MSP Course Catalogue 2020-2021

Overview of Courses and Skills for the Academic Year 2020-2021 (Version May 2020)

	Biology	Chemistry	Mathematics and Computer Sciences	Physics	Neuroscience	Interdisciplinary
Core Courses	**BIO1101** Introduction to Natural Biology (P2 & P5)	**CHE1101** Introduction to Chemistry (P1 & P4)		**PHY1101** Introduction to Physics (P1 & P4)		**INT1101** Introduction to Liberal Arts and Sciences (P2 & P5)
100 Level Courses			**MAT1006** Applied Statistics (P5) **MAT1007** Mathematical Tools for Scientists (P5)		**NEU1001** Introduction to Neuroscience (P4) **NEU1002** Biological Foundations of Behavior (P5)	**INT1003** Introduction to Biomedical Engineering (P4) **INT1005** Commercializing Science and Technology (P5) **INT1006** Sustainable Development P2)
200 Level Courses	**BIO2001** Cell Biology (P1 & P4) **BIO2002** Ecology (P5) **BIO2003** General Botany (P4) **BIO2004** General Zoology (P1) **BIO2005** Evolutionary Biology (P4) **BIO2007** Genetics (P1 & P4) **BIO2008** Great Transformations in Vertebrate Evolution (P2) **BIO2010** Human Anatomy and Physiology (P4)	**CHE2001** Organic Chemistry (P1 & P4) **CHE2002** Inorganic Chemistry (P1) **CHE2003** Physical Chemistry (P1) **CHE2004** Spectroscopy (P1) **CHE2006** Biochemistry (P2) **CHE2007** Solid State Chemistry (P4)	**MAT2002** Optimization (P1) **MAT2004** Linear Algebra (P5) **MAT2005** Statistics (P5) **MAT2006** Calculus (P4) **MAT2007** Introduction to Programming (P1) **MAT2008** Differential Equations (P4) **MAT2009** Multivariable Calculus (P2)	**PHY2001** Classical Mechanics (P5) **PHY2002** Thermodynamics and Statistical Physics (P4) **PHY2003** Vibrations and Waves (P1) **PHY2004** Electromagnetism (P4) **PHY2005** Quantum Theory (P5) **PHY2006** Electronics (P1) **PHY2007** Optics (P2) **PHY2008** Solar System Astronomy (P4) **PHY2009** Stellar Astronomy (P1) **PHY2010** Galactic Astronomy (P2)	**NEU2001** Cognitive Neurosciences: from Sensation to Perception (P2) **NEU2002** Neuropsychopharmacology (P5)	**INT2007** Science in Action (P2) **INT2008** Molecular Toxicology (P4) **INT2009** Biophysics (P4)
300 Level Courses	**BIO3001** Molecular Biology (P2 & P5) ***BIO3002* *Ecophysiology*/*** **BIO3003** Microbiology (P5) **BIO3004** Animal Behavior (P5) **BIO3007** Tropical Ecology (P2) **BIO3008** Hominin Paleontology (P5) **BIO3010** Genomics and Proteomics (P4)	**CHE3001** Organic Reactions (P2) **CHE3002** Transition Metal Chemistry (P5) **CHE3004** Modern Catalytic Chemistry (P2) **CHE3006** Quantum Chemistry (P5) **CHE3007** Advanced Physical Chemistry (P2) **CHE3008** Analytical Science and Technology (P1) **CHE3009** Crystallography (P5)		**PHY3001** Quantum Mechanics (P1) **PHY3002** Theory of Relativity (P2) **PHY3004** Nuclear and Elementary Particle Physics (P2) **PHY3005** Relativistic Electrodynamics (P4) **PHY3006** General Relativity (P5) **PHY3007** Advanced Mathematical Techniques of Physics (P1)	**NEU3001** Neuroscience of Action (P1)	**INT3001** Philosophy of Technology (P1) **INT3002** Advanced Microscopy: Theory and Applications (P5) **INT3003** Biomaterials (P4) **INT3005** Biobased Materials and Technology (P2) **INT3007** Systems Biology (P2) **INT3008** Regenerative Medicine (P4) **INT3009** Chemical Ecology (P2)** **INT3010** Science and the Visual Arts (P4)

	Biology	Chemistry	Mathematics and Computer Sciences	Physics	Neuroscience	Interdisciplinary
Core Skills						**PRA1101** Introduction to Scientific Research I (P1 & P4) **PRA1102** Introduction to Scientific Research II (P2 & P5)
100 Level Skills				**PRA1003** Basic Physics Laboratory (P2 & P5)	**PRA1005** Data Collection Techniques in the Neurosciences (P4)	
200 Level Skills	**PRA2009** Field Skills in Biology (P5) **PRA2011** Exploring the World of Plants (P4) **PRA2013** Practical Zoology (P2) **PRA2014** Genetics (P1 & P4) **PRA2019** Natural Science Illustration (P4)	**PRA2002** Chemical Synthesis (P1 & P4) **PRA2004** Inorganic Synthesis (P1) **PRA2008** Physical Chemistry (P5)	**PRA2003** Programming (P2)	**PRA2006** Electronics Lab (P1) **PRA2007** Physics Laboratory (P2 & P5)		**PRA2005** Advanced Molecular Laboratory Skills (P4) **PRA2010** Synthetic Biology (P2) **PRA2015** Advanced Academic Skills (P1) **PRA2017** NanoBiology (P1) **PRA2018** Capita Selecta in Life Sciences (P2)
300 Level Skills	**PRA3003** Molecular Biology (P2 & P5) **PRA3010** Microbiology Skills (P5) **PRA3011** The Limburg Landscape (P5) **PRA3017** Applied Cell Biology (P4) **PRA3023** Plant Physiology and Microbiomes (P1)	**PRA3001** Advanced Organic Synthesis (P2) **PRA3008** Transition Metal Chemistry (P5) **PRA3014** Spectroscopic Methods (P4) **PRA3018** Molecular Modelling (P1) **PRA3020** Analytical Chemistry in the Art World (P4)	**PRA3021** Topics in Scientific Computing (P1)	**PRA3002** Advanced Physics Laboratory (P2 & P5) **PRA3012** Advanced Electronics (P4) **PRA3024** Analysis of Big Data in Physics (P4)		**PRA3005** Polymer Processing (P2) **PRA3006** Programming in the Life Sciences (P2) **PRA3022** iGem Project (P1)

All courses are 5 ECTS
All skills are 2.5 ECTS

** Not offered in 2019-2020*

*** Offered once every other year*

ACADEMIC YEAR 2020-2021 - FALL SEMESTER

	Period 1		Period 2	
	Courses	**Skills**	**Courses**	**Skills**
Biology	BIO2001 Cell Biology BIO2004 General Zoology BIO2007 Genetics	PRA2014 Genetics PRA3023 Plant Physiology and Microbiomes	BIO1101 Introduction to Biology BIO2008 Great Transformations in Vertebrate Evolution BIO3001 Molecular Biology BIO3007 Tropical Ecology	PRA2013 Practical Zoology PRA3003 Molecular Biology
Chemistry	CHE1101 Introduction to Chemistry CHE2001 Organic Chemistry CHE2002 Inorganic Chemistry CHE2003 Physical Chemistry CHE2004 Spectroscopy CHE3008 Analytical Science and Technology	PRA2002 Chemical Synthesis PRA2004 Inorganic Synthesis PRA3018 Molecular Modelling	CHE2006 Biochemistry CHE3001 Organic Reactions CHE3004 Modern Catalytic Chemistry CHE3007 Advanced Physical Chemistry	PRA3001 Advanced Organic Synthesis
Mathematics & Computer Science	MAT2002 Optimization MAT2007 Introduction to Programming	PRA3021 Topics in Scientific Computing	MAT2009 Multivariable Calculus	PRA2003 Programming
Physics	PHY1101 Introduction to Physics PHY2003 Vibrations and Waves PHY2006 Electronics PHY2009 Stellar Astronomy PHY3001 Quantum Mechanics PHY3007 Advanced Mathematical Techniques of Physics	PRA2006 Electronics Lab	PHY2007 Optics PHY2010 Galactic Astronomy PHY3002 Theory of Relativity PHY3004 Nuclear and Elementary Particle Physics	PRA1003 Basic Physics Laboratory PRA2007 Physics Laboratory PRA3002 Advanced Physics Laboratory
Neuroscience	NEU3001 Neuroscience of Action		NEU2001 Cognitive Neurosciences: From Sensation to Perception	
Interdisciplinary	INT3001 Philosophy of Technology	PRA1101 Introduction to Scientific Research I PRA2015 Advanced Academic Skills PRA2017 NanoBiology PRA3022 iGem Project	INT1101 Introduction to Liberal Arts and Sciences INT1006 Sustainable Development INT2007 Science in Action INT3005 Biobased Materials and Technology INT3007 Systems Biology INT3009 Chemical Ecology	PRA1102 Introduction to Scientific Research II PRA2010 Synthetic Biology PRA2018 Capita Selecta in Life Sciences PRA3005 Polymer Processing PRA3006 Programming in the Life Sciences

ACADEMIC YEAR 2020-2021 - SPRING SEMESTER

	Period 4		Period 5	
	Courses	**Skills**	**Courses**	**Skills**
Biology	BIO2001 Cell Biology BIO2003 General Botany BIO2005 Evolutionary Biology BIO2007 Genetics BIO2010 Human Anatomy and Physiology BIO3010 Genomics and Proteomics	PRA2011 Exploring the World of Plants PRA2014 Genetics PRA2019 Natural Science Illustration PRA3017 Applied Cell Biology	BIO1101 Introduction to Biology BIO2002 Ecology BIO3001 Molecular Biology BIO3003 Microbiology BIO3004 Animal Behaviour BIO3008 Hominin Paleontology	PRA2009 Field Skills in Biology PRA3003 Molecular Biology PRA3010 Microbiology PRA3011 The Limburg Landscape
Chemistry	CHE1101 Introduction to Chemistry CHE2001 Organic Chemistry CHE2007 Solid State Chemistry	PRA2002 Chemical Synthesis PRA3014 Spectroscopic Methods PRA3020 Analytical Chemistry in the Art World	CHE3002 Transition Metal Chemistry CHE3006 Quantum Chemistry CHE3009 Crystallography	PRA2008 Physical Chemistry PRA3008 Transition Metal Chemistry
Mathematics & Computer Science	MAT2006 Calculus MAT2008 Differential Equations		MAT1006 Applied Statistics MAT1007 Mathematical Tools for Scientists MAT2004 Linear Algebra MAT2005 Statistics	
Physics	PHY1101 Introduction to Physics PHY2002 Thermodynamics and Statistical Physics PHY2004 Electromagnetism PHY2008 Solar System Astronomy PHY3005 Relativistic Electrodynamics	PRA3012 Advanced Electronics PRA3024 Analysis of Big Data in Physics	PHY2001 Classical Mechanics PHY2005 Quantum Theory PHY3006 General Relativity	PRA1003 Basic Physics Laboratory PRA2007 Physics Laboratory PRA3002 Advanced Physics Laboratory
Neuroscience	NEU1001 Introduction to Neuroscience	PRA1005 Data Collection Techniques in the Neurosciences	NEU1002 Cognitive Neurosciences: Biological Foundations of Behaviour NEU2002 Neuropsychopharmacology	
Interdisciplinary	INT1003 Introduction to Biomedical Engineering INT2008 Molecular Toxicology INT200X Biophysics INT3003 Biomaterials INT3008 Regenerative Medicine INT3010 Science and the Visual Arts	PRA1101 Introduction to Scientific Research I PRA2005 Advanced Molecular Laboratory Skills	INT1101 Introduction to Liberal Arts and Sciences INT1005 Commercializing Science and Technology INT3002 Advanced Microscopy: Theory and Applications	PRA1102 Introduction to Scientific Research II

BIO1101 Introduction to Biology

Course coordinator
Dr. Jessica Nelson, Faculty of Science & Engineering, Maastricht Science Programme.
Contact: jessica.nelson@maastrichtuniversity.nl

Pre-requisites
- ✓ None

Co-requisites
- ✓ PRA1102 Introduction to Scientific Research II

Objectives
After this course, students should be able to:
- Apply basic knowledge of ecology, evolution, and molecular and organismal biology to discuss cutting-edge biological research and its impacts on society.
- Explain how the following six core biological concepts apply to the multiple scales of organization and time in biological systems: regulation, self-organization, evolution, inheritance, communication, and interaction.
- Do calculations relevant to biological concepts.

Description of the course
This course provides an overview of the major branches of biological sciences and the fundamental processes relevant to each. The major topic areas covered are ecology, evolution, cell and molecular biology, genetics, and organismal biology. For each topic, you will explore how the content connects to the central concepts of all biological sciences: regulation, self-organization, evolution, inheritance, communication, and interaction.

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 and 2 two-hour PBL tutorials per week.

Assessment
Evaluation of student performance will be based on short essay homework questions each week, contribution to the discussion during tutorial meetings, and a final exam at the end of the course.

BIO2001 Cell Biology

Course coordinators

Prof. dr. Martijn van Griensven and Dr Aart van Apeldoorn: MERLN Institute for Technology-Inspired Regenerative Medicine; Faculty of Health, Medicine and Life Sciences.
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Contact: (Period 1): 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 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).
- To understand how the cell produces the energy it needs to function.
- To understand communication between the cell interior and exterior of the cell (cell signalling).

Description of the course

This course aims to develop a detailed understanding of the cell as the basic unit of life. The basic built up of a cell including cell membrane composition, cytoplasm and organelles will be eluded. Furthermore, methods of visualisation of those will be discussed in detail. 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*. Proteins need to move into organelles through translocation and there is a continuous transport between the different organelles (intracellular vesicular transport) and between the cell interior and the extracellular environment (endocytosis and exocytosis). All of 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. And the cell needs energy from oxidative phosphorylation or photosynthesis to perform these functions. 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 which will be introduced, explained, supplemented and discussed in the preceding lecture. There are five main lectures. 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, video, 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
During this course, you will gain insight in the importance of plants for life on earth and the unique adaptations that plants have. The course will illustrate major aspects of plant form, function and development, and the evolution of the major plant groups.

Description of the course
Plants are a vital part of anyone's life. However, many people suffer from plant blindness: the inability to notice the plants in one's own environment. This blindness can lead to the inability to recognize the importance of plants in the biosphere, and in human affairs. However, it also leads to a lower appreciation of the aesthetic and unique biological features of the life forms belonging to the Plant Kingdom. Finally, the blindness contributes to the misguided and anthropocentric ranking of plants as inferior to animals. This course is designed to show the general importance of plants and illustrate their unique adaptations. Topics that will be covered are divided into two main categories: plant structure, and plant physiology and development. Topics of plant structure include: growth and division of cells, primary growth of stems (the herbaceous plant), leaves, roots, secondary growth (the woody plant), and flowers and reproduction. Plant physiology and development will include plants and energy (e.g. photosynthesis, respiration), nutrition and transport in plants (soils, mineral uptake and water flows), and plant growth and development.

Literature
Botany, an introduction to plant biology. J.D. Mauseth, 6th ed. 2017. Jones & Bartlett Learning. ISBN: 978-1-284-07753-7

Instructional format
You will have two two-hour standing tutorials per week followed by an interactive lecture to revise the study material. Also, you will do a group poster assignment and a reflection on your final exam.

Assessment
There will be three points of assessment: a) group poster on a plant division, b) an individual knowledge assessment, and c) and an individual reflection on your individual knowledge assessment.

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 & Tupper, T.A. *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. Linnea van Griethuijsen, Faculty of Science and Engineering, Maastricht Science Programme.
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Pre-requisites
- ✓ None

Co-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, 3rd ed. 2019. W.H.Freeman & Co Ltd.
- One module of Simbio's evobeaker package (http://simbio.com/products-college/EvoBeaker) for evolutionary simulations (will be provided by MSP).

Instructional format
Two-hour interactive lecture followed by two two-hour standing tutorials per week. Also, you will do a PechaKucha presentation and a computer simulation on natural selection.

Assessment
Three grades will be awarded during this course: a) MC questions of the simulation assignment, b) PechaKucha presentation, c) final exam.

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
- ✓ None

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.
- 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.
- A final evaluation on tutorial attendance and active participation during the complete course.

BIO2008 Great Transformations in Vertebrate Evolution

Course coordinator
Prof. Dr. Leon Claessens, Faculty of Science and Engineering, Maastricht Science Programme.

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Pre-requisites
✓ BIO2004 General Zoology or BIO2005 Evolutionary Biology

Objectives
In this course you will gain insight into evolutionary change over geological time, focusing on our own biological lineage, the vertebrates. You will gain a broader understanding of vertebrate paleontology, phylogeny, biomechanics and physiology. You will learn how to contextualize, examine and explain biological and evolutionary processes in deep time.

Description of the course
An exploration of vertebrate evolution and paleobiology, with emphasis on the anatomical and physiological transformations that occurred at the evolutionary originations of major vertebrate groups. Structure and function of both extant and extinct taxa are explored, as documented by modern fauna and the fossil record. Topics studied include locomotion and the origin of fins and limbs, the transition from water to land, dinosaur physiology, the origin of flight, and mammalian reproduction.

Literature
- Benton, M.J. (2014). Vertebrate Palaeontology. 4th Ed. Wiley-Blackwell. ISBN: 1118406842
- Select scientific articles; access through the UM library.

Instructional format
One lecture and two tutorials per week.

Assessment
Midterm and final examination, contribution to tutorial group meetings, tutorial exercises and tutorial project.

BIO2010 Human Anatomy and Physiology

Course coordinator
Dr. Nynke van den Akker, Faculty of Health, Medicine and Life Sciences, Department of Physiology.
Contact: n.vandenakker@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

- ✓ None

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

Recommended literature source are:

- "Molecular Cell Biology" by Lodish, Berk, Kaiser (W.H. Freeman, 8thedition, 2016).
- "Introduction to Genetic Analysis" by Griffiths, Wessler, Carrol, Doebley (W.H. Freeman, 10thedition, International Edition, 2012).
- "Molecular biology of the Cell" by Alberts et al.

Additional literature will be provided as a reader.

Instructional format

Lectures and tutorial group meetings.

Assessment

- A midterm theoretical examination (multiple choice and open questions) on all lectures and theoretical content of weeks 1-3.
- A final examination on all lectures and theoretical content of BIO3001, consists of ±30 questions (multiple-choice and open questions).
- A final evaluation on tutorial attendance and active participation.

BIO3002 Ecophysiology

PLEASE NOTE: This course only runs in alternate years (odd), alternating with BIO3002 Ecophysiology (even). It will not run in academic year 2020-21, but will run in 2021-22

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

- ✓ BIO2001 Cell Biology
- ✓ BIO2007 Genetics

Co-requisites

- ✓ None

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

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

BIO3004 Animal Behaviour

Course coordinator
Dr. Linnea van Griethuijsen, Faculty of Science & 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. (2018). *Animal Behavior* (11th international edition). Sinauer / Oxford University Press. (ISBN 9781605358949).
- Scientific articles which can be obtained online via UM library.

Instructional format
Two-hour lecture and 2 two-hour tutorials per week, zoo visit.

Assessment
Final exam + Pechakucha presentation online + interaction with literature using an online tool.

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
Rain forests are perhaps the most interesting of all biomes in the popular imagination. However, 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. In this course, you will get an overview of the characteristics and importance of tropical rain forests, study their history and think about their future.

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. 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 three parts:
- group grade for final exam assignment.
- individual fact sheet grade (including the presentation).
- individual counter-proposal grade (including the presentation).

BIO3008 Hominin Paleontology

Course coordinator

Prof. Dr. José Joordens, Faculty of Science and Engineering, Maastricht Science Programme.
Contact: j.joordens@maastrichtuniversity.nl

Pre-requisites

- ✓ BIO2005 Evolutionary Biology or
- ✓ BIO2008 Great Transformations in Vertebrate Evolution

Objectives

In this course you will gain insight into the evolution of the hominin lineage, focussing on the evolutionary developments over the past 7 million years. You will gain a broader understanding of the correlations between climatic, environmental and ecological changes and the development of our own genus *Homo*. You will learn about the importance of combining geological and fossil records, and interpreting them in the light of ecosystems and biogeography.

Description of the course

An overview of hominin paleoecology and evolution, with emphasis on the overarching question: what made us human? The course combines insights from three disciplines: geology, biology and archaeology. We will explore the presently known and still expanding hominin fossil record, using a natural selection and sexual selection perspective. Topics studied include the history of the field, the origin of hominin bipedality, the evolution of the body plan, development of tool use, expansion of hominins out of Africa into Eurasia, speciation and extinction.

Literature

- Neil Shubin (2008). Your Inner Fish: a journey into the 3.5-billion-year history of the human body. Penguin Books.
- Bernard Wood (2019). Human Evolution, a Very Short Introduction (2nd edition). Oxford University Press.
- Select scientific articles; access through the UM library.

Instructional format

One lecture and two tutorials per week.

Assessment

Midterm and final examination, contribution to tutorial group meetings, tutorial exercises and tutorial project.

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

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 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 subjects 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'. Planned is a visit to laboratories using omics technology, as well as 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.

CHE1101 Introduction to Chemistry

Course coordinators

Dr. Chris Bahn, Faculty of Science and Engineering, Maastricht Science Programme.
Contact: chris.bahn@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ PRA1101 Introduction to Scientific Research I

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

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

CHE2001 Organic Chemistry

Course coordinator

P4: Dr. Hanne Diliën: Faculty of Science and Engineering, Maastricht Science Programme.
Contact: hanne.dilien@maastrichtuniversity.nl

P1: Dr. Matt Baker: Faculty of Health, Medicine and Life Sciences, MERLN.
Contact: m.baker@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 or 3rd edition; Wiley (ISBN: 9781118452288/978-1119110477).

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

- A midterm examination, which consists of multiple choice questions.
- A final examination, which consists of open questions.
- 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 (strongly)
- ✓ 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 (coordination chemistry).
- To introduce students to the basic ideas in organometallic 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. A review of VSEPR and VB theory and molecular orbital theory (MO), crystal field theory (CFT); The solid state: packing, packing factors, Bravais lattices, the crystal systems; HSAB, Pearson classification, super acids, Pauling Rules; The Main group: Allotropes, patterns in main-group chemistry and the double-bond rule; A comprehensive overview of coordination chemistry: nomenclature, coordination number and geometry, oxidation states, d-electron counting and the 18-VE rule; Organometallic chemistry: history, alkyl, aryl, alkene, carbene and carbyne complexes. Semiconductors, Boranes and their structure, the Dewar-Chatt-Duncanson (DCD) model.

Literature
To be determined amongst:
- Shriver and Atkins: Inorganic Chemistry (Oxford).
- Huheey, Keiter, Keiter: Inorganic Chemistry (Harper Collins).
- 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. Veaceslav Vieru, Faculty of Science and Engineering, Maastricht Science Programme.

Contact: v.vieru@maastrichtuniversity.nl

Pre-requisites
- ✓ None

Recommended
- ✓ MAT1007 Mathematical Tools for Scientists

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 to describe and understand chemical and environmental processes.
- To derive via statistical thermodynamics important thermodynamic quantities (e.g. internal energy, enthalpy, entropy, Gibbs and Helmholtz energies).

Description of the course
This course aims to introduce the students to the core of physical chemistry – thermodynamics. First, it introduces classical thermodynamics and applies it to macroscopic systems. Subsequently, statistical thermodynamics is introduced and linked to the main thermodynamic quantities. Students will learn throughout the course how to apply thermodynamics to analyse the physical and chemical properties of gasses, solutions and solids, with a focus on mathematical derivations of formulas. The course covers, *inter alia*, the laws of thermodynamics; chemical and electrochemical potentials; phase diagrams; mixing of solutions; properties of gasses; statistical thermodynamics and the derivation of internal energy, enthalpy, entropy, equilibrium constants; electrochemistry.

Literature
- McQuarrie, Donald A.; Simon, John D. *Physical Chemistry: A Molecular Approach* (any edition). University Science Books.
- Atkins, Peter. *Physical Chemistry* (any edition). Oxford University Press.

Instructional format
Lectures and tutorials.

Assessment
Assessment will be based on:
- two written exams, a mid-term exam covering topics of the first three weeks, and a final exam consisting of open questions at the end of the course.
- participation in and contribution to the tutorials as assessed by the attending tutor.

CHE2004 Spectroscopy

Course coordinator
Dr Burgert Blom, Faculty of Science and Engineering, Maastricht Science Programme.
Contact: burgert.blom@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 or 5th edition (International Edition): Brooks/Cole.

Instructional format
Lectures and tutorial group meetings.

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

CHE2006 Biochemistry

Course coordinators

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

N. Deckers, Faculty of Health, Medicine and Life Sciences, Department of Biochemistry.
Contact: 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).

CHE2007 Solid State Chemistry

Course coordinator

Dr. Giuditta Perversi, Faculty of Science and Engineering, Maastricht Science Programme.
Contact: g.perversi@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ None

Objectives

- To expand on the student's knowledge of Chemistry and understand how properties are modified in a solid state framework.
- To introduce the student to the fundamental science behind chemistry in solid state and the processes that steer it.
- To familiarise the students with materials of high technological relevancy and show the clear relationship between theory and its applications.
- To understand the state-of-the-art and have some indication of the challenges of the field.
- To give a stable foundation to pursue future master-level studies in the field.

Description of the course

The six weeks of the course will aim to cover a total of six modules on key themes, among batteries, magnets, superconductors, semiconductors and solar cells, multiferroics, thermoelectrics, porous systems (MOFs/zeolites), fuel cells and oxygen ion conductors. The students' preferences and specific interests will be taken into account for one or two modules. Each lecture will aim to cover both basic theory and applications. The tutorials sessions will complement this approach and help the students familiarise with the concepts.
The course it its entirety will aim to provide the students with the tools needed to understand the strengths, state-of-the-art and upcoming challenges of the very varied field that solid state chemistry represents.

Literature

- P. A. Cox, "The electronic structure and chemistry of solids", Oxford Science Pub., 1999; A.R. West, "Solid State Chemistry and its applications", 2nd Ed, 2014.
- C. Kittel, "Introduction to solid state physics", John Wiley & Sons Inc., 8th Ed, 2005.

These books are advanced literature and the students can broadly refer to them for support. Additional references will be given on a lecture-by-lecture base.

Instructional format

The course is lecture-based, with one lecture and two corresponding tutorials to attend each week.

Assessment

The student's performance will be assessed with:

- a midterm examination consisting of an article review and presentation.
- a final examination with open and multiple choice questions on all the six themes covered.
- the contribution to the tutorial sessions.

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 or 3rd edition; Wiley (ISBN: 9781118452288/978-1119110477).

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
- Midterm examination, which consists of open questions and problems.
- Final examination, which consists of open questions and problems.
- A paper or presentation on multistep synthesis.
- 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 (CHE2002).
- 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, Multinuclear NMR 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 innovative themes in organometallic chemistry will be provided. Survey of themes covered: Associative, Dissociative and Interchange mechanisms, Eigen-Wilkins mechanism, Inner and outer-sphere electron transfer, Marcus Theory. The MO description of the 18VE rule for the three classes of octahedral complexes (I, II and III); Transition metal alkyl complexes synthesis and reactivity, Transition metal Fischer and Schrock Type carbenes: synthesis and reactivity; Carbyne complexes; The molecular orbital description of ferrocene and related Cp complexes and reactivity; The Doetz Reaction and alkyne and alkene metathesis, Triple bonding in heavy alkynes and alkenes (Ge, Sn and Pb), Hydrides: classical and non-classical; An introduction to the notion of a catalyst cycle; Clusters, M-M bonding, and Isolobal Theory; 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).

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 CHE3002, 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.

CHE3006 Quantum Chemistry

Course coordinator

Dr. Veaceslav Vieru, Faculty of Science and Engineering, Maastricht Science Programme.

Contact: v.vieru@maastrichtuniversity.nl

Pre-requisites

- ✓ MAT1007 Mathematical Tools for Scientists

Co-requisites

- ✓ None

Recommended

- ✓ MAT2004 Linear Algebra

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 introduce students to the foundations of quantum mechanics and its application in chemistry. It will start with the introduction of quantum mechanics through the analysis of Stern-Gerlach spin measurements to allow students to learn about the Dirac and matrix notation. The basic postulates of quantum mechanics will be introduced through their manifestation in the Stern-Gerlach experiments. Subsequently, traditional wave-function aspects of quantum mechanics will be studied via a few exactly solvable models - a particle in a box, the hydrogen atom, the harmonic oscillator, with a view to emphasizing their connections to the basic postulates. The course will conclude by presenting the basics of approximation methods, such as variational method and perturbation theory and their application to multielectron systems.

Literature

- McIntyre, David H. *Quantum mechanics: A paradigms Approach*. Pearson Education.
- McQuarrie, Donald A., and Simon, John D. *Physical Chemistry: A Molecular Approach* (any edition).
- University Science Books.

Instructional format

Lectures and tutorials.

Assessment

Assessment will be based on:

- two written tests, a mid-term exam covering topics of the first three weeks, and a final exam consisting of open questions at the end of the course
- participation in and contribution to the tutorials as assessed by the attending tutor.

CHE3007 Advanced Physical Chemistry

Course coordinator
Dr. Veaceslav Vieru, Faculty of Science and Engineering, Maastricht Science Programme.
Contact: v.vieru@maastrichtuniversity.nl

Pre-requisites
- ✓ MAT1007 Mathematical Tools for Scientists

Recommended
- ✓ CHE2003 Physical Chemistry

Co-requisites
- ✓ None

Objectives
Students are expected to:
- Calculate and interpret kinetics data (e. g. chemical reaction rates, rate constants).
- Use steady state approximation and predict mechanisms of chemical reactions.
- Apply transition state theory and collision theory.
- Understand photochemistry and Jablonski diagrams.

Description of the course
The course introduces students to chemical kinetics, the branch of physical chemistry that helps to understand the rates of chemical reactions and provide concrete evidence for the mechanisms of chemical reactions. It will first cover phenomenological kinetics of simple and complex reactions (e.g. parallel, consecutive, chain reactions, chemical oscillations), before moving on to collision theory and transition state theory (developed by Eyring, Evans and Polanyi). The course will end by presenting elements of photochemistry and some kinetic theories of catalysis.

Literature
Atkins, Peter. *Physical chemistry* (any edition). Oxford University Press.
McQuarrie, Donald A.; Simon, John D. *Physical Chemistry: A Molecular Approach* (any edition). University Science Books.

Instructional format
Lectures and tutorials.

Assessment
Assessment will be based on:
- two written exams, a mid-term exam covering topics of the first three weeks, and a final exam consisting of open questions at the end of the course.
- participation in and contribution to the tutorials as assessed by the attending tutor.

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 the basics in analytical sciences & technologies, molecular structures, their physico chemical properties the importance for the design of analytical methodologies.
- Create a fundamental understanding in "sampling, storage and sample pre-treatment" in the quantification of target compounds, together with a basic knowledge of analytical statistics.
- Insight into fundamental mechanisms of separation technologies (chromatography & electrophoresis), and correlate the "physico chemical properties of molecules to the "mode of action" in gas- super critical and liquid chromatography, CE, FFF and UAC.
- To obtain an understanding of the fundaments in spectroscopic technologies, including UV/VIS, IR/Raman, Fluorescence, Phosphorescence, MS and NMR.
- To become familiar with quantification and molecular structure analysis of chemicals, metabolites, bio- and synthetic polymers using hyphenated technologies, e.g. LC- flow-NMR.
- Obtain insight into different applications of analytical methodologies and acquire sufficient background for more advanced courses in chemical synthesis, polymer-, bio-chemistry and life.
- To gain insight in "Process Analytical Technologies" applied by in-, at and on-line detection technologies, regulatory requirements. Application of advanced technologies in (micro) flow-chemical reactors.

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. It will introduce the basisc of analytical technologies, and 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 (e.g. LC-MS/MS) 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. In the end the students should be able to design a analytical methodology on basis of their gained knowledge.

Literature
Fundamentals of Analytical Chemistry, Skoog (ed. 2014), power point slides, articles to be distributed

Instructional format
Lectures and tutorial group meetings.

Assessment
- Presentation of gained knowledge for specific technology on basis of a small literature research.
- Weekly tutorials – attendance and contributions.
- A final examination consisting of short answer and explanation questions.

CHE3009 Crystallography

Course coordinator
Dr. Giuditta Perversi, Faculty of Science and Engineering, Maastricht Science Programme.
Contact: g.perversi@maastrichtuniversity.nl

Pre-requisites
- ✓ CHE2002 Inorganic Chemistry OR
- ✓ CHE2003 Physical Chemistry OR
- ✓ CHE2004 Linear Algebra

Recommended
- ✓ CHE2007 Solid State Chemistry

Given the nature of the course, waivers will be granted if the student even without the strict prerequisites has a sufficient scientific background to benefit from the course. This is at the course coordinator's discretion. This course is not recommended to students in their first year of study.

Objectives
- To introduce the students to the extensive and interdisciplinary field of crystallography.
- To provide the basis on how crystal can be classified and treated with group theory.
- To familiarise the students with the International Tables of Crystallography.
- To outline the process of diffraction and the available experimental techniques.
- To suggest some advanced application and state-of-the-art advancement to understand the potential of the field.

Description of the course
The six lectures of this course will lay the foundations of crystallography, starting from group theory and symmetry as a concept, extending it to crystal families and space groups and applying it in diffraction principles and experimental techniques. Beyond these basics, more advanced discussion topics will be discussed according to the students' preferences, among local structure analysis, magnetism in crystallography, incommensurate crystallography, phase transitions, mineralogy, and protein crystallography. The tutorials sessions will complement the lectures and help the students gain a deeper understanding of the topic and some methodological approaches to state-of-the-art problems that involve crystallography. Though the course will have a physical chemistry approach to the subject, crystallography is an inherently interdisciplinary field and students that are passionate about mathematics and physics are encouraged to join.

Literature
- Michael Glazer and Gerald Burns, "Space Groups for Solid State Scientists", 3rd Ed., 2013.
- C. Giacovazzo, "Fundamentals of crystallography", *Oxford University Press, 1992.*

(The second book is advanced and covers a wide breath of crystallography. The students can refer to it for deeper mathematics and extensive commentary. Additional material for specific subjects will be given in the relevant lectures, when applicable.)

Instructional format
The course is lecture-based, with one lecture and two corresponding tutorials to attend each week.

Assessment
The student's performance will be assessed with:
- a midterm examination consisting of an article review and presentation.
- a final examination with open and multiple choice questions.
- the contribution to the tutorial sessions.

INT1101 Introduction to Liberal Arts and Sciences

Course coordinators
Dr. Kasper Eersels, Faculty of Science and Engineering, Maastricht Science Programme.
Contact: kasper.eersels@maastrichtuniversity.nl

Pre-requisites
- ✓ None

Co-requisites
- ✓ PRA1102 Introduction to Scientific Research II

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 and a written debate argumentation.

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
Midterm and final written exam.

INT1005 Commercializing Science and Technology

Course coordinator
Dr. Jermain Kaminski, Assistant Professor on Entrepreneurship, SBE.

Contact: jermain.kaminsky@maastrichtuniversity.nl

Pre-requisites
- ✓ None

Co-requisites
- ✓ None

Objectives
- Foster an entrepreneurial spirit, no matter your background.
- Develop a basic understanding of technology entrepreneurship.
- Explore and discuss scientific literature and practical case studies.
- Develop and present your own venture idea.

Description of the course
This course aims to help you understand technology entrepreneurship and how to turn a technical product into an operating business. In doing so, we will adopt a strongly entrepreneurial lens and draw from examples in entrepreneurial practice. The course is intended for students who want to leverage their science background in starting their own business, extend an existing business, or better understand the entrepreneur and process in technology entrepreneurship.
Through a series of practice cases, readings, podcasts, activities, and sessions with instructors and peers, you examine key topics in entrepreneurship. They include ideation, market research, product development and framing, business planning and strategy, intellectual property, team and culture, and fundraising. Supported by an external guest lecture, we will also examine the human aspects of innovation, specifically issues of team dynamics, roles, and shares. This course puts major emphasis on the entrepreneurial competencies, tools, and methodologies, as opposed to technological competences, in early-stage commercialization processes. As an integral part of this course, you will develop and present a detailed business plan for a novel start-up idea, and further provide analytic insights into a selected general purpose technology. We hope that the thinking and toolsets learned in this course will help you one day to start your own business, or to innovate successfully within a technology company.

Literature
We will provide you with links to academic papers, case materials and websites.

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. The course actively encourages you to make mistakes and to ask the counterfactual.

Assessment
Your final score will consist of four components:

- Participation.
- Field project report.
- Final presentation of the field project.
- Class facilitation.

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

Prof. dr. Pim Martens, Maastricht Sustainability Institute, School of Business and Economics.
Contact: p.martens@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.

INT2007 Science in Action

Course coordinator
Annelies Jacobs, Faculty of Arts and Social Sciences, Department of Technology & Society Studies.
Contact: a.jacobs@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 do not take place in a social, cultural, political, or economic vacuum. 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 at the organization of knowledge production and its collaborative character from an STS perspective. We also study how credible facts are established and published and address questions about the integrity of science, in particular when the field of science interacts with economic parties. 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 affect 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, 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, Department of Pharmacology and Toxicology.
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 bio activation and bio-inactivation in the toxicity of drugs and other xenobiotics and natural toxins.
- 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 biotransformation 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 including those employed in Chinese traditional medicine..

Literature

During the course, a selection of scientific papers is handed out.

Instructional format

Lectures, short practicals and tutorial group meetings.

Assessment

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

INT2009 Biophysics

Course coordinator

Dr. Nuria Sánchez, M4I Nanoscopy, Faculty of Health, Medicine and Life Sciences.
Contact: nuriasánchez@unam.mx

Recommended

- CHE2003 Physical Chemistry
- CHE2006 Biochemistry

Objectives

- To introduce the students to the principles of calorimetric and spectroscopic techniques.
- To understand protein folding and its relation to function.
- To witness the function of a protein as a result of its interaction with a ligand.
- To have an overview of the biophysical techniques used to understand the kinetic and thermodynamic principles that control protein folding and binding.
- To understand how mutations can affect the native structure and function of a protein.

Description of the course

Proteins are biomolecules that participate in almost all cellular functions; their structure, or lack thereof, is essential to perform them. As such, it is important to understand the principles and molecular forces that 1) dictate the acquisition of the native structure of a protein and 2) mediate the recognition between the native state of a protein and other molecules.
The aim of this course is to review the molecular forces that drive a polypeptide chain to attain its native conformation starting from the unfolded state. Students will learn how mutations or even storage conditions can destabilise the native state of a protein, and hence its function. Additionally, the course will review the different mechanisms used by proteins to specifically recognise and bind to their ligands; including other proteins, nucleic acids or small organic molecules such as drugs. The course will initially provide an overview of protein structure together with the principles of thermodynamics and chemical equilibrium. Subsequently in the course, students will be introduced to different biophysical techniques commonly used to study protein folding and their interactions. Calorimetric and spectroscopic techniques will be introduced together with the basis of each technique, the information they provide, how to interpret the results and understand the benefits, limitations and complementarity of each technique.

Literature

- “Proteins: Structures and molecular properties” by Thomas E. Creighton. W. H. Freeman & Co. ISBN 0-7167-1566
- “Structure and mechanism in protein science. A guide to enzyme catalysis and protein folding” by Alan R. Fersht. W. H. Freeman & Co. ISBN 0-7167-3268-8
- “Protein Folding” in Handbook of Neurochemistry and Molecular Neurobiology by A. Szilágyi, J. Kardos, S. Osváth, L. Barna and P. Závodszky. Volume 7, Chapter 10. P.p. 303-344. Springer. ISBN 978-0-387-30346-8
- “Biophysical chemistry” in Tutorial Chemistry texts by Alan Cooper. The Royal Society of Chemistry. ISBN 978-0-85404-480-1
- “Principles of Fluorescence Spectroscopy” by Joseph R. Lakowicz. Springer, ISBN 978-0-387-46312-4

Instructional format

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

Assessment

Students will be assessed by: a written midterm exam, tutorial - participation and exercises, a final exam.

INT3001 The Philosophy of Technology

Course coordinator

Tsjalling Swierstra, Faculty of Arts and Social Sciences.

Contact: t.swierstra@maastrichtuniversity.nl

Pre-requisites

- ✓ PRO1001 Philosophy of Science*

**Note: the project PRO1001 will no longer be offered at MSP*

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

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

INT3002 Advanced Microscopy: Theory and Applications

Course coordinator

Dimitris Kapsokalyvas (MOLCELB), Faculty of Health, Medicine and Life Sciences.
Contact: d.kapsokalyvas@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Recommended

- ✓ PHY1001 Elements of Physics or PHY1101 Introduction to 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

Light microscopy is an established visualization method used in many fields as a standard analysis tool - from histopathological examination of biopsies, to observation of rare minerals' optical properties. Technological advances in light sources and electronics have made possible the development of advanced imaging modalities. Such modalities can be used to image anything from the detailed structure of the nuclear pore, to the development of a whole zebrafish embryo in real time, with subcellular resolution. Advanced techniques include Confocal microscopy, Two-photon microscopy, Light Sheet microscopy and Super-resolution microscopy. In this course the advantages and disadvantages of each technique are going to be discussed and relevant applications are going to be presented. Practical sessions will help students get acquainted with such techniques and experience how microscopic images are created. Basic image processing of these images is going to be performed. This course is aimed at any student 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 Life sciences.

Assessment

Will consist of the combination of

- one interim assessment.
- one assessment at the end of the course based on a group assignment.

INT3003 Biomaterials

Course coordinators

Dr. C. Mota & Dr. P. Wieringa, Department of Complex Tissue Regeneration, MERLN Institute for Technology-Inspired Regenerative Medicine, Maastricht University.
Contact: c.mota@maastrichtuniversity.nl
Contact: p.wieringa@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 introduce the student to the selection of processing techniques and their working principles.
- To provide a detailed understanding of the interaction of biomaterials with surrounding tissues and the complete organism.
- Translational pathway of the different biomaterials to clinical applications.

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 working principles of the processing techniques commonly used to modify a raw biomaterial to develop a clinical product will be explained. 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. The translational pathway of each group of biomaterials will be explained highlighting the complex implementation necessary to bring a product to the clinics.

Literature

Biomaterials Science: An Introduction to Materials in Medicine ISBN 9780123746269 (hardcover), ISBN 9780080877808 (eBook). Ebook available Maastricht University library.

Instructional format

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

Examination

Two multiple choice mid-terms, a final examination with open questions and posterpresentation on the short project concerning biomaterials research.

INT3005 Biobased Materials and Technology

Course coordinators

Prof. Yvonne van der Meer, Biobased Materials & Aachen-Maastricht Institute for Biobased Materials.
Contact: Yvonne.vandermeer@maastrichtuniversity.nl

Dr. Ketie Saralidze, Science Masters, Sciences, Faculty of Science and Engineering.
Contact: k.saralidze@maastrichtuniversity.nl

Prerequisite

- ✓ CHE2001 Organic Chemistry

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

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

INT3007 Systems Biology

Course coordinators

Dr. Martina Summer-Kutmon, Maastricht Centre for Systems Biology (MaCSBio), Department of Bioinformatics (BiGCat).

Contact: martina.kutmon@maastrichtuniversity.nl

Dr. Judith Peters, Department of Cognitive Neuroscience.

Contact: j.peters@maastrichtuniversity.nl

Pre-requisites

- ✓ PRO1002 Research Project

Co-requisites

- ✓ None

Recommendations

- ✓ We strongly advise students to have followed at least one level 2000 course in biology, chemistry, mathematics or neuroscience.

Objectives

- To give an overview of the relevant areas of Systems Biology from cellular to tissue to whole-body level
- Studying relevant mathematical and computational techniques
- Understanding complex and multiscale biological processes
- Applying this knowledge about complex systems 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 can integrate their current expertise and knowledge in the required way. Systems biology must fill that gap. 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 dynamic systems, networks, and constraint-based modelling. We discuss many examples from amongst others cancer metabolism (molecular modeling), neuroscience (tissue-level modeling), and diabetes (whole-body level modeling). Practical skills will be trained in computer practicals. Successful participation at this course is the perfect preparation for a Master in Systems Biology.

Literature

A list of papers and suggested books for additional information will be provided during the course.

Instructional format

Lectures, tutorial group meetings, and computer practicals.

Assessment

- A final written exam.
- A group presentation.
- An individual assignment.

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

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.
- Biofabrication: including technologies that enables the production of scaffolds and biological constructs.
- Engineering design aspects: including 2D cell expansion, 3D tissue growth, bioreactors, engineering of surface properties to guide cell-material interactions, 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

A final examination, which consists of open questions, a written report and an oral presentation on the short project concerning regenerative medicine research.

INT3009 Chemical Ecology

PLEASE NOTE: This course only runs in alternate years (even), alternating with BIO3002 Ecophysiology (odd). It will run in academic year 2020-21, but not in 2021-22.

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

Under revision. Details will be published closer to the course.

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. Since the 19th century, scientists have investigated 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 the fine arts and their 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 a 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
- A final examination, which consists of essay questions.
- A PowerPoint presentation on a selected conservation problem.
- A mid-term examination.
- The contributions to the tutorial group meetings.

MAT1006 Applied Statistics

Course coordinators

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 analyses in a variety of scenarios.
In most scientific research, researchers have to deal with the problem of drawing conclusions about a 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 the basis for explaining a number of widely used applied statistical methods: ANOVA, Chi-square and Nonparametric tests. 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. Georgios Stamoulis, Faculty of Science and Engineering, Department of Data Science and Knowledge Engineering.
Contact: georgios.stamoulis@maastrichtuniversity.nl

Pre-requisites
- ✓ MAT2004 Linear Algebra

Recommended
In addition, it is useful to have a basic understanding of approximation by Taylor series. Students should have a 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
A written midterm and a written final exam, with open questions. The resit exam covers all the material of the course.

MAT2004 Linear Algebra

Course coordinator

Mathias Staudigl, Faculty of Science and Engineering, Department of Data Science and Knowledge Engineering.
Contact: m.staudigl@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.* 5 th ed.). Pearson.
ISBN 13: 9780321982384.

Instructional format

There are two 2hr lectures per week and two tutorial classes. 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

Course coordinator
Dr. Gijs Schoenmakers: Faculty of Science and Engineering, Department of Data Science and Knowledge Engineering.
Contact: gm.schoenmakers@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).
- 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
Mirela Popa, Faculty of Science and Engineering, Department of Data Science and Knowledge Engineering.
Contact: mirela.popa@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. Furthermore, these objectives will be reinforced through short digital interactive sessions organized during the lectures.
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. 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

TBA

Contact:

Pre-requisites

- ✓ None

Co-requisites

- ✓ None

Objectives

- Identify, interpret and apply fundamentals of imperative programming such as variables, conditionals, iteration, etc.
- Identify, interpret and apply fundamentals of object-oriented programming, including defining classes, invoking methods, using class libraries, etc.
- Give examples of important topics and principles of software development.
- Point out obvious mistakes in programs and analyze how they run.
- Design, compose and evaluate programs that solve specific problems.
- 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

- A final examination, which consists of questions related to the course material.
- Programming assignments.
- 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. Ton Storcken, School of Business and Economics, Department Quantitative Economics.

Contact: t.storcken@maastrichtuniversity.nl

Pre-requisites

- ✓ MAT2006 Calculus

Objectives

- To develop the insight that certain problems in natural sciences can be modelled through differential and difference equations.
- To be able to solve specific types of differential and difference equations, including linear differential and difference equations, with constant coefficients.

Description of the course

In many Sciences, among which Physics, Chemistry, Biology, Computer Science and Economics, differential and difference equations help to model processes of change. In this introductory course, we will focus on the basics of differential and difference equations. In particular, we study first order difference and differential equations as well as the solution set of higher order linear versions of these, having constant coefficients.

Literature

Handouts will be distributed during the course (EleUM).
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 Modelling Applications – D.G. Zill – 2013 – BROOKS/COLE Cengage Learning
- Ordinary Differential Equations – W. Adkins and M. Davidson – 2012 - Springer
- Onlinear dynamics and Chaos, 2^{nd} Ed. – Steven H. Strogatz – 2015 – Westview Press

Instructional format

Lectures and exercices.

Assessment

A written midterm and a written final exam with open questions.

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.

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

Course coordinator
Dr. Peter van Ruitenbeek, Faculty of Psychology and Neuroscience.
Contact: p.vanruitenbeek@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.
- Obtain understanding of and experience in how present within the scientific process.

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; or Biopsychology 10th ed – Pinel, 2018; or Physiology of Behavior 12th ed – Carlson, 2017).

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 make a written exam, and do a practical assignment (oral presentation or poster).

NEU2001 Cognitive Neurosciences: From Sensation to Perception

Course coordinator
Lars Hausfeld, Faculty of Psychology & Neuroscience.
Contact: lars.hausfeld@maastrichtuniversity

Pre-requisites
- ✓ 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
Participation, oral presentation, final exam.

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* or
- ✓ NEU1001 Introduction to Neuroscience or
- ✓ INT2008 Molecular Toxicology

**Note: the course INT1002 will no longer be offered at MSP.*

Co-requisites

- ✓ None

Objectives

- 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 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, the psychostimulants, the antidepressants 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 format

Lectures and tutorial group meetings.

Assessment

Written assignments and presentations.

NEU3001 Neuroscience of Action

Course coordinator

Peter Stiers, Faculty of Psychology & Neuroscience.

Contact: peter.stiers@maastrichtuniversity.nl

Pre-requisites

- ✓ NEU1002 Cognitive Neurosciences: Biological Foundations of Behaviour
- ✓ 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 pencil), 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, final exam.

PHY1101 Introduction to Physics

Course coordinator

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

Contact: c.pawley@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ PRA1101 Introduction to Scientific Research I

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 acquaint the student with the story of a scientist behind each principal corner stone of physics treated in 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. 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.

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. Next to the scientific part of this course, there will also be a social and historical angle: a great scientist linked to each corner stone of physics will be central in every lecture. 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 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

- Students are asked to write a course work about a physicist of their interest.
- Final examination.

PHY2001 Classical Mechanics

Course coordinator

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

Pre-requisites

- ✓ MAT2006 Calculus

Recommended

- ✓ 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. Jessica Steinlechner, GWPF, Faculty of Science and Engineering.
Contact: jessica.steinlechner@maastrichtuniversity.nl

Pre-requisites
- ✓ None

Recommended
- ✓ PHY1001 Elements of Physics or PHY1101 Introduction to 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 laws of thermodynamics, entropy, enthalpy 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
Concepts in Thermal Physics by Blundell and Blundell, Oxford University Press 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. In parallel to these there will also be 'individual exercises' to be completed outside of the classroom.

Assessment
- Written or oral presentations about course content.
- Written examination.

PHY2003 Vibrations and Waves

Course coordinator
Dr. Sebastian Steinlechner, GWPF, Faculty of Science and Engineering.

Contact: s.steinlechner@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
- ✓ MAT2009 Multivariable Calculus

Recommended
- ✓ MAT2004 Linear Algebra
- ✓ PHY1001 Elements of Physics or PHY1101 Introduction to Physics

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:
- Electrostatics
- Electric Field in Matter
- Magnetostatics
- Magnetic Fields in Matter

These topics are divided over the six lecturing weeks of the course. In addition, there will be exercises on Vector Analysis during the tutorials and as homework.

Literature
The course will closely follow the book *Introduction to Electrodynamics* by David J Griffiths, chapters 1–6.

Instructional format
This course follows a 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 group. Next to these there are also "individual Exercises" to be prepared as homework for the second tutorial.

Assessment
In week 4 and 7 there are a midterm and final exam. There is a participation score that will be issued after week 6.

PHY2005 Quantum Theory

Course coordinator
Dr. Jacco de Vries, GWPF, 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 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. Stefan Hild, GWPF, Faculty of Science and Engineering.
Contact: stefan.hild@maastrichtuniversity.nl

Pre-requisites
- ✓ PHY1001 Elements of Physics or PHY1101 Introduction to Physics

Recommended
- ✓ PHY2003 Vibrations and Waves

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.
- To understand and be able to apply interference and diffraction theory to a range of problems.

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.). After the geometrical approach, we will move forward to physical optics where light is considered to be a wave. In this part more complex phenomena like polarization, interference, diffraction and their application (e.g. non-reflective coatings, Michelson interferometer,…) will be described.

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 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
Written coursework and final examination.

PHY2008 Solar System Astronomy

Course coordinator

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

Contact: chad.ellington@maastrichtuniversity.nl

Pre-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 homework assessments, contributions to tutorial group meetings, tutorial exercises, midterms, independent research/observational reports, final examination.

PHY2009 Stellar Astronomy

Course coordinator

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

Contact: chad.ellington@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Objectives

- Review the electromagnetic spectrum and usefulness of spectroscopic observations, including blackbody thermal radiation, emission/absorption spectra and how they can be used to determine chemical composition, relative radial velocities, surface temperatures, luminosities of objects throughout our universe.
- Identify the overall structure of our Sun from core to corona, covering nuclear fusion, highlighting structures/processes of energy transfer & how each region can be studied.
- Describe the conditions under which stars form & why their formation mass is so important.
- Synthesize apparent magnitude, surface temperature & parallax to determine information such as stellar luminosity (absolute magnitude), distance & stellar size…comparing/contrasting with our own Sun & applying to more distant stars for which parallax information is lacking.
- Recognize spectral types of stars, being able to identify them based on surface temperature (color), spectral features, stellar mass and/or luminosity class.
- Differentiate types of binary stars and utilize observational data to find physical properties of the stars, such as: combined mass, individual mass and physical size (as applicable).
- Illustrate color-magnitude (H-R) diagrams, locating major types of stars as well as explaining differences for young versus old star clusters…identifying the turn-off point and how/why it can be utilized to determine star cluster ages.
- Understand the importance of intrinsic variable stars, especially pulsating and cataclysmic variables and their contributions towards the cosmological distance ladder, being able to identify types based upon light curve and spectroscopic observations.
- Apply the cosmological distance ladder to determine distances to particular types of stars.
- Discuss stellar changes from formation to death, highlighting differences of low versus high mass stars from that of our Sun and how their remnants contribute to future star formation and planet formation.

Description of the course

This course begins with an overview of information available by studying the spectrum of light from objects within our universe. We then look at our own star, the Sun, covering what humanity has learned thus far about its interior structure/composition. Next, we study properties of other stars including: how they form, how long they last, how they change over time & the many remnants they leave behind.

Literature

- Carroll, B. & Ostlie, D. (2017). An Introduction to Modern Astrophysics (2^{nd} ed.). Cambridge.
- Selected articles and materials will be referenced/provided to the students.

Instructional format

Each week of this course is focused on various topics concerning stars and stellar evolution, consisting of overview lectures and discussion group meetings. The first meeting may introduce the weekly group assignments/exercises 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, tutorial exercises, midterms, independent research/observational reports, final examination.

PHY2010 Galactic Astronomy

Course coordinator

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

Contact: chad.ellington@maastrichtuniversity.nl

Recommended

- ✓ PHY2009 Stellar Astronomy

Objectives

- Illustrate the size/structure of our Milky Way Galaxy, how we are able to measure motions of stars/gas clouds, map its overall structure and determine our place within which.
- Compare/contrast the shapes, sizes & compositions of: spiral, elliptical, peculiar & irregular galaxies; being able to classify to which type they belong based upon imagery, orbital motions of bodies within which and/or physical content descriptions.
- Evaluate observational evidence to differentiate between the top-down and bottom-up models describing galactic formation.
- Discuss competing models explaining the presence of galactic spiral arms.
- Breakdown the historical classifications of active galaxies into the subcategories of: radio galaxies, Seyfert galaxies, quasars & blazars; understanding their impact on galactic evolution.
- Explain the methods of determining distances to galaxies within the cosmological distance ladder, applying them to various galactic structures.
- Describe the various pieces of evidence for dark matter within most galaxies and clusters of galaxies.
- Relate how observations of distant supernovae led to the discovery that our universe is accelerating in its expansion rate.
- Identify the key observations supporting the Big Bang as well as how problems with this model led to the inflationary hypothesis & the problems it solves.
- Summarize the eras of our universe after the Big Bang, identifying various processes that occurred within each and/or differentiated them from each other.

Description of the course

This course begins with an exploration of our Milky Way Galaxy, identifying its overall structure and our Sun’s place within which. Continuing outward, we study properties of other galaxies, highlighting properties of varying types, how they form and change with time. Finishing up with how large scale observations lead us to the initial conditions of our universe and the Big Bang theory itself.

Literature

- Carroll, B. & Ostlie, D. (2017). An Introduction to Modern Astrophysics (2nd ed.). Cambridge.
- Selected articles and materials will be referenced/provided to the students.

Instructional format

Each week of this course is focused on various topics concerning stars and stellar evolution, consisting of overview lectures and discussion group meetings. The first meeting may introduce the weekly group assignments/exercises 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, tutorial exercises, midterms, independent research/observational reports, final examination.

PHY3001 Quantum Mechanics

Course coordinator
Dr. Stefan Danilishin, GWPF, Faculty of Science and Engineering.

Contact: stefan.danilishin@maastrichtuniversity.nl

Pre-requisites
- ✓ PHY2005 Quantum Theory

Co-requisites
- ✓ None

Recommended
- ✓ MAT2006 Calculus
- ✓ MAT2004 Linear Algebra

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 quantum phenomena in real physical systems.
- 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: quantum tunnelling, approximation methods such as the variational principle and time (in)dependent perturbation theory, state transitions, quantum entanglement and quantum fluctuations. Each of these subjects is taught on a theoretical level as lecture, and on a practical level with exercises.

Literature
- "Modern Quantum Mechanics", J.J. Sakurai.
- "Introduction to Quantum Mechanics", David J Griffiths.
- "Quantum Mechanics", Susskind, Friedman, Basic Books, ISBN 0465036678.
- 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.

PHY3002 Theory of Relativity

Course coordinator

Dr. Gideon Koekoek, GWPF, Faculty of Science and Engineering.
Contact: gideon.koekoek@maastrichtuniversity.nl

Pre-requisites

- ✓ PHY2001 Classical Mechanics

Co-requisites

- ✓ None

Objectives

- To acquaint the participants with the entirety of Special Relativity.
- To build up Special Relativity in the historical way (by means of thought experiments) as well as from rigid mathematical foundations.
- To understand 4-vectors and the mathematics of Minkowksi-spacetime as a complete description of Special Relativity, and apply them correctly in solving exercises.
- To be able to read and create Minkowski spacetime diagrams, and apply them correctly in solving exercises.
- To acquaint the students with the Lagrangian formalism of Nature, and to apply it in relativistic setting to derive relativistic physical laws.
- To be able to identify and solve the misconceptions and paradoxes in Special Relativity.

Description of the course

This course focuses on one of the two variants of Einstein's Theory of Relativity, that is known as Special Relativity, which is a complete description of space and time at the most fundational level of Nature. Most notably, the Theory of Relativity posits that space (lengths) and time (durations) are not separate entities, but are intimately entwined with each other; it also posits that these are not fixed but depend on the inertial system of the observer. This makes for a rich and interesting underlying structure of space and time. Building up this structure and learning how to apply it to exercises and physical situations, is the main goal of the lecture series.
We will start our series by identifying, historically, how Special Relativity was discovered and how it followed naturally from the laws of electromagnetism; we will then build up its laws and relationships in the historical (but limited) way of Gedankenexperiments, followed by the rigorous (but complete) way of Minkowski-geometry. We will introduce Lagrangian formalism of theoretical physics to derive the laws of special-relativistic mechanics. We will apply the theory in numerous exercises, for which we will also find graphical ways of getting insight in their solutions.
Finally, we will study the paradoxes and misconceptions; Special Relativity is a theory that is easy to misunderstand, and it is important that we study which misconceptions there are, how to identify them, and how to remedy them.

Literature

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

The tutorials will consist of highly interactive sessions, in which we will solve and discuss exercises in a group-effort, where the focus lies both on the mathematics as the physical interpretation of the results. In parallel to these group-exercises there will also be 'individual exercises to be completed outside of the classroom.

Assessment

Midterm and Final exam.

PHY3004 Nuclear and Elementary Particle Physics

Course coordinator

Prof. Marcel Merk, Faculty of Science and Engineering, Maastricht University.
Contact: m.merk@maastrichtuniversity.nl

Pre-requisites

- ✓ PHY2005 Quantum Theory

Co-requisites

- ✓ None

Recommended

- ✓ MAT2004 Linear Algebra
- ✓ MAT2006 Calculus
- ✓ PHY3001 Quantum Mechanics
- ✓ 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 what fundamental particles exist, what their properties are, and how they interact through the three fundamental forces, with the theories of Quantum Electrodynamics, the weak force, and Quantum Chromodynamics. We will use Feynman diagrams and Fermi's golden rule to calculate interaction cross-sections for a simple toy model. In addition, we will explore the beautiful concept of symmetry in nature, and its relation to conservation laws.
In the last week, we will discuss practical particle detectors and accelerators and the latest hot topics in the field. We will plan a trip to the ELSA particle accelerator in Bonn where we can observe a particle accelerator and detectors up close.*
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. In the last three weeks, time will be reserved to work on specific topics for the group projects. In the last week, a seminar will be organized to present the group work to each other.

Literature

"Introduction to Elementary Particles", David J Griffiths.

Instructional format

Lectures and PBL tutorial group meetings.

Assessment

Group project and presentation (peer-reviewed), final exam, tutorial exercise presentations.

PHY3005 Relativistic Electrodynamics

Course coordinator

Dr. Stefan Danilishin, GWPF, Faculty of Science and Engineering.

Contact: stefan.danilishin@maastrichtuniversity.nl

Pre-requisites

- PHY2004 Electromagnetism
- PHY3002 Theory of Relativity

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

The tutorials will consist of highly interactive sessions, in which we will solve and discuss exercises in a group-effort, where the focus lies both on the mathematics as the physical interpretation of the results. In parallel to these group-exercises there will also be 'individual exercises' to be completed outside of the classroom.

Assessment

Midterm and Final exam.

PHY3006 General Relativity

Course coordinator

Prof. Dr. Jo van den Brand, GWPF, Faculty of Science and Engineering.
Contact: j.vandenbrand@maastrichtuniversity.nl

Pre-requisites

- ✓ PHY2001 Classical Mechanics
- ✓ PHY3002 Theory of Relativity

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

The tutorials will consist of highly interactive sessions, in which we will solve and discuss exercises in a group-effort, where the focus lies both on the mathematics as the physical interpretation of the results. In parallel to these group-exercises there will also be ‘individual exercises’ to be completed outside of the classroom.

Assessment

Midterm and Final exam.

PHY3007 Advanced Mathematical Techniques of Physics

Course coordinator

Dr. Gideon Koekoek, GWPF, Faculty of Science and Engineering.
Contact: gideon.koekoek@maastrichtuniversity.nl
Lecturers:
Dr. Gideon Koekoek & Prof. Dr. Jo van den Brand
Contact: j.vandenbrand@maastrichtuniversity.nl

Pre-requisites

- ✓ MAT2004 Linear Algebra
- ✓ MAT2009 Multivariable Calculus

Objectives

To provide students training and fluency in the following mathematical techniques of physics:

- Fourier series
  Theorem of Riemann-Lebesque, Dirichlet, Jordan, theorem of Abel-Poison, Cauchy series.
- Fourier integrals
  Banach space, Hilbert space; Schwarz inequality, Parseval, connection to Heisenberg uncertainty relation.
- Bessel and Legendre functions
  Complete sets of orthonormal functions, Euler's constant, Fourier-Bessel series, Hankel transform.
- Laplace transformation
  Complex function theory, *s*-plane, initial value problems for (partial) differential equations.
- Variational methods
  First order PDEs, second order PDEs; Lagrangian, Euler-Lagrange equation.
- Green's functions
  Solving of potential equations, Dirichlet and von Neumann problems, Wronskian determinant.

Description of the course

The Italian physicist Galileo already remarked in the 16th century that "the book of nature is written in mathematics". In the centuries and development of physics since, this has become true to the point that advanced mathematics is inseparably entwined with physics. Indeed, for a professional career in physics research, a rigorous training in advanced mathematical techniques is a necessity. In this course, we will provide a number of the most important topics needed in active research in physics. Topics include integral transforms, techniques of solving partial differential equations, finding particular solutions by Green's function techniques, complete sets, Fourier analysis and its relationship to data-analysis and quantum mechanics, and variational calculus. In all cases, the mathematics will be practiced in the context of real-life examples of fundamental theories of physics, such as quantum field theory and relativity.

Literature

- Arfken & Weber & Harris: *Mathematical Method for Physicists*, 7th edition or higher.
  ISBN 978-0-12-384654-9.
- lecture notes by Jo van den Brand & Gideon Koekoek.

Instructional format

Lectures and tutorial group meetings.

Assessment

Midterm and Final exam.

PRA1101 Introduction to Scientific Research I

Course coordinators

Dr. Erik Steen Redeker & Dr. Chris Pawley, Faculty of Science & Engineering, Maastricht Science Programme.
Contact: erik.steenredeker@maastrichtuniversity.nl or c.pawley@maastrichtuniversity.nl

Co-requisites

- ✓ CHE1101 Introduction to Chemistry
- ✓ PHY1101 Introduction to Physics

Objectives

- Explore the different natural sciences in a laboratory setting.
- To prepare for a lab from a safety perspective.
- To understand the handling of materials and solutions and disposal of waste material.
- How to work safely in a laboratory environment.
- To be able to relate a research question to a scientific theory and a research experiment.
- Design and setup a simple research plan to answer the research question.
- Understand the use of control samples, reference values, blanks, standards in experimentation.
- To be able to perform and record basic laboratory research experiments in a safe and scientifically valid way.
- Generate valuable data from a scientific experiment.
- Learn the basics of writing lab reports.

Description of the skill

The academic world has its own strict set of rules with respect to collecting data, analyzing the data, and writing and reporting about it. 'Introduction to Scientific Research' focuses on designing and performing scientific research experiments in the lab. It will teach you some basic laboratory skills commonly used in chemical, biological or physics research. Students will gain experience in how to design and set up an experiment in order to answer a specific scientific question. During the laboratory sessions, students will execute experiments, learn how to record the methods and observations, and perform the necessary measurements to generate valuable data with the final goal to answer the scientific question. You will conduct basic data analysis, interpret the analysis, and report the findings.
Basic practical techniques will be taught, such as the accurate weighing, preparing solutions and dilutions, working with pipettes and volumetric glassware, performing simple analysis, ...
In PRA1101 Introduction to Scientific Research I, students will start with learning how to work in a safe manner in a laboratory environment, with respect for themselves, others, and the environment. You will learn how to design an experiment in order to generate valuable data. You will perform experiments and learn the basics of documenting procedures and observations and how to write specific parts of a lab report.
This skills course continues with PRA1102 Introduction to Scientific Research II in which you will focus more on how to analyze and interpret the data generated in the experiments and how to report the conclusions and findings.

Literature

Course manual and online instructions on the Student Portal.

Instructional format

This skills training will consist out of several interactive lectures, practical lab work, and PBL sessions on experimental design, data analyses, and reporting of data.

Assessment

Pre-lab and post-lab assignments, final examination.

PRA1102 Introduction to Scientific Research II

Course coordinators
Dr. Linnea van Griethuijsen: Faculty of Science and Engineering, Maastricht Science Programme.
Contact: l.vangriethuijsen@maastrichtuniversity.nl

Dr. Stefan Jongen: Faculty of Science and Engineering, Maastricht Science Programme.
Contact: stefan.jongen@maastrichtuniversity.nl

Co-requisites
- ✓ BIO1101 Introduction to Biology
- ✓ INT1101 Introduction to Liberal Arts and Sciences

Objectives
- Explore the different natural sciences in a laboratory setting.
- Relate a research question to a scientific theory and a research experiment.
- Design and setup a simple research plan to answer the research question.
- Understand the use of control samples, reference values, blanks, and standards in experimentation.
- Perform and record basic laboratory research experiments in a safe and scientifically valid way.
- Generate valuable data from a scientific experiment.
- Conduct basic data analysis.
- Interpret and discuss experimental results.
- Further learn the basics of writing lab reports.

Description of the skill
The academic world has its own strict set of rules with respect to collecting data, analyzing the data, and writing and reporting about it. 'Introduction to Scientific Research' focuses on designing and performing scientific research experiments in the lab. It will teach you some basic laboratory skills commonly used in chemical, biological or physics research. Students will gain experience in how to design and set up an experiment in order to answer a specific scientific question. During the laboratory sessions, students will execute experiments, learn how to record the methods and observations, and perform the necessary measurements to generate valuable data with the final goal to answer the scientific question. You will conduct basic data analysis, interpret the analysis, and report the findings.
Basic practical techniques will be taught, such as the accurate weighing, preparing solutions and dilutions, working with pipettes and volumetric glassware, performing simple analysis, ...
PRA1102 Introduction to Scientific Research II builds on PRA1101 Introduction to Scientific Research I and you will gain more experience in how to design and set up an experiment in order to answer a specific scientific question from. During laboratory sessions, you will execute experiments and record the necessary data. You will learn how to analyze and interpret the data generated in the experiments and further learn how to discuss the results and report the findings in partial lab reports.

Literature
Course manual and online instructions on the Student Portal.

Instructional format
This skills training will consist out of several interactive lectures, practical lab work, and PBL sessions on experimental design, data analyses, and reporting of data.

Assessment
Pre-lab and post-lab assignments, final examination.

PRA1003 Basic Physics Laboratory

Course coordinator

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

Contact: c.pawley@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ None

Recommended

- ✓ PHY1001 Elements of Physics or equivalent high school physics knowledge.

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 skill

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. 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 small teams 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 and fill-in sheets.

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
- ✓ USB stick and wired headphones

Co-requisites
- ✓ None

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

Description of the skill
Neuroscience uses a range of techniques to make inferences about the workings of the brain and its relationship to perception, behaviour, health and disease. This skill course will introduce the fundamentals of experimental design, data collection, analysis and interpretation, covering methods for measuring behaviour, perception and electrophysiology (the electrical activity of the brain). To make the knowledge concrete, students will perform experiments and data analysis, and write a report comparing methods used to measure perceptual sensitivity. In addition, to build a wider appreciation of field, students will read and present a journal article.
Computer programming is an essential skill for modern neuroscience, used to run experiments and perform data analysis. This skill forms a large portion of the course, you will learn the basic functionality of MATLAB and the Fieldtrip toolbox. No previous programming experience is expected.
Students **must have** with them a USB stick with at least 4GB free space (windows formatted) and wired headphones.

Literature
Hand-outs and relevant literature will be provided by coordinator.

Instructional format
Lectures, Group meetings and computer meetings.

Assessment
Intermediate assignment based on group work. Presentation of a selected journal article and lab report based on practical sessions.

PRA2002 Chemical Synthesis

Course coordinator

P1: Dr. Matt Baker: Faculty of Health, Medicine and Life Sciences, MERLN.
Contact: m.baker@maastrichtuniversity.nl
P4: Dr. Hanne Diliën: Faculty of Science and Engineering, Maastricht Science Programme.
Contact: hanne.dilien@maastrichtuniversity.nl

Pre-requisites

- ✓ PRA1001 Research methods or PRA1101 Introduction to Scientific Research I
- ✓ PRA1002 Research, Data Analysis and Presentation Academic Skills or PRA1102 Introduction to Scientific Research II

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 skill

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

- The laboratory notebook with developed protocols.
- Pre-lab online assessment.
- Lab reports.

PRA2003 Programming

Course coordinator

Cameron Browne, Faculty of Science and Engineering Department of Data Science & Knowledge Engineering.
Contact: cameron.browne@maastrichtuniversity.nl

Pre-requisites

- ✓ MAT1004 Imperative Programming or MAT2007 Introduction to Programming

Co-requisites

- ✓ None

Objectives

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

Description of the skill

The hands-on 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 during weekly labs and an assignment. Topics include:

- Elements of Java programs.
- Efficiency and coding style.
- Object-oriented programming.
- Recursion.
- Basics of graphical user interface (GUI) programming.
- Exceptions and error handling.
- File input and output.
- Threads and multithreading.

Literature

No specific text book is required, although students are referred to the online book Introduction to Programming Using Java by David J. Eck (http://math.hws.edu/javanotes/). Relevant literature will be available online and referred to in the lab handouts as needed.

Instructional format

The course will be taught in a computer lab. Each session will start with a short lecture to introduce the week's topic, followed by short programming tasks that demonstrate practical applications of the topic, to be completed during the session. Students should bring their own laptop with a Java SDK installed (Eclipse preferred) ready to write and run Java programs.

Assessment

The assessment will be based on the programming tasks and a larger take-home assignment.

PRA2004 Inorganic Synthesis

Course coordinator

Dr. Giuditta Perversi, Faculty of Science and Engineering, Maastricht Science Programme.
Contact: g.perversi@maastrichtuniversity.nl

Pre-requisites

- ✓ PRA1001 Research methods or PRA1101 Introduction to Scientific Research I
- ✓ PRA1002 Research, Data Analysis and Presentation Academic Skills or PRA1102 Introduction to Scientific Research II

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 skill

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 or PRA1101 Introduction to Scientific Research I

Co-requisites

- ✓ None

Objectives

- To be able to efficiently plan experiments related to molecular research in chemistry, biology and biochemistry.
- To understand and execute protein extraction, separation and analysis tools frequently used in a (bio)chemical and biological laboratory.
- To be able to accurately follow and develop 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 skill

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 5 lab days, students will perform a set of integrated biology and chemistry experiments. The different experiments however are connected and form one integrated experiment. In can be said that two of the skills days have an emphasis on biological or biochemical aspects of molecular research, two days focus more on the chemical aspects and one day combines both in a final experiment. 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 skill
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 sessions.

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, Sensor Engineering.
Contact: bart.vangrinsven@maastrichtuniversity.nl

Pre-requisites

- ✓ 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

Recommended

- ✓ PHY1001 Elements of Physics or equivalent high school physics knowledge.

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 skill

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 (Coulomb's Law), 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 and the ability of the team members to design and execute a suitable experiment in physics as assessed through proposals.

PRA2008 Physical Chemistry

Course coordinator
Dr. Veaceslav Vieru, Faculty of Science and Engineering, Maastricht Science Programme.
Contact: v.vieru@maastrichtuniversity.nl

Pre-requisites
- ✓ None

Co-requisites
- ✓ None

Recommended
- ✓ CHE2003 Physical chemistry

Objectives
For the course, students are expected to perform various physical chemistry experiments and analyze the obtained data, involving *inter alia* kinetics analysis, thermodynamics analysis, electrochemistry analysis, and spectroscopy analysis.

Description of the skill
During this practicum, we will investigate how physical data is extracted from different experiments. Each week, students will perform different experiments focusing on the different aspects of physical chemistry (thermodynamics, electrochemistry, kinetics, spectroscopy). Students are expected to work out different constants or information from the data they collected from experiments. Error analysis will also take a large part in the training as it is completely inherent to physical chemistry.

Literature
Atkins, Peter. *Physical chemistry* (any edition). Oxford University Press.

Instructional format
Weekly practical sessions.

Assessment
Assessment will be based on the quality of pre-lab work, lab reports, lab notebooks, results obtained, error analysis, as well as answers to post-lab 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 or PRA1102 Introduction to Scientific Research II

Co-requisites

- ✓ BIO2002 Ecology

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. 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 skill

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.

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 skill

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

Pre-requisites
- ✓ None

Co-requisites
- ✓ BIO2003 General Botany

Objectives
In this skills-training you will get an overview of the characteristics of one of the most important lineages of life: land plants. At the end of this skills-training you should have insight into the most important aspects in these groups and explain their characteristics. Furthermore, you gain specifically insight into the flowering plants and their mode of reproduction.

Description of the skill
There are currently between 300.000 and 350.000 species of land plants known. These vary tremendously in terms of their characteristics and diversity. Several groups have only one to a few species while the flowering plants constitute the majority of species. This group is also by far the most important plant group for humans in terms of food, health, and economic value.
In this skill, you will first study the evolutionary history of four groups (the 'mosses', ferns, 'gymnosperms' and angiosperms). You will focus on the life cycle of these groups and learn how the differences in life cycles are related to adaptations that are connected to water availability. Then you will focus mainly on flowering plants. You learn what the vegetative plant body looks like and why. After this, you focus on the reproductive strategies of angiosperms and look at flowers, fruits and seeds. Finally, you will learn how to plant physiological experiments to study some of the vital process in plants such as transpiration and phloem transport.

Literature
- Botany, an introduction to plant biology. J.D. Mauseth, 6th ed. 2017. Jones & Bartlett Learning. ISBN: 978-1-284-07753-7
- Campbell Biology. J.B. Reece et al. 2015. Pearson.

Instructional format
Weekly laboratory exercises and experiments.

Assessment
There will be three points of assessment: a) worksheets for week 1-2, b) a group poster assingment on week 3-4, and c) one scientific report on week 5.

PRA2013 Practical Zoology

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 or PRA1102 Introduction to Scientific Research II
- ✓ 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 skill
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
Servé Olieslagers: Faculty of Health, Medicine and Life Sciences, Maastricht University.
Contact: s.olieslagers@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 and qualitative analyses nucleic acid products.
- To isolate RNA from eukaryotic cells and apply reverse transcription to generate copy DNA
- To perform and comprehend polymerase chain reaction (PCR) analysis.
- Basic cloning techniques: manipulation of DNA products using restriction digestion and ligation.
- To study specific proteins from tissue by Western immunoblotting.
- To present in-depth knowledge in an essay on predefined genetic concepts.

Description of the skill
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).
- The PowerPoint files from the BIO2007 lectures.

Instructional format
Skills group meetings.

Assessment
Attendance to the skills meetings is required (cf. Rules and Regulations).
A written skills exam.
Group presentation.
A final evaluation on skills attendance and active participation is scored.

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 or PRA1102 Introduction to Scientific Research II

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 skill

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

Boyle J & Ramsay S (2017) Writing for Science Students, ISBN 978-1137571519.

Instructional format

Assisted individual work, peer reviewing.

Assessment

Written work.

PRA2017 NanoBiology

Coordinator
Dr Raimond Ravelli: M4I Nanoscopy, Faculty of Health, Medicine and Life Sciences.
Contact: rbg.ravelli@maastrichtuniversity.nl

Pre-requisites
- ✓ None

Recommended
- ✓ CHE2006 Biochemistry
- ✓ BIO2001 Cell Biology

Objectives
- Learn about NanoBiology; the complexity of living systems at the nanometer-scale.
- Visualise Evolutionary Conservation of protein complexes (nano-machinery).
- Employ the principles of physics and chemistry in a quantitative fashion to living matter (biology, agriculture and medicine).
- Use protein structure databases such as the Protein Data Bank and UniProt.
- Make slide animations that involve protein structures to learn function.
- Learn how to make homology models and visualize them.
- Learn about intrinsically disordered proteins and how to identify them *in silico.*
- To be able to identify Functional Sites in macromolecules.
- Learn about proteopedia.org and how to contribute to it.

Description of the skill
Methods in molecular modelling and structural visualization have become a necessary and complementary tool to the experimental techniques used to study proteins at the nanometer-scale. They can be used to investigate the structure, dynamics and physicochemistry of biological macromolecules. Participants will learn how to use user-friendly software for visual investigation of 3D molecular structures of proteins or nucleic acids, the interactions with each other and with other ligands, like drugs. Specifically, students will acquire the abilities needed to i) identify the (un)structural regions in molecules and evaluate characteristic features (motifs), ii) identify structural templates obtained from protein sequence alignments to build homology protein models, iii) visualize and examine the obtained three-dimensional model and iv) refine it to obtain an energetically favorable model. This skill is designed for students interested in biology and chemistry, but with no previous experience in structural biology or computational chemistry. It progresses rapidly to powerful tools that will be of interest to interdisciplinary students who wish to specialise in protein structure and bioinformatics.

Literature
This skill will be taught using some classic older peer-reviewed literature as source material, as well as some modern ones.

- Burley, S., Berman, H., Bhikadiya, C., Bi, C., Chen, L., & Di Costanzo, L. et al. (2018). RCSB Protein Data Bank: biological macromolecular structures enabling research and education in fundamental biology, biomedicine, biotechnology and energy. *Nucleic Acids Research*, *47*(D1), D464-D474. doi: 10.1093/nar/gky1004
- Kovacs, N., Petrov, A., Lanier, K., & Williams, L. (2017). Frozen in Time: The History of Proteins. *Molecular Biology And Evolution*, *34*(5), 1252-1260. doi: 10.1093/molbev/msx086
- Kyte, J., & Doolittle, R. (1982). A simple method for displaying the hydropathic character of a protein. *Journal Of Molecular Biology*, *157*(1), 105-132. doi: 10.1016/0022-2836(82)90515-0
- Levitt, M., & Chothia, C. (1976). Structural patterns in globular proteins. *Nature*, *261*(5561), 552-558. doi: 10.1038/261552a0
- Pauling, L., Corey, R., & Branson, H. (1951). The structure of proteins: Two hydrogen-bonded helical configurations of the polypeptide chain. *Proceedings Of The National Academy Of Sciences*, *37*(4), 205-211. doi: 10.1073/pnas.37.4.205
- Ramachandran, G., & Sasisekharan, V. (1968). Conformation of Polypeptides and Proteins. *Advances In Protein Chemistry*, *23*, 283-437. doi: 10.1016/s0065-3233(08)60402-7

Instructional format
This skill is organized as a series of computational practicals.

Assessment
Students will be required to do online exercises and to prepare short reports on the activities performed. At the end of the skill, small groups of students (2-4 people) will give a presentation to an academic audience.

PRA2018 Capita Selecta in Life Sciences

Coordinators

Prof. Dr. Peter Peters, M4I Nanoscopy, Faculty of Health, Medicine and Life Sciences.
Contact: pj.peters@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ None

Objectives

The objective of this skill is to acquire insight into trending topics.

- Critical reading (literature)
- To quickly comprehend and discuss a new topic
- Debate the news coverage (objectivity, bias, fear spreading, prediction models)
- Predict effects in the near future based on current insights
- Obtain some hands-on experience in a trending topic
- Laboratory visit or field trip to places that work on the topic. Examples: MUMC+ coronavirus testing or Brightlands CryoSol startup company.

Description of the skill

Capita Selecta is unique and addresses trending topics in the (bio)chemical, biotechnology or the imaging field. For example, it may cover a recent virus outbreak or a profound breakthrough in biotechnology, such as CRISPR, or the latest Nobel prize in Chemistry, Physiology or Medicine. Students will quickly explore a 'hot topic'. Students will acquaint themselves with the theoretical basis of the subject. If possible, they will critically investigate news coverage (from scientific papers to popular news flashes) and discuss the media reports. To acquaint the students better with the current trends and research, there will be visits to companies/laboratories that are involved.

Literature

As the nature of this skill is a 'hot topic', the literature recommendation are of a digital nature; 'trending topics' related to biochemistry, biotechnology and imaging in the news, such as:
https://www.nature.com
https://www.bbc.com/news/health
https://www.ncbi.nlm.nih.gov/pubmed/trending/
https://www.sciencemag.org
https://www.sciencedaily.com/news/plants_animals/biochemistry/
https://crosstalk.cell.com/blog/topic/trends-in-biochemical-sciences
https://www.medicalnewstoday.com/categories/biology-biochemistry
At the start students will be provided with a list of literature, relevant to the topic.

Instructional format

We will start with an introductory lecture and continues with specialized journal clubs. In addition, it will include several lab visits inside and outside the University, including industries/companies. Students will also be arranged in the lab to get hands-on experiences on techniques related to these 'hot topics'.

Assessment

As a middle-term and final evaluation, small groups of students will have debates that will be graded at a group level. The students will be assessed individually by participation grade and a written report of students' argument for the debates.

PRA2019 Natural Science Illustration

Course coordinator
Dr. Jessica Nelson: Faculty of Science and Engineering, Maastricht Science Programme.
Contact: jessica.nelson@maastrichtuniversity.nl

Pre-requisites
- ✓ None

Co-requisites
- ✓ None

Recommended
- ✓ BIO2003 General Botany and / or BIO2004 General Zoology

Objectives
After this skill, students should be able to:
- Explain the historical and modern importance of natural science illustration.
- Accurately draw biological subjects.
- Apply arrangement guidelines to produce pleasing compositions for illustrations.
- Produce illustrations in graphite and ink.
- Digitize illustrations and use them to construct scientific figures.

Description of the skill
This skill will introduce you to natural science illustration and train you in drawing techniques used in this field. No artistic experience is assumed for students entering this practical and drawing techniques for technical illustration differ from those taught in many art classes, so instruction will start with basic drawing. You will then explore techniques using pencil and ink, as well as guidelines for composition. You will also get experience digitizing and digitally editing illustrations to construct scientific figures for publications. Your final project for the course will be to produce a full illustration in either of the introduced media.

Literature
Course manual and provided articles.

Instructional format
One whole-day class per week that will include demonstration of techniques and time to work on illustration assignments.

Assessment
Weekly drawing assignments, short writing assignments, and final illustration project.

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

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 skill

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 (therefore it is recommended to already have experience in operating the IR and NMR in the chemelot labs).

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

The laboratory notebook with developed protocols, practical reports.

PRA3002 Advanced Physics Laboratory

Course coordinator

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

Contact: c.pawley@maastrichtuniversity.nl

Pre-requisites

- ✓ 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

Recommended

- ✓ PHY1001 Elements of Physics or equivalent high school physics.

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

Servé Olieslagers, Faculty of Health, Medicine and Life Sciences, Maastricht University.
Contact: s.olieslagers@maastrichtuniversity.nl

Pre-requisites

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

Co-requisites

- ✓ BIO3001 Molecular Biology

Objectives

- To be able to investigate protein/nucleic acid interactions via an electrophoretic mobility shift assay (EMSA).
- To perform and comprehend a cytological staining and to visualize and interpret the results.
- To extract small nuclear RNA species, assess RNA quality and determine isolation efficiency.
- To isolate proteins from cells and perform protein quantification.
- To perform a chemotaxis assay and interpret the results.
- To perform an immunoprecipitation (IP) and interpret the final results by Western immunoblotting.
- To put together a research grant proposal plan based on previously published research; to present and defend it towards peers and tutors.

Description of the skill

The general aim of this skills course is to obtain detailed knowledge about the techniques that can be applied to address molecular processes in mammalian biology. 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 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

- Attendance to the skills meetings is required. A final evaluation on skills attendance and active participation is scored.
- A written skills exam based upon the practical techniques and information received during the first 4 weeks of skills.
- A final student group scientific proposal writing activity and group presentation.

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, and elastomeric polymers and coatings/paints.

Description of the skills
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.
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
- Assessment of the motivation.
- Assessment of the practical skills.
- A written lab report at the end of every experiment.

PRA3006 Programming in the Life Sciences

Course coordinator
Dr. Egon Willighagen & Dr. Chris Evelo, Department of Bioinformatics – BiGCaT, Faculty of Health, Medicine and Life Sciences.
Contact: egon.willighagen@maastrichtuniversity.nl

Pre-requisites
- ✓ MAT2007 Introduction to Programming

Objectives
- To have the ability to recognize various classes of chemical entities in biology and pharmacology and to understand the basic physical and chemical interactions between them.
- 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, like genes, RNA, proteins, metabolites, and drugs, is of key interest. Not only do these interactions play an important role in the regulation of gene expression, inhibition of proteins, and they basically define all cellular processes. For example, pharmacology is the science studies the action of drugs on protein, and metabolism, similarly, depends on the interactions of small molecule substrates with enzymes.
With the increasing amount of knowledge and data in the life sciences, automation becomes increasingly important. Big data and small, complex data alike provide challenges to integrate data from different experiments and data sources. Various core life sciences databases provide SPARQL end point to their knowledge, while Wikidata is a spider in this web of semantic data. In this course, you will learn to use how to interact with SPARQL endpoints with JavaScript and visualize the results graphically with a library like d3.js or Cytoscape.js.

Literature
- "JavaScript & jQuery: The Missing Manual" by D.S. McFarland (O'Reilly, 2nd edition, 2011)
- "Wikidata as a knowledge graph for the life sciences" by A. Waagmeester et al. eLife, 2020, https://doi.org/10.7554/eLife.52614
- "WikiPathways: a multifaceted pathway database bridging metabolomics to other omics research" by D. Slenter et al. NAR, 2018, https://doi.org/10.1093/NAR/GKX1064
- "Semantic Web programming" by J. Hebeler. 2009. UB Library
- "Semantic Web for the working ontologist: effective modeling in RDFS and OWL" by D. Allemang, J.A. Hendler. 2011. UB Library
- "Git from the Bottom Up" by J. Wiegley. https://jwiegley.github.io/git-from-the-bottom-up/

Instructional format
Five hands-on practicals.

Assessment
- An end product consisting of working source code and documentation (individual)
- An end presentation describing the product, research question, results, and conclusions (group)
- A oral assessment (individual)
- A git repository as lab notebook (individual)

PRA3008 Transition Metal Chemistry

Course coordinator:

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

This skill is modelled as a research endeavour and focuses on the multi-step synthesis, characterization and further exploration of organometallic complexes. The complexes prepared will be new. 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), 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

- ✓ BIO2001 Cell Biology
- ✓ BIO2007 Genetics

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 skill

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 5).

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 skills
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. Ask part of this skill you will also be introduced in the use of Geographical Information Systems (GIS) software.

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 the weeks you will visit field sites by bike or bus. Parts of some days will be devoted to learning GIS analyses. 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 might 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) an individual GIS assignment, 2) an individual review report on one of the excursions, and 3) a group review report on one of the excursions.

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

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 skill

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 sessions: 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.

PRA3014 Spectroscopic Methods

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

Pre-requisites
- ✓ CHE2001 Organic Chemistry
- ✓ CHE2004 Spectroscopy

Co-requisites
- ✓ None

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

Description of the skill
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, COSY spectroscopy.
- Mass spectrometry using GC and LC.
- Optional: 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
- Lab reports, including theoretical background, procedures, data presentation and discussion.
- Laboratory notebook and lab safety.
- A chemical analysis project.

PRA3017 Applied Cell Biology

Course coordinator
Prof. Martijn van Griensven: Faculty of Health Medicine and Life science, Maastricht University.

Contact: m.vangriensven@maastrichtuniversity.nl

Pre-requisites
- ✓ PRA2014 Genetics

Co-requisites
- ✓ None

Objectives
The main objective of this course is to provide a practical introduction into molecular and cell biology. We will use osteoblasts to study the effects of a hypoxia mimic on programmed cell death. A variety of experiments will be performed to study the effects on RNA and protein level. Cell Profiler will be used for image/data analysis.

Description of the skills
These skills will contain:
- Immunohistochemistry (IHC) on apoptotic markers in treated and untreated cells.
- qPCR using Sybr Green for anti- and apoptotic markers.
- Metabolic assays (LDH assay).
- Western blot (for protein expression levels upon treatment of cells).
- Computational analysis of obtained data (Use of CellProfiler to analyse IHC data).

Literature
- Course manual.
- Oxygen-distribution within 3-D collagen I hydrogels for bone tissue engineering (P Wolff, Materials Science & Engineering C95 (2019) 422-427).

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
- Attendance to skills meetings is required (cf Rules and regulations)
- Mini quizzes regarding the technique will be given before the start of a practical topic to make sure students come prepared to the course.
- At the end of week 4 a written skills exam will be provided. This exam will contain ±25 questions related to the practical techniques and information received during the first 4 weeks of the course.
- Keeping an organized laboratory notebook.
- Practical reports.

PRA3018 Molecular Modeling

Course coordinator

Dr. Veaceslav Vieru: Faculty of Science and Engineering, Maastricht Science Programme.

Contact: v.vieru@maastrichtuniversity.nl

Pre-requisites

- ✓ CHE3006 Quantum Chemistry

Co-requisites

- ✓ None

Objectives

- To demonstrate as to what can be achieved using molecular modelling software.
- To identify the most appropriate basis sets for solving different problems.
- To extract via calculations a variety of measurable properties (HOMO/LUMO, transition states, energies, electron densities…).
- To interpret the results of calculations and draw conclusions as to how a reaction will proceed.
- To study transition states and their relevance in chemistry.

Description of the skills

This practicum will introduce students to the basics of computational chemistry via a series of different calculations carried out with Gaussian software. Among others, students will learn how to run Hartree-Fock and Density Functional Theory (DFT) single point calculations and how to include the electron correlation energy via Møller–Plesset second-order perturbation theory. Equally, they will learn to optimize the geometry of molecules, calculate infra-red spectra, study reaction paths and finding the transition states. Moreover, they will be instructed to compute potential energy surfaces, consider solvent effects and calculate rate constants.

Literature

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

Instructional format

Practical sessions.

Assessment

Assessment will be based on the quality of lab reports, lab notebooks, results obtained.

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. Giuditta Perversi: Faculty of Humanities and Sciences, Maastricht Science Programme.
Contact: g.perversi@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 skills

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

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

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 skill

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 KEN1540 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.

PRA3022 iGEM Project

Please note: *this project runs from period 4 to period 2 in the following academic year. Registration can only be done for period 1.*

Course coordinator

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

Pre-requisites:

- ✓ PRO3022 iGem Project

Co-requisites:

- ✓ None

Objectives

Students will acquire an in-depth view of the scientific process of the design, build and test cycle of a synthetic biological system and will get experience in …

Description of the skill

The iGEM competition is a prestigious international student competition on synthetic biology and is organized yearly by the Massachusetts Institute of Technology (MIT). In this competition student teams from all over the world try to tackle real-world problems by using synthetic biology. In this project, several important aspects of science will be experienced.
Students will brainstorm and decide on their own biological design. This design will then be modelled and built by using standard, interchangeable parts. In addition to the practical aspects, students will also be responsible for project management, funding, media attention and communication to the general public. At the end of the competition, the team will present the project at the iGEM jamboree in Boston in a poster session and by giving an oral presentation.

Literature

This skill requires self-study and literature research as a basis. No text book is required.

Instructional format

A combination of group meetings, self-study, brainstorm sessions, participation in local iGEM team meet-up and workshops.

Assessment

Students will be assessed on a combination of: the overall participation in the iGEM team (based on input in brainstorm and project meetings), practical work on the design and building of the biological system and the contribution to scientific presentations (oral and poster).

PRA3023 Plant Physiology and Microbiomes

Course coordinator

Dr. Jessica Nelson: Faculty of Science and Engineering, Maastricht Science Programme.
Contact: jessica.nelson@maastrichtuniversity.nl

Pre-requisites

- ✓ BIO2003 General Botany

Co-requisites

- ✓ None

Objectives

After this practical, students should be able to:

- Conduct an experiment on plant growth and physiological responses to microbes.
- Contextualize their experiments with knowledge of plant microbiome research and its applications in agriculture and ecology.
- Perform sterile techniques for using gnotobiotic plant growth systems.
- Measure plant responses to biotic and abiotic stimuli.
- Correctly apply statistical tests to analyze a plant growth experiment.
- Use ImageJ to measure data images.

Description of the skill

As research on microbes living in and on plants has accumulated in recent years, it has become increasingly clear that plants' success and responses to their abiotic environment are mediated by their microbiomes. A number of approaches exist to investigate the impacts of microbes on plant physiology; one particularly powerful method is to use gnotobiotic growth systems in which plants are grown sterile, then exposed to a known set of microbes. In this skill, you will conduct a project in which you inoculate sterile plants with a set of microbes and measure their effects on plant growth and success. You will learn how to collect and analyze growth data, practice techniques for sterile plant propagation and for measuring plant responses to various abiotic stimuli.

Literature

Various primary literature articles and the course manual.

Instructional format

One whole-day laboratory session per week.

Assessment

Reports on laboratory exercises, laboratory notebooks, practical exercises e.g. tests of sterile technique, and report on the results of a month-long growth experiment.

PRA3024 Analysis of Big Data in Physics

Course coordinator

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

Contact: jacco.devries@maastrichtuniversity.nl

Pre-requisites

- ✓ MAT2007 Introduction to programming

Recommended

- ✓ At least a handful of physics courses at level 3000.

Objectives

At the end of the skill, students will be able to:

- Experiment with code in python in a notebook-like setup.
- Recognise the basic concepts of data analysis in physics.
- Compare and Evaluate various types of data.
- Perform statistical analysis on a variety of physics data sets, in order to extract meaningful physical parameters.
- Perform a proper analysis of errors, correlations and significance.
- Demonstrate awareness of the concept of false positives in data.

Description of the skill

As the world is digitizing, data is being generated by the terabytes per second. As such, there is a great need for people who can make sense of all these data and extract meaningful conclusions. In physics, the last 20 years has seen movement away from individuals working in research groups, towards large, international collaborations. Within these collaborations, data gathering and handling are essential for the successful completion of the experiments. Typical examples are through telescope observations, gravitational wave detectors or particle accelerators.

This skill is a general introduction to analysis of data from physics experiments. We will learn the systematic treatment of data - following logic and statistics - to reach answers to our questions and assess their significance. We will change datasets (and teachers) every week, which will consist of LIGO/Virgo data, CERN/LHCb data and astrophysical datasets. This skill will introduce modern computing skills for data handling such as artificial intelligence, data mining and scalability through (for example) parrallelization. We will make use of Jupyter notebooks running on a server at MSP, for which you just need to bring your laptop with a browser. The first week will cover an introduction to the python programming language.

At the end of the skill we hope to have provided you with a diversity of perspectives on data within physics as well as the skill to interpret and analyse such data.

Literature

TBD

Instructional format

Full-day practical setup, bring your own laptop.

Assessment

Lab Reports, Code Review, Peer-to-Peer feedback.

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 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**
SCI3007	Endocrinology	1
SCI3005	Metabolism, Nutrition and Exercise	2
SCI3050	Advances in Biomedical Sciences	2
HUM2022	Digital Media	2
HUM2051	Philosophical Ethics	4
SCI2031	Immunology	5