-1-107-03885-1.

Instructional format

Lectures and tutorial group meetings, including computer classes.

Assessment

1. A final examination, which consists of open questions.
2. Hand-ins of assignments from the tutorial group meetings.

INT3008 Regenerative Medicine

Course coordinator

Prof. L. Moroni, MERLN Institute for Technology-Inspired Regenerative Medicine, Complex Tissue Regeneration Group, FHML, Maastricht University;
Contact: l.moroni@maastrichtuniversity.nl

Pre-requisites

- ✓ BIO2001 Cell Biology
- ✓ CHE2001 Organic Chemistry

Co-requisites

- ✓ None

Objectives

The objectives of the course "Regenerative Medicine" are to introduce students to classic and novel concepts at the base of strategies to regenerate tissues and organs. The courses will briefly overview the biomaterial classes used to fabricate scaffolds and the processing technologies used for fabrication. Further insights on cell sources and cell nutrition will be explained. Different applications will be discussed spanning from skin to skeletal tissues and organ regeneration. After attending the course, students will be able to understand:

- biomaterials and processing technologies used to fabricate scaffolds for tissue engineering;
- cell sources and activity;
- cell nutrient limitations in engineered tissues and technologies used to enhance cell viability;
- successful and unsuccessful strategies to regenerate tissue and organs;
- ethical principles revolving around regenerative medicine and clinical applications.

Description of the course

Regenerative medicine has been defined as an interdisciplinary field that integrates principles of engineering and life sciences to develop biological substitutes that restore, maintain, or improve tissue and organ functions. Three main gears are generally needed to achieve tissue regeneration: cell-based therapies, tissue-inducing factors, and biocompatible matrices or scaffolds. These components have been investigated singularly or in combination to create engineered tissues. Regenerative medicine research includes the following areas:

- Biomaterials: including novel biomaterials that are designed to direct the organization, growth, and differentiation of cells in the process of forming functional tissue by providing both physical and chemical cues.
- Cells: including enabling methodologies for the proliferation and differentiation of cells, acquiring the appropriate source of cells such as autologous cells, allogeneic cells, xenogeneic cells, stem cells, genetically engineered cells, and immunological manipulation.
- Biomolecules: including growth and other differentiating factors.
- Engineering design aspects: including 2D cell expansion, 3D tissue growth, bioreactors, vascularization, cell and tissue storage and shipping (biological packaging).
- Biomechanical aspects of design: including properties of native tissues, identification of minimum properties required for engineered tissues, mechanical signals regulating engineered tissues, and efficacy and safety of engineered tissues

In this course, we will introduce most of these elements through some examples that have already successfully reached the clinics and others that have still to be further improved to enter daily clinical practices.

Literature

"Tissue Engineering", editors J. de Boer and C.A. van Blitterwijk, Academic Press Series in Biomedical Engineering, Elsevier Inc (2015).
"Principles of Regenerative Medicine", editors A. Atala, R. Lanza, J.A. Thomson, and R.M. Nerem, Elsevier Inc (2008).

Instructional format

Lectures, tutorial groups meetings, a small research based project using literature resources.

Examination

1) A final examination, which consists of a mixture of open and multiple choice questions; 2a) a written report and 2b) oral presentation on the short project concerning regenerative medicine research.

INT3009 Chemical Ecology

*PLEASE NOTE: This new course will start in **2018-2019** and will only run in alternate years (even), alternating with BIO3002 Ecophysiology (odd)*

Course coordinator

Dr. John Sloggett: Faculty of Science and Engineering, Maastricht Science Programme
Contact: j.sloggett@maastrichtuniversity.nl

Pre-requisites

- ✓ BIO2001 Cell Biology
- ✓ CHE2001 Organic Chemistry

Co-requisites

- ✓ None

Objectives

- To understand what chemical ecology is
- To gain a knowledge of the chemical bases of a diversity of intraspecific and interspecific interactions
- To understand the contributions that both chemists and biologists make to chemical ecology
- To understand a variety of the methodological techniques used in chemical ecology
- To understand how semiochemicals may be used in human endeavours such as pest control

Description of the course

Chemical ecology is the study of how chemicals, called semiochemicals, mediate interactions within and between species. In this course we will examine how the different classes of semiochemicals are used by organisms. We will examine how chemists and biologists study these interactions and how some of these interactions can be used to assist humans, by manipulating organisms in the nature.

Literature

Scientific papers

Instructional format

Lectures, tutorial sessions and seminars.

Assessment

TBA

INT3010 Science and the visual arts

Course coordinator

Prof. Renée van de Vall, Faculty of Arts & Social Sciences

Contact: r.vandevall@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ None

Objectives

- To get acquainted with an important field of applied scientific research: conservation science
- To obtain understanding of the historical development of conservation science as a discipline and profession.
- To obtain understanding of how scientific practices function in cultural contexts such as fine arts conservation.
- To recognise the debates and controversies scientific research and its applications may raise in the context of the arts.
- To acquire some hands-on experience with the laboratory practice of fine arts conservation.

Description of the course

This course is ideal for students who are interested in the broad application of science and in the interaction between science and the fine arts. Contemporary conservation of paintings, sculptures and other works of visual art is unthinkable without the natural sciences. Scientists investigate the behaviour of paints and other materials such as plastics in order to prevent or repair degradation. Sophisticated spectroscopic techniques are employed to look through paint layers and discover hidden information. Laboratory analytical techniques are used to identify and help characterise materials used by artists to create art works and those used by conservators to repair them. Time and again, however, the question is raised how the information provided through these techniques relates to the aesthetics of the artworks. This course will trace the breaking of disciplinary boundaries; the growing impact of the sciences in fine art conservation and how it has reframed the way museums define their task of preserving and presenting cultural heritage. Actual case histories, like the much disputed restoration of Barnett Newman's painting Who is Afraid of Red, Yellow and Blue III and the interdisciplinary research project around Mondrian's Victory Boogy Woogy will illustrate both the tensions and the fruitful collaborations between the scientific and the aesthetic approaches to art. This course is developed together with the Stichting Restauratie Atelier Limburg (SRAL: http://www.sral.nl/en)) and is an unique opportunity to work with professional experts from a wide array of disciplines. Theoretical discussions are provided context through practical sessions given at the SRAL studios by their conservation staff. Students will handle art works, investigating their materiality and discover the manner in which they are constructed using non-invasive non-destructive analytical techniques and equipment.

Literature

Selected articles and chapters will be provided to the students

Instructional format

Lectures, tutorial group meetings, conservation studio workshops and practical exercises.

Assessment

1. A final examination, which consists of essay questions,
2. A PowerPoint presentation on a selected conservation problem,
3. A mid-term examination,
4. The contributions to the tutorial group meetings.

MAT1006 Applied Statistics

Course coordinator

Dr. J. Schepers, Department of Methodology & Statistics, FPN, Maastricht University;
contact: jan.schepers@maastrichtuniversity.nl
Dr. A. Cassese, Department of Methodology & Statistics, FPN, Maastricht University;
contact: alberto.cassese@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ None

Objectives

- To enhance students' understanding of the basics of inferential statistics.
- To broaden the scope of statistical methods that students are acquainted with by introducing a number of widely used applied tests that were not covered in PRA1002.
- To understand how researchers determine required sample sizes for a number of (simple) designs and to be able to apply these methods.
- To familiarize students with statistical software, so that they can independently run the analyses that are covered in this course and are able to correctly interpret the corresponding output.

Description of the course

At the end of this course, students should be familiar with the basic concepts of inferential statistics, and will be able to perform basic statistical analysis in a variety of scenarios.
In most scientific research, researchers have to deal with the problem of drawing conclusions about some population characteristic of interest, relying only on a sample of observations from that population. Inferential statistics is a way to tackle this problem. This course starts by covering the foundations of inferential statistics, emphasizing the logic behind the statistical reasoning process. This logic is then employed to explain a number of widely used applied statistical methods: ANOVA, Chi-square, Nonparametric tests and multiple regression. Students will learn how to run each of these methods using the statistical software package SPSS. Additionally, they will learn how to determine the required number of observations needed to be able to show, with a fixed probability, a specified research hypothesis.

Literature

Suggested: Statistics for the Life Sciences (5th ed.) by Samuels, M.L., Witmer, J.A. & Schaffner, A. Publisher: Pearson (2016).

Instructional format

Lectures and tutorial groups meetings.

Examination

A midterm assignment (topics: weeks 1 through 3) and a final exam (topics: week 1 through 6).

MAT1007 Mathematical tools for scientists

Course coordinator

Dr. Chris Pawley, Faculty of Science and Engineering, Maastricht Science Programme

Contact: c.pawley@maastrichtuniversity.nl

Pre-requisites

✓ None

Co-requisites

✓ None

Note: It is not intended that this course be a pre-requisite for further mathematics courses.

Objectives

- To acquire an understanding of mathematical tools that are useful in solving problems within the Natural Sciences.
- To be able to apply these tools to appropriate situations and correctly evaluate numerical solutions.
- To gain an appreciation of the suitability for using mathematical tools in certain scientific situations and develop a lifelong appreciation for the use of mathematics in science.

Description of the course

This course builds on the material in PHY1002 and introduces some new concepts that are important in many natural sciences. It is most suitable for students interested in taking non-mathematical focused courses who want to further their understanding of mathematics. (Physics, mathematics and computer science focused students should expect to take other Mathematics courses – rather than this one).
The topics covered include further differentiation and integration, differential equations, mathematical series, exponential decay and growth. Some vectors and matrices may be covered, as well as an introduction to linear algebra. This course will focus on the application of mathematical tools to problems which are challenging or impractical to solve without them.

Literature

Calculus Volume 1 from OpenStax, ISBN 193816802X, www.openstax.org/details/calculus-volume-1
Calculus Volume 2 from OpenStax, ISBN 1938168062, www.openstax.org/details/calculus-volume-2
Calculus Volume 3 from OpenStax, ISBN 1938168070, www.openstax.org/details/calculus-volume-3

Other open source mathematical literature will be used as required to supplement the above texts.

Instructional format

This course follows a derivative of the Problem-Based Learning (PBL) method. Each week of this course consists of a lecture and two tutorial meetings. In parallel to these there will also be 'individual exercises' to be completed outside of the classroom.

Assessment

Problem sheets, final examination

MAT2002 Optimization

Course coordinator

Dr. Carlo Galuzzi, Faculty of Science and Engineering, Department of Data Science and Knowledge Engineering.
Contact: c.galuzzi@maastrichtuniversity.nl

Pre-requisites

- ✓ MAT1002 or MAT2004 Linear Algebra

Recommended

In addition it is useful to have a basic understanding of approximation by Taylor series. Student should have basic knowledge in calculus, especially in derivatives.

Co-requisites

- ✓ None

Objectives

- To become familiar with the basic concepts and methods of optimization.
- To understand how techniques from calculus and linear algebra are useful for optimization.
- To become familiar with a diversity of optimization problems and solution techniques.
- To be able to cast certain real-world problems into the form of optimization problems.
- To be able to solve certain optimization problems with software (Matlab).

Description of the course

Optimization occurs in most branches of science and in many different forms. In this course we address the most common and basic optimization techniques. First we consider unconstrained functions in several variables. We discuss stationary points and optima, and provide analytical methods based on solving systems of equations. Computer implementations use iterative numerical techniques (gradient methods and hill climbing, Newton methods, etc.). We put some emphasis on least squares problems. These are often encountered in the context of fitting models to measurement data. Next we address linear functions subject to linear constraints, which give linear programming problems. These have many applications, and several solution methods are available (e.g., the simplex algorithm, interior point methods and primal-dual methods). We discuss many examples and exercises. To demonstrate the wide range of applicability, these are taken from different fields of science and engineering.

Literature

Hand-outs will be distributed during the course.
Recommended literature:

- F.S. Hillier and G.J. Lieberman: Introduction to Operations Research (10th edition). McGraw-Hill, 2015 ISBN 978-0-07-352345-3.
- A.D. Belegundu and T.R. Chandrupatla: Optimization Concepts and Applications in Engineering (2nd ed.). Cambridge university Press, 2011.

Instructional format

Lectures and exercises, including one computer class with Matlab, in order to study optimization in a mixed and interactive way.

Assessment

Two homework assignments (10% of the final grade, each), a written midterm (40% of the final grade) and a written final exam (40% of the final grade) with open questions.

MAT2004 Linear Algebra

Course coordinator

Ronald Westra, Faculty of Science and Engineering, Department of Data Science and Knowledge Engineering
contact: rachel.cavill@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ None

Objectives

In this course we provide an introduction to the main topics of linear algebra. Emphasis is on an understanding of the basic concepts and techniques, and on developing the practical, computational skills to solve problems from a wide range of application areas.

Description of the course

Linear algebra is incredibly useful in many fields from computer graphics to chemistry and biology. The lectures and tutorials will include examples from many areas of science, and the recommended textbook contains even more examples from a wider range of applications.

Throughout the course we maintain a strong emphasis on the geometrical interpretations, illustrating our understanding of the mathematics at play.

We start with matrices, and their usages. We then look at linear transformations and move into vector spaces. We build up to understanding and calculating eigenvalues and eigenvectors, we then look at how to simplify large matrices through techniques such as diagonalization and finish the course glimpsing at how linear algebra is used in data analysis across the modern sciences.

Literature

Lay, David C. (2012). *Linear Algebra and Its Applications.* (4th ed.). Pearson.
ISBN 13: 978-0-321-62335-5

Instructional format

There are two 2hr lectures per week and one tutorial class. The tutorial class uses a mixture of case studies and sets of questions like those seen on the exams.

Assessment

There will be two written exams on parts of the course. The first of these takes place around the midpoint of the course, and the second in the last week of the course. For those who do not pass these tests and are eligible for a resit according to MSP's rules and regulations, there will be a resit exam provided on the entire course in the resit week.

MAT2005 Statistics

Note: this course replaces MAT1003 Statistics. If you have successfully completed MAT1003 you may not participate in MAT2005.

Course coordinator

Dr. Kateřina Staňková: Faculty of Science and Engineering, Department of Data Science and Knowledge Engineering
Contact: k.stankova@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ None

Objectives

- To have deep understanding of fundamental concepts in probability and statistics, including how these concepts are derived, why they are useful, what assumptions you have to pose when applying them, etc.
- To be familiar with the most frequently used probability distributions/densities and statistical procedures (statistical estimation and hypothesis tests), here again with focus on the deep understanding as opposed to approaching these concepts as a "black box" or a "recipe".
- To develop a critical thinking when deciding whether certain statistical procedure is the most suitable for a certain problem, as opposed to blindly applying a pre-specified procedure.
- To be able to read and summarize scientific articles in applied probability/statistics.

Description of the course

Many real-life situations involve uncertainty and give rise to problems in the fields of probability theory or statistics. In this course, the focus will be on the deep understanding of tools which are necessary to analyse such situations. Firstly, we will address (or refresh) basics of probability theory and the underlying combinatorial principles, because it is impossible to properly understand statistical concepts without understanding probability and its mathematical foundations. Subsequently, we will focus on (both discrete and continuous) random variables, concepts of expectation, mean, variance and independence, proceeding to probability distributions (e.g. discrete uniform, binomial, multinomial, hypergeometric, geometric, Poisson, continuous uniform, normal, gamma, exponential). Here we will learn for what problems these distributions are useful and under which assumptions they can/should be applied, stressing also common misconceptions when trying to apply certain concept blindly (which unfortunately happens very often among applied scientists). We will extend our scope to multi-dimensional random variables and joint, conditional, and marginal probability distributions. We will also discuss random sampling, sample distributions of means and variances, and the central limit theorem, again focusing on common misconceptions related to these topics. We will address also statistical estimation (point estimation and interval estimation; confidence intervals). Finally, we will discuss various hypothesis tests (and related errors) and goodness-of-fit tests. In their presentations, students will focus on selected statistical topics and how these can be applied in practice, using scientific articles in applied probability/statistics as their study source.

Literature

- Book: Walpole, Myers, Myers & Ye: Probability & Statistics for Engineers & Scientists. Any edition (pdf format will be provided via EleUM)
- Lecture notes and selected scientific articles (will be provided via EleUM)

Instructional format

Lectures and tutorials

Assessment

A midterm exam (topics: weeks 1 through 3), a final exam (topics: weeks 4 through 6), a presentation on one of the selected topics. Each of these components will have an equal weight in the final grading.

MAT2006 Calculus

Course coordinator

Dr. Carlo Galuzzi, Faculty of Science and Engineering, Department of Data Science and Knowledge Engineering.
Contact: c.galuzzi@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ None

Objectives

- To become familiar with functions and limits.
- To become familiar with differentiation and integration.
- To understand how to use differentiation and limits/continuity of a function to sketch the graph of a function.
- To become familiar with sequences and series.
- To understand the basic of differential equations and Taylor series.

Description of the course

In this course, we will discuss, among others, the following topics: limits and continuity, integration and differentiation, inverse and transcendental functions, mean value theorem, sequences and series. In addition to the main facts and concepts, problem solving strategies will be discussed as well. Both the intuition behind the concepts and their rigorous definitions will be presented along with a number of examples and formal mathematical proofs so to better understand the concepts.
Knowledge and understanding: Calculus offers an indispensable basis, in the contents as well as in the methodologies, for studying and applying exact sciences, which will be built on during the rest of the curriculum.
Applying knowledge: The skills and facts which are taught in this course are of use for most of modern engineering or scientific problems. After the completion of the course, the students should be able to solve simple problems in the areas mentioned above and to judge the validity of a mathematical argument, which is related to the material of the course.
Skills: After having passed the exam, the student will be able to tackle not only the standard type of problems (graph-drawing, calculation of maxima and minima of functions, computing limits, summing infinite series etc.), but also apply his knowledge to considerably more relevant problems.

Literature

Hand-outs will be distributed during the course.
Recommended literature:

- Calculus, A Complete Course by A. Adams and C. Essex, 8th Edition – Pearson 2014
- Thomas' Calculus' by M. Weir, J. Hass, and C. Heil, 12th Ed. Or newer -- Pearson

Instructional format

Lectures and exercises.

Assessment

A written midterm and a written final exam, which both contribute equally to the final grade (50% + 50%). The resit, if needed, represents 100% of the final grade. All examinations include open questions.

MAT2007 Introduction to Programming

Note: this course replaces MAT1004 Imperative Programming. If you have successfully completed MAT1004 you may not participate in MAT2007.

Course coordinator

Apostolis Zarras: Faculty of Science and Engineering, Department of Knowledge Engineering

Contact: apostolis.zarras@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ None

Objectives

1) Identify, interpret and apply fundamentals of imperative programming such as variables, conditionals, iteration, etc.
2) Identify, interpret and apply fundamentals of object-oriented programming, including defining classes, invoking methods, using class libraries, etc.
3) Give examples of important topics and principles of software development.
4) Point out obvious mistakes in programs and analyze how they run.
5) Design, compose and evaluate programs that solve specific problems.
6) Use a software development environment to create, debug, and run programs.

Description of the course

The course provides the basics of computer science and computer programming. After a short introduction to computer organization, the principles of structured programming in Java are presented. The main topics of the course are: data types, statements and sequential execution, conditional statements, loops, methods, and recursion. Final part of the course introduces students to the concepts of object-oriented programming design and teaches them how to design their own classes to model and solve several problems. No prior programming experience is assumed.

Literature

Allen B. Downey, Think Java: How to Think like a Computer Scientist, Green Tea Press, 2012, http://www.greenteapress.com/thinkapjava/
David J. Eck, Introduction to Programming Using Java, Sixth Edition, 2011, http://math.hws.edu/javanotes/

Instructional format

Lectures, tutorials and lab group meetings.

Assessment

1. A final examination, which consists of questions related to the course material,
2. Programming assignments,
3. Lab exercises.

MAT2008 Differential Equations

Note: this course replaces MAT3004 Differential Equations. If you have successfully completed MAT3004 you may not participate in MAT2008.

Course coordinator

Dr. Carlo Galuzzi, Faculty of Science and Engineering, Department of Data Science and Knowledge Engineering

Contact: c.galuzzi@maastrichtuniversity.nl

Pre-requisites

- ✓ MAT2006 Calculus

The student should also be familiar with the basics of linear algebra (including solution of equations and matrices) to understand the theoretical lectures and being able to solve the exercises during the tutorials.

Objectives

- To develop the insight that certain problems in the natural sciences can be described through functions and differential equations and can be solved by techniques such as integration, differentiation, and optimization.
- To be able to classify differential equations by type and order.
- To be able to solve specific types of differential equations, including linear differential equations, second order differential equations with constant coefficients, using undetermined coefficients and variation of parameters.
- To have some understanding of how to use series, Laplace transforms, and numerical methods to solve differential equations.

Description of the course

This is a course about the art of using differential equations to model different phenomena in Physics, Chemistry and Biology. A differential equation is a mathematical equation for an unknown function of one or several variables that relates the values of the function itself and its derivatives of various orders. Differential equations can be broadly classified as linear and nonlinear, and ordinary and partial. This course is limited to linear and nonlinear ordinary differential equations. We will focus on understanding whether these differential equations have a solution, and if so, what properties this solution has. We will see how to solve first order and higher order differential equations including linear differential equations, second order differential equations with constant coefficients, using undetermined coefficients and variation of parameters. Since nonlinear differential equations are the main tool in the Natural Sciences and the differential equations occurring in real applications almost never can be solved analytically, we will see different numerical methodologies for solving differential equations.

Literature

- Hand-outs will be distributed during the course.
- Examples of books on (ordinary) differential equations are:
  - An Introduction to Ordinary Differential Equations – J. C. Robinson – 2004 – Cambridge University Press
  - A first course in Differential Equations with Modeling Applications – D. G. Zill – 2013 – BROOKS/COLE Cengage Learning
  - Ordinary Differential Equations – W. Adkins and M. Davidson – 2012 - Springer
  - Nonlinear dynamics and Chaos, 2nd Ed. – Steven H. Strogatz – 2015 – Westview Press

Instructional format

Lectures and exercises.

Assessment

A written midterm and a written final exam with open questions. The midterm and the final exam both contribute equally to the final grade (50% + 50%).

MAT2009 Multivariable Calculus

Course coordinator

Ronald Westra, Faculty of Science and Engineering, Department of Data Science and Knowledge Engineering
contact: westra@maastrichtuniversity.nl

Pre-requisites

- ✓ MAT2006 Calculus

Recommended

- ✓ MAT1002 or MAT2004 Linear Algebra (highly recommended)

Objectives

This course is intended to introduce Science students in the essential mathematics to describe and analyse continuous time-varying systems as they occur in Electromagnetism, Hydrodynamics, and Quantum Mechanics.

Description of the course

Multivariate calculus is the extension of calculus in one variable to calculus with functions of several variables: the differentiation and integration of functions involving multiple variables, rather than just one. Considerable attention will be devoted to vector calculus, or analysis, and will be concerned with differentiation and integration of vector fields, primarily in 3-dimensional Euclidean space. Vector calculus plays an important role in differential geometry and in the study of partial differential equations. It is used extensively in physics and engineering, especially in the description of electromagnetic fields, gravitational fields and fluid flow.
Throughout the course we maintain a strong emphasis on its application in Physics and Chemistry.

Literature

To-be-determined, but likely: Vector Analysis, A Physicist's Guide to the Mathematics of Fields in Three Dimensions, Author: N. Kemmer, Cambridge University Press, ISBN: 9780521290647

Instructional format

There are two 2hr lectures per week and one tutorial class. The tutorial class uses a mixture of case studies and sets of questions like those seen on the exams.

Assessment

There will be two written exams on parts of the course. The first of these takes place around the midpoint of the course, and the second in the last week of the course. For those who do not pass these tests and are eligible for a resit according to MSP's rules and regulations, there will be a resit exam provided on the entire course in the resit week.

MAT3003 Game Theory

Course coordinator
TBD

Pre-requisites
- ✓ MAT1002 or MAT2004 Linear Algebra
- ✓ MAT2006 Calculus

Recommended
- ✓ Basic knowledge of linear programming

Objective
To familiarize the students with the mathematical fundamentals of Game Theory.

Description of the course
We provide an introduction to the field of Game Theory. Game Theory is the mathematical study of problems, called games, that involve two or more decision makers, called players, who each have their own individual preferences over the possible outcomes. In a game each player always aims to maximize his individual payoff and chooses his actions accordingly. These actions may be probabilistic or deterministic, depending on the situation. Meanwhile he reasons logically about actions that might be taken by the other players. A basic diff erence exists between strategic and non-strategic models. Both types of models and their solution concepts will be discussed. Issues like value, fairness, manipulations, threats, optimality and rationality will be addressed.

Literature
Lecture Notes Introduction to Game Theory by Frank Thuijsman will be provided.

Instructional format
Frontal but interactive instruction and active training in comprehending the instructed material by spending a lot of time on problem solving, either individually or jointly with other participants. There are no tutor groups for this course. During all plenary sessions instruction and practice will alternate in line with the progress of the material in the lecture notes.

Assessment
Note: the assessment content for this course deviates from MSP Rules & Regulations!

There will be one 3-hour written exam that consists of solving a number of "open" problems.

MAT3005 Numerical Mathematics

Note: this course replaces MAT2003 Numerical Mathematics. If you have successfully completed MAT2003 you may not participate in MAT3005.

Course coordinator

Dr. Pieter Collins: Faculty of Science and Engineering, Department of Knowledge Engineering
Contact: pieter.collins@maastrichtuniversity.nl

Pre-requisites

- ✓ MAT2007 Introduction to Programming
- ✓ MAT2006 Calculus
- ✓ MAT2004 Linear Algebra

Co-requisites

- ✓ None

Objectives

- To provide an understanding of core techniques in scientific computing.
- To have an understanding of theoretical properties of numerical algorithms.
- To be able to analyse which numerical methods are appropriate to solve a given problem.
- To be able to modify existing numerical methods to solve new problems.
- To provide the background knowledge and skills needed to solve problems in scientific computing arising in later courses and in scientific practise.

Description of the course

Predicting the yield of a chemical process, the path of a space rocket, the effect of a particular medicine, or filling the gaps in gene expression data: all these are scientific problems which can be formulated mathematically. Unfortunately they are in general too difficult to solve by hand using analytical methods like those you have learned in calculus, so are typically solved with the aid of computers using *numerical* methods, which calculate approximate solutions for specific values of the data describing the problem.

Since the development of high-performance digital computing, scientific computing using numerical mathematical techniques has become a cornerstone of the modern scientific process. The ability to use computational tools, assess the suitability of numerical methods, and develop new numerical algorithms is an essential part of the modern scientist's knowledge.

In this course we address essential concepts in numerical mathematics, and numerical algorithms for the solution of some core problems in the mathematical sciences, including arithmetic with floating-point numbers, algebraic equations, polynomial interpolation, integration and differentiation, ordinary differential equations, least-squares approximation, Fourier series, matrix equations and eigenvalues.

Literature

J. Douglas Faires & Richard Burden, "Numerical Methods" (International 4th Edition) ISBN-13:978-0-495-38569-1 (Recommended; not required)
Curtis F. Gerald & Patrick O. Wheatley, "Applied Numerical Analysis" (7th Edition) ISBN-13: 978-0-321-13304-5 (Suggested alternative)

Instructional format

Lectures, tutorials, computer practicals.

Assessment

Final exam, homework assignments.

NEU1001 Introduction to Neuroscience

Course coordinator

Dr. L. de Nijs, School for Mental Health and Neuroscience, Division neuroscience, FHML, Maastricht University.
Contact: laurence.denijs@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Recommended

- ✓ Knowledge of biology and chemistry at the high school level is assumed.

Objectives

- To introduce the students to the field of neuroscience, the study of the nervous system.
- To provide fundamental basis of the anatomy, development, and physiology of the nervous system.

Description of the course

This course begins with the study of the nervous system structure, ranging from the macroscopical to microscopical level, and its development. Next, the fundamental mechanisms by which information flows within and between nerve cells will be addressed. This includes the aspects of membrane permeability, action potential generation and propagation, synaptic transmission, post-synaptic mechanisms of signal integration and the construction of neural circuits. Finally, the vascular system and the microenvironment of the brain will be discussed.

Literature

- M. F. Bear, B. W. Connors, M. A. Paradiso. Neuroscience, Exploring the Brain. Wolters Kluwer Health, 2015 (4th edition).
- D. Purves, G.J. Augustine, D. Fitzpatrick, W.C. Hall, A.S. LaMantia, L.E. White, Neuroscience, Sinauer Associates, 2012 (5the edition).
- E. R. Kandel, J. H. Schwartz, T. M. Jessell, S. A. Siegelbaum, A. J. Hudspeth. Principles of Neural Science, McGraw-Hill, 2012 (5th edition).

Instructional format

Tutorial groups meetings and lectures.

Examination

An oral presentation on the content of tutorial meetings and a final exam (open questions).

NEU1002 Cognitive Neurosciences: Biological Foundations of Behaviour

Note: this course replaces INT1004 Cognitive Neurosciences: Biological Foundations of Behaviour If you have successfully completed INT1004 you may not participate in NEU1002.

Course coordinator

Dr. Peter van Ruitenbeek, Faculty of Psychology and Neuroscience
Contact: p.vanruitenbeek@maastrichtuniversity.nl

Dr. Bert Lenaert, Faculty of Psychology and Neuroscience
Contact: bert.lenaert@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ None

Objectives

- Students will have a basic understanding of biological foundations of behaviour, such as sleep/wake behaviour, language, memory, eating and drinking, and emotion.
- Comprehension of chemical control (neurotransmission and hormones) by the brain and dysfunctional control (e.g. addiction or anxiety disorders)
- A basic understanding of how to study the biological foundations of behaviour

Description of the Course

Why do some people develop into a male and some into a female? Why are we hungry in the morning? Why do people become addicted to drugs? Is our brain active during sleep? How do mood disorders originate? These and other questions will be addressed in this course. The most important part of our body to explain behaviour is our brain. This course will provide basic knowledge of neuroanatomy (how certain parts of the brain are connected) and neurophysiology (how neurons operate to communicate) in order to understand several themes of behaviour (e.g. eating, addiction, sleep) and disorders.

Literature

Required literature
Neuroscience: Exploring the Brain – Bear, 4th edition.

Additional literature
A couple of journal articles will be used and several biological psychology books can be used in addition (Biological psychology – Breedlove, 2013; Biopsychology 10th ed – Pinel, 2018; or Physiology of Behavior – Carlson, 2013 -)

Instructional format

The course is made up out of a combination of Lectures and PBL tutorial groups.

Assessment

To do justice to the objectives of this course, students will be assessed in two different manners. Students will take part in an exam (80%), and a practical assignment (20%).

NEU2001 Cognitive Neurosciences: From Sensation to Perception

Note: this course replaces INT2003 Cognitive Neurosciences. If you have successfully completed INT2003 you may not participate in NEU2001.

Course coordinator

Lars Hausfeld, Faculty of Psychology & Neuroscience

Contact: lars.hausfeld@maastrichtuniversity.nl

Pre-requisites

- ✓ INT1004 or NEU1002 Cognitive Neurosciences: Biological Foundations of Behaviour

Co-requisites

- ✓ None

Objectives

To understand the physiological basis of visual and auditory perception.

Description of the course

The goal of this course is to understand the basic physiologic principles that underlie visual and auditory perception. The course will introduce the sensory systems that are responsible for vision and hearing in humans. Central topics include the nature of the stimulus (physical attributes such as amplitude and frequency, and perceptual attributes such as intensity and colour), the transduction process (the transformation of a physical stimulus into a neural signal leading to a subjective experience), the functional neuroanatomy of the human sensory system (the organization of sensory neurons into functional maps, columns, and pathways), and mechanisms for object perception (the organization of sensory features into meaningful percepts, for example, a face in a crowd or speaker at a loud party). Finally, the course will introduce psychophysical and neuroscientific methods designed for measuring perception.

Literature

- Goldstein, E. & Brockmole, J. (2016). Sensation and perception (10th edition). Australia: Cengage Learning. [ISBN: 978-1-305-58029-9]
- E-reader

Instructional format

Lectures and tutorials

Assessment

Written assignment (20%), presentation (20%), final exam (60%)

NEU2002: Neuropsychopharmacology

Note: this course replaces INT3004 Neuropsychopharmacology. If you have successfully completed INT3004 you may not participate in NEU2002.

Course coordinator

Eef Theunissen, Department of Neuropsychology & Psychopharmacology, Faculty of Psychology and Neuroscience
Contact: e.theunissen@maastrichtuniversity.nl

Pre-requisites

- ✓ INT1002 Basic Principles of Pharmacology

Co-requisites

- ✓ none

Objective(s)

- To know the basic principles of neurotransmission & the basic mechanism of drug-receptor interaction
- To understand the mechanism of action of the major groups of drugs acting in the central nervous system
- To understand the major neurotransmitter systems in the brain and their role in cognitive and affective disorders and functions
- To understand the pharmacotherapy of anxiety disorders, CNS degenerative disorders, ADHD
- To understand the acute and long term effects of drugs of abuse

Description of the Course

In the first part of the course the focus will be on the molecular and cellular biology of the nervous system. Focus will be the neurotransmission process, in particular the role of neurotransmitter receptors as a basis for understanding the mode of action of CNS drugs. The second part of the course will give an overview of the major classes of a number of CNS drugs: the hypnotics and sedatives, the anxiolytics, and the drugs used to treat CNS degenerative disorders. The pharmacology of these drugs will be put in the perspective of their clinical use. The final part of the course will be devoted to illicit drugs, their acute and long term effects, and their potential as medicines.

Literature

Journal articles, book(s) chapter(s).

Instructional Approach

Lectures and tutorial group meetings

Form of Assessment

Written assignments and presentations

NEU3001 Neuroscience of Action

Course coordinator

Peter Stiers, Faculty of Psychology & Neuroscience

Contact: peter.stiers@maastrichtuniversity.nl

Pre-requisites

- ✓ INT1004 or NEU1002 Cognitive Neurosciences: Biological Foundations of Behaviour
- ✓ INT2003 or NEU2001 Cognitive Neurosciences: from Sensation to Perception

Co-requisites

- ✓ None.

Objectives

The course investigates the neural implementation of action, from the lowest level of simple reflexes to the highest level of the decision to act in order to obtain a goal.

Description of the course

The most general function of our brain is to interact with our environment to obtain what we desire and to avoid what is disadvantageous. The brain plans and executes actions to accomplish this. Actions can be simple (e.g., picking up a pencile), effortful (e.g., endurance running), complex (e.g., dancing), or symbolic (e.g., stick up your thumb to get a ride), etc. In all of these actions our brain is involved, but not to the same degree. Evolution has organized motor functions in a hierarchical system that delegates important motor and control functions to lower levels of the nervous system. This allows the brain to spent more time on other important functions, among which the selection of goals and the planning of how to pursuit them. Our understanding of the neural mechanisms of decision making, action selection, action planning and action execution has gained a lot from studying neural disorders (Parkinson's disease, orbitofrontal patients, obsessive compulsive disorder, etc.) which will also be considered in the course.

Literature

Journal articles, book chapters.

Instructional format

Lectures and tutorials.

Assessment

Oral presentation (30%), final exam (60%)

PHY1001 Elements of Physics

Course coordinator

Dr. Ronald Westra: Faculty of Sciences and Engineering, Department of Knowledge Engineering
Contact: westra@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ None

Objectives

- To acquaint the student with the essential building blocks of Physics.
- To acquire a general understanding of the theoretical and practical methods in these fields and to be able to apply this knowledge to concrete problems.
- To serve as sufficient basis in physics for students in their future education.
- To be able to apply this knowledge to practical problems.
- To be able to read texts that build on the subjects of this course.

Description of the course

Physics is the study of all aspects of Nature, covering the behaviour of objects under the action of given forces and the nature and origin of gravitational, electromagnetic, and nuclear force fields. This is an introductory course in Physics intended for a broad audience with a scientific interest, that comprehensively trains students to the basic, classical, and essential fundamentals of physics. As such it is a prerequisite for most courses in the further Physics curriculum. The course aims at an understanding of the fundamental principles of Nature and how to apply them in concrete practical situations. The emphasis is on intuition rather than mathematical rigour; this is addressed in the follow-up physics courses. In this course we address the principal corner stones of Physics:

1. Elements of classical mechanics;
2. Elements of thermodynamics;
3. Elements of electromagnetism;
4. Elements of optics and waves;
5. Elements of modern physics.

Each of these subjects is taught on a theoretical level as lecture, and on a practical level with exercises in practical training sessions. This course is a good preparation for the physics lab skills involving experimental and practical physics PRA1003, PRA2007, PRA3002.

Literature

The textbook for this course is:

University Physics with Modern Physics, H.D. Young & R. A. Freedman, Pearson Education (US), 13th International edition, May 2011

Instructional format

This course follows the Problem-Based Learning (PBL). Each week of this course is devoted to a major subject of physics, and consists of a plenary lecture, and two discussion group meetings. The first meeting starts with reviewing several 'Discussion Questions' followed by the more conceptual "Group Assignments" that can be fruitfully studied in the discussion group with PBL. The results of these are presented in the second tutor group meeting. Next to these there are also "individual Exercises".

Assessment

In week 4 there will be a midterm exam (MTE). In week 7 there is the final exam (FE). The final grade is based on the average of MTE and FE.

PHY1002 Introduction to Natural Sciences: Mathematical Foundations of Physics

Course coordinator
Dr. Chad Ellington, Faculty of Science and Engineering, Maastricht Science Programme

Contact: chad.ellington@maastrichtuniversity.nl

Pre-requisites
- ✓ None

Co-requisites
- ✓ PRA1002 Research Data Analysis and Presentation Academic Skills

Objectives
- To provide an introduction to the main topics of calculus.
- To provide students with the necessary knowledge and skills to successfully study other advanced science courses.
- To introduce complex numbers, functions, differentiation and integration – for functions of a single variable and for functions of several variables.
- To demonstrate methods for solving linear differential equations.
- To enable students to develop the insight to solve certain problems in science and engineering through functions, (differential) equations and other techniques of calculus (such as integration, differentiation and optimization).

Description of the course
Mathematics is inextricably linked to the understanding of science and this course is designed to cover the mathematical concepts that will prove fundamental tools for the natural science courses you will encounter at MSP, with an emphasis on physics.

As new students to the MSP come from a diverse range of backgrounds, your knowledge of mathematics will vary considerably. As such, each of you will find that some of the material from this course acts as revision whereas some topics are completely new – please bare in mind that it's what you know at the end of the course that counts!

It is important to note that maths is only useful if it can be implemented, and this skill is acquired by attempting to solve problems and perform calculations; this is the main aim of the weekly tutorials.

The course will address complex numbers, differentiation, differential equations, integration, functions of two variables and multiple integrals. This course is part of the academic core in the natural sciences.

Literature
Engineering Mathematics, 7th Edition, Stroud, K. A. and Dexter D. J. (Palgrave, 2013).

Instructional format
Lectures and tutorial group meetings.

Assessment
1. Online assessments.
2. A final examination.
3. The contributions to the tutorial group meetings.

PHY2001 Classical Mechanics

Course coordinator

Dr. Ronald Westra: Faculty of Sciences and Engineering, Department of Knowledge Engineering
Contact: westra@maastrichtuniversity.nl

Pre-requisites

- ✓ MAT2006 Calculus

Recommended

- ✓ MAT1002 or MAT2004 Linear Algebra

Co-requisites

- ✓ None

Objectives

- To acquaint the student with the basics of Classical Mechanics
- To acquire general understanding of theoretical and practical methods in Classical Mechanics.
- To serve as sufficient basis for future education in physical sciences.
- To be able to apply this knowledge to concrete practical problems.
- To be able to read texts that build on the subjects of this course.

Description of the course

Classical mechanics forms the central part of all physical science and engineering. It accurately describes the dynamical effects of forces under all conditions. It can be divided into *statics*: the study of equilibrium, and *dynamics*: the study of motion caused by forces. Though classical mechanics fails on the scale of atoms and molecules, it remains the framework for much of modern science and technology. This is an intensive course that comprehensively trains the students to the basic, classical, and essential fundamentals of classical mechanics. The course aims at an understanding of the fundamental principles of Classical Mechanics and how to apply them in specific situations. Here we address the major parts of Classical Mechanics: statics and kinematics, Newton's laws, work and energy, momentum and collisions, rotational dynamics, and gravitation. Each of these subjects is taught on a theoretical level as lecture, and trained on a practical level with exercises and practical training sessions. Associated (but not co-required) to this course are skill courses Physics Laboratory PRA1003, PRA2007, PRA3002, involving experimental practical training sessions.

Literature

CLASSICAL MECHANICS, AN UNDERGRADUATE TEXT, R. Douglas Gregory, Cambridge University Press 2006, isbn-13 978-0-521-82678-5.

Instructional format

Each week of this course is devoted to a major subject of Classical Mechanics, and consists of a plenary lecture, and two discussion group meetings. The first meeting starts with reviewing several discussion questions and practical exercises in PBL (Problem-Based Learning) format, followed by assigning some challenging assignments to student teams. In the second meeting each student team present their solution to their challenge problem. The grading of the course consists of the averages of the student presentations and the two written exams.

Assessment

In week 4 there will be a written midterm exam (MTE). In week 7 there is the written final exam (FE). The final grade is based on the averages of the student presentations, the MTE, and the FE.

PHY2002 Thermodynamics and Statistical Physics

Course coordinator

Dr. Kathleen Denolf: Faculty of Science and Engineering, Maastricht Science Programme

Contact: kathleen.denolf@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Recommended

- ✓ PHY1001 Elements of Physics

Objectives

- To acquire general understanding of theoretical and practical methods in Thermodynamics and Statistical Physics
- To be able to apply this knowledge in analysis and resolution of practical problems.
- To develop an understanding and interest in state of the art research in this field
- To connect concepts and ideas from throughout the course to build skills in applying knowledge to new and novel concepts

Description of the course Thermodynamics is the study of many-particle systems in terms of their macroscopic quantities such as temperature, heat, energy, and entropy. Statistical Physics relates these macroscopic quantities to the microscopic properties such as kinetic and rotational energy and vibrations, using statistics. In this course, participants will achieve comprehension of the fundamentals of Thermodynamics and Statistical Physics. We cover the major elements of this subject: temperature and heat, thermal properties of matter, the first and second law of thermodynamics, entropy and free energy, the relation between macroscopic parameters and microscopic dynamics, and the statistics of thermodynamic ensembles. Each of these subjects is taught on a theoretical level as lectures, and trained on a practical level with exercises and by using knowledge in applied situations in PBL tasks.

Literature

Required *Thermodynamics, A. Steane, Oxford University Press,1st Edition, December 2008*

Recommended *Statistical Mechanics: Entropy, Order Parameters and Complexity, J. Sethna, Oxford University Press, 1st Edition, 2006*

Instructional format

This course follows the Problem-Based Learning (PBL) method. Each week of this course consists of a lecture and two tutorial meetings. In each of the tutorial meetings we will conduct a PBL post-discussion and a PBL pre-discussion. In parallel to these there will also be 'individual exercises' to be completed outside of the classroom.

Assessment

Prior to the course commencing, the coordinator and participants will design suitable assessments which satisfy the rules and regulations of the programme and learning outcomes of the course while being tailored to the individuals participating.

PHY2003 Vibrations and Waves

Course coordinator

Dr. Chris Pawley: Faculty of Science and Engineering, Maastricht Science Program

Contact: c.pawley@maastrichtuniversity.nl

Pre-requisites

- ✓ PHY2001 Classical Mechanics

Co-requisites

- ✓ None

Objectives

- To acquaint the student with the fundamental principles of vibrations and waves as they apply to all systems
- To develop an understanding of damping and forcing on vibrations
- To identify appropriate mathematical methods to solving problems relating to these phenomena (such as differential equations)
- To understand wave characteristics such as standing waves, beats, wave packets and the Doppler effect

Description of the course

Vibrations and waves covers the behaviour of many physical systems ranging from optical or acoustic to mechanical, oscillating systems. Participants will investigate simple harmonic oscillators, particle and packet velocities as well as damped, driven and coupled oscillators. The use of Fourier series to describe waves will allow a more mathematical analysis to take place. We will explore of sound propagation in a variety of media including sounds in gasses, liquids and solids (strings, rods etc.). In addition, the behaviour of interfering waves (such as formation of standing waves) will be demonstrated. Material properties such as reflection, transmission and impedance will also be covered.

Literature

Vibrations and Waves, A. P. French, W.W.Norton (US), 2nd edition, 1971

Vibrations and Waves, George C. King, John Wiley and Sons (UK), 1st edition, 2009

Instructional format

This course follows the Problem-Based Learning (PBL) method. Each week of this course consists of a lecture and two tutorial meetings. In each of the tutorial meetings we will conduct a PBL post-discussion and a PBL pre-discussion. These tutorials will contain a significant number of practical demonstrations as well as computer. In parallel to these there will also be 'individual exercises' to be completed outside of the classroom.

Assessment

Prior to the course commencing, the coordinator and participants will design suitable assessments which satisfy the rules and regulations of the programme and learning outcomes of the course while being tailored to the individuals participating.

PHY2004 Electromagnetism

Coordinator

Dr. Benedikt Poser: Faculty Psychology and Neurosciences, Maastricht University

Contact: benedikt.poser@maastrichtuniversity.nl

Prerequisites

- ✓ PHY1001 Elements of Physics

Recommended

- ✓ MAT1002 or MAT2004 Linear Algebra

Co-requisites:

- ✓ None

Objectives

- To acquaint the student with the basics of electromagnetism.
- To acquire general understanding of theoretical and practical methods in electromagnetism.
- To serve as sufficient basis for future education in physical sciences.
- To be able to apply this knowledge to concrete practical problems.
- To be able to read texts that build on the subjects of this course.

Description of the course

Electromagnetism, also known as Maxwell theory, is the science of one of the four fundamental forces in Nature and deals with the effects of electrical charge and the associated force fields and energies. Electromagnetism unites the concepts of electricity and magnetism. These two concepts and their relations form the core of this course, which ultimately can be expressed in the four fundamental laws of electromagnetism: Maxwell's equations. Important components of the course are:

1. Electrostatics: Charge, electric forces, Coulomb's law, the electric field, electric potential and energy;
2. (Classical) Electrodynamcs: Electrical flux, Gauss law;
3. Magnetism: Magnetic fields, magnetic flux, Gauss's law for magnetism;
4. Maxwell's Laws: The four Maxwell equations and the Lorentz Force;
5. Electromagnetic radiation and waves;
6. Advanced topics / recap

These topics are divided over the six lecturing weeks of the course.

Literature

A course manual and title for the associated text book will be provided during the course.

Instructional format

This course follows classic teaching format with elements of Problem-Based Learning (PBL). Each week of this course is devoted to a major subject of electromagnetism, and consists of a plenary lecture of two hours, and two discussion group meetings – each of two hours. The first tutorial meeting starts with reviewing several 'Discussion Questions' followed by the more conceptual assignments and exercises that can be studied jointly in the discussion group. Next to these there are also "individual Exercises" to be prepared or the second tutorial.

Assessment

In week 7 there is a final exam (FE) which counts for 80% of the final course grade. There is a participation score that will be issued after Week 3 (ie. the first half of the course), and after week 6 (i.e. for the second half of the course); each of these participation based assessment points count for 10% of the final course score.

PHY2005 Quantum Theory

Course coordinator

Dr. Jacco de Vries, Maastricht Science Programme, Faculty of Science and Engineering
Contact: jacco.devries@maastrichtuniversity.nl

Pre-requisites

- ✓ MAT2004 Linear Algebra

Note: Following Linear Algebra simultaneously to PHY2005 allows for a waiver

Co-requisites

- ✓ None

Recommended

- ✓ MAT2006 Calculus
- ✓ PHY2001 Classical Mechanics

Objectives

At the end of the course, students will be able to

- Understand the foundations underlying Quantum Mechanics
- Solve Schrödingers wave equation for analytically solvable potentials
- Calculate QM expectation values of physical observables and their time evolution
- Use the operator and vector space notation in calculations
- Calculate the non-classical behavior resulting from the postulates of QM
- Understand the modern orbital atomic model of Hydrogen and calculate the corresponding wave functions.

Description of the course

This course is an introduction to Quantum Mechanics, aimed at interested physics or chemistry students. Some prior knowledge of classical physics, linear algebra and infinitesimal calculus will help in looking through the equations and understand what is going on. When looking at the world at very small scales, classical physics (classical mechanics, electromagnetism, thermodynamics) is no longer sufficient to explain our observations. In order to describe the phenomena at these scales, we will enter the strange world of wave functions, probabilities of reality and Schrödingers equation.

Starting from the failings of classical physics, we will see the necessity of describing the world in a different way, and try to make sense of it in terms of classical variables like position and momentum. We will calculate the quantized energy states of various analytically solvable systems like the square-well potential and the harmonic oscillator, before turning to the proper linear-algebraic description of quantum mechanics. We will explore things like tunneling, commutation relations of operators, Heisenberg's uncertainty principle, Pauli's exclusion principle and spin. Finally, we will do a proper treatment of the hydrogen atom in 3D and its orbitals.

Literature

"Introduction to Quantum Mechanics", David J Griffiths

Instructional format

Lectures and tutorial group meetings.

Assessment

Problem sheets, midterm exam, final exam

PHY2006 Electronics

Coordinator

Dr. Bart van Grinsven: Faculty of Science and Engineering, Maastricht Science Programme

Contact: bart.vangrinsven@maastrichtuniversity.nl

Pre-requisites:

- ✓ None

Co-requisites:

- ✓ PRA2006 Electronics

Objectives

- Identify various electronic components and describe their basic functions in DC or AC circuits.
- Apply Ohm's law and Thevenin's theorem to circuits determining a range of different resistance, voltage and power values in different configurations.
- Apply basic magnetic principles to the process of AC power generation and DC motors.
- Explain the different mechanisms for conduction in various semiconductor types and how these differ from conductors and insulators.
- Sketch band-gap diagrams and IV characteristics of various materials and semiconducting components and describe how these change under different biasing conditions.
- Describe a variety of different uses for semiconductors and specify the functioning of some semiconducting devices.
- Sketch and calculate the output voltages of op-amps when in open-loop or controlled-gain circuits, when given information about the input voltages (or vice versa).
- Perform conversions and calculations in base 2 (binary), draw and simplify logic gate circuits, write out their truth tables and use Boolean algebra, de Morgan's laws and Karnaugh maps to simplify Boolean expressions and logic circuits.
- Calculate correct sampling frequencies in signal processing, resolutions for DAQ and optimal amplifications of signals.
- Apply DAQ theory to hypothetical problems solely based on the specification sheets of a DAQ card and proper description of a signal.

Description of the course

In this course you will learn the fundamentals of electronics beginning with simple electrical theory. You'll explore the role of different components and devices, learn the laws governing their behaviours and should develop an understanding of basic circuitry. You will learn about Ohm's and Kirchhoff's laws, resistances, voltages, DC and AC currents, capacitors, inductors, diodes, junctions and transistors. You'll also cover the basics of digital electronics (logic gates and Boolean algebra). We will look at how combinations of discrete devices can be used to build up more complex circuitry and you will have the opportunity to see how electronics can be used to build up the technology which we are most familiar today from flat-screen TVs and smartphones. Nearly everything we use in this day and age relies on electronics. We hope that throughout this course you learn to appreciate how the technology around you functions and we hope to pull apart some electronic devices to explore their inner workings.

Instructional format

1 x 2 hour lecture per week
2 x 2 hour tutorial per week

Assessment

Presentation, tutorial contribution grade and a final exam.

PHY2007 Optics

Course coordinator

Dr. Kathleen Denolf, Faculty of Science and Engineering, Maastricht Science Programme

Contact: kathleen.denolf@maastrichtuniversity.nl

Pre-requisites

- ✓ MAT2008 Differential Equations
- ✓ PHY2003 Vibrations and Waves

Co-requisites

- ✓ None

Objectives

- To acquire an understanding of optical systems and how they behave in nature.
- To be able to apply this understanding appropriate situations and correctly evaluate numerical solutions.
- To design imaging systems and evaluate their resolution, field of view and magnification
- To understand the limitations and aberrations in optical systems.

Description of the course

The study of optics begins with a geometrical approach, modelling light as rays which can travel according to specific rules. Essentially optics treats all rays as travelling in straight lines until such a point that they reach an optical device such as a mirror, lens or obstacle. Based on these principles, we can assess the behavior of optical devices (telescopes, microscopes, cameras for example) but also begin to understand optical phenomena which occur in everyday life (i.e. rainbows etc.). The course will conclude with some systems design and with a view on developing curiosity towards more advanced optical devices.

Literature

To be confirmed.

Instructional format

This course follows the Problem-Based Learning (PBL) method. Each week of this course consists of an interactive lecture and two tutorial meetings. In parallel to these there will also be 'individual exercises' to be completed outside of the classroom.

Assessment

Problem sheets, mid-term examination, final examination

PHY2008 Solar System Astronomy

Course coordinator

Mr. Chad K. Ellington: Faculty of Science and Engineering, Maastricht Science Programme (MSP)

Contact: chad.ellington@maastrichtuniversity.nl

Pre-requisites

✓ None

Co-requisites

✓ None

Objectives

- Introduce the electromagnetic spectrum and usefulness of spectroscopic observations, including: blackbody thermal radiation, emission/absorption spectra and how they can be used to determine relative radial velocities, surface temperatures and chemical composition of objects throughout our universe.
- Interpret historical observations of planetary positions and their influence on early models of solar system motions.
- Introduce scientific understanding of our solar system, including: the planets, their moons, asteroids, comets and dwarf planets.
- Understand currently accepted formation scenarios of the solar nebula.
- Describe mechanisms that modify the surfaces of terrestrial planets: such as volcanism, impact cratering, tectonism (including geomagnetism) and erosion.
- Compare and contrast characteristics of the capability of various solar system bodies in retaining various atmospheric constituents.
- Summarize physical properties and orbital characteristics of minor bodies.

Description of the course

This course begins with an overview of information available by studying the spectrum of light from objects within our universe. Then we transition to historical observations of planetary motions within our sky, how it affected models of our solar system and our eventual increased understanding of the planetary laws of motion. We continue with in-depth investigations into the formation of our solar system as well as physical characteristics (including surface/interior/atmospheric modification) of numerous solar system bodies; including: terrestrial planets, gas/ice giants & minor planet constituents such as satellites, asteroids, comets & dwarf planets.

Literature

- Astronomy via OpenStax, ISBN 1947172247
- Selected articles and materials will be referenced/provided to the students

Instructional format

This course will hopefully follow the Problem-Based Learning (PBL). Each week of this course is focused on various topics within our solar system, consisting of overview lectures and discussion group meetings. The first meeting will introduce the weekly group assignments/labs with discussion questions where results with further discussions in the subsequent tutor group meetings. These may be followed by individual exercises, which may include independent research and/or observations

Assessment

Online assessments, contributions to tutorial group meetings, independent research/observational reports, final examination

PHY3001 Quantum Mechanics

Course coordinator

Dr. Jacco de Vries, Maastricht Science Programme, Faculty of Science and Engineering

Contact: jacco.devries@maastrichtuniversity.nl

Pre-requisites

- ✓ PHY2005 Quantum Theory

Co-requisites

- ✓ None

Recommended

- ✓ MAT2006 Calculus
- ✓ PHY3002 Theory of Relativity

Objectives

- To deepen and broaden the understanding of the theoretical and practical principles of Quantum Mechanics.
- To use this knowledge to study, model, and understand elementary particles, atoms and molecules.
- To serve as basis for future students who want to specialize in these topics.
- To be able to apply this knowledge to practical problems.
- To be able to read scientific texts that build on the subjects of this course.

Description of the course

This course addresses some advanced concepts in Quantum Mechanics and builds on the introductory course PHY2005 Quantum Theory. The course is organized around the following topics: basic logic in classical and quantum mechanics; the time evolution of quantum systems; quantum entanglement and the nature of reality; and more subjects which are yet to be determined as of now. Each of these subjects is taught on a theoretical level as lecture, and on a practical level with exercises. Moreover, Students collaborate in teams on a QM problem oriented project.

Literature

1. "Modern Quantum Mechanics", J.J. Sakurai
2. "Introduction to Quantum Mechanics", David J Griffiths
3. "Quantum Mechanics", Susskind, Friedman, Basic Books, ISBN 0465036678
4. Handouts on specific texts during the lectures

Instructional format

Lectures and PBL tutorial group meetings with weekly student team challenge problems.

Assessment

Midterm exam, final exam, weekly problems and a project.

PHY3002 Theory of Relativity

Course coordinator

Dr. Gideon Koekoek: Faculty of Science and Engineering, Maastricht Science Programme
Contact: gideon.koekoek@maastrichtuniversity.nl , room KAP2 1.037

Pre-requisites

- ✓ PHY2001 Classical Mechanics

Co-requisites

- ✓ None

Objectives

- To acquaint the participants with the entirety of special relativity
- To introduce participants to the concepts and ideas in general relativity
- To acquire general understanding of theoretical and practical methods in relativity
- To be able to apply this knowledge in analysis and resolution of practical problems.
- To be able to read texts that build on the subjects of this course.

Description of the course

The theory of relativity deals with the physical effects of high speed or curvilinear motion and gravity on the structure of space and time. This theory is the unique work of the physicist Albert Einstein, which overthrew earlier physical theories, and redefined the fundamental concepts of space, time, matter, energy, and gravity. Along with quantum mechanics, relativity is a central concept in modern physics. In particular, relativity provides the basis for understanding cosmic processes and the geometry of the universe itself. This intensive course intends to comprehensively train the participants in the essential fundamentals of the theory of relativity. Here we address the major elements of this subject: special relativity, spacetime, mass and energy, Minkowski space, gravity, and cosmology. Each of these subjects is taught on a theoretical level as lecture, and trained on a practical level with group exercises which can be solved during PBL sessions.

Literature

Relativity: An introduction to space-time physics, Steve Adams, Taylor and Francis (US), First edition, 1997
Special Relativity, T.M.Helliwell, University Science Books (US), First edition 2010
Relativity: A very short introduction, Russell Stannard, Oxford University Press (UK), First edition, 2008

Instructional format

This course follows the Problem-Based Learning (PBL) method. Each week of this course consists of two tutorial meetings followed by an interactive lecture. In each of the tutorial meetings we will conduct a PBL post-discussion and a PBL pre-discussion. In parallel to these there will also be 'individual exercises' to be completed outside of the classroom.

Assessment

Prior to the course commencing, the coordinator and participants will design suitable assessments which satisfy the rules and regulations of the programme and learning outcomes of the course while being tailored to the individuals participating.

PHY3004 Nuclear and Elementary Particle Physics

Course coordinator
Dr. Jacco de Vries, Maastricht Science Programme, Faculty of Science and Engineering

Pre-requisites
- ✓ PHY2005 Quantum Theory

Co-requisites
- ✓ None

Recommended
- ✓ MAT1002 or MAT2004 Linear Algebra
- ✓ MAT2006 Calculus
- ✓ PHY3002 Theory of Relativity

Objectives
- To acquire a general understanding of key concepts in Nuclear and elementary Particle physics
- To be able to apply this knowledge to numerical calculations.
- To be able to read scientific texts that build on the subjects of this course.

Description of the course
This course provides an overview of the key concepts in nuclear and elementary particle physics. Nuclear physics is the study of complex nuclei. The following topics will be explored: basic nuclear properties, the nuclear force, models of nuclear structure, different types of nuclear decay, and nuclear fission and fusion and their applications. Particle Physics provides us with an understanding of the fundamental particles in the universe and the interactions between them. This course will provide an overview of the particles and interactions in the Standard Model of particle physics. Students will be taught how to use Feynman diagrams to calculate interaction cross-sections for simple examples within Quantum Electrodynamics (QED), which describes the electromagnetic interaction. An overview of the development of the Standard Model through experimental observations will also be provided.

This course requires a good understanding of Quantum Mechanics. Special relativity is also inherent in Modern Particle Physics, however for this course any necessary concepts will be taught in the lectures.

In the first four weeks, the material will be discussed, while the skills will be applied in the tutorial classes. The last two weeks are reserved for an extensive literature review on an advanced topic in the field. There will be no lectures or tutorial meetings during that time, but students will be expected to work in groups.

Literature
"Introduction to Elementary Particles", David J Griffiths

Instructional format
Lectures and PBL tutorial group meetings.

Assessment
Assessed problem sheets, group project and presentation, final exam

PHY3005 Relativistic Electrodynamics

Course coordinator

Dr. Gideon Koekoek: Faculty of Science and Engineering, Maastricht Science Programme
Contact: gideon.koekoek@maastrichtuniversity.nl , room KAP2 1.037

Pre-requisites

- ✓ PHY2004 Electromagnetism
- ✓ PHY3002 Theory of Relativity

Co-requisites

- ✓ none

Objectives

- To acquire general understanding of electrodynamics.
- To be able to use Maxwell equations to solve practical problems
- To get well-acquainted with the mathematical apparatus of field theories and potentials
- To rewrite electrodynamics in the language of 4-vectors, so as to make its relativistic character explicit.
- To understand the importance of gauge invariance and Lorentz invariance in field theories.

Description of the course

Electrodynamics is the theory that describes all (non-quantum) aspects of electric and magnetic fields and their interaction with charged matter; most notably is describes the dynamics of these fields in time. The basic rules of Electrodynamics are laid out by the famous Maxwell Equations, that were covered in the prerequisite course Electromagnetism (PHY2004).

Maxwell's Equations reveal, when written in the appropriate mathematical language of scalar and vector potentials, that the theory of Special Relativity is fully embedded in Electrodynamics from the get-go, without having to artificially build this in. In fact, it can be shown that Electrodynamics would be mathematically inconsistent if the laws of physics had not obeyed the rules of Special Relativity. In this course, the goal is to make this intimate connection between Electrodynamics and Special Relativity explicitly clear.

The course will start with an overview of Maxwell's Equations and their qualitative meaning, starting from a few experimental facts (Gauss' Law and Biot-Savart's Law). Taking Maxwell's Equations as the foundation of the rest of the course, we will reformulate them in terms of scalar and vector potentials and show that there is a mathematical freedom in choosing these potentials without affecting the resulting physics. We will then find the equations that the potentials obey, and write down the general solution to them. It will next be discussed how one can take into account the time delay that occurs when sources and particles on which the act are a sizeable distance away. Finally, after an overview of 4-vectors, Lorentz-transformations, Minkowski-spacetime and tensors has been provided, the theory will be cast into the language of 4-vectors to make explicit the deep connection Electrodynamics shares with Special Relativity. The course ends with a qualitative overview of how Electrodynamics is embedded in other branches of physics.

Literature

"Introduction to Electrodynamics", David Griffiths, 4th Edition (or higher)

Instructional format

Lectures and tutorial group meetings.

Assessment

Midterm (25% of total grade)

Student Presentations (25% of total grade)

Final exam (50% of total grade)

PHY3006 General Relativity

Course coordinator

Dr. Gideon Koekoek: Faculty of Science and Engineering, Maastricht Science Programme
Contact: gideon.koekoek@maastrichtuniversity.nl , room KAP2 1.037

Pre-requisites

- ✓ PHY2001Classical Mechanics
- ✓ PHY3002 Theory of Relativity

Recommended:

- ✓ MAT2008 or MAT3004 Differential Equations

Co-requisites

- ✓ None

Objectives

- To understand the theory of Special Relativity as a tensor theory
- To reformulate gravity as a curvature of spacetime
- To understand tensor algebra as a mathematical apparatus
- To be able to calculate spacetime curvature in the presence of mass and energy
- To be able to calculate motion in curved spacetime
- To understand black holes, cosmology, and gravitational waves as specific examples of the theory learned.

Description of the course

General Relativity is the best theory of gravity that we have. It refines and supersedes the classical Newtonian theory of Universal Gravitation, and leads to many interesting and exotic predictions about the Universe and objects within it. In this course, we will build up the General Theory of Relativity, the relation between curved spacetimes and matter and energy, study the mathematics needed to do the necessary calculations, and apply it to some interesting cases. Among those are Schwarzschild black holes, Friedmann-Robertson-Walker Universes, and gravitational waves.

Literature

- Lecture Notes by the lecturer (available as download)
- Recommended: "Gravity", by James B. Hartle
- Recommended: "Gravitation & Cosmology", by Stephen Weinberg (note: this text is mathematically advanced)

Instructional format

This course follows the Problem-Based Learning (PBL) method. Each week of this course consists of two tutorial meetings followed by an interactive lecture. In each of the tutorial meetings we will conduct a PBL post-discussion and a PBL pre-discussion. In parallel to these there will also be 'individual exercises' to be completed outside of the classroom.

Assessment

Midterm (25% of total grade)

Student Presentations (25% of total grade)

Final exam (50% of total grade)

PRA1001 Research Methods

Course coordinator

Dr. Linnea van Griethuijsen, Faculty of Science and Engineering, Maastricht Science Programme
Contact: l.vangriethuijsen@maastrichtuniversity.nl
Dr. Erik Steen Redeker, Faculty of Science and Engineering, Maastricht Science Programme
Contact: erik.steenredeker@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ BIO1001 Introduction to Natural Sciences: Biology
- ✓ CHE1001 Introduction to Natural Sciences: Chemistry

Objectives

- To be able to perform basic chemical and biological laboratory research experiments in a safe and scientifically sound manner.
- To understand the handling of materials and solutions (weighing, preparing solutions, working with pipettes and volumetric glassware).
- To learn to setup and execute a scientific research experiment.
- To provide an introduction to scientific research reporting.

Description of the course

This course focuses on experimental research methods and reporting. In addition, it teaches basic laboratory skills necessary to perform experiments in a chemical, biological, or physics laboratory. Students will learn to work in a safe manner, with respect for themselves, others, and the environment. Basic techniques will be taught, such as the accurate measurement of volumes and weights. Students will gain experience in the logistics of setting up and performing an experiment with the final goal of communicating their findings in a report. Typical topics, which will be covered in this skills training are:

- Chemical and biological separations and isolations (distillation, extraction, chromatography)
- Acids and bases (measuring pH, using buffer solutions, titrations)
- Chemical and biological kinetics (enzymes, reaction order)
- Thermodynamic properties of compounds and reactions
- Introduction into microscopy and imaging of biological samples

Literature

Mandatory: Reed R., Holmes D., Weyers J. & Jones A. (2012). *Practical Skills in Biomolecular Sciences* (4th Edition). Pearson (ISBN10 1408245523; ISBN13 9781408245521)
Recommended: Zubrick, J. W. (2016). *The Organic Chem Lab Survival Manual: A Student's Guide to Techniques* (10th Edition). Wiley (E-text ISBN 978-1-119-18314-3; Paperback ISBN 978-1-118-87578-0)

Instructional format

This practical course is organized as a series of laboratory sessions. Students will be required to prepare short reports on the various laboratory activities performed.

Assessment

Online pre-lab quizzes, post-lab reports, scientific drawings, questionnaire sheets, and a practical lab exam during exam week

PRA1002 Research, Data Analyses and Presentation Academic Skills

Course coordinators

Dr. Fabrice Birembaut: Faculty of Science and Engineering, Maastricht Science Programme
Contact: fabrice.birembaut@maastrichtuniversity.nl
Dr. Roy Erkens: Faculty of Science and Engineering, Maastricht Science Programme
Contact: roy.erkens@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ MAT1001 or PHY1002 Introduction to Liberal Arts and Sciences : Mathemataical Foundations of Physic
- ✓ INT1001 Introduction to Liberal Arts and Sciences

Objectives

To familiarize students with the most basic skills required in science. These include:

- Common statistical data analysis skills
- Finding and selecting literature using Web of Science and Scifinder
- Referencing literature using Endnote
- Writing a scientific article
- Master basic presentation skills for giving a scientific presentation

Description of the skills

The academic world has its own strict set of rules with respect to collecting data, analysing them, and writing and reporting about them. This course will provide you an introduction into this academic skills set. The first step for any scientific investigation is to find out what is already known. Although you probably always have used Google to find information, this search engine is not the best tool to find peer-reviewed scientific knowledge. Therefore, you will be introduced into two common scientific search tools and shown how to use them: Web of Science and Scifinder. Once you have found literature, you will learn how to manage and use the citations with a bibliographic data management tool called Endnote.
Next to literature searches, you will be introduced into the rules of writing a proper scientific article. Scientific writing is a branch of its own with particular and peculiar do's and don'ts. Scientific articles present content in a certain order and have a clear division into topics. They also require a particular writing style. Many students have at first problems with writing scientifically and therefore a substantial portion of this skill is devoted to this topic.
A scientific article is mostly about data. However, these data are never presented in the form they were collected. Usually some form of statistical analysis is required. In this skill you will practice with the most basic descriptive statistical techniques available to explore data.
Finally, the presentation training is designed to help you strengthen your abilities to present scientifically, effectively and efficiently at seminars and similar events.

Literature

"A guide to academic writing skills" (2nd ed., Wilkinson & Hommes) will be provided via the Student Portal.

Instructional format

This training will consist out of several interactive library sessions, lectures and PBL sessions on scientific writing, lectures and practical work on statistical data analysis, and a presentation workshop.

Assessment

Students will be assessed on four key elements in this course, namely 1) draft version of scientific paper, 2) final version of scientific paper, 3) data analysis in-class and take-home assignments, and 4) presentation on a topic in the natural sciences.

PRA1003 Basic Physics Laboratory

Course coordinator

Dr. Christopher Pawley: Faculty of Science and Engineering, Maastricht Science Program

Contact: c.pawley@maastrichtuniversity.nl

Pre-requisites

- ✓ PHY1001 Elements of Physics

Co-requisites

- ✓ None

Objectives

- To acquire understanding of practical methods in experimental physics.
- Being able to solve technical problems in a physical experiment.
- To be able to relate the experiment to the relevant physical theory.
- To be able to process empirical data in relation to the theoretical physical predictions using the adequate statistical and graphical tools.
- To be able to properly describe the experimental methods and results in technical reports.

Description of the skills

The aim of this skill is for participants to understand what physics means by performing instructive physical experiments that reveal fundamental physical principles, and also to attain a level of dexterity with experimental devices. Physics is an empirical science and not a mere collection of mathematical laws. In this sense this practical is an appropriate counterpart for the more theoretic and mathematical physics courses. Moreover, the aim of this training is to improve your ability to report and summarize your experimental work in a few pages. The skill consists of a collection of 7 different experiments. Students cooperate in pairs and each week performs a different experiment. Each week requires the participants to learn the theory, design and plan an appropriate experiment, collect and analyse their data to understand the physical principles contained within. These experiments are supplemented with a full day of training at the beginning regarding various "tools" used in practical physics, which can be applied during this skill.

Topics:

Mechanics: Newton's Laws Experiment, Conservation of momentum and impulse, Projectile Motion, Mechanical waves, Harmonic Motion.

Thermodynamics: Thermal Energy, Equilibrium Temperature, Specific Heat, Ideal Gas Law

Optics: Michelson's interferometer.

Literature

There is no book directly associated to this course. Information on the individual experiments is provided in this syllabus and in separate detailed experiment descriptions. Additionally, this course relates to the introductory course Physics: Elements in Physics. The textbook for this course is: University Physics with Modern Physics, H.D. Young & R. A. Freedman, Pearson Education (US), 13th International edition, May 2011. For the underlying physical principles of the experiments we refer to this textbook.

Instructional format

This course takes place in the physics laboratory in Chemelot. Students work in couples during the skill. Each week each couple jointly studies a different experiment, i. perform measurements, ii. process the experimental data, and iii. write a report. The final grade is based on these reports. During the course students also learn more about the basis theory of Experimental Physics, like sources of errors and error propagation.

Assessment

Evaluation of student performance will be based on lab reports, peer review, fill-in sheets and the quality of their logbook.

PRA1005 Data Collection Techniques in the Neurosciences

Course coordinator

Dr. Mark Roberts: Faculty of Psychology and Neuroscience, Department of Cognitive Neuroscience

Contact: mark.roberts@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ None

Objectives

This skill has the aim of familiarizing students with basic techniques for data collection and analysis in behavioural neuroscience and fMRI.

Description of the skills

The skills will cover relevant laws of sensory perception (Weber, Fechner, Stevens), and introduce testing procedures for the measurement of detection and discrimination thresholds. These will include constant stimuli methods, and various adaptive testing procedures. In addition, there will be an introduction to Signal Detection Theory and derived measures of detectability or discriminability.

In order to make this knowledge concrete, students conduct experiments based on several of these testing procedures. The end goal is to test one of the colleague-students and determine a sensory threshold with provided software.

Students will also be familiarized with the analysis (Brainvoyager QX) and interpretation of an fMRI dataset.

In addition to the empirical data collection and analysis, relevant literature will be covered on specific testing procedures, and on particularly beautiful examples of current state of the art experiments.

Literature

No mandatory literature. Hand-outs will be provided by coordinator.

Instructional format

Lectures, Group meetings and computer meetings

Assessment

Intermediate assignment, participation, presentation and essay (average of grades)

PRA2002 Chemical Synthesis

Course coordinator

Dr. Hanne Diliën: Faculty of Science and Engineering, Maastricht Science Programme

Contact: hanne.dilien@maastrichtuniversity.nl

Pre-requisites

- ✓ PRA1001 Research methods
- ✓ PRA1002 Research, Data Analysis and Presentation Academic Skills

Co-requisites

- ✓ CHE2001 Organic Chemistry

Objectives

- To be able to perform organic synthetic experiments in a structured and safe manner.
- To understand specific separation and purification techniques commonly used in organic chemistry.
- To gain a practical understanding of the impact of the choice of reagents, solvents and conditions on the outcome of an organic reaction.
- To gain further skills in scientific research reporting.

Description of the skills

This skills focuses on the development of a clear understanding of the synthesis of organic chemical compounds. It is important for the students to learn how to convert their theoretical knowledge on chemical reactivity to actual design and execution of synthetic chemical reactions. Typical topics, which will be covered in this skills training are:

- Safe handling of organic reagents and safe execution of organic experiments.
- Commonly used organic synthetic laboratory techniques.
- Synthetic chemistry of various organic reaction types (*e.g.* nucleophilic substitutions and eliminations, electrophilic reactions and radical chemistry).
- Stereochemistry in organic synthesis.
- Purifications and separations in chemistry.
- Spectroscopy and characterization of organic compounds.

Literature

- Practical laboratory instructions.
- For students intending on continuing and specializing in organic chemistry, a practical book, such as "Multiscale Operational Organic Chemistry" by John W. Lehman (Pearson, 2nd edition, 2009) may be interesting.

Instructional format

This training is organized as a series of laboratory sessions. The students will have to prepare short reports on the various laboratory activities of this training. The theory required for the skills is introduced during the tutorial group meetings of the co-requisite course: CHE2001 Organic Chemistry.

Assessment

1. The behaviour in the laboratory,
2. The laboratory notebook with developed protocols,
3. Pre-lab online assessment,
4. Lab reports.

PRA2003 Programming

Course coordinator

Cameron Browne: Faculty of Science and Engineering, Department of Knowledge Engineering

Contact: cameron.browne@maastrichtuniversity.nl

Pre-requisites

- ✓ MAT1004 Imperative Programming or MAT2007 Introduction to Programming

Co-requisites

- ✓ None

Objectives

To familiarize students with the practical skills required in computer programming.

Description of the course

The course is intended to introduce students to more practical concepts involved with computer programming. The students will gain experience implementing these concepts in programming tasks described by each assignment. Topics include:

- Introduction to computational complexity
- Implementing recursive methods
- Object-oriented programming
- Basics of graphical user interface (GUI) programming
- Exceptions and error handling
- File input and output
- Introduction to data structures

Literature

No additional text book necessary. Relevant literature will be available online and referred to on the assignments.

Instructional format

The course will be taught in a computer lab. In these lab group meetings, students will be briefly introduced to the concepts and will then focus on understanding the practical applications of these concepts through programming assignments.

Assessment

The assessment will be based on the programming assignments.

PRA2004 Inorganic Synthesis

Course coordinator

Dr Burgert Blom, Faculty of Science and Engineering, Maastricht Science Programme

Contact: burgert.blom@maastrichtuniversity.nl

Pre-requisites

- ✓ PRA1001 Research methods
- ✓ PRA1002 Research, Data Analysis and Presentation Academic Skills

Recommended:

- ✓ CHE2001 Organic Chemistry
- ✓ PRA2002 Chemical Synthesis

Co-requisites

- ✓ CHE2002 Inorganic Chemistry

Objectives

- To implement principles seen in class in a laboratory setting
- To learn the basic synthetic techniques in inorganic chemistry
- To synthesize and study a range of inorganic compounds

Description of the skills

This skills will focus in the synthesis and analysis of inorganic compounds, focusing primarily on coordination compounds and their spectroscopy.

Literature

Girolami, Rauchfuss, Angelici: Synthesis and Technique in Inorganic Chemistry (University Science Books). Woollins: Inorganic Experiments (Wiley VCH).

Instructional format

Laboratory sessions

Assessment

Assessment may include but may not be limited to: laboratory participation, laboratory notebook, written laboratory reports, pre- and post-laboratory problem sets and practical or theoretical exams.

PRA2005 Advanced Molecular Laboratory Skills

Course coordinator

Dr. Erik Steen Redeker, Faculty of Science and Engineering, Maastricht Science Programme
Contact: erik.steenredeker@maastrichtuniversity.nl

Pre-requisites:

- ✓ PRA1001 Research Methods

Co-requisites:

- ✓ None

Objectives

- To be able to efficiently plan experiments related to molecular research in chemistry, biology and biochemistry
- To understand and execute typical separation and analysis tools frequently used in a chemical and biological laboratory
- To be able to accurately develop and follow scientific protocols and procedures
- To be able to correctly use a lab notebook and do scientific reporting in the form of scientific reports

Description of the course

This course focuses on experimental research methods and reporting. In essence it is a sequel to the core practical training PRA1001 Research Methods. The main goal is to provide students with sufficient laboratory skills to successfully complete more advanced skills and projects in chemistry and biology/biochemistry related to (bio)molecular laboratory research. During the six weeks, students will perform a variety of integrated biology and chemistry experiments. It can be anticipated that three of the six skills days have an emphasis on chemical aspects of molecular research, whereas the other three days focus more on biological and biochemical aspects. The course will be structured in the Research Based Learning (RBL) format, with room for student initiatives.

Literature

Lab manual. Useful additional literature: "Practical skills in Biomolecular sciences" by Reed, R., Holmes, D., Weyers, J., Jones, A. (Pearson).

Instructional format

PBL/RBL, work in subgroups, research experiments, assignments

Assessment

Pre-lab preparation, lab notebook reporting, scientific reports

PRA2006 Electronics Lab

Coordinator
Dr. Bart van Grinsven: Faculty of Science and Engineering, Maastricht Science Programme

Contact: bart.vangrinsven@maastrichtuniversity.nl

Pre-requisites:
- ✓ None

Co-requisites:
- ✓ PHY2006: Electronics

Objectives
By the end of this course you will be able to:
- follow a circuit diagram and built a circuit on a breadboard by identifying and using the correct components, supplies and measurement devices to check the circuit.
- collect experimental readings using multimeters and oscilloscopes to fault find and compare device function to theory in DC and AC configurations
- plot and analyse graphs of results and perform calculations of resistances, power, currents and (various types of (average/RMS)) voltage drops across various sections of circuits or components.
- build and analyse RC filters while calculating their gain, time constants and cut-off frequencies.
- build diode rectifying circuits and identify the benefits of full/half wave/smoothing circuits.
- use op-amps in various configurations to amplify weak signals by calculating and selecting the appropriate resistors and use op-amps as comparators for digital conversion.
- programme and wire up an Arduino using the software to control various circuit devices as inputs and outputs.
- write clear reports outlining experimental observations and how they compare to theory
- keep clear notes which contain enough information for someone to be able to repeat and test the experiments and builds which you undertook.

Description of the course
This practical addresses the basic concepts essential for mastering the principles of electronics applicable to direct current (DC) and alternating current (AC) circuit analysis. The emphasis is on the basic physics behind electronics, the application of the fundamental laws of electronics to discrete electrical components, and the network theorems used in circuit analysis. The first weeks involve schematic reading, the mathematics behind electronics, and elementary circuit analysis. Here the students acquire the fundamental concepts of DC and AC theory and progresses through capacitive circuits with emphasis on AC circuit analysis, with special emphasis on sinusoidal waveforms, filters and rectifiers.
The practical continues with semiconductor physics, namely diode and transistor characteristics and their applications, most notably operational amplifiers (and comparators).
The next part of the practical entails the study of digital logic, its operations, principles and applications. The course concludes with an introduction to microprocessor circuits and techniques using the Arduino microcontroller.

Literature
A course manual and detailed experiment descriptions will be provided during the practical.

Instructional format
Laboratory session

Assessment
The final assessment is based mainly on lab reports by students but some lab days will also require the completion of pre-lab quizzes

PRA2007 Physics Laboratory

Course coordinator

Dr. Chris Pawley: Faculty of Science and Engineering, Maastricht Science Programme
Contact: c.pawley@maastrichtuniversity.nl
Dr. Bart van Grinsven: Faculty of Science and Engineering, Maastricht Science Programme
Contact: bart.vangrinsven@maastrichtuniversity.nl

Pre-requisites

- ✓ PHY1001 Elements of Physics
- ✓ PRA1003 Basic Physics Laboratory

Note: Waivers are unlikely to be granted unless applicants can show their experience in experimental physics is equivalent to that of PRA1003

Co-requisites

- ✓ None

Objectives

This practical is aimed at obtaining a deeper understanding of physics by performing various key experiments in the areas of Classical Mechanics, Quantum Mechanics, and Electromagnetism. Examples are the photoelectric effect, blackbody radiation, angular momentum, Faraday's law, and the Coulomb's law. The focus will be on the design and execution of the experiments and their relation to the fundamental laws and principles of physics. Another objective is the further training of physical laboratory techniques and procedures. Furthermore, attention will be paid on data analysis and reporting. This lab relates to level 200 physics courses such as Classical Mechanics, Quantum Mechanics, and Electromagnetism.

Description of the skills

This skill will contain:

- Design, use and measurement in physical experimentation;
- Gathering data using automated processes;
- Data manipulation and analysis using modern tools such as MATLAB or python;
- Experiments in mechanics (Gyroscope dynamics, Driven Damped Harmonic Oscillator), Quantum Physics (Photoelectric Effect, Blackbody Radiation, Atomic Spectra), and Electrodynamics (Charge of the Electron (Millikan's experiment), Faraday's Law of Induction Experiment).

Literature

University Physics with Modern Physics, H.D. Young & R. A. Freedman, Pearson Education (US), 13th International edition, May 2011.

Practical Physics, G.L. Squires, Cambridge University Press, 4th edition, September 2001.

Measurements and their Uncertainties: A practical guide to modern error analysis,
I. Hughes & T. Hase, Oxford University Press, August 2010.

Instructional format

In this skill participants work together in a small team and each of the six weeks perform a different physical experiment. Each experiment is thoroughly planned, executed, and analysed by the team, and each week a report is submitted. The final grade is based on these reports. Participants are expected to more independent that in the PRA1003 Basic Physics Lab, but staff are available for support.

Assessment

The grade is based on the submitted laboratory reports, the participant's individual lab journal the ability of the team members to design and execute a suitable experiment in physics.

PRA2008 Physical Chemistry

Course coordinators

Dr. Fabrice Birembaut: Faculty of Science and Engineering, Maastricht Science Programme
Contact: fabrice.birembaut@maastrichtuniversity.nl

Pre-requisites

- ✓ none

Co-requisites

- ✓ none

Recommended

- ✓ CHE2003 Physical chemistry

Objectives

By the end of the course students will be able to:

- Perform various physical chemistry experiments and analyse the data. These will involve:
- Kinetics analysis
- Thermodynamics analysis
- Electrochemistry analysis
- Spectroscopy analysis

Description of the skill.

During this skill we will investigate how physical data is extracted from different experiments. Each week you will perform different experiments focusing on different parts of physical chemistry (thermodynamics, electrochemistry, kinetics, spectroscopy) and you will then have to work out different constants or information from the data you collected during the day. Error analysis will also take a large part in the training as it is completely inherent to physical chemistry.

Literature

Atkins – Physical chemistry, any edition, OUP.

Instructional format

Each week you will have practical sessions

Assessment

Student performance will be evaluated on the basis of:

1) Their prelab work
2) Their lab reports
3) Their lab notebooks
4) The quality of their results.
5) The error analysis
6) Their answers to the postlab questions.

PRA2009 Field Skills in Biology

Course coordinator

Dr. John Sloggett: Faculty of Science and Engineering, Maastricht Science Programme
Contact: j.sloggett@maastrichtuniversity.nl

Pre-requisites

- ✓ PRA1002 Research Data Analysis and Presentation Skills

Co-requisites

- ✓ None

Objectives

For an ecologist, the field is a much less controlled, though much more realistic environment than the lab, and a completely different set of practical skills are required. In this course you will learn how to generate well controlled reliable, results in the field. You will be shown a diversity of methods to collect, count and identify animals and plants, both direct (e.g. collecting) and indirect (e.g. identification from sounds). You will learn how to measure important environmental variables that can determine the results you get (e.g. soil characteristics, temperature, humidity) and most importantly some basic means to plan for and interpret all that complex data.

Description of the skills

This skills will include:

- Training in the use of a diversity of methods to collect or count organisms in the field
- Training on the measurement of some important environmental characteristics
- The means to identify of species or higher taxa of certain environmentally or taxonomically important groups or indicator species in the field or lab
- Planning of field experiments
- Interpretation of field results, including some statistical work

Literature

Wheater, C.P., Bell, J.R. & Cook, P.A. (2011). *Practical Field Ecology: A Project Guide*, John Wiley & Sons (Not obligatory but useful)

Instructional format

Practical classes outdoors. This means that appropriate clothing is needed such as Wellingtons, trousers that can get dirty, rain clothing, a watertight back-pack etc. Classes will take place even when it is raining.

Assessment

Worksheets; behaviour and practical approach during classes; exam

PLEASE NOTE: One of the classes in this course will be conducted in the evening until about 24:00. Attendance for this class is obligatory and if you register for this course, you must attend!

PRA2010 Synthetic Biology

Course coordinator

Dr. Erik Steen Redeker, Faculty of Science and Engineering, Maastricht Science Programme
Contact: erik.steenredeker@maastrichtuniversity.nl

Pre-requisites:

- ✓ PRA2005 Molecular Lab Skills
- ✓ PRA2014 Genetics

Co-requisites:

- ✓ None

Objectives

- Understand synthetic biology concepts
- Understand engineering concepts of design, build and test
- Practical application of synthetic biology concepts
- Learning and implementing basic molecular biology lab skills
- Collect and analyze experimental data

Description of the course

Synthetic biology aims to (re)construct genetic systems by using molecular biology, genetic engineering and microbiology methods from an engineering point-of-view. This engineering approach focuses on four important principles: abstraction, modularity, standardization and design/modelling. In this way it is possible to extend and apply genetic techniques to real world applications. The goal of this practical course is to design, build, and experiment with biological systems using molecular biology techniques relevant to the field of synthetic biology in combination with engineering concepts.

Literature

Course manual.

Instructional format

This practical course is organized as a series of laboratory sessions.

Assessment

The assessment will consist of short reports on the various laboratory activities of this training and an individual essay. The exact format will be announced during the course.

PRA2011 Exploring the World of Plants

Course coordinator
Dr. FeiYian Yoong: Faculty of Science and Engineering, Maastricht Science Programme

Contact: feiyian.yoong@maastrichtuniversity.nl

Pre-requisites
- ✓ None

Co-requisites
- ✓ BIO2003 General Botany

Objectives
This course aims to provide you with a more extended scientific perspective in plant anatomy, morphology, and physiology throughout the lifecycle from the concepts discussed in BIO2003 in a practical setting.

Description of the course
You will get an expanded view of the world of plants from the BIO2003 course. In this practical course, the concepts introduced in BIO2003 will be further reiterated through laboratory experiments. You will get hands-on experiences in various scientific observations and discussions to better understand the morphological and physiological aspects of a plant throughout a plant lifecycle. You will dissect plant organs and learn more about the arrangement of plant structures in correspondence to various physiological functions. Not only will you gain some practical skills in microscopy and physiology, you will also develop a better understanding of plant architectural body plan and development in accordance to their adaptations to the environment. In your exploration of the world of plants, you will obtain a greater insight to a plant physiological function in relation to their anatomical and morphological structures.

Literature
- ✓ Botany, an introduction to plant biology. J.D. Mauseth, 6th ed. 2016. Jones & Bartlett Learning. ISBN-13: 9781284077537
- ✓ Some scientific articles.

Instructional format
Weekly laboratory experiments and continuous scientific observations over the course period. One excursion may be part of the course.

Assessment
Worksheets, one laboratory report, and practical assessment.

PRA2013 Practical Zoology

Note: this course replaces PRA2012 Anatomy, Morphology and Behaviour of Animals. If you have successfully completed PRA2012 you may not participate in PRA2013.

Course coordinator

Dr. John Sloggett: Faculty of Science and Engineering, Maastricht Science Programme

Contact: j.sloggett@maastrichtuniversity.nl

Pre-requisites

- ✓ PRA1002 Research, Data Analysis and Presentation Skills
- ✓ BIO2004 General Zoology

Objectives

The skills will include:

- Carrying out experiments on physiology, behaviour, biodiversity and other aspects of zoology
- Analysing zoological data
- Writing up zoology experiments
- Knowledge of conservation of zoological samples

Description of the skills

The skill aims to provide a greater insight into the different aspects of zoology and how they are studied in the laboratory. You will learn different experimental approaches used in zoology in including physiological testing, behavioural analysis and measures of animals diversity. This course aims to provide you with better skills in handling both live and dead animal samples and in interpreting what you see in a biologically relevant way.

Please note that in this course you are required to carry out experimental work with live (invertebrate) animals, which may harm them.

Literature

Recommended is the book used for course BIO2004 General Zoology

Instructional format

One whole-day Chemelot lab per week and museum visit

Assessment

Lab performance, write ups and reports

PRA2014 Genetics

Course coordinator

Prof. dr. Leon de Windt: Faculty of Health, Medicine and Life Sciences, Maastricht University.
Contact: l.dewindt@maastrichtuniversity.nl

Pre-requisites

- ✓ BIO2001 Cell Biology

Co-requisites

- ✓ BIO2007 Genetics

Objectives

- To be able to purify genomic DNA from eukaryotic cells and plasmid (circular) DNA from prokaryotic cells and perform quantitative analyses on each product.
- To perform and comprehend polymerase chain reaction (PCR) analysis.
- Analyze DNA products using restriction digestion, ligation and agarose gel electrophoresis.
- To isolate RNA from eukaryotic cells and apply reverse transcription to generate copy DNA
- To study specific proteins by Western immunoblotting.
- To independently use genetic and genomic websites, general and specialized databases and determine relationships of genes within and between databases.
- To have sufficient technical training for more advanced skills in molecular biology and the life sciences.
- To apply genetic principles to a pre-assigned task and present the findings to a larger audience.

Description of the skills

The skills trainings are aimed to obtain a basic introduction to techniques and methods in modern Genetics. The first skills take place at a designated skills laboratory at Chemelot campus; subsequent skills training topics "Genomes and Genomics" and are taught in a computer landscape. These days integrate theoretical and practical information. Each student will receive theoretical and practical *in silico* training in the morning, followed by a limited number of tasks to execute on the computer and answered in a skills report. The final skills consist of a student group presentation where the combined theoretical and practical skills on Genetics are applied to a pre-assigned task.

Literature

"Introduction to Genetic Analysis" by Griffiths, Wessler, Carrol, Doebley (Palgrave Macmillan, 11thedition, 2015. ISBN-13: 9781464109485).

Instructional format

Skills group meetings.

Assessment

- Attendance to the skills meetings is required (cf. Rules and Regulations). In case of any absence, a motivation is required via the Office of Student's Affairs.
- A written skills exam consisting of ± 20 questions provided at the end of the 4th week of the Skills course. Return of this exam in the 5th skills week, before start of course topic "Genomes and Genomics". The questions are purely based upon the practical techniques and information received during the first 4 weeks of skills. This factor weighs in 60% to the final grade.
- The skills 6th week topics "Genomes and Genomics" and is taught in a computer landscape. These days integrate theoretical and practical information. Each student will receive theoretical and practical in silico training in the morning, followed by a limited number of tasks to execute on the computer and answered in a skills mid-term report. This examination factor weighs in 30% to the final grade.
- A final evaluation on Skills attendance and active participation is scored and will count 10% towards the final grade.

PRA2015 Advanced Academic Skills

Course coordinator

Dr. John Sloggett: Faculty of Science and Engineering, Maastricht Science Programme

Contact: j.sloggett@maastrichtuniversity.nl

Pre-requisites

- ✓ PRA1002 Research, Data Analyses and Presentation Academic Skills

Co-requisites

- ✓ None

Objectives

- To improve written skills
- To improve presentation skills
- To improve argumentation skills
- To teach students how to manage their time
- To improve skills related to group working

Description of the skills

A good researcher does not only know a lot about his/her specific topic, they are also able communicate their findings to others. Several key skills are very important in this. Advanced Academic Skills will continue where PRA1002 left off, and will go more into depth. Advanced Academic Skills may be particularly useful for students who are more generally interested in the process of scientific communication.

Literature

Literature via handouts. No mandatory textbook.

Instructional format

Assisted individual work, peer reviewing.

Assessment

Written work and other presentational skills.

PRA3001 Advanced Organic Synthesis

Course coordinator

Dr. Hanne Diliën: Faculty of Science and Engineering, Maastricht Science Programme

Contact: hanne.dilien@maastrichtuniversity.nl

Pre-requisites

- ✓ PRA2002 Chemical Synthesis
- ✓ PRA3014 Spectroscopic Methods

Co-requisites

- ✓ CHE3001 Organic Reactions

Objectives

The main objective of this skill is to provide a solid foundation in multi-step organic synthesis. Most organic compounds cannot be prepared in a single step. Instead, a sequence of reactions has to be designed to obtain these materials. Some of these steps may require complex chemistry, very reactive intermediates or inert atmospheres. This course focuses on these special situations.

Description of the skills

This skill will contain:

- Advanced synthetic chemistry of various organic reaction types.
- Multi-step organic synthesis.
- Synthesis and handling of reactive compounds under inert atmosphere.
- Extensive use of spectroscopic characterization.

Literature

- Practical laboratory instructions.
- For students intending on continuing and specializing in organic chemistry, a practical book, such as "Multiscale Operational Organic Chemistry" by John W. Lehman (Pearson, 2nd edition, 2009) may be interesting.

Instructional format

This training is organized as a series of laboratory sessions. The students will have to prepare short reports on the various laboratory activities of this training. The theory required for the skills is introduced during the tutorial group meetings of the co-requisite course: CHE3001 Organic Reactions.

Assessment

1. The behaviour in the laboratory,
2. The laboratory notebook with developed protocols,
3. Practical reports.

PRA3002 Advanced Physics Laboratory

Course coordinators

Dr. Chris Pawley: Faculty of Science and Engineering, Maastricht Science Program

Contact: c.pawley@maastrichtuniversity.nl

Pre-requisites

- ✓ PHY1001 Elements of physics
- ✓ PRA1003 Basic Physics Laboratory
- ✓ PRA2007 Physics Laboratory

Note: Waivers are unlikely to be granted unless applicants show significant expertise in experimental physics or similar subject (equivalent to the two pre-requisite skills).

Co-requisites

- ✓ None

Objectives

- To acquaint the participants with an overview of the main areas in high level experimental physics
- To illustrate the relationship between observation, experiment and hypothesis
- To give the participants a better understanding of the laws of physics
- To hone the skills required for planning and conducting experimental physics
- To develop the skills of experimental design and the impact this has on the outcome.

Description of the skill

This skill is the culmination of the physics laboratory modules, and requires participants to use the skills that they have acquired in their previous lab experiences to good effect in order to design and conduct suitable experiments. The participants will have the opportunity to conduct experiments in material science, thermodynamics, optics, nuclear and particle physics and chaotic dynamics. During this skill, the participants will design experiments to test hypotheses in a variety of fields, ensuring that the data that they gather is sufficient to address pertinent questions in this field. Unlike the prerequisites, the participants will not be given step-by-step instructions for each experiment - a certain level of independence is both expected and required.

Literature

University Physics with Modern Physics, H.D. Young & R. A. Freedman, Pearson Education (US), 13th International edition, May 2011.

Practical Physics, G.L. Squires, Cambridge University Press, 4th edition, September 2001.

Measurements and their Uncertainties: A practical guide to modern error analysis,
I. Hughes & T. Hase, Oxford University Press, August 2010.

Instructional format

This skill is taught in a 'carousel' style – participants work in small teams (2 or 3 per team) with each team working on a different experiment during the session. During each subsequent week the team conducts a different experiment, this provides the opportunity for each team to perform experiments in diverse areas of physics during the entire module.

Assessment

Assessment consists of personal contribution within the lab, quality of lab notes kept plus individual lab reports written following the laboratory session. Each participant produces three lab reports for the duration of the course. These are marked considering the quality of the experimental design as well as the report itself.

PRA3003 Molecular Biology

Course coordinators

Dr. Paula da Costa Martins: Faculty of Health, Medicine and Life Sciences, Maastricht University.
Contact: p.dacostamartins@maastrichtuniversity.nl

Pre-requisites

- ✓ BIO2001 Cell Biology
- ✓ BIO2007 Genetics
- ✓ PRA2014 Genetics

Co-requisites

- ✓ BIO3001 Molecular Biology

Objectives

- To grasp the contextual setting which animal models are commonly used in Molecular Life Sciences.
- To apply DNA cloning, transfection and imaging procedures using prokaryotic and eukaryotic cells.
- To perform quantitative analyses on (non)coding RNA species and proteins from cell culture and organ biopsies.
- To apply molecular biological principles to a pre-assigned task and present the findings to a larger audience.
- To interpret scientific results and to write a scientific proposal on a Molecular Biological approach to relevant human disorders and defend it in a larger audience.

Description

The general aim of this skills course is to obtain detailed knowledge about the techniques that can be applied to address molecular processes in cell signaling and control of gene expression. Topics include the activation of intracellular signaling pathways; analysis of cellular responses; analysis of gene expression; analysis of protein activation; in silico analysis of signaling pathways; and the culmination of the above elements in an essay and assignment to indicate active understanding of the above processes. The skills days are designed to provide a perspective of how cutting edge molecular biological techniques are applied to tackle major research questions in modern biomedical research.

Literature

A reader is provided at the start of the course. Other recommended literature will be announced later.

Instructional format

Skills group meetings.

Assessment

1. Attendance to the skills meetings is required. A final evaluation on Skills attendance and active participation is scored and will count 20% towards the final grade.
2. A written skills exam based upon the practical techniques and information received during the first 4 weeks of skills. This factor weighs in 40% to the final grade.
3. A final student group scientific proposal writing activity and group presentation. This group grade counts 40% to the final individual grade.

PRA3005 Polymer Processing

Course coordinator

Cyriel Mentink PhD: Chemelot Innovation and Learning Labs

Contact: cyriel.mentink@chillabs.nl

Pre-requisites

- ✓ CHE2001 Organic Chemistry

Co-requisites

- ✓ none

Objectives

- To have the skills to determine the physical and mechanical properties of polymers and to increase the understanding of the underlying analytical methods
- To obtains skills in the processing of polymers e.g. extrusion and injection moulding, compounding, pressing, etc
- To obtain an understanding of the processing of different polymers like thermoplastic, thermosetting and elastomeric polymers and coatings/paints

Description of the course

In this practical course the processing and mechanical testing of polymers will be explored. The course will exist of four different experiments. In these experiments the processing and testing of a specific polymer will be conducted.

Thermoplastic polymers will be compounded (pure and as a blend) and processed in a blow or flat film trough extrusion. By the use of injection moulding standard dog bones will be made for mechanical testing. Mechanical and physical properties of the product will be determined by tensile and bending strength analysis, Melt Flow Index (MFI) and a notched test bar impact test.

Thermosetting polymers will be processed into composites. Different techniques for constructing composite materials will be addressed. Attaching different composite parts to each other is complicated and different methods will be explored. Mechanical and physical testing will be performed using the above described techniques.

Rolling and pressing techniques will be used to process elastomers and the process of vulcanisation will be studied. After processing mechanical and physical testing will be performed.

Coatings/paints play are an important application area of polymers. A basic coating will be made and will be processed. Characteristics like scratch and impact resistance of this coatings will be tested.

Literature

Practical Manual and SOP's of the used equipment

Instructional format

Practical Course

Assessment

1. Assessment of the motivation
2. Assessment of the practical skills
3. A written lab report at the end of every experiment

PRA3006 Programming in the Life Sciences

Course coordinator

Dr. Chris Evelo, Dr. Egon Willighagen: Department of Bioinformatics – BiGCaT, Faculty of Health, Medicine and Life Sciences

Contact: chris.evelo@maastrichtuniversity.nl

Pre-requisites

- ✓ PRA2003 Programming

Co-requisites

- ✓ None

Objectives

- To have the ability to recognize various classes of chemical entities in pharmacology and to understand the basic physical and chemical interactions.
- To be familiar with technologies for web services in the life sciences.
- To obtain experience in using such web services with a programming language.
- To be able to select web services for a particular pharmacological question.
- To have sufficient background for further, more advanced, bioinformatics data analyses.
- To be familiar with modern software development practices.

Description of the course

In the life sciences the physical interactions between chemical entities is of key interest. Not only do these play an important role in the regulation of gene expression, and therefore all cellular processes, they are also one of the primary approaches in drug discovery. For example, pharmacology is the science studies the action of drugs, and for many common drugs, this is studying the interaction of small organic molecules and protein targets. Metabolism, similarly, depends on the interactions of small molecule substrates with enzymes.

And with the increasing information in the life sciences, automation becomes increasingly important. Big data and small data alike, provide challenges to integrate data from different experiments. The Open PHACTS platform is an example of many public websites providing an application programming interface (API) as a web services to support biological research and in this course you will learn how to use such web services from programming languages, allowing you to link data from such knowledge bases to other platforms, such as those for data analysis.

Literature

"Rang and Dale's Pharmacology" by Rang *et al.* (Pearson, 7th edition, 2012).

"JavaScript & jQuery: The Missing Manual" by D.S. McFarland (O'Reilly, 2nd edition, 2011)

"Open PHACTS: semantic interoperability for drug discovery" by A. Williams et al. Drug Discovery Today, 2012, http://dx.doi.org/10.1016/j.drudis.2012.05.016

Instructional format

Six hands-on full-day practicals.

Assessment

1. An end product consisting of working source code and documentation (individual)
2. An end presentation describing the product, research question, results, and conclusions (group)
3. A oral assessment (individual)

PRA3008 Transition Metal Chemistry

Course coordinator:

Dr. Marie C. Correia; Faculty of Science and Engineering, Maastricht Science Programme
Contact: marie.correia@maastrichtuniversity.nl

Pre-requisites:

- ✓ PRA2002 Chemical Synthesis
- ✓ PRA2004 Inorganic Synthesis
- ✓ CHE2004 Spectroscopy

Recommended:

- ✓ CHE3001 Organic Reactions
- ✓ PRA3014 Spectroscopic Methods

Co-requisites:

- ✓ CHE3002 Transition Metal Chemistry

Objectives

- To adapt common synthetic techniques towards inorganic and organometallic compounds
- To learn Schlenk-line and glovebox techniques in order to work with air-sensitive transition metal compounds
- To apply the theoretical knowledge gained in CHE3002 in a laboratory setting
- To use diverse analytical techniques to explore the physical, electronic and spectroscopic properties of the transition metal complexes synthesized
- To experimentally perform catalytic reactions to test the complexes synthesized

Description of the course

This practical is modelled as a research endeavour and focuses on the multi-step synthesis, characterization, and catalytic exploration of organometallic complexes. These complexes allow for an introduction to organometallic (coordination) chemistry, geometrical distortions, ligand isomerism, backbonding interactions, and catalysis. Students will be required to use SciFinder to search the published literature in order to determine the way forward for their synthetic scheme and analysis. Concepts from the Transition Metal Chemistry Lecture (CHE3002) can be related back to this practical, and provide a foundation that can be utilized in order to successfully complete this course.

Literature

Published scientific research articles accessed via SciFinder.
The following textbooks will be available for reference:

- Kilian, P. (2010) *General Spectroscopic Techniques and Report Writing* in *Inorganic Experiments* (3rd Revised Edition) Edited by Woollins, J. D., Wiley-VCH, (ISBN: 978-3-527-32472-9).
- Bochmann, M. (2015). *Organometallics and Catalysis*. Oxford University Press (ISBN: 978-0-19-966821-2).
- Miessler, G. L.; Fischer, P. J.; Tarr, D. A. (2013) *Inorganic Chemistry* (5th Edition), Pearson (ISBN-10: 129202075X; ISBN-13: 9781292020754).

Instructional format

This practical course is organized as a series of laboratory sessions.

Assessment

Grades in this course will depend on pre-lab preparation (presented as chalk-talk and hardcopy), quizzes, notebook entries, lab performance, and a final written report prepared as a journal article.

PRA3010 Microbiology

Course coordinator

Frank Stassen, Faculty of Health, Medicine and Life Sciences

Contact: f.stassen@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ BIO3003 Microbiology

Objectives

In this skill training you will perform microbiological tests such as a variety of biochemical and molecular methods that enable you to identify an infectious agent and genetic relatedness in case of an outbreak.

Description of the course

Medical Microbiology is concerned with the diagnosis, treatment and prevention of infectious diseases. For identification and treatment of an infectious agent patient samples are analysed in a medical microbiology laboratory. In the first three weeks of this skill training you will get acquainted with the basic microbiological techniques such as, microbial culture, biochemical tests, antimicrobial resistance, and molecular characterisation. In the subsequent weeks, you will each analyse a potential outbreak for which you will need to determine the infectious agent, analyse the antimicrobial resistance pattern to propose therapy as well as the genetic composition of the micro-organism in order to determine genetic relatedness. For this you will use the techniques that you have learned in the previous weeks. Finally you will need to present your results in a practical report.

Literature

- Murray. *Medical Microbiology*. (7th ed.), Elsevier Mosby.
- Primary literature

Instructional format

Weekly laboratory experiments.

Assessment

Your practical skills will be evaluated and marked. Moreover, you will be marked on the quality of your research plan (week 3) and a written practical report on the outbreak analyses (week 6).

PRA3011 The Limburg landscape

Course coordinator

Dr. Roy Erkens: Faculty of Science and Engineering, Maastricht Science Programme

Contact: roy.erkens@maastrichtuniversity.nl

Pre-requisites

- ✓ PRA2009 Field Skills in Biology
- ✓ **A good quality bike to make field trips**

Co-requisites

- ✓ None

Objectives

The landscape of Limburg is unique in the Netherlands, especially the Southern part. In terms of botanical and geological diversity but also in terms of elevation the province has a clearly distinct profile from the other provinces in the Netherlands. It is also this landscape you see on a daily basis while studying at Maastricht University. The main objective of this skills training is to familiarise you with the biological characteristics and geological history of the province so you can understand the evolution of its natural landscape.

Description of the course

The landscape of Limburg, like any other landscape, displays a variety of features. Some of these reflect man's ongoing endeavour to adapt the landscape to its needs. For instance, there has been a clear impact of human behaviour in the province from the moment that Neolithic farmers arrived in these parts around 4000 BC. Other features represent a natural evolution of the landscape on a scale of (tens of) millions to several thousands of years to very recent. Distinct features are the geology, the variety in landforms and different climatic conditions. This combination of geological, geomorphological and climatic factors has endowed the province with its own characteristic wealth of especially botanical variety but also explains the findings of for instance Mosasaurs. Topics covered in this skills training are the geological history of Limburg, characteristics and management of the riverine landscape of the Maas, the practice of nature conservation and the ecology of different types of South Limburg forests.

Literature

This skill will use solely primary literature as a basis for the tasks. No text book is required.

Instructional format

Every week a major topic will be addressed (e.g. geology, paleobiology, hydrobiology, nature conservation). During four weeks a field site will be visited by bike or bus. The bus will be arranged by MSP but you are responsible for having a proper bike available (e.g. proper brakes etc.). On some days we will bike substantial distances in an elevated landscape so also make sure you are in good health.

Assessment

The assessment will consist of three assignments: 1) group assignment (15% of final grade), 2) individual review report (50% of final grade), and 3) group (2 students) review report (35% of final grade).

PRA3012 Advanced Electronics

Coordinator

Dr. Bart van Grinsven: Faculty of Science and Engineering, Maastricht Science Programme
Contact: bart.vangrinsven@maastrichtuniversity.nl

Prerequisites

- ✓ PRA2006 Electronics Lab
- ✓ PHY2006 Electronics

Co-requisites:

- ✓ *None*

Objectives

- To appreciate the theory behind digital (Boolean) logic and logic gate applications and to develop an insight into how computers function.
- To design, study and build circuits involving adders, flip-flops, counters and sequential logic and understand how these devices can be used in everyday electronics.
- To understand how an electrocardiogram (ECG) measures the heart's electrical pulses and translates these into an analogue waveform.
- To build an ECG generator and detector and collect measurements using these.
- To use impedance spectroscopy to distinguish between different samples and understand the principles behind this technique.

Description of the course

The course builds on the introductory electronics lab and is split into three, two-week long projects covering the following topic areas:

- **Digital electronics for computing:**

This project covers the basics of binary number systems, Boolean algebra, and logic devices. You will build a digital clock to provide an appreciation of how digital devices can perform different functions. A similar device will be built using the Arduino microcontroller to better understand how an integrated microcontroller can achieve the same functions of many discrete logic components.

- **Analogue electronics with bioengineering applications:**

In this project you will build an ECG generator and measurement unit using analogue components with the aim of better understanding analogue electronics and their potential applications in biomedical engineering. Students will gain a more detailed insight into the charging and discharging characteristics of biological and technological capacitors as well as understanding the function of amplifiers, filters and counters.

- **Electrochemical impedance measurement and biosensor technology**

Impedance spectroscopy is an electronic read-out technology which emerged in the Nazi era, used to investigate the structural quality of U-boats. Through the decades the technology was optimized and is now an established technology, implemented in (bio) medical research. It has been used for the detection of proteins, neurotransmitters and even the detection of single nucleotide polymorphisms in DNA sequences. In this project you will mimic this last experiment and try to delineate impedimetric signals in way that DNA melting times can be calculated and based on this information you will try to distinguish between a full matching DNA sequence and a mutated DNA sequence.

Literature

A course manual and detailed experiment descriptions will be provided during the practical.

Instructional format

Laboratory session: Students working in small teams working on a different project every two weeks.

Assessment

Assessment is based on question sheets to be completed within the lab, lab reports and an oral assessment.

PRA3013 Bioinorganic Chemistry

Course coordinator:
Dr. Marie C. Correia; Faculty of Science and Engineering, Maastricht Science Programme
Contact: marie.correia@maastrichtuniversity.nl

Pre-requisites:
- ✓ PRA2002 Chemical Synthesis
- ✓ PRA2004 Inorganic Synthesis
- ✓ CHE2004 Spectroscopy

Recommended:
- ✓ CHE3004 Modern Catalytic Chemistry

Co-requisites:
- ✓ None

Objectives:
Peptidomimetic organometallic complexes will be synthesized, structurally characterized and explored as catalysts for various bio-mimicking reactions.

- To learn how to design peptidomimetic oligomers of glycine (peptoids) using commercially available or easily synthesized coordinating ligands
- To utilize multistep solid-phase synthetic techniques to produce peptoids
- To understand the coordination of peptoids to metal cations and to explore the catalytic ability of these systems
- To use diverse analytical techniques to explore the physical, electronic and spectroscopic properties of the synthesized complexes

Description of the course:
Within nature, metalloproteins and enzymes perform essential roles; such as, fixing hydrogen and nitrogen, converting sunlight to chemical energy, acting as transport or storage agents, and many others. This course provides a practical introduction to the structural and functional roles of metal-containing molecules in biologically relevant systems. Emphasis will be placed on mimicking biological activity by engineering non-natural catalytic systems that mimic the active sites of enzymes. Students will build on their previous theoretical and synthetic knowledge of organic, inorganic and catalytic chemistry by designing multi-coordinating peptidomimetic ligand systems, producing organometallic complexes and catalytically testing their new complexes.

Literature
Published scientific research articles accessed via SciFinder.
The following textbooks will be available in lab for reference:

- Bochmann, M. (2015). *Organometallics and Catalysis*. Oxford University Press (ISBN: 978-0-19-966821-2).
- Miessler, G. L.; Fischer, P. J.; Tarr, D. A. (2013) *Inorganic Chemistry* (5th Edition), Pearson (ISBN-10: 129202075X; ISBN-13: 9781292020754).

Instructional format
This practical course is organized as a series of laboratory sessions.

Assessment
Grades in this course will depend on pre-lab preparation, quizzes, notebook entries, lab performance, and reports written as journal articles.

PRA3014 Spectroscopic Methods

Course coordinator

Dr. Dario Romano: Faculty of Science and Engineering, Biobased Materials

Contact: dario.romano@maastrichtuniversity.nl

Pre-requisites

- ✓ CHE2001 Organic Chemistry
- ✓ CHE2004 Spectroscopy

Co-requisites

- ✓ None

Objectives

- To learn to identify chemical compounds using a variety of available analytical techniques.
- To have a basic understanding of the theoretical background of the measurement principles typically used in spectroscopy and spectrometry.
- To be able to develop an analytical strategy to identify an unknown compound.
- To be able to operate typical spectroscopic instruments.

Description of the course

This course focuses on several topics in analytical chemistry and will contain:

- Identification and structure elucidation of molecules and materials with advanced spectroscopy and spectrometry
- UV-Vis spectroscopy
- FT-IR spectroscopy
- ^{1}H and ^{13}C NMR spectroscopy
- Mass spectrometry using GC and LC
- Gel Permeation Chromatography

Literature

The textbooks from the pre-requisite courses.

Manuals of the different instruments will be provided.

Instructional format

Interactive laboratory sessions.

Assessment

1. Lab reports and written procedures
2. Laboratory notebook
3. An chemical analysis project

PRA3017 Applied Cell Biology

Course coordinator

Prof. Jan de Boer: Faculty of Health Medicine and Life science, Maastricht Science Programme

Contact: jan.deboer@maastrichtuniversity.nl

Pre-requisites

- ✓ PRA2005 Advanced Laboratory Skills
- ✓ BIO2001 Cell Biology

Co-requisites

- ✓ None

Objectives

The main objective of this course is to provide a practical introduction into molecular and cell biology and to demonstrate how experimental cell biology can be used in the context of regenerative medicine. We will use osteoblasts to study the effects of a hypoxia mimic on angiogenic markers. A variety of experiments will be performed to study differences on RNA and protein level. Cell Profiler will be used for image/data analysis.

Description of the skills

This skill will contain:

- Cell culture
- Immunohistochemistry
- qPCR
- Metabolic assays

Literature

- Practical laboratory instructions.
- A small molecule approach to engineering vascularized tissue. Doorn J1, Fernandes HA, Le BQ, van de Peppel J, van Leeuwen JP, De Vries MR, Aref Z, Quax PH, Myklebost O, Saris DB, van Blitterswijk CA, de Boer J. Biomaterials. 2013 Apr;34(12):3053-63

Instructional format

This training is organized as a series of laboratory sessions. The students will have to prepare short reports on the various laboratory activities of this training.

Assessment

1. Questionnaires (40%)
2. The laboratory notebook with developed protocols, (20%)
3. Practical reports (40%)

PRA3018 Molecular Modeling

Course coordinator

Dr. Fabrice Birembaut: Faculty of Science and Engineering, Maastricht Science Programme

Contact: fabrice.birembaut@maastrichtuniversity.nl

Pre-requisites

- ✓ CHE3006 Quantum Chemistry

Co-requisites

- ✓ None

Objectives

- To provide an understanding of what can be achieved using molecular modelling software
- To evaluate the most appropriate basis sets to use to solve different problems
- To perform calculations in order to extract various measurable (HOMO/LUMO, Transition states, energies, electron densities…etc)
- To analyse calculation results to draw conclusion as to a reaction will proceed
- To study transition states and their relevance in chemistry

Description of the course

Molecular modelling is an important part of chemistry for any industry but more particularly the pharmaceutical industry. It helps with determining the shape of molecules and therefore prevent problems down the line when those molecules need to react. It is also possible to study the reactivity of molecules as well as understand the pathway of certain reactions by determining the shape of the transition state.

During these skill sessions, you will be using a piece of software called Gaussian® in order to perform various calculations on system that would apply in real life situations, solve problems as well as assess the validity of certain models.

Literature

Atkins, P., Friedman, R. Molecular Quantum Mechanics (5th ed.) Oxford University Press.

Cramer, J. Essentials of Computational Chemistry – Theories and Models (2nd ed.) Wiley

Instructional format

Practical sessions

Assessment

Student performance will be evaluated on the basis of:

1) Their lab reports
2) Their lab notebooks
3) The quality of their results.

PRA3019 Plant Breeding and Physiology

Course coordinator

Dr. FeiYian Yoong: Faculty of Science and Engineering, Maastricht Science Programme

Contact: feiyian.yoong@maastrichtuniversity.nl

Pre-requisites

- ✓ BIO2003 General Botany

Co-requisites

- ✓ None

Objectives

In this course, you will gain an insight to the various breeding strategies in manipulating the genetic and physiological basis of a plant to increase the agricultural output for food security. You will also be exposed to the important relationship between plant breeding and physiology in improving plant growth and yield.

Description of the course

The increasing global population has urged the need to increase food security to every inhabitant on this planet. A larger agricultural output has never been in such popular demand than before. In the context of increasing food production, plant growth has been dissected thoroughly from the perspective of their physiological functions. Plant physiology plays a vital role in agricultural production with a close relationship with plant breeding and agronomy. The combination of plant breeding and physiology provides a powerful tool in enhancing the spatial and temporal arrangement of the farming system. In this course, we will look at the impacts of the environmental and genetic manipulation on the physiology of a plant. From this course, you will gain a deep understanding and appreciation of various plant breeding strategies and physiological functions in improving the agricultural output. As agriculture plays an important role in the economic, social, and environmental challenges of the global society, this course will provide you a greater insight on how to combat the vulnerable global food security using plant breeding and physiology approaches.

Literature

Students will be given a variety of articles and book chapters which will be made available online on a weekly basis.

Instructional format

Weekly laboratory experiments and observations. Most experiments require several weeks for completion. One excursion may be incorporated in this course.

Assessment

To be determined.

PRA3020 Analytical chemistry in the Art World

Note: this course replaces PRA3007 Conservation Science Skills. If you have successfully completed PRA3007 you may not participate in PRA3020.

Course coordinator

Dr. Fabrice Birembaut: Faculty of Science and Engineering, Maastricht Science Programme
Contact: fabrice.birembaut@maastrichtuniversity.nl

Pre-requisites

- ✓ CHE2001 Organic chemistry

Co-requisites

- ✓ INT3010 Science and the visual arts: conservation and its histories

Objectives

- To become acquainted with various analytical techniques used for the investigation of paintings and other works of art, and of artists' materials.
- To obtain practical experience with some of these techniques.
- To answer research questions connected to works of art and artists' materials.
- To further develop hands-on experience with the laboratory practices of discovering fraud and forgery, as well as of supporting fine arts conservation.

Description of the course

Over the last decades the field of conservation science has evolved in parallel with that of forensic science. Currently the scientific investigation of art works plays an increasingly important role in the understanding and interpretation of artist materials and artistic expression. Many non-destructive (NDT) and non-invasive analytical techniques are used, hand-in-hand with more traditional photographic methods, for the identification and detection of fakes and forgery. These same techniques are also indispensable in the decision-making processes used by conservators to determine treatment protocols for individual art works. Modern instrumental techniques make it possible to extract a whole array of 'big data' from a 'grain of original material'. This skills training module is intended to be a first practical introduction to this highly interesting, broad and quickly expanding field. The course will take place predominately in the conservation studios of the Stichting Restauratie Atelier Limburg (SRAL) and the training will be mainly given by the SRAL staff. Actual artworks, often undergoing conservation treatment, will provide the source material for study. Laboratory work will take place both at the SRAL (Maastricht) and at Chemelot.

After a general introduction, the group will be divided into small subgroups that will work on the different practical and research problems, such as:

- the analysis of paint cross-sections from (authentic) paintings, using different analytical techniques for the identification of pigments, binding materials, varnishes, etc.
- the complex synthesis of an old pigment, via different routes, followed by the analytical identification of the different colourful reaction products.
- the analysis of several pigments and resins used in the past.

A large number of different techniques will be employed, including: optical and UV microscopy, UV spectroscopy, FTIR, SEM/EDX, etc. The difficulty in interpreting results and the relevance of these outcomes for the scientific research and investigation of fine art paintings (such as dating, proof of authenticity, attribution, etc) will be discussed. Relevant literature on artists' materials and research methods will be studied and used to support findings.

Literature

Selected articles and chapters will be provided to the students

Instructional format

Practical work, group discussions, laboratory visits and literature research.

Assessment

- A mid-term examination, which consists of a research paper,
- A final examination (power point presentation on research design),
- The contributions to the collective practical work.

PRA3021 Topics in Scientific Computing

Course coordinators

Dr. Pieter Collins: Faculty of Science and Engineering, Department of Knowledge Engineering
Contact: pieter.collins@maastrichtuniversity.nl
Dr. Georgios Stamoulis: Faculty of Science and Engineering, Department of Knowledge Engineering
Contact: georgios.stamoulis@maastrichtuniversity.nl

Pre-requisites

- ✓ PRA2003 Programming
- ✓ MAT2006 Calculus
- ✓ MAT1002 or MAT2004 Linear Algebra

Recommended

- ✓ MAT3005 Numerical Mathematics

Objectives

- To learn some important algorithms for scientific computing.
- To know the assumptions for and rationale behind these algorithms, understand where they can be applied, and where they may fail.
- To gain experience implementing algorithms and applying them to scientific problems .

Description of the course

Scientific computing concerns the use of computers to analyze and solve problems arising in biology, chemistry and physics. This generally involves the construction of a mathematical model of the scientific problem, and solving the mathematical problem using computational algorithms. The purpose may be to improve the understanding of natural phenomena or to make predictions of behaviour under different conditions.
A broad range of scientific problems can be tackled computationally, including simulation methods (for dynamic systems); transform methods (for processing data and images) and optimisation methods (for learning models from data and improving technological processes).
This course will focus on well-established algorithms which will each be applied to a realistic scientific case study. The methods are frequency-domain Fourier/wavelet analysis (for signal processing and quantum physics), principle component analysis and clustering algorithms (for classification of images), integrators for ordinary differential equations (for simulation and control of spaceships), finite-difference solvers for partial differential equations (for investigating pattern formation), and combinatorial optimisation (for phylogenetic reconstruction).
The course will be entirely based on the use of Matlab, a high-level scientific programming language and interactive environment for numerical computation, visualization, and programming. This course is complemented by MAT3005 Numerical Mathematics, in which students learn in more depth the basic algorithms of scientific computing.

Literature

All material (problem descriptions and supporting literature) will be provided during the course and made available through the Student Portal. There is no specific textbook.

Instructional format

Lecturing, computer-based group practical, problem-based learning.
There are no separate tutor groups for this course.

Assessment

Class participation; Final report (group). There is 100% attendance requirement.

Courses Available at University College Maastricht

MSP students are welcome to register for the following courses, provided they meet the prerequisites. Students should apply via "myUM" in the same way as they would apply for external education. These requests will be automatically approved by the MSP Board of Examiners. Students wishing to take courses at UCM not listed in this appendix should also follow the full external education request procedure. Their motivated requests will be evaluated by the Board of Examiners. More details on UCM courses are available in the UCM course catalogue.

Course	**Title**	**Period**
SCI2031	Immunology	4
SCI3005	Metabolism, Nutrition and Exercise	5
SCI3007	Endocrinology	1
SCI3050	Advanced in Biomedical Sciences	2