MSP Course Catalogue 2025-2026
May 2025

Overview of Courses and Skills for the Academic Year 2025-2026

	Biology	Chemistry	Physics	Mathematics and Computer Sciences #	Interdisciplinary + Neurosciences
Core Courses	**BIO1101** Introduction to Biology (P2)	**CHE1101** Introduction to Chemistry (P1)	**PHY1101** Introduction to Physics (P1)		**INT1101** Introduction to Liberal Arts and Sciences (P2)
1000			**PHY1003** Mechanics (P4)	**MAT1006** Applied Statistics (P2)	**INT1003** Introduction to Biomedical Engineering (P4)
Level Courses				**MAT1007** Mathematical Tools for Scientists (P5)	**INT1005** Commercializing Science and Technology (P5)
					INT1007 Introduction to Earth Sciences (P4)
					NEU1001 Introduction to Neuroscience (P4)
					NEU1003 Computational Neuroscience (P5)
2000	**BIO2001** Cell Biology (P1 & P4)	**CHE2004** Spectroscopy (P1)	**PHY2002** Thermodynamics and Statistical Physics (P5)	**MAT2004** Linear Algebra (P5)	**INT2007** Science in Action (P2)●
Level Courses	**BIO2002** Ecology (P5)	**CHE2006** Biochemistry (P2)	**PHY2003** Vibrations and Waves (P2)	**MAT2005** Probability and Statistics (P5)	**INT2008** Molecular Toxicology (P5)
	BIO2003 General Botany (P4)	**CHE2007** Solid State Chemistry (P5)	**PHY2004** Electricity and magnetism (P4)	**MAT2006** Calculus (P4)	**INT2009** Biophysics (P5)
	BIO2004 General Zoology (P1)	**CHE2009** Fundamentals of Organic Chemistry (P1 & + P4)	**PHY2005** Fundamentals of Quantum Mechanics (P5)	**MAT2007** Introduction to Programming (P1)	**INT2010** Principles of Mass Spectrometry (P4)
	BIO2005 Evolutionary Biology (P4)	**CHE2010** General Chemistry (P5)	**PHY2006** Electronics (P1)	**MAT2008** Differential Equations (P4)	**INT2012** Archaeological Science (P4)
	BIO2006 Biotechnology (P5)	**CHE2011** Organic Chemistry (P2)	**PHY2007** Optics (P5)	**MAT2009** Multivariable Calculus (P2)	**INT2013** Fundamentals of Science Education (P1))●
	BIO2007 Genetics (P1 & P4)		**PHY2008** Solar System Astronomy (P5)		**INT2014** Imaging Engineering (P5)
	BIO2008 Great Transformations in Vertebrate Evolution (P2)		**PHY2009** Stellar Astronomy (P1)		**NEU2003** Neuroethology (P1)
	BIO2010 Human Anatomy and Physiology (P4)		**PHY2010** Galactic Astronomy (P2)		**NEU2004** Neural Circuits and Dynamics (P2)
			PHY2011 Special Relativity (P4)		**NEU2005** Systems Neuroscience: From Genes to Behaviour (P1)
			PHY2012 Structure of Matter (P1)		
3000	**BIO3001** Molecular Biology (P2 & P5)	**CHE3001** Organic Reactions (P2)	**PHY3001** Quantum Mechanics (P1)		**INT3001** The Philosophy of Technology (P1))●
Level Courses	***BIO3002*** Ecophysiology (P2)**	**CHE3006** Quantum Chemistry (P1)	**PHY3002** Theory of Relativity (P2)		**INT3002** Advanced Microscopy: Theory and Applications (P1)
	BIO3003 Medical Microbiology (P5)	**CHE3007** Chemical Kinetics (P2)	**PHY3004** Elementary Particle Physics (P2)		**INT3003** Biomaterials (P4)
	BIO3004 Animal Behaviour (P5)	**CHE3009** Crystallography (P4)	**PHY3005** Electrodynamics (P5)		**INT3005** Biobased Materials and Technology (P2)
					INT3007 Systems Biology (P2)
	BIO3007 Tropical Biology (P2)	**CHE3010** Inorganic Chemistry (P1)	**PHY3006** General Relativity (P5)		**INT3008** Regenerative Medicine (P4)
	BIO3010 Genomics and Proteomics (P4)	**CHE3011** Instrumental analysis (P4)	**PHY3008** Cosmology (P2)		*INT3009 Chemical Ecology (P2)*/***
		CHE3012 Nanomaterials and catalysis (P5)	**PHY3009** Hamiltonian & Lagrangian Mechanics (P1)		**INT3011** Landscape Archaeology (P5)
					INT3012 Science Education: Model-Based Inquiry (P5)
					INT3014 Conservation Palaeobiology (P1)

Overview of Courses and Skills for the Academic Year 2025-2026

	Biology	Chemistry	Physics	Mathematics and Computer Sciences #	Interdisciplinary + Neurosciences
Core Skills					**PRA1101** Introduction to Scientific Research I (P1)
					PRA1102 Introduction to Scientific Research II (P2)
1000 Level Skills			**PRA1003** Basic Physics Laboratory (P2 & P5)		**PRA1005** Data Collection Techniques in Neuroscience (P5)
					PRA1008 Basic of Palaeontology(P4)
2000 Level Skills	**PRA2009** Field Skills in Biology (P5)	**PRA2008** Physical Chemistry (P5)	**PRA2006** Electronics Lab (P1)	**PRA2003** Programming (P1)	**PRA2005** Advanced Molecular Laboratory Skills (P4)
	PRA2011 Exploring the World of Plants (P4)	**PRA2032** Fundamentals of Organic Chemistry Laboratory (P1 & P4)	**PRA2007** Physics Laboratory (P5)	**PRA2028** Mathematics and Art (P1)	**PRA2010** Synthetic Biology (P2)
	PRA2013 Practical Zoology (P2)	**PRA2033** Organic Chemistry Laboratory (P2)	**PRA2023** Astronomical Observing Techniques (P5)	**PRA2029** 3D Visualizations and Transformations (P4)	**PRA2015** Advanced Academic Skills (P1)
	PRA2014 Genetics (P1 & P4)	**PRA2034** General Chemistry Laboratory (P5)		**PRA2031** Python Programming Language (P4)	**PRA2018** Capita Selecta in Modern Sciences (P2)
	PRA2026 R Programming Language (P1)				**PRA2019 Scientific Illustration** (P1)
	PRA2030 Introduction in Mycology (P1)				**PRA2020** Practical Mass Spectrometry (P5)
					PRA2022 Integrated Assessment Modelling of Climate Change (P2)
					PRA2025 Vertebrate Functional Morphology (P2)
					PRA2024 Geology (P1)
					PRA2027 Fundamentals of Science Communication (P1)
3000 Level Skills	**PRA3003** Molecular Biology (P2 & P5)	**PRA3001** Advanced Organic Synthesis (P2)	**PRA3002** Advanced Physics Laboratory (P2)	**PRA3021** Topics in Scientific Computing (P1)	**PRA3005** Polymer Processing (P2)
	PRA3010 Microbiology (P5)	**PRA3014** Spectroscopic Methods (P4)	**PRA3012** Advanced Electronics (P4)		**PRA3006** Programming in the Life Sciences (P2)
	PRA3011 The Limburg Landscape (P5)	**PRA3018** Molecular Modeling (P1)	**PRA3024** Analysis of Big Data in Physics (P4)		**PRA3022** Gem Competition (P1)
	PRA3017 Applied Cell Biology (P4)	**PRA3028** Inorganic Synthesis (P1)			**PRA3025** Science Communication: Curating Science Exhibits (P4)
	PRA3023 Plant Physiology and Microbiomes (P2)				**PRA3026** Science Teaching Skills (P5)
	PRA3503 Microbiome Analysis (P1)				**PRA3027** Advanced Functional Morphology (P2)
					PRA3504 The Academic Life Cycle (P4)

**Not offered in 2025-2026*

***Offered once every other year*

All courses are 5 ECTS. All skills are 2.5 ECTS

● *Note: this course fulfils the humanities or social science topic (MSLAS) requirement*

 # All MAT courses fulfill the MAT requirement

ACADEMIC YEAR 2025-2026 - FALL SEMESTER

	Period 1		Period 2	
	Courses	**Skills**	**Courses**	**Skills**
Biology	BIO2001 Cell Biology	PRA2014 Genetics	BIO1101 Introduction to Biology	PRA2013 Practical Zoology
	BIO2004 General Zoology	PRA2026 R Programming Language	BIO2008 Great Transformations in Vertebrate Evolution	PRA3003 Molecular Biology
	BIO2007 Genetics	PRA2030 Introduction in Mycology	BIO3001 Molecular Biology	PRA3023 Plant Physiology and Microbiomes
		PRA3503 Microbiome Analysis	BIO3002 Ecophysiology	
			BIO3007 Tropical Biology	
Chemistry	CHE1101 Introduction to Chemistry	PRA2032 Fundamentals of Organic Chemistry Laboratory	CHE2006 Biochemistry	PRA2033 Organic Chemistry Laboratory
	CHE2004 Spectroscopy	PRA3018 Molecular Modelling	CHE2011 Organic Chemistry	PRA3001 Advanced Organic Synthesis
	CHE2009 Fundamentals of Organic Chemistry	PRA3028 Inorganic Synthesis	CHE3001 Organic Reactions	
	CHE3006 Quantum Chemistry		CHE3007 Chemical Kinetics	
	CHE3010 Inorganic Chemistry			
Physics	PHY1101 Introduction to Physics	PRA2006 Electronics Lab	PHY2003 Vibrations and Waves	PRA1003 Basic Physics Laboratory
	PHY2006 Electronics		PHY2010 Galactic Astronomy	PRA3002 Advanced Physics Laboratory
	PHY2009 Stellar Astronomy		PHY3002 Theory of Relativity	
	PHY2012 Structure of Matter		PHY3004 Elementary Particle Physics	
	PHY3001 Quantum Mechanics		PHY3008 Cosmology	
	PHY3009 Hamiltonian & Lagrangian Mechanics			
Mathematics & Computer Science	MAT2007 Introduction to Programming	PRA2003 Programming	MAT1006 Applied Statistics	
		PRA2028 Mathematics and Art	MAT2009 Multivariable Calculus	
		PRA3021 Topics in Scientific Computing		
Interdisciplinary	INT2013 Fundamentals of Science Education	PRA1101 Introduction to Scientific Research I	INT1101 Introduction to Liberal Arts and Sciences	PRA1102 Introduction to Scientific Research II
	INT3001 The Philosophy of Technology	PRA2015 Advanced Academic Skills	INT2007 Science in Action	PRA2010 Synthetic Biology
	INT3002 Advanced Microscopy: Theory and Applications	PRA2019 Scientific Illustration	INT3005 Biobased Materials and Technology	PRA2018 Capita Selecta in Modern Sciences
	INT3014 Conservation Palaeobiology	PRA2024 Geology	INT3007 Systems Biology	PRA2022 Integrated Assessment Modelling of Climate Change
		PRA2027 Fundamentals of Science Communication		PRA2025 Vertebrate Functional Morphology
	NEU2003 Neuroethology	PRA3022 iGem Competition	NEU2004 Neural Circuits and Dynamics	PRA3005 Polymer Processing
	NEU2005 Systems Neuroscience: From Genes to Behaviour			PRA3006 Programming in the Life Sciences
				PRA3027 Advanced Functional Morphology

ACADEMIC YEAR 2025-2026 - SPRING SEMESTER

	Period 4		Period 5	
	Courses	**Skills**	**Courses**	**Skills**
Biology	BIO2001 Cell Biology	PRA2011 Exploring the World of Plants	BIO2002 Ecology	PRA2009 Field Skills in Biology
	BIO2003 General Botany	PRA2014 Genetics	BIO2006 Biotechnology	PRA3003 Molecular Biology
	BIO2005 Evolutionary Biology	PRA3017 Applied Cell Biology	BIO3001 Molecular Biology	PRA3010 Microbiology
	BIO2007 Genetics		BIO3003 Medical Microbiology	PRA3011 The Limburg Landscape
	BIO2010 Human Anatomy and Physiology		BIO3004 Animal Behaviour	
	BIO3010 Genomics and Proteomics			
Chemistry	CHE2009 Fundamentals of Organic Chemistry	PRA2032 Fundamentals of Organic Chemistry Laboratory	CHE2007 Solid State Chemistry	PRA2008 Physical Chemistry
	CHE3009 Crystallography	PRA3014 Spectroscopic Methods	CHE2010 General Chemistry	PRA2034 General Chemistry Laboratory
	CHE3011 Instrumental analysis		CHE3012 Nanomaterials and catalysis	
Physics	PHY1003 Mechanics	PRA3012 Advanced Electronics	PHY2002 Thermodynamics and Statistical Physics	PRA1003 Basic Physics Laboratory
	PHY2004 Electricity and magnetism	PRA3024 Analysis of Big Data in Physics	PHY2005 Fundamentals of Quantum Mechanics	PRA2007 Physics Laboratory
	PHY2011 Special Relativity		PHY2007 Optics	PRA2023 Astronomical Observing Techniques
			PHY2008 Solar System Astronomy	
			PHY3005 Electrodynamics	
			PHY3006 General Relativity	
Mathematics & Computer Science	MAT2006 Calculus	PRA2029 3D Visualizations and Transformations	MAT1007 Mathematical Tools for Scientists	
	MAT2008 Differential Equations	PRA2031 Python Programming Language	MAT2004 Linear Algebra	
			MAT2005 Propability and Statistics	
Interdisciplinary	INT1003 Introduction to Biomedical Engineering	PRA1008 Basic of Palaeontology	INT1005 Commercializing Science and Technology	PRA1005 Data Collection Techniques in Neuroscience
	INT1007 Introduction to Earth Sciences	PRA2005 Advanced Molecular Laboratory Skills	INT2008 Molecular Toxicology	PRA2020 Practical Mass Spectometry
	INT2010 Principles of Mass Spectrometry	PRA3025 Science Communication: Curating Science Exhibits	INT2009 Biophysics	PRA3026 Science Teaching Skills
	INT2012 Archaeological Science	PRA3504 The Academic Life Cycle	INT2014 Imaging Engineering	
	INT3003 Biomaterials		INT3011 Landscape Archaeology	
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BIO1101 Introduction to Biology

Course coordinator
David Cortens, Faculty of Science and Engineering, Maastricht Science Programme
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Pre-requisites
- ✓ None

Co-requisites
- ✓ PRA1102 Introduction to Scientific Research II (only in Period 2)

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 for Mendelian inheritance.

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
Taylor et al. (2021). Campbell Biology: Concepts & Connections (10th edition, global edition). Pearson.
ISBN10: 1-292-40134-6 ISBN13: 978-1-292-40134-8

Instructional format
One question and answer session and two PBL tutorials per week.

Assessment
Evaluation of student performance will be based on:
- Contribution to the discussion during tutorial meeting;
- A presentation in week 4 of the course;
- A final written exam at the end of the course.

BIO2001 Cell Biology

Course coordinators

Prof. dr. Martijn van Griensven and Dr Aart van Apeldoorn: Department cBITE, MERLN Institute for Technology-Inspired Regenerative Medicine; Faculty of Health, Medicine and Life Sciences.
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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 builtup 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: 9780 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:

- A written midterm exam;
- A final exam at the end of the course period (open book);
- A poster (period 4) or a presentation (period 1) 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.

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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 is 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. (2015) *Elements of Ecology*, 9th edition ISBN 9781292077406.

Instructional format
One lecture plus two tutorials per week.

Assessment
- Tutorial grade
- Debate
- Exam

BIO2003 General Botany

Course coordinator

Dr. Phil Klahs: Faculty of Science and Engineering, Maastricht Science Programme
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Pre-requisites

- ✓ None

Co-requisites

- ✓ PRA2011 Exploring the World of Plants

Objectives

During this course, you will gain terminology to describe the major aspects of plant form, function and development. We will investigate trends in the evolution of the major plant groups as well as unique adaptations.

Description of the course

This course is designed to add botanical terminology to your vocabulary and practice employing that knowledge in PBL tutorials pertaining to botanical themed tasks. This course will provide insight into growth and division of cells, primary growth of stems (the herbaceous plant), leaves, roots, secondary growth (the woody plant), reproduction, flowers, seeds, and fruit.

Literature

Botany, an introduction to plant biology. J.D. Mauseth, 7th ed. 2021. Jones & Bartlett Learning. ISBN: 978-1-284-15735-2

Instructional format

You will have one interactive lecture and two 1½ hour tutorials per week.

Assessment

The assessments will include:

- Quizzes on Canvas
- An individual project about a plant Family

BIO2004 General Zoology

Course coordinator

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

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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 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 specificadaptations 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. (2023) *Zoology*, 12th edition, ISBN: 978-1266701634.

Instructional format

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

Assessment

- Tutorial grade
- 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 unifiesall phenomena of life from the level of (macro)molecules to ecosystems. Ever since the Modern Synthesisearly last century (when Darwin's insights were combined with modern genetics), evolutionary researchhas 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 increasein 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 excellentopportunity to obtain a base in evolutionary knowledge, regardless of the field you will work in (biologyor 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.; Should a 4th edition be available, then both the 3rd and 4th edition will be acceptable.
- Evolutionary simulation computer programme (mandatory). Before the course starts, more information will be provided to those enrolled. A purchase may be required.

Instructional format

Interactive lecture followed by two tutorials per week. Also, you will do a PechaKucha presentation and a computer simulation on natural selection.

Assessment

In this course you will do a PechaKucha presentation on an evolutionary biology topic, there is a final exam and several small assignments.

BIO2006 Biotechnology

Course coordinator
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Pre-requisites
BIO2001: Cell Biology

Co-requisites
None

Objectives

- Get insight in the different fields of biotechnology and their impact on society.
- Learn the theory of essential biotechnological techniques.
- Generate a biotechnological idea with potential to be commercialized.

Description of the course
Biotechnology is a thriving, innovative and diverse field in science and industry. It contributes to many aspects of our society for example, food production, pharmaceutical development and the treatment of waste.
In this course, you will be able to explore the different fields of biotechnology and get a clear understanding on how these applications influence our lives.
The first lectures will teach you the theory behind some of the most common techniques that have revolutionized biotechnology. Then, you will get insight in how biotechnological ideas can turn into commercial companies via guest lectures.
During this course, you will work in small groups and have the chance to come up with your own biotechnological idea and develop it into a prospective commercial product. The journey from brainstorming an idea to delivering a presentation about your product will be the focus in this course.

Literature
The suggested textbook for this course is: Thieman et al, Introduction to Biotechnology (4th edition, global edition). Pearson. ISBN: 9781292261799.
Relevant references for scientific articles and webpages with additional information will be provided.

Instructional format
Weekly lectures and tutorial group meetings.

Assessment
There will be a minimum of two points of assessment. Assessment may include, but may not be limited to:

- Written midterm exam;
- Peer review;
- Final presentation.

BIO2007 Genetics

Course coordinator

Prof. dr. Leon de Windt, Department of Molecular Genetics (DMG), Faculty of Science and Engineering, Faculty of Health, Medicine and Life Sciences, Maastricht University.
Contact: l.dewindt@maastrichtuniversity.nl

Pre-requisites

- ✓ BIO2001 Cell Biology

Co-requisites

- ✓ PRA2014

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 understand the molecular basis of single and multiple gene inheritance (Mendel's laws), sex-linked single gene inheritance, complex genetic conditions, and to interpret human pedigrees.
- To have sufficient background for more 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, 12th edition, 2020. ISBN-13: 9781319114770).

Instructional format

Lectures and tutorial group meetings.

Assessment

- A group presentation on a paper related to the course's topics to be delivered at the end of the course;
- 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.

BIO2008 Great Transformations in Vertebrate Evolution

Course coordinator
Prof. Dr. Leon Claessens, Faculty of Science and Engineering, Maastricht Science Programme.
Contact: leon.claessens@maastrichtuniversity.nl

Pre-requisites
- ✓ None

Co-requisites
- ✓ PRA2025 Vertebrate Functional Morphology

Recommended
- ✓ 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. (2024). Vertebrate Palaeontology. 5th Ed. Wiley-Blackwell. ISBN: 1394195087;
- Select scientific articles; access through the UM library.

Instructional format
One lecture and two tutorials per week.

Assessment
- Online Quizzes;
- Graphical Abstract;
- Final examination.

BIO2010 Human Anatomy and Physiology

Course coordinator
Aaron Isaacs, Faculty of Health, Medicine and Life Sciences, CARIM, Department of Physiology.
Contact: a.isaacs@maastrichtuniversity.nl

Pre-requisites
- ✓ None

Co-requisites
- ✓ None

Objectives
- To understand membrane and electrophysiology, particularly in the heart;
- To elucidate the structure and function of the cardiovascular system;
- To describe blood pressure and gas homeostasis and the role of hormonal and neurological control in regulating them;
- To describe the systems involved in energy balance and volume control;
- To investigate the interplay between organs (and systems) to better comprehend the function of humans as complete organisms.

Description of the course
BIO2010 focuses on the structure (anatomy) and function (physiology) of some of the major systems in the human body. As structure and function are closely interrelated, with function often following from form, this course seeks to illuminate the interplay between these two disciplines and how they relate to individual organ systems (as well as the interactions between them).

The course starts with a brief recap of the smallest living subunit of the human body – the cell – and subsequently delves into some of the different organ networks of the body, including the cardiovascular, respiratory, renal, endocrine, nervous (particularly autonomic), and gastro-intestinal systems. Finally, those disparate complexes will be integrated at the level of the complete human organism.

A central feature of the course will be "homeostasis", that is "the processes by which the body reacts to changes in order to keep conditions inside the body, for example temperature, the same". As this course is too short to elaborate on all aspects of anatomy and physiology, particular attention is paid to the cardiovascular system. This is especially relevant as the circulatory network is involved in many aspects of homeostatic regulation.

The course will provide a foundation for those who pursue a(n) (academic) career in Life Sciences, Biometrics, Biomaterials, Biochemistry, or Medicine.

Literature
Online library accessmedicine.mhmedical.com. Several books will be of use, including Guyton and Hall (Textbook of Medical Physiology), Marieb and Hoehn (Human Anatomy and Physiology), Ganong (Review of Medical Physiology) and Silverthorn (Human Physiology: An Integrated Approach).

Instructional format
Lectures and tutorials.

Assessment
- Professional Conduct;
- Collaboration;
- Oral presentation;
- Written Test is given with Testvision

BIO3001 Molecular Biology

Course coordinator
Dr. Kathia Jimenez, Maastricht Science Programme, Maastricht University.
Contact: k.jimenezmonroy@maastrichtuniversity.nl

Pre-requisites
- ✓ BIO2001 Cell Biology
- ✓ BIO2007 Genetics

Co-requisites
- ✓ PRA3003 Molecular Biology

Objectives
- Analyze gene structure/function and different gene regulatory mechanisms (chromatin remodeling and (post)transcriptional regulation) in prokaryotes and eukaryotes.
- Summarize the best-characterized cell signaling mechanisms in eukaryotic cells.
- Summarize how epigenetic changes and gene silencing take place
- Summarize how gene manipulation can be achieved for different applications
- Summarize the type of stem cells that can be produced and their application.
- Learn how to apply concepts and tools from molecular biology into current research articles related to diagnostics and therapeutics in the cellular complexity of eukaryotes and prokaryotes. Critically evaluate research articles and apply this knowledge.

Description of the course
The general aim of this course is to obtain detailed knowledge about the molecular processes in cell signaling and control of gene expression. Topics include intracellular signaling pathways; chromatin structure and remodeling; recruitment and assembly of transcription factors; eukaryote mRNA synthesis, processing, modification, stability and translation; stem cells and reprogramming; and the application of the above factors in current research. The tutorials will be partially in Problem Based Learning (PBL) and multiple-choice format, with exercises designed to provide a perspective on 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
The course will be given throughout 12 tutorial sessions, all onsite. Any exceptions need to be discussed and agreed upon with the course coordinator. Once a week, the PBL sessions are followed by a Q&A session related to the respective topic. Every tutorial will have a chairperson and a scribe appointed so that every student gets to perform in one of these roles.
Pre-discussions will be done on the whiteboard, post-discussions can be flexible (white board or google doc).

Assessment
There will be a minimum of two points of assessment. Assessment may include, but may not be limited to:
- Final exam
- Presentation grade
- Tutorial participation

BIO3002 Ecophysiology

PLEASE NOTE: This course only runs in alternate years (odd), alternating with INT3009 Chemical Ecology (even). It will run in academic year 2025-2026 but not in 2026-2027.

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

Recommended

- ✓ BIO2004 General Zoology

Objectives

- To understand what ecophysiology is;
- 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;
- To understand how how ecophysiology provides a predictive framework for organismic adaptation to an anthropogenically changed world.

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 human-related 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. Although there is a greater focus on the physiological adaptations of animals, the adaptations of other organismic groups, such as plants, are also considered.

Literature

Scientific papers.

Instructional format

Lectures and tutorial sessions.

Assessment

- Tutorial grade
- Group report on an ecophysiological subject
- Open book exam

BIO3003 Medical 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

- ✓ PRA3010

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 principles 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 the importance of the microbiome 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.

Part of the course will be group presentation on a microbiological topic (either selected from a provided list, or on a chosen topic)

Literature

Murray. *Medical Microbiology*. (8th ed.), Elsevier Mosby.

Instructional format

Lectures and tutorial group meetings.

Assessment

- A final examination, which consists of multiple choice and open questions (70%).
- A group presentation on a selected topic in microbiology (30%).

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
- To gain an understanding of how animal behaviour is studied;
- To recognize ultimate and proximate causes of behaviour and understand how they are related;
- To understand what triggers behaviour and the importance of behaviour in an animal's chances of survival and reproductive success;
- To 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) historyof 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 wewill study the evolution of altruism, reproductive behaviour and communication. We will also discuss how animals decide on foraging strategies, how they avoid predators,find suitable territories or decide to migrate. Behavioural research in zoo's and their role in species conservation will be discussed. Proximate causes of behaviour, what triggers behaviours and what is the role of ontogeny (organismal development), are also part of the course. Although the basisof 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
- Rubenstein (2022). *Animal Behaviour* (12th edition). Sinauer / OxfordUniversity Press. (ISBN 0197559085, 9780197559086).
- Scientific articles which can be obtained online via UM library.

Instructional format
Lecture and 2 tutorials per week.

Assessment
- Final exam;
- Presentation;
- Animal behaviour video;
- Interaction with literature using an online tool.

BIO3007 Tropical Biology

Course coordinator

Dr. Roy Erkens: Faculty of Science and Engineering, System Earth Science

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, therole of tropical forests in relation to climate change and global carbon cycling will be investigated, and alink will be made to tropical savannas and dry tropical forests. Finally, you will investigate the IUCN redlist and will experience different dimension (e.g. biological, cultural, and political) of nature conservation in tropical areas.

Literature

This course will use solely primary literature as a basis for the tasks. No textbook is required.

Instructional format

Each week is devoted to a major topic in tropical rain forest ecology that will be studied using 1½h (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 and a general final session in which you decide on the best proposals). The final assessment of this module consists of the creation of a final work that shows your knowledge on tropical biology, connected to a development trajectory with peer- and self-evaluation moments.

Assessment

Your final grade will consist of these parts:

- Individual fact-sheet grade;
- Individual counter-proposal grade;
- Individual contribution and development assessment;
- Group grade for final assignment.

Next to this there are four pass/fail assessments for the hand-ins of the peer-review and self-evaluation activities.

BIO3010 Genomics and Proteomics

Course coordinator
Prof. Dr. M. Honing, Faculty of Health, Medicine and Life Sciences, Human Biology, Maastricht University.
Contact: m.honing@maastrichtuniversity.nl

Pre-requisites
- ✓ BIO2007

Recommended
- ✓ Knowledge on Analytical technologies (CHE3008), Statistics (MAT1006)

Objectives
- To understand how technologies in the "Omics" sciences are used to unravel the biology of life.
- To understand the basic principles analytical techniques in support of genomics, proteomics, metabolomics and data sciences.
- To gain insight in the advantages and limitations of omics-based experiments, design of *in vitro* and *in vivo* studies.
- 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
With introduction of genomics in the early 90's of the last century, it has added an extra dimension to the understanding of the molecular nature of life, allowing the detection of many different endogenuous compound classes. Prerequisites were the unraveling of the genome, the proteome and metabolome of humans and other organisms, with special attention to the development of biomedical and analytical methods for the simultaneous analysis of the expression levels of as much as possible genes, proteins and endogenuous metabolites. This course will give students insight in the analytical principles behind omics-technologies such as array-based analysis (PCR, DNA sequencing), 2D and capillary electrophoresis, mass spectrometry and advanced statistical and data informatics. It will discuss 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 within the context opf drug discovery.

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.
- Malone et al. Microarrays, deep sequencing and the true measure of the transcriptome. BMC Biology 2011.

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'.

Examination/Assessment
The examinations with take place at the midterm (presentation) and at the end of the course as an written exam, encompassing need to know and interpretation questions.

CHE1101 Introduction to Chemistry

Course coordinator
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 (only in Period 1)

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
Chemistry, via OpenStax (https://openstax.org/details/books/chemistry-atoms-first-2e)
ISBN-10: 1-947172-63-8
ISBN-13: 978-1-947172-63-0

Instructional format
Lectures, Q&A sessions, and tutorial group meetings.

Assessment
- A midterm examination consisting of multiple choice, short answer, calculation and explanation questions;
- Weekly homework assignments
- A final examination consisting of multiple choice, short answer, calculation andexplanation questions.

CHE2004 Spectroscopy

Course coordinator

Annelies van der Bok, Faculty of Science and Engineering, Maastricht Science Programme.
Contact: annelies.vanderbok@maastrichtuniversity.nl

Pre-requisites

- ✓ CHE2001 Organic Chemistry or CHE2009 Fundamentals of 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 and report this in a concise matter.

Description of the course

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 these techniques will be discussed. Then, the reading and interpretation of spectral analysis will be covered. The main focus of the course will be on acquiring knowledge and practical expertise to characterize chemical compounds, primarily organic molecules. You will learn to develop an analytical strategy to get structural information for unknown molecules by combining the experimental data of the abovementioned techniques.

Literature

Spectroscopy; Lampman, Pavia, Kriz, Vyvyan; 4th or 5th edition (International Edition): Brooks/Cole.

Instructional format

Lectures and tutorial group meetings.

Assessment

- A 'midterm' assignment combining spectral analysis of NMR, FT-IR, MS, and UV-Vis
- A final examination on the spectral analysis and theoretical background of these techniques. The exam consists of open questions and problems.
- The contributions to the tutorial group meetings.

CHE2006 Biochemistry

Course coordinators

Prof. dr. L. Schurgers, Faculty of Health, Medicine and Life Sciences, Department of Biochemistry, l.schurgers@maastrichtuniversity.nl
Dr. A. Jaminon, Faculty of Health, Medicine and Life Sciences, Department of Biochemistry, a.jaminon@maastrichtuniversity.nl
Dr. S. Agten, Faculty of Health, Medicine and Life Sciences, Department of Biochemistry, s.agten@maastrichtuniversity.nl
N. Deckers, Faculty of Health, Medicine and Life Sciences, Department of Biochemistry, n.deckers@maastrichtuniversity.nl (corresponding coordinator)

Contact: l.schurgers@maastrichtuniversity.nl
Contact (corresponding coordinator)*:* n.deckers@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ None

Objectives

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

- Communicate on fundamental principles governing structure, function, and interactions of biological molecules;
- Appreciate the science of biochemistry and its relevance to Health and Disease;
- Understand the roles of macromolecules such as proteins, lipids, polysaccharides, and DNA in living cells and relate to diseases such as hyperventilation, thrombosis and scurvy;
- Identify, explain, and discuss the basic principles of enzyme catalysis and inhibition;
- Enter advanced courses that require more detailed biochemistry knowledge and enroll to various Master programs in life sciences.

Description of the course

Biochemistry is considered the mother of all life sciences. Understanding biochemical principles 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 biomacromolecules including proteins, lipids, carbohydrates, and DNA which are key molecules associated in life. We will further provide insight in the specificity and actions of enzymes, the biocatalysts of the cell. Additionally, we will explain metabolic pathways that result inthe generation of ATP, the major energy source in life and how certain substances can interfere and lead to disease or death. Finally, we will discuss recent concepts of genome editing that revolutionise treatment of diseases by gene therapy.

Literature

- Biochemistry (9th ed. or later). ; Berg, J.M., Tymoczko, J.L., Gatto G.J., Stryer, L. ; W.H. Freeman and company. ISBN-10: 1-319-11465-2; ISBN-13: 978-1-319-11465-7;
- Biochemistry (6th ed. or later); Garrett R.H. and Grisham C.M. ; Cengage Learning. Student ed. ISBN: 978-1-305-57720-6; Loose-leaf ed. ISBN: 978-1-305-88604-9.

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 to better understand the fundamentals of health and disease.

Assessment

- Mid-term examination;
- Final examination.

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
Solid state chemistry, also referred to as Materials chemistry, is a very technologically relevant branch of chemistry. Treating materials as a bulk, however, requires a slightly different theoretical background. This course aims to provide the correct technical framework to chemistry in the solid state, and combine basic theory with very real-life applications.
How does chemistry work in the solid state? Where do the properties of material come from? How do you see them happening and what parameters influence them? This course will aim to answer all of these questions to give students at all levels a different big-picture view of materials.
The six weeks of the course will cover a total of six modules on key themes. Fixed themes are electrical conduction, batteries, solar cells, magnets and superconductors. The students' preferences and specific interests will be taken into account for one or two modules and might involve guest lecturers. The tutorials sessions will complement thisapproach 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
- A.R. West, "Solid State Chemistry and its applications", 2nd Ed, 2014;
- P. M. Woodward, P. Karen,. J. S. O. Evans and T. Vogt. "Solid State Materials Chemistry" Cambridge University Press, 2021.

In addition, the students can also refer to the following advanced literature for a more support:
- P. A. Cox, "The electronic structure and chemistry of solids", Oxford Science Pub., 1999;
- C. Kittel, "Introduction to solid state physics", John Wiley & Sons Inc., 8th Ed, 2005.

Additional references will be given on a lecture-by-lecture basis.

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 written examination;
- A final examination with open and multiple choice questions on all the six themes covered;
- Homework assignments and/or contribution to the tutorial sessions.

CHE2009 Fundamentals of Organic Chemistry

Course coordinator

Dr. Hanne Diliën, Faculty of Science and Engineering, Sensor Engineering department
Contact: hanne.dilien@maastrichtuniversity.nl

This course cannot be followed in case you already followed CHE2001 Organic Chemistry

Pre-requisites

- ✓ None

Co-requisites

- ✓ PRA2032 Fundamentals of Organic Chemistry lab

Recommended

- ✓ None

Objectives

- To be able 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 get an introduction into organic reactions and organic reaction mechanisms;
- In specific, to enable you to understand substitution and elimination 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 organicchemistry 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 and reaction mechanisms. Focus, will be on a selection of fundamental organic reactions, more in specific substitution and elimination reactions.

Literature

Literature suggestions will be given during the course

Instructional format

Lectures and tutorial group meetings. The tutorial group meetings will also be used to prepare with tasksfor the co-requisite skill.

Assessment

- A midterm examination, which consists of multiple choice questions;
- A final examination, which consists of open questions;
- Weekly quizzes

CHE2010 General Chemistry

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

Pre-requisites
- ✓ CHE1101 - Introduction to Chemistry

Co-requisites
- PRA2034 - General Chemistry Lab

Objectives
- To extend knowledge of bonding theories within larger molecules
- To obtain an understanding of the various mathematical relationships present in ideal and real gases
- To use the concepts of intermolecular forces to predict physical properties of substances
- To gain a deeper and broader understanding of solution equilibria

Description of the course
The emphasis of this course will be to extend a number of essential topics from the Introduction to Chemistry course. The first part of the course will focus on bonding in molecules, molecular symmetry, character tables, and their applications. The second part will examine intermolecular forces and what factors impact phases transitions certain physical properties. In the final part, the course focuses on solution equilibria and properties.

Literature
Chemistry, via OpenStax (https://openstax.org/details/books/chemistry-atoms-first-2e)
ISBN-10: 1-947172-63-8
ISBN-13: 978-1-947172-63-0.

Instructional format
Lectures, PandA sessions, and tutorial group meetings

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

CHE2011 Organic Chemistry

Course coordinators

Dr. Hanne Diliën, Faculty ofScience and Engineering, Sensor Engineering Department.

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This course cannot be followed in case you already followed CHE2001 Organic Chemistry + CHE3001 Organic Reactions

Pre-requisites

- ✓ CHE2009 Fundamentals of Organic Chemistry

Co-requisites

- ✓ PRA2033 Organic Chemistry Laboratory

Recommendations

- ✓ CHE2004 Spectroscopy

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.

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, aromatic molecules, unsaturated molecules, ketones, carboxylic acids and amines. Knowledge of the various types of organic reactions will provide the basic skills to design synthesis sequences to obtain specific organic compounds. Furthermore, the reaction types will be placed in an appropriate context with regard to practical applicability.

Literature

Suggestions for literature will be given during the course.

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 organic chemistry.

Assessment

- Midterm examination;
- Final examination;
- Quizzes.

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 organicreactions 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.

CHE3006 Quantum Chemistry

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

Pre-requisites
- ✓ MAT2006 or MAT2009

Co-requisites
- ✓ PRA3018 Molecular Modeling

Recommended
- ✓ MAT2004 and/or MAT2008 and/or MAT2009

Objectives
- To apply quantum chemistry methods to describe chemical systems;
- To predict some molecular properties by solving quantum chemistry equations;
- To recognize 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:
- Mid-term written exam covering topics of the first three weeks;
- Final written exam covering the entire course.

CHE3007 Chemical Kinetics

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

Pre-requisites
- ✓ MAT2006

Recommended
- ✓ PHY2002 Thermodynamics and Statistical Mechanics

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;
- Understand kinetic theory of gases;
- 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:
- Mid-term written exam covering topics of the first three weeks;
- Final written exam covering the entire course.

CHE3009 Crystallography

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

Pre-requisites
- ✓ PRO1002 Project Period P6 (at least 1000 level)

Recommended
- ✓ CHE2007 Solid State Chemistry
- ✓ CHE2002 Inorganic Chemistry
- ✓ MAT2004 Linear Algebra

This course is NOT recommended for students in their first year of study. If you haven't taken at least two semesters at MSP waivers are unlikely to be granted.

Otherwise, given the interdisciplinary nature of the course, a sufficient scientific background to benefit from the course and an interest in the topic will suffice, regardless of the recommended prerequisites.

Objectives
- To introduce the students to the extensive and interdisciplinary field of crystallography;
- To provide the basis on how crystals 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, to obtain a comprehensive understanding on how matter in the solid state is systematized and analysed. We will start from the concept of symmetry, including a formal introduction to the fundamentals of group theory. The 230 space group will be derived from first principles, including some historical prespective. You will be taught how to break down all the information contained in a space group with the aid of the International Tables. Once these fundamentals are established, the actual experimental implications will be outlined, focusing on diffraction as the technique of election to obtain information in solids. Alongside this, advanced topics will be discussed according to the students' preferences, among local structure analysis, magnetism in 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 breadth 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:
- Tutorial participations and weekly homework;
- A midterm examination consisting a group assignment OR an individual poster+presentation;
- A final examination with open and multiple choice questions.

CHE3010 Inorganic Chemistry

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

Pre-requisites
- ✓ CHE2001 Organic Chemistry (strongly) OR CHE2009 Fundamentals of Organic Chemistry

Co-requisites
- ✓ PRA3028 Inorganic Synthesis

Recommended
- ✓ The course integrates nicely with Spectroscopy (CHE2004)

NOTE: You cannot follow this course if you followed CHE2002 Inorganic Chemistry

Objectives
- Acquire a comprehensive understanding of bonding throughout the periodic table (including d and f block), and its correlation with periodic trends
- Systematise molecular geometry approaches through VESPR (and its pitfalls) and recognize associated point-group symmetries
- Lay the foundations of more complex bonding in d-block complexes (Crystal field theory, full Molecular Orbital of octahedral d-block complexes)
- Provide a rigorous theoretical basis of the experimental analysis of transition metal compounds (informed by the bonding), especially in terms of symmetry-analysis of Raman/IR activity
- Understand the appearance of colour in inorganic compounds and their UV-Vis transitions
- Introduce organometallic reactivity, and basic understanding of catalytic cycles

Description of the course
This course will immerse the students into the world of chemistry beyond carbon, and aims to provide a broad survey of the chemistry available when transition metals are involved. The first half of the course will reimagine bonding, interactions among atoms, stability rules and geometry in a way that is compatible to the whole periodic table. VSEPR is reviewed and expanded with molecular symmetry. Crystal Field Theory (CFT) for d-block complexes will be covered and then expanded into a full molecular orbital theory (MO) description for d-block octahedral complexes. In the second half of the course, the newfound knowledge will be used to understand the properties of transition metal complexes: IR and Raman activities will be derived with symmetry analysis; colours and UV-Vis transitions will be explained; organometallic reactivity and the fundamentals of catalysis are provided.

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

Instructional format
Flipped classroom: the students are provided with content ahead of the week. The content is required to tackle the tutorial problems and homework. A weekly plenary Q/A wraps up after the tutorials.

Assessment
The course has three standard points of assessment, of which the homework and participation is embedded in the tutorial sessions and aims to ensure full-engagement of the students.
- Midterm exam (week 3 or 4);
- Final exam (Week 7);
- Weekly homework and Tutorial group participation (Week 1 to Week 6);

CHE3011 Instrumental analysis

Course coordinator
Annelies van der Bok, Faculty of Science and Engineering, Maastricht Science Programme.
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Pre-requisites
- ✓ CHE2004 Spectroscopy

Co-requisites
- ✓ None

Recommended
CHE2002/CHE3010 Inorganic Chemistry

Objectives
To be able to:
- Explain the interaction of spins with magnetic fields.
- Interpret multidimensional NMR spectra (COSY, TOCSY, NOESY, HMBC, HSQC) for structural analysis of chemical compounds.
- Link the electronic structure of organic and inorganic materials to their spectroscopic properties.
- Describe the interactions of electrons with a specimen when using electron microscopy techniques.
- Describe how the devices discussed in the course operate and how resulting data can be interpreted.

Description of the course
This course expands upon the knowledge acquired during CHE2004 spectroscopy and introduces other techniques used to study the properties of chemical compounds. The three main topics are NMR, absorption & luminescence, and electron microscopy. For NMR, we will examine spin relaxation processes, pulse sequences (spin-echo experiment), and the interpretation of various 2D NMR spectra. We will also briefly discuss the basic concepts of MRI and how this technique can be used in fields other than medicine.
The second part of the course will focus on the relationship between the electronic structure of compounds (atoms in solids or molecules) and their spectroscopic properties. We will identify the typical features of the absorption and emission spectra of organic molecules, transition metals, and lanthanides. We will revisit the Frank-Condon principle, determine term symbols from microstates, and understand the Tanabe-Sugano and Dieke diagrams. We will also discuss the instrumental principles of a spectrophotometer, quantum yield measurements, and time-resolved luminescent experiments. Depending on time and interest, we can address Förster resonance energy transfer (FRET) or correlation spectroscopy.
The last part focuses on electron microscopy (SEM and TEM) combined with energy-dispersive X-ray spectroscopy (EDX) and electron diffraction.

Literature
- Atkins, Peter. *Physical Chemistry* (any edition). Oxford University Press.
- Scientific papers and other (recommended) literature will be communicated later.

Instructional format
Lectures and tutorial group meetings

Assessment
- Tutorial group participation/Take-home assignments/ group assignments
- Final examination with open questions covering the entire course

CHE3012 Nanomaterials and Catalysis

Course coordinator

Annelies van der Bok, Faculty of Science and Engineering, Maastricht Science Programme.
Contact: annelies.vanderbok@maastrichtuniversity.nl

Pre-requisites

- ✓ CHE2002/CHE3010 Inorganic Chemistry

Co-requisites

- ✓ None

Recommended

- ✓ CHE2001 Organic Chemistry and CHE2003 Physical Chemistry

Objectives

- Understand the basic principles of heterogeneous, homogeneous, and biocatalysis, including reaction rates and mechanisms.
- Formulate the advantages and disadvantages of different types of catalysis.
- Explain how the unique properties of nanomaterials influence catalytic activity.
- Explain the influence of nanoparticle size and shape on the optical properties of semiconductor and metal nanoparticles.
- Describe how the size, shape, and surface of colloidal nanoparticles and nanostructures can be controlled during synthesis and post-synthesis procedures.

Description of the course

Nanomaterials are a rapidly growing class of materials in terms of research and applications. Their large surface-to-volume ratio makes them ideal for catalytic reactions, and they possess tunable physical properties on the nanoscale that differ from bulk. This tunability makes them compelling for a wide variety of applications.

The content of this course is (1) the essential aspects of homogenous, heterogenous, and bio-catalysis, (2) Nanostructures that play an essential role in catalysis, for example, porous structures, and (3) tunalbe physical properties on the nanoscale, for example, quantum confinement effect in semiconductor nanoparticles and surface plasmon resonance for metallic particles (4) synthesis of colloidal nanoparticles and nanostructures, and (5) current research and applications in nanomaterial science.

Literature

Scientific papers and other literature will be decided well before the start of the course.

Recommended:

Catalysis: Concepts and Green Applications; Gadi Rothenberg; 2nd Edition; Wiley-VCH. ISBN: 978-3-527-80890-8

Nanoparticles: Workhorses of Nanoscience; C. de Mello Donega; SpringerVerlag. ISBN: 978-3-662-44822-9

Instructional format

Lectures and tutorial classes

Assessment

- Tutorial group participation.
- Take-home assignments, and/or group assignment.
- Final examination with open questions covering the entire course.

INT1101 Introduction to Liberal Arts and Science

Course coordinator

Dr. Kasper Eersels, Faculty of Science and Engineering, Sensor Engineering Department.

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Dr. Hanne Diliën, Faculty of Science and Engineering, Sensor Engineering Department.

Contact: hanne.dilien@maastrichtuniversity.nl

Dr. Rocio Arreguin Campos, Faculty of Science and Engineering, Sensor Engineering Department.

Contact: r.arreguincampos@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, you will be able:

- To understand the main theoretical approaches within the philosophy of science and its usefulness in a natural sciences context;
- To understand the nature of academic knowledge and the process of scientific development;
- To know how science is done ("the scientific method");
- To discuss the importance norms and values in scientific environments;
- To explore the structure and use of basic argumentation in various formats of communication;
- To use historical and sociological case studies of scientific practice in mastering the above objectives.

Description of the course

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:

- Peter Godfrey-Smith: Theory and Reality: An Introduction to the Philosophy of Science, Second Edition. (ISBN: 978-0-2266-1865-4)

In addition, students will study a variety of articles and book chapters, which will be made available onlineon a weekly basis.

Instructional format

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

Assessment

Assessments in this course include:

- An essay assignment;
- A debate assignment.

INT1003 Introduction to Biomedical Engineering

Course coordinator
Daan van Beek, Maastricht Centre for Systems Biology (MaCSBio).

Contact: d.beek@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 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. In particular, the course includes an introduction to systems physiology, basic concepts of bioinstrumentation, an introduction to biomedical signal analysis and modeling and biomedical 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;
- Final written exam.

INT1005 Commercializing Science and Technology

Course coordinator
Dr. Jermain Kaminski, School of Business Economics, Department of Organization, Strategy and Entrepreneurship
Contact: jermain.kaminski@maastrichtuniversity.nl

Pre-requisites
- ✓ None

Objectives
- Fostering an entrepreneurial spirit, regardless of your background
- Understanding the commercialization of science and technology
- Exploring and discussing scientific literature and practical case studies
- Learning science communication in a new technological context
- Getting to know technology entrepreneurs and experts
- Prototyping and presenting your own business idea

Description of the course
Technology may hold the secret to resolving many of the issues that impact our daily lives, even if it is unknown to us at present.

This course aims to provide you with the tools and expertise required to move a scientific or technological idea from the lab to the marketplace. You will have the opportunity to immerse yourself in a technology field of your choice, such as biotechnology, machine learning, or quantum computing, and gain a deep understanding of how to communicate, identify, and address a new startup idea.

Through a series of real-world cases, readings, media, and activities that include group work and LEGO Serious Play, you will explore key entrepreneurial and strategic topics. These include ideation, prototyping, market research, customer surveys, business modelling, intellectual property (patents), technology transfer, ethical aspects, and innovation financing. With the help of guest experts, we will also explore the human aspects of innovation teams and the dynamics you face as a startup founder.

Assessments in this course will include PBL chairing and participation, a technology podcast to enhance scientific communication skills, and a group presentation of a new startup idea in the technology field of your choice.

We hope that the mindset and tools you learn in this course will one day help you start your own business and join the ranks of other MSP graduates who have taken this opportunity.

Literature
Canvas will include all academic papers, case materials, and websites.

Instructional format
This course is taught through a combination of problem-based learning, a science communication task, and a startup project that will challenge you to apply your newly acquired knowledge to realistic problem situations of entrepreneurs that want to start a new venture.

Assessment
- Participation
- Session chairing
- Technology podcast
- Prototyping and presentation of a science-based startup idea

INT1007 Introduction to Earth Sciences

Course coordinator
Dr. Jesse Hennekam, Faculty of Science & Engineering, Maastricht Science Programme
Contact: j.hennekam@maastrichtuniversity.nl

Pre-requisites
- ✓ None

Co-requisites
- ✓ None

Objectives
During this course you will develop a fundamental understanding of the abiotic and biotic processes responsible for shaping our planet. From the formation of our Solar System to the Earth as we know it today, you will gain insight on the enormous powers continuously impacting and changing the planet.

Description of the course

This course will provide you with a basic understanding of processes acting on our planet. Earth Sciences is an interdisciplinary field, combining branches of physics, chemistry and biology in a pursuit to better understand the Earth and its features. We will unravel the geological past and gain a better understanding of all the factors impacting our planet, responsible for shaping the Earth as we know it. You will become aware of the importance of time, and learn how to think in different timescales. The continents with its mountain ranges, the vast oceans, the atmosphere and life, all are continuously subjected to change, although often hidden on human timescales. This course will focus on how the Earth continuously seems to change throughout its 4.5 billion years of existence.

Literature
"Earth: portrait of a planet" by S. Marshak, 7th International Student Ed. 2022. W. W. Norton & Company, ISBN: 978- 0393882766

Instructional format
Lectures and tutorials

Assessment
- Biweekly quizzes
- Oral presentation
- Exam

INT2007 Science in Action

Note: this course fulfils the humanities or social science topic (MSLAS) requirement

Course coordinator

Jessica Mesman, Faculty of Arts and Social Sciences, Department of Society Studies.
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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 knowledgeproduction in the sciences;
- Identify the complexities of how scientific knowledge is distributed, communicated and debated in society;
- Critically analyze ‘common sense’ views of the making and use of scientific claims.

Description of the course

Situated in the field of Science and Technology Studies (STS), this course analyses the social and cultural complexities involved in the production and dissemination of scientific knowledge. The course aims to clarify how social, cultural, political, or economic forces play an inextricable role in the practice and production of science. For example, to understand the science-society relationship, we analyse the historical context in which Einstein developed his theory of relativity to discuss the integrity of research. We also look at a 1970s controversy about gravitational waves, when their existence had not yet been confirmed, to understand how scientific claims are accepted or rejected within the scientific community. In addition, insights from cultural anthropology allow us to discuss how ethnicity, gender and social class influence scientific practices and their output. Such a perspective also enables us to step back and look at science as one among many knowledge systems and relate it to other knowledge frames. An analysis of the relationship between science and society cannot ignore economic dynamics and the digital world in which we live. Therefore, the course will also consider the commercialization of science, as well as Big Data, 'fake-facts,' and the role of Wikipedia, Google Scholar and ChatGPT in the production of knowledge. In this way, the course considers both the broader socio-economic context in which science operates and the immediate context in which scientific facts are established (i.e. the lab). Along these lines, we enter the world of scientists.

Literature

Available on Canvas section: Modules and Resources

Instructional format

Tutorial group meetings (be aware: a format is chosen by you and one of your fellow students in close consultation with the tutor), lectures, video analyses, and an interview of a researcher.

Assessment

- Participation in -and preparation of- discussions and assignments (team/individual); 20%
- Group presentation on basis of interview results and literature; 30%
- Individual paper: 50%

INT2008 Molecular Toxicology

Course coordinator

Dr Misha Vrolijk, Faculty of Health, Medicine and Life Sciences Maastricht University, Departmentof Pharmacology and Toxicology.
Contact: m.vrolijk@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 biotransformationof 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 book chapters and scientific papers is made available.

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

Coordinator

Dr. Anjusha Mathew: M4i Institute, Faculty of Health, Medicine, and Life Sciences.
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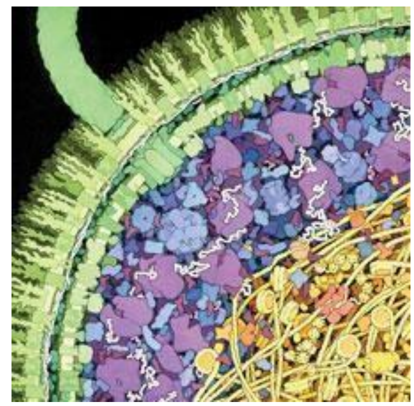
Pre-requisites

- ✓ None

Recommended

- ✓ CHE2006 Biochemistry
- ✓ BIO2001 Cell Biology
- ✓ INT2010 Principles of Mass Spectrometry

Objectives



- Students can understand the key concepts in molecular and cellular biophysics.
- Students will have a comprehensive overview of the different biophysical techniques that can be used to study biological molecules in vitro and in vivo.
- Students will be able to compare different biophysical techniques and choose the appropriate one to study different biological phenomena.
- Students will be able to get the gist of a scientific publication that uses one or more of the biophysical methods that were introduced in the course.

Description of the course

Although the life we see around us appears very diverse it is remarkably similar at the level of molecules.

Biophysics applies the principles of physics and chemistry, the methods of mathematical analysis, and computer modelling to understand how biological systems work. It seeks to explain biological function in terms of the structures and properties of specific molecules. The aim of this course is to provide a comprehensive overview of many biophysical techniques, to relate them to each other, and to show how these can be used to study biological molecules. The biophysical techniques will be introduced following the outline of one book [1], and cover transport, hydrodynamics, mass spectrometry, spectroscopy, diffraction, microscopy, computational modelling, and NMR. You will learn how to determine molecular structures, how to study dynamic diffusion properties, how to measure ion transport and protein folding, and how to characterize conformational changes. Each lecture will deal with one or two groups of techniques. The tutorials will go into more depth for some of those techniques.

Recommended reading

[1] "Biophysical Techniques" by Iain D. Campbell. Oxford University Press, ISBN 978-0199642144;

[2] "Methods in Molecular Biophysics" by Serdyuk and Zaccai. Cambridge University Press, ISBN978-0511811166.

[3] Britt, Hannah M., Tristan Cragnolini, and Konstantinos Thalassinos. "Integration of mass spectrometry data for structural biology." Chemical Reviews 122.8 (2021): 7952-7986.

Instructional format

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

Assessment

The assessment will be based on:
Midterm & final written exams

INT2010 Principles of Mass Spectrometry

Course coordinator

Dr. Ian Anthony, Imaging Mass Spectrometry, Faculty of Health, Medicine and Life Sciences.

Contact: i.anthony@maastrichtuniversity.nl

Prerequisite

- ✓ None

Objectives

- Understand mass spectrometry, tandem mass spectrometry, and the generation of mass spectral images.
- Explain the physics of ion generation, mass analysers, and how a mass spectrometer works in conjunction with separation techniques
- Determine elemental and molecular compositions from mass spectra.
- Utilize data analysis techniques for mass spectral interpretation.
- Work in teams to apply mass spectrometry to answer research questions.

Description of the course

Mass spectrometers are instruments that answer two questions – "What chemicals are in this sample?" and "What is the amount of those chemicals present?". Answering these two questions is necessary for everything from environmental pollution analysis and rapid disease diagnoses to computer chip manufacturing and fossil dating. In this course you will learn the theory, physics, chemistry, and engineering of modern mass spectrometers – including the ions they measure, the data they produce, and the applications for which they are used. Course weeks follow themes of (i) introduction and basics of MS, (ii) ionization systems, (iii) control of ions and mass analyzers, (iv) using MS to probe molecular structures, (v) MS data analysis, and (vi) MS imaging. By the end of this course, you will have a working knowledge of modern mass spectrometry systems including the physics of how they function and how you can adapt them to answer chemical, biological, and medical questions. You will gain skills in physics, chemistry, mass spectral interpretation, and mass spectrometry data analysis techniques. Throughout the course, you will work in a group to develop a solution for using mass spectrometry to solve a real-world problem.

Literature

Scientific articles will be distributed.

Instructional format

Lectures and group tutorial meetings

Assessment

- Weekly tutorial meeting attendance and participation
- Group presentation of a mass spectrometry research proposal
- A final examination consisting of multiple choice and short answer questions on mass spectrometry systems and spectra interpretation

INT2012 Archaeological Science

Course coordinator

Dr. Kyle Jazwa, Maastricht Science Programme, Faculty of Science and Engineering.

Contact: k.jazwa@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Recommended

- ✓ None

Objectives

- Introduce students to archaeology, archaeological sciences, and archaeology as a science.
- Provide a foundation in the basic methods, common research questions/topics, and popular (global) examples of archaeology and archaeological findings.
- Demonstrate the potential of science to help us understand past societies and human history.
- Show how multiple scientific disciplines and methods can (together) answer important research questions (archaeological and otherwise).
- Develop students' interdisciplinary research abilities.

Description of the course

This introduction to archaeology is designed for science students. Archaeology is the study of human past through the analysis of material remains. Because the material record of the past is invariably incomplete, archaeologists embrace a variety of methods, techniques, tools, and theories from any and all natural sciences, social sciences, or humanities disciplines. Armed with this diverse toolkit, archaeologists and their collaborators attempt to answer research questions related to past human technologies, diet, health, disease, genetic diversity, identity, social organization, settlement, environment, economy, trade, interaction, migration/movement, religion, etc. In this course, we will explore how science and archaeology can together be used to learn more about these topics and the methods used by scientist-archaeologists (e.g., archaeobotany, archaeozoology, geoarchaeology, archaeometry, archaeochemistry, environmental archaeology, archaeoastronomy) working in the discipline.

The course will begin by establishing the essential background to archaeological methods, research, and interpretation. We will then examine how each branch science has contributed to archaeological research. For this, we will rely on real archaeological case studies and research questions from around the world. Some flexibility will also be offered such that the students' interests can be tailored to the case studies, research questions, and scientific methods that are considered. By the end of the course, students will not only learn more about archaeology, but also the interdisciplinary potential of their science education.

Literature

Richards, M.P. and K. Britton. 2020. *Archaeological Science. An Introduction*. Cambridge University Press. ISBN: 9780521144124.

Instructional format

Interactive course meetings and group tutorials.

Assessment

- One writing assignment (choose one topic among several options);
- Final exam;
- Short, weekly activities (in-class and homework).

INT2013 Fundamentals of Science Education

Note: this course fulfils the humanities or social science topic (MSLAS) requirement

Course coordinator

Dr. May Lee, Faculty of Science and Engineering, Maastricht Science Programme
Contact: may.lee@maastrichtuniversity.nl

Pre-requisites

- ✓ PRO1002: Project Period (1000-level)

Co-requisites

- ✓ None

Recommendations

- ✓ None

Objectives

- ✓ At the end of this course, students will be able to:
- ✓ define performance expectations that reflect three-dimensional learning
- ✓ collaborate with peers to design and implement a lesson that align to the defined performance expectation and learning objectives
- ✓ use high-leverage teaching practices to elicit and press on students' ideas about science

Description of the course

This course involves the learning about high-leverage teaching practices, and the different aspects of teaching involved in developing and teaching a science lesson aimed at high school students.

Literature

We will use primary literature, which are accessible through the course Canvas/UM Library webpage. No textbook is required.

Instructional format

Lectures will be interactive and address different components of model-based inquiry in science education. During tutorials, students will discuss assigned readings related to aspects of teaching science, in addition to planning and designing activities for the lesson they will eventually teach to others.

Assessment

The course grade is based on the students' performances on various (individual and group) activities: short written assignments, analysis of teaching, lesson plans and reports, and implementation of the designed lesson.

INT2014 Imaging Engineering

Course coordinator
Dr. Gavin Hazell, Faculty of Science and Engineering
Contact: gavin.hazell@maastrichtuniversity.nl

Pre-requisites
- ✓ None

Co-requisites
- ✓ None

Recommendations
- ✓ None

Objectives
At the end of this course, students will be able to:
- ✓ Understand the underlying principles of various imaging systems and how they are applied to capture data.
- ✓ Analyse and evaluate the functionality of different imaging modalities.
- ✓ Critically assess the limitations and challenges of imaging systems.

Description of the course
Imaging technologies are at the forefront of scientific exploration and analysis across a diverse set of fields. This course introduces the fundamental principles and advanced techniques of imaging engineering applied across a range of areas. This may include biomedical imaging, planetary exploration and space observation. Through a combination of theoretical knowledge, hands-on exercises and case studies, students will explore the technical challenges and innovative solutions in these fields.

Literature
We will use primary literature, which are accessible through the course Canvas/UM Library webpage. No textbook is required.

Instructional format
The course will follow a weekly format, combining lectures and problem-based learning.

Assessment
The course grade is based on the students' performances on various (individual and group) activities.

INT3001 The Philosophy of Technology

Note: this course fulfils the humanities or social science topic (MSLAS) requirement

Course coordinator

Massimiliano Simons, Faculty of Arts and Social Sciences.

Contact: massimiliano.simons@maastrichtuniversity.nl

Robert Gianni, Faculty of Arts and Social Sciences.

Contact: r.gianni@maastrichtuniversity.nl

Pre-requisites

- ✓ PRO1002 Research project

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 westeer 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 tonew 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

Swierstra, T., Lemmens, P., Sharon, T., Vermaas, P. (Eds) (2022). *The Technical Condition. The Entanglement of Technology, Culture, and Society*. Boom. [isbn 978 90 8953 895 6]
Additional obligatory readings will be provided in the course manual; For the assignments, students have to find some literature themselves.

Instructional format

Lectures and tutorial group meetings.

Assessment

- Preparation of reading materials and active participation in group discussions;
- Participation in a debate that will take place in class;
- A mid-term assignment (33,3%);
- A final written, closed-book exam on issues, literature and perspectives discussed in the course (66,6%).

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
- Murphy, D. B.; Davidson, M. W. Fundamentals of Light Microscopy and Electronic Imaging, Second Edition; Wiley-Blackwell, 2012
- Pawley, J. B. Handbook of Biological Confocal Microscopy, 3rd ed.; Springer: New York, NY, 2006

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
- Weekly assignments - Image Portfolio;
- Written exam at the end of the course.

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 hydrogels, and composites thereof;
- To introduce the student to the evaluation, characterization, and testing of biomaterials;
- To introduce the student to material processing techniques and their working principles;
- To provide a detailed understanding of the interaction of biomaterials with surrounding tissues and the complete organism;
- To train students to select an appropriate biomaterial for a given clinical application.
- 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 materials can play in solving biomedical problems. Relevant questions inthis context are: which requirements make a material suitable for a specific biomedical application? Which biomedical problem is to be solved, and which material offers the best solution? What manufacturing techniques should be considered? A logical framework will be introduced to help navigate the selection criteria to match an application with a possible biomaterial solution.
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 behaviour 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 willbe 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 will be explained highlighting the complex implementation necessary to bring a biomaterial medical product tothe clinic.

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

Instructional format
Lectures, tutorial group meetings and a small research-based project using literature resources.

Examination
- Two multiple choice mid-terms;
- A poster presentation on the short project concerning biomaterials research;
- A final examination with a combination of multiple choice and open questions.

INT3005 Biobased Materials and Technology

Course coordinators

Prof. Yvonne van der Meer, Aachen Maastricht Institute for Biobased Materials.

Contact: Yvonne.vanderMeer@maastrichtuniversity.nl

Dr. Katie Saralidze, Aachen Maastricht Institute for Biobased Materials

Contact: k.saralidze@maastrichtuniversity.nl

Prerequisite

CHE2001 Organic Chemistry

Objectives

At the end of the course, students are able to

- Explain what biobased materials are and summarize the different types of feedstocks, their conversion pathways via biorefineries towards biobased building blocks, intermediates, and materials.
- Interpret the relationship between material composition, properties, applications, and circularity approaches.
- Explain the impact of biobased materials and technologies on the environment (biodegradation, composting, recycling, sustainability assessment, carbon footprint).
- Analyze scientific literature and create a presentation explaining the goals, methods, and results and how these relate to the course
- Critically reflect on presentation skills and presentations of scientific literature by other students.

Description of the course

Concerns about climate change and the security of industrial feedstock sources have accelerated the interest and development of biobased materials. However, scientists, policymakers, and companies face technological, environmental, and societal challenges to implement the transition from a linear and fossil-based to a circular and biobased society.

The scientific field of Biobased Materials provides a multidisciplinary approach in which biology, chemistry, (bio)chemical engineering, and sustainability assessment are integrated to develop the materials of the future. This creates an opportunity to not only replace currently made materials (like plastics and polymers) with biobased alternatives but also to produce new materials with additional functionalities derived from renewable biological sources. New technologies may be required to obtain suitable synthesis routes to produce biobased materials, with tunable performance properties forapplications in the health industry, packaging, consumer products, textiles, etc.

This course exploits the development of biobased materials involving the biology of biological feedstock, the chemistry of biobased building blocks and polymers, the technological processes, principles of circularity, and environmental and societal implications. This course also aims to create a critical as well as a creative attitude towards biobased materials and technologies. The students should be able to recognize the challenges and possibilities concerning materials in the transition towards a sustainable biobased circular economy and society.

Literature

A list of selected scientific papers will be provided during the course.

Instructional format

Lectures, guest lectures from experts in different fields, and tutorial group meetings.

Assessment

- Presentation and discussion session on a particular biobased material/technology (at least 30 minutes). The case study for the presentation can be selected by the students;
- Written open-book exam.

INT3007 Systems Biology

Course coordinators

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

Contact: martina.kutmon@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. Third year DACS students interested in following the course are welcome to contact us about a waiver for the pre-requisite.

Objectives

- To give an overview of the relevant areas of Systems Biology from cellular to tissue to population 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 rapid progress of genome sequencing and other -omics technologies, a wealth of multilevel data on the molecular nature of biological systems has been generated. Although biological systems are composed of elements, their true essence of a system lies in their dynamics and interactions. To fully understand these complexities, neither biological nor mathematical expertise alone is sufficient -systems biology fills this critical gap.

Systems biology is a modern approach to biological and biomedical research, taking a holistic view and relying heavily on mathematical and computational models to complement experimental work.

The goal of this course is to provide an overview of systems biology, covering its key principles, experimental methodologies, and a variety of modeling techniques. Students will be introduced to the mathematical foundations of dynamic systems, networks, and constraint-based modeling. Throughout the course, we will explore applications across different biological contexts, including molecular and cellular systems, tissue-level processes, and population-level models. Example applications will include different molecular processes, diseases such as cancer, plant systems, neuroscience and epidemic modeling. Practical skills will be developed through hands-on computer sessions.

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.

INT3008 Regenerative Medicine

Course coordinator
Dr. D. Kilian, MERLN Institute for Technology-Inspired Regenerative Medicine, Complex Tissue Regeneration Department, FHML, Maastricht University.

Contact: david.kilian@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 discussedspanning 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.

Assessment
- A final examination, which consists of open questions;
- An oral presentation on the short project concerning regenerative medicine research

INT3009 Chemical Ecology

Note: This course only runs in alternate years (even), alternating with BIO3002 Ecophysiology (odd). It will run in academic year 2026-27, but not in 2025-26.

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. Such interactions are very diverse, including, within species, mating, intraspecific competition, social status and foraging and, between species, predation and parasitism, defence and mutualisms such as pollination. In this course we will examine how the different semiochemicals originate and how they are used and detected 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. Students are encouraged to develop their own interests and the course is not limited to one particular organismic group. Both biologists and chemists are encouraged to join the course.

Literature

Scientific papers.

Instructional format

Lectures, tutorial sessions and seminars.

Assessment

- Tutorial grade
- Research pitch
- Open book exam

INT3011 Landscape Archaeology

Course coordinator
Dr. Kyle Jazwa, Maastricht Science Programme, Faculty of Science and Engineering.
Contact: k.jazwa@maastrichtuniversity.nl

Pre-requisites
- ✓ INT2012: Archaeological Science

Recommended
- ✓ PRA2015: Advanced Academic Skills

Objectives
- Gain a deeper understanding of archaeological research, fieldwork, and analysis.
- Understand how (all) sciences can be applied to interdisciplinary research and answer questions about human society, culture, economics, technology, and interaction.
- Experience how a specific scientific field can be applied to interdisciplinary research and archaeology projects.
- Become a productive and successful member of an interdisciplinary research group.
- Gain sufficient preparation for upper-level archaeological (or interdisciplinary) research (e.g., BTR thesis, Honours Research Programme, MA thesis) and/or participation in an archaeological fieldschool.
- Further develop research abilities.

Description of the course

In this course, students will apply their science background to archaeology and practice more advanced archaeological analysis and interpretation. Whereas "Introduction to Archaeological Sciences" offered a broad survey of archaeological sciences, this course focuses on a single archaeological case study (chosen by the class from a list of possibilities). Students will not only explore the cultural, historical, social, political, economic, environmental, and technological background of that case study, but also the diverse scientific methods, techniques, and specialties that can be brought to bear to better understand it.

Much of the course will be focused on a single project: developing a program of archaeological field- and lab-work.[1] Students will first propose a set of research questions related to their case study. With this orienting their research, each tutorial group will then create a multidisciplinary research proposal aimed at answering those research questions. Because this is developed by the students, the students will also generate a unique list of readings, discussion topics, and tasks for the course.

By taking this course, students will gain a deeper understanding of archaeological research, analysis, fieldwork, sciences, ethics, and politics. They will also better appreciate how their scientific training can be applied to social, cultural, and economic topics and be positioned well to undertake more advanced interdisciplinary research – in archaeology or otherwise (e.g., BTR, MA thesis) – and/or participate in an archaeological fieldschool.

Literature
None (assigned research articles)

Instructional format
Interactive course meetings and group tutorials.

Assessment
- Quizzes (2);
- Research Journal;
- Peer Assessment;
- Research Paper (group assignment).

[1] N.B. We will not actually undertake the field project due to lack of permissions, etc.

INT3012 Science Education: Model-Based Inquiry

Course coordinator
Dr. May Lee, Faculty of Science and Engineering, Maastricht Science Programme
Contact: may.lee@maastrichtuniversity.nl

Pre-requisites
- ✓ INT2013: Fundamentals of Science Education

Co-requisites
- ✓ PRA3026: Science Teaching Skills

Recommendations
- ✓ None

Objectives
At the end of this course, students will be able to:
- ✓ develop a series of explanatory models and activities, including assessments, to explain scientific phenomena related to an anchoring event
- ✓ collaborate with peers to design and implement sequential lessons that focus on model-based reasoning

Description of the course
This course involves using explanatory models to design two consecutive lessons for students learning science in high school.

Literature
We will use primary literature, which are accessible through the course Canvas/UM Library webpage. No textbook is required.

Instructional format
Lectures will be interactive and address different components of model-based inquiry in teaching science. During tutorials, students will discuss assigned readings related to aspects of teaching science, in addition to planning and designing activities for the sequential lessons they will eventually teach to others.

Assessment
The course grade is based on the students' performances on various (individual and group) activities, such as short written assignments, analysis of others' teaching, lesson plans and reports, and teaching implementation.

INT3014 Conservation Palaeobiology

Course coordinator

Prof. Dr. Frank Wesselingh, Faculty of Science & Engineering, Maastricht Science Programme
Contact: frank.wesselingh@maastrichtuniversity.nl
Dr. Jesse Hennekam, Faculty of Science & Engineering, Maastricht Science Programme
Contact: j.hennekam@maastrichtuniversity.nl

Prerequisite

- ✓ PRA1008 Basic of Palaeontology or INT1007 Introduction to Earth Sciences

Objectives

In this course we will use the geological record of environmental, climatic and biodiversity change to explore past biodiversity crises. We will investigate causes and consequences of significant environmental changes, but also the recovery of ecosystems. We will use this knowledge to outline possible pathways and threats for the current Anthropocene Biodiversity Crisis and develop mitigating strategies for the sustainable earth of the future.

Description of the course

Today, nature across the globe is facing very rapid and dramatic changes. We are witnessing the loss of species and habitats everywhere. The question is whether we are approaching the next mass extinction event (MEE) or perhaps we are already in one. But we should also examine whether nature is capable of dealing with the impact of mankind. We are not certain how further decline of biodiversity will affect ecosystems, and how it will affect our own livelihood; and whether it may even become a threat to our existence as a species.
Biodiversity change is a natural occurring phenomenon and is happening continuously. Alongside these constant changes over time, the planet encountered very large global biodiversity crises in the geological past. The best known is the meteorite that killed off the dinosaur world 66 million years ago (Ma). But the worst MEE was the so-called "Great Dying" 252 Ma ago, when 95% or more of all species on earth disappeared.
We have identified five MEEs in Earth's history, as well as some smaller, yet very severe, biodiversity crises. Climate change has been one of the triggers in these crises, and today's climate change certainly is also a driver of biodiversity and ecosystem loss. Each crisis had its own combination of drivers and settings that shaped biotic decline pathways and recovery. We can learn from these past crises to examine the question whether we are in the sixth MEE, to understand potential pathways, and mitigate threats. To apply our lessons from the deep past, we will explore today's stakeholders in conservation palaeobiology and assess how to reach out to them in order to actually make impact.

Literature

Required: either Benton, M. & Harper, D. 2020. Introduction to Paleobiology and the Fossil Record, 2nd Edition. Wiley-Blackwell. 656 pp (from the Introduction Paleontology course) or: Marshak, S. 2022. Earth, Portrait of a Planet. 7nd Edition. W.W. Norton and Company. 929 pp (from the Introduction Earth Sciences course). *Recommended*: Brannen, P. 2017. The Ends of The World. One World. 322 pp.

Instructional format

The course consists of lectures, tasks, and an assignment where you examine a specific biodiversity crisis from the geological past in a group setting and its lessons for the Anthropocene.

Assessment

- Presentation
- Report
- Weekly exercises
- Peer evaluation

MAT1006 Applied Statistics

Note: this course fulfils the MAT requirement.

Course coordinators

Matthijs Hermeling, School of Business and Economics, Department of Quantitative Economics

Contact: matthijs.hermeling@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 practice the application of statistical concepts by solving applied problems;
- 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 must 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 provides a structured approach to addressing this challenge. This course starts by covering the foundations of inferential statistics, emphasizing the logic behind the statistical reasoning process. This foundation serves as the basis for several widely used statistical methods: including *t*-test, ANOVA, Chi-square and Regression models. Students will learn how to apply and interpret these methods using statistical software.

Literature

Suggested: OpenIntro Statistics, 4th Edition, 2019, by David Diez, Çetinkaya-Rundel, Christopher D. Barr, together with the MyOpenMath digital learning environment.

Instructional format

Lectures and tutorial group meetings.

Examination

- Weekly assignments in the digital tool MyOpenMath;
- Applied student project;
- A final exam.

MAT1007 Mathematical tools for scientists

Note: this course fulfils the MAT requirement.

Course coordinator

Dr. Mariet Hofstee, Faculty of Science and Engineering, Maastricht Science Programme.

Contact: mariet.hofstee@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 the introductory courses in Semester 1 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 and need to fulfill their MAT requirement. (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

Open Educational Resources (OER) available online are used. Based on these books a list of learning goals, keywords and references is posted each week, allowing students to use any books they have available in addition to the online resources:

- Active Prelude to Calculus, Matthew Boelkins, https://activecalculus.org/prelude/book-1.html
- Active Calculus Single Variable, https://activecalculus.org/single/book-1.html
- Active Calculus Multivariable, https://activecalculus.org/multi/book-1.html
- Other open source mathematical literature will be used as required to supplement the above texts.

Instructional format

Lecture and tutorials. The first tutorial practices basic techniques, the second tutorial class each week uses a mixture of some more involved exercises, case studies and use of (online) mathematical tools.

Assessment

- Online quizzes on WeBWorK;
- Written midterm exam;
- Written final exam;
- Short written final paper demonstrating the use of Mathematical Tools in your field of interest
.

MAT2004 Linear Algebra

Note: this course fulfils the MAT requirement.

Course coordinator

Monica Salvioli, Faculty of Science and Engineering, Department of Advanced Computing Sciences
Contact: m.salvioli@maastrichtuniversity.nl

Pre-requisites

Substantial high school experience in Mathematics. If you are unsure whether this course is suitable for you, you can contact the coordinator to discuss your situation.

Objectives

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

Description of the course

In this course you will gain insights into algebraic and geometric concepts including vectors, matrices, linear transformations, eigenvalues and eigenvectors and orthogonality. You will learn to perform basic algorithmic calculations with matrices and equations in order to solve different problems. You will also gain insights into the applications of linear algebra in several fields.

Literature

David C. Lay, Steven R. Lay, Judi J. McDonald, Linear Algebra and its Applications, 6th ed., Pearson, ISBN 978-1-292-35121-6.

Instructional format

Every week we will have one lecture and two tutorial sessions. The tutorials are devoted to the working on examples illustrating and supporting the theory learned in the lecture.

Assessment

The following assessment points apply to this course:

- One mid-term;
- Written exam.

For those who do not score sufficiently in these assessment points, there will be a resit exam covering the material of the entire course.

MAT2005 Probability and Statistics

Note: this course fulfils the MAT requirement

Course coordinator

Dr. Otti D'Huys: Faculty of Science and Engineering, Department of Data Science and Knowledge Engineering

Pre-requisites

- ✓ None

Co-requisites

- ✓ None

Recommendations

- ✓ MAT2006 Calculus is strongly recommended

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 theoryor 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 beapplied, 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 alsodiscuss random sampling, sample distributions of means and variances, and the central limit theorem, again focusing on common misconceptions related to these topics. Then we address statistical estimation(point estimation and interval estimation; confidence intervals). Finally, we will discuss various hypothesis tests, goodness-of-fit tests and tests for independence and homogeneity. In their presentation/report, students will focus on a selected statistical topic and how this 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 Canvas).

Instructional format

Lectures and tutorials.

Assessment

- A midterm exam (topics: first half of the course, worth 30% of the final grade);
- A final exam (topics: second half of the course, worth 50% of the final grade);
- A practical group assignment (worth 20% of the final grade).

MAT2006 Calculus

Note: this course fulfils the MAT requirement.

Course coordinator

Tim Dick, Faculty of Science and Engineering, Department of Data Science and Knowledge Engineering
Contact: tim.dick@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ None

Objectives

- To become familiar with functions and limits.
- To become familiar with differentiation.
- To understand how to use differentiation and limits/continuity to sketch the graph of a function.
- To become familiar with integration.

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. 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, to facilitate a better understanding of 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. This is specifically tested in an assignment.
Skills: After having passed the course, 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 etc.), but also apply his/her knowledge to considerably more relevant problems.

Literature

Recommended literature:

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

Instructional format

Lectures and tutorials.

Assessment

- 3 intermediate quizzes, each worth 10%
- A written final exam, worth 70%.

The final examination includes open questions.

MAT2007 Introduction to Programming

Course coordinator

Panos Christakoglou, Faculty of Science and Engineering, Maastricht Science Programme.
Contact: panos.christakoglou@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ None

Objectives

- Develop an understanding of basic programming concepts such as variables, control structures, functions, and data types.
- Learn to formulate and solve problems algorithmically, using appropriate programming constructs.
- Acquire skills in data manipulation and analysis through introductory exposure to the Python programming language.
- Get familiar with Object Oriented Programming principles with practical experience in e.g. C++.
- Explore how programming can be applied in various scientific domains, including data analysis, simulation, and modelling.
- Explore the integration of language model generation techniques, such as the ones used by ChatGPT, into programming workflows to enhance code generation, documentation, and natural language understanding tasks.

Description of the course

The course serves as an introduction to programming tailored for students without prior experience. It is divided into two parts: the first part focuses on basic programming concepts, principles, and problem-solving techniques, emphasising language-agnostic approaches. The second part presents the basics of C++, and introduces elements of Python and R programming. The course concludes with an exploration of Language Model Generation (LMG) using examples from ChatGPT.

Literature

- "Programming Logic and Design" by Joyce Farrell
- "C++ Programming Language" by Bjarne Stroustrups
- "An Introduction to Python Programming for Scientists and Engineers" by Johnny Wei-Bing Lin *et al.*
- "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville

Instructional format

Lectures, tutorials and lab group meetings.

Assessment

- Attendance
- 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. This course fulfils the MAT requirement.

Course coordinator

Dr. Mariet Hofstee, Faculty of Science and Engineering, Maastricht Science Programme.

Contact: mariet.hofstee@maastrichtuniversity.nl

Pre-requisites

- ✓ MAT2006 Calculus

Objectives

- To develop insight in problems in natural sciences that can be modelled through ordinary differential equations.
- To be able to solve specific types of differential equations, including first- and second-order differential equations, and systems of linear differential equations.
- To learn how to use freely available (online) tools to graph, model and solve ordinary differential equations.

Description of the course

In many Sciences, among which Physics, Chemistry, Biology, Computer Science and Economics, differential equations help to model processes of change. In this introductory course, we will focus on the basics of differential equations. In particular, we study first order differential equations as well as the solution set of higher order linear versions of these with constant coefficients. In addition we will solve systems of linear differential equations. We will study a variety of techniques, including Laplace Transforms, eigenvalues and eigenvectors, and numerical methods.

Literature

Open Educational Resources (OER) available online are used. Based on these books a list of learning goals, keywords and references is posted each week, allowing students to use any books they have available in addition to the online resources:

- https://commons.libretexts.org/book/math-103458, Math 420: Differential Equations, Ron Breitenbach, Cosumnes College
- https://math.libretexts.org/Bookshelves/Differential_Equations/Differential_Equations_for_Engineers_(Lebl) , "Differential Equations for Engineers", Jiří Lebl, Oklahoma State University

Some additional resources:

- https://openstax.org/books/calculus-volume-2/pages/4-introduction "Introduction to Differential Equations", Chapter 4 from Openstax Calculus Volume 2
- https://openstax.org/books/calculus-volume-3/pages/7-introduction "Second Order Differential Equations", Chapter 7 from Openstax Calculus Volume 3
- Delft University "Numerical Methods for Ordinary Differential Equations"

Instructional format

Lecture and tutorials. The first tutorial practices basic techniques, the second tutorial class each week uses a mixture of some more involved exercises, case studies and computer modeling.

Assessment

- Online quizzes on WeBWorK;
- Written midterm exam;
- Written final exam;
- Short written final paper demonstrating the use of ODEs in your field of interest

MAT2009 Multivariable Calculus

Note: this course fulfils the MAT requirement

Course coordinator

Dr. Mariet Hofstee, Faculty of Science and Engineering, Maastricht Science Programme.

Contact: mariet.hofstee@maastrichtuniversity.nl

Pre-requisites

- ✓ MAT2006 Calculus

Recommended

- ✓ MAT2004 Linear Algebra (highly recommended)

Objectives

This course is intended to introduce Science students in the essential mathematics to describe continuous systems with multiple variables.

Description of the course

Multivariate calculus is the extension of calculus of one variable to calculus with functions of several variables: notably the differentiation and integration of functions involving multiple variables. Considerable attention will be devoted to vector calculus, with focus on differentiation and integration of vector fields, primarily in 3-dimensional Euclidean space.

Literature

Open Educational Resources (OER) available online are used. Based on these books a list of learning goals, keywords and references is posted each week, allowing students to use any books they have available in addition to the online resources. Main resources listed here, additional links provided on Canvas:

- Active Calculus - Multivariable (Main resource), https://activecalculus.org/multi/root-1-2.html
- Openstax Calculus 3, https://openstax.org/details/books/calculus-volume-3/

Some additional resources:

- https://math.libretexts.org/Bookshelves/Calculus/Map%3A_Calculus__Early_Transcendentals_(Stewart) , A general Calculus Textmap organized around the textbook "Calculus: Early Transcendentals" by James Stewart
- https://www.mecmath.net/ , Vector Calculus by Michael Corral, includes numerical examples (Java based)

Instructional format

Lecture and tutorials. The first tutorial practices basic techniques, the second tutorial class each week uses a mixture of some more involved exercises, case studies and computer modeling.

Assessment

The assessment for the course will consist of:

- Online quizzes on WeBWorK;
- Written midterm exam;
- Written final exam;
- Short written final paper demonstrating the use of multivariable Calculus in your field of interest

NEU1001 Introduction to Neuroscience: Perception

Course coordinator

Dr. L. de Nijs, Mental Health and Neuroscience Research Institute, Division translational 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.
- A final exam (open questions).

NEU1003 Computational Neuroscience

Course coordinator
Prof. Dr. Renaud B. Jolivet, Maastricht Centre for Systems Biology and Bioinformatics (MaCSBio)

Contact: r.jolivet@maastrichtuniversity.nl

Pre-requisites
None

Co-requisites
None

Objectives
By the end of this course, students will be able to:

- explain the importance and relevance of using mathematical and computational methods to study the nervous system;
- detail the variety of methods and approaches that have been developed in the field and explain their relative strengths and weaknesses;
- apply their knowledge to the study of problems in computational neuroscience;
- explain what the major remaining challenges are in our computational understanding of the nervous system.

Description of the course
Neuroscience as a field is driven today mostly by technology. The vast amount of data collected by neuroscientists makes it essential to develop appropriate mathematical and computer-based methods to analyze and model the nervous system and its sub-components. Computational neuroscience – sometimes called Theoretical Neuroscience, Mathematical Neuroscience or Neuroinformatics – is the study of the brain and peripheral nervous systems and their constituting parts using mathematics, physics and computer science.

The course will introduce basic concepts in neuroscience and explain how to develop models to study the brain at various scales, from the sub-cellular level (synapses, spines, dendrites, axons) to cellular level mechanisms (action potential generation and propagation, backpropagation, plasticity) up to the neural network and systems levels (neural networks, population and neural mass models). The students will be familiarized with the main concepts in the field, the variety of approaches and problems in the computational study of the brain and its cells (neurons, other non-neuronal cells), and with some of the most important computational tools and datasets in the field (Brian, NEURON, EBRAINS).

By the end of the course, you will have a strong foundation in computational neuroscience, equipping you with the skills to investigate brain function in both health and disease using computational methods.

Literature
This course does not necessitate textbooks, but two are recommended as further reading:

- Abbott & Dayan
  "Theoretical Neuroscience: Computational and Mathematical Modeling of Neural Systems"
  MIT Press, 480 pp., 2001.
- Gerstner, Kistler, Naud & Paninski,
  "Neuronal Dynamics: From single neurons to networks and models of cognition"
  Cambridge University Press, 590 pp., 2014.

Instructional format
Each week includes a lecture introducing the week's topic, along with a tutorial group meeting for discussion. Additionally, students will participate in hands-on practical sessions.

Assessment

- *Group presentation (30%)*
- *Written exam (70%)*

NEU2003 Neuroethology

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

Pre-requisites
- ✓ NEU1001 Introduction to Neuroscience OR NEU1002 Cognitive Neurosciences: Biological Foundations of Behaviour OR BIO3004 Animal Behaviour

Co-requisites
- ✓ None

Objectives
At the end of this course, you will be able to …
- Describe the type of research questions neuroethologists aim to answer.
- Explain how sensory information is processed in sensory organs and neural networks.
- Explain how motor output is produced and how sensory information may alter it.
- Discuss the role of neuromodulation, circadian rhythms and biological clocks on the neural control of behaviour.
- Describe the neural basis of orientation, navigation and communication.
- Describe several classic studies in the field of neuroethology and explain to what insights those studies have led.

Description of the course
Neuroethology is the branch of science that studies the underlying neurobiological mechanisms of natural behaviours in (non-human) animals. After a short recap of the basics of neurobiology and an introduction to the history of the field of neuroethology, we will dive into case studies that illustrate the core findings in this field. We will look at the use of sensory information for orientation and localization, how sensory information is processed, the neuronal control of motor output and sensorimotor integration. Other topics include: motivational changes through neuromodulation, circadian rhythms and biological clocks, large-scale navigation, communication through song, and the cellular mechanisms of learning and memory. Many of the case studies we discuss are considered classics in the field, and are expected to be understood in detail. Examples of such case studies are; the jamming avoidance response in weakly electric fish, central pattern generators in decapod crustaceans, production and perception of cricket song and the sensitization of the gill-withdrawal reflex in *Aplysia*.

Literature
Behavioural Neurobiology: An Integrative Approach (Third Edition), Günther K. H. Zupanc.
ISBN:9780198738725 Publisher: Oxford University Press

Instructional format
Lecture and 2 tutorials per week.

Assessment
Several small assignments, including a computer simulation. Graphical abstract of a paper and final exam.

NEU2004 Neural Circuits and Dynamics

Course coordinator

Luke Edwards, Faculty of Psychology & Neuroscience.

Contact: luke.edwards@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ None

Objectives

To be able to:

- ✓ explain neural pathways in terms of connections and integration of neural circuits
- ✓ analyse brain networks using graph theory
- ✓ describe the role of network dynamics in learning.

Description of the course

This course investigates the fundamental principles of neuronal circuits in the brain, using the visual pathway as a key example. Through the lens of the physical wiring in the brain and graph theory we will examine how neural circuits process information, support sensory and cognitive functions, and adapt through learning. By the end of the course, students will have gained a deeper understanding of the structure and dynamics of neural circuits and have developed the skill to apply graph-based approaches to describe brain networks, aligning with fundamental techniques in network neuroscience.

Literature

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

Instructional format

Lectures, tutorials and computer practicals.

Assessment

- ✓ Oral presentation 30%
- ✓ Final exam 70%

NEU2005 Systems Neuroscience: From Genes to Behaviour

Course coordinator

Michelle Moerel, Maastricht Centre for Systems Biology (MaCSBio)
Contact: michelle.moerel@maastrichtuniversity.nl

Pre-requisites

- ✓ NEU1001 Introduction to Neuroscience

Recommended

- ✓ Basic understanding of genetics, e.g. high school biology or BIO2007

Objectives

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

- explain the relevance of studying the brain across multiple scales, and provide examples of how interactions across these levels underlie human cognition and behaviour;
- identify and evaluate appropriate experimental techniques for investigating brain function at different levels, including omics, circuit, and whole-organ approaches;
- use computational tools to analyze large-scale neural datasets, integrate findings across multiple levels of brain organization, and apply quantitative methods to study brain function;
- apply their knowledge to understanding brain disorders, analyzing how disruptions at various levels contribute to neurological and psychiatric conditions.

Description of the course

Understanding the brain requires exploring its organization across multiple scales—from genes and molecules to neural circuits and behaviour. Each of these levels contributes to brain function in a distinct yet interconnected way, shaping human cognition and behaviour. Advances in omics technologies, electrophysiology, and brain imaging now enable investigating how these various levels operate in both health and disease.

In this course, you will explore the multi-scale nature of brain function, gaining a deeper understanding of how molecular processes drive cellular activity, how neural circuits give rise to complex computations, and how these dynamics translate into cognition and behaviour. You will examine cutting-edge approaches such as spatial transcriptomics to map gene expression within neural circuits, epigenetics to explore how environmental factors shape brain function, and imaging genetics to uncover links between genetic variation, brain structure, and cognition. Beyond biological knowledge, you will gain hands-on experience with the computational tools essential for modern neuroscience research. Through practical applications, you will learn to analyze large-scale neural datasets, integrate findings from multiple levels of organization, and apply quantitative approaches to uncover new insights into brain function.

By the end of the course, you will have a strong foundation in systems neuroscience, equipping you with the skills to investigate brain function in both health and disease using a combination of experimental and computational methods.

Literature

This course will use solely primary literature as a basis for the tasks. No textbook is required.

Instructional format

Each week includes a lecture introducing the week's topic, along with a tutorial group meeting for discussion. Additionally, students will participate in hands-on practical sessions (building up to a graded group presentation) or lab visit to apply theoretical concepts in practice. The final assessment consists of a written exam.

Assessment

Group presentation (30%)
Written exam (70%)

PHY1101 Introduction to Physics

Course coordinator

Dr. Lorenzo Reverberi, Faculty of Science and Engineering, Maastricht Science Programme.
Contact: l.reverberi@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ None

Objectives

- Outline key historical developments of the field of physics and its major branches today
- Describe basic physical phenomena using appropriate terminology and notation
- Check dimensional consistency of relations, and convert between units
- Apply dimensional and unit analysis to identify patterns and relationships between quantities, and explain natural phenomena
- Perform reasonable order-of-magnitude estimates for various physical quantities
- Identify suitable idealisations and models of natural phenomena, and be aware of their approximations and limitations
- Use physical laws and principles to interpret and solve problems, for example: Newton's Laws; conservation of energy, linear momentum and angular momentum; laws of thermodynamics; relativistic velocity addition, Lorentz contraction and time dilation.

Description of the course

Physics is the natural science that aims to understand the constituents of the universe and their interactions and behaviour, from subatomic particles to the largest cosmic structures.
This course will introduce participants to what studying physics at university and thinking like a physicist is all about. We will start at the very basics – units, measurements, motion – and gradually build towards the revolutions of the 20th century: relativity and quantum physics. Topics will be covered at an introductory but rigorous level, and we will put special emphasis on the history of the scientific discoveries, as well as practical applications of physics through estimation, model-building, and real-life examples of the concepts.

Literature

[1] University Physics volumes 1, 2 & 3, OpenStax College, https://openstax.org/.
[2] T. A. Moore, *Six Ideas that Shaped Physics* (1998), WCB/McGraw-Hill
[3] L. Bloomfield, *How Things Work: The Physics of Everyday Life* (2015), John Wiley & Sons.
[4] W. T. Griffith and J. W. Brosing, *Physics of Everyday Phenomena* (2009), McGraw-Hill.

Instructional format

One lecture and two tutorials per week.

Assessment

- Weekly quizzes
- Weekly tutorial assessments
- Midterm exam
- Final exam

PHY1003 Mechanics

Course coordinator
Dr. Lorenzo Reverberi, Faculty of Science and Engineering, Maastricht Science Programme.
Contact: l.reverberi@maastrichtuniversity.nl

Pre-requisites
- ✓ PHY1101 Introduction to Physics

Co-requisites
- ✓ None

Recommended
- ✓ None

Objectives
- Communicate and apply physical reasoning and problem-solving strategies effectively.
- Study the motion of particles and rigid bodies using principles of kinematics and dynamics.
- Interpret and construct free-body diagrams and use them to analyse forces acting on systems.
- Apply Newton's laws, conservation of energy, conservation of momentum and angular momentum to solve mechanics problems.
- Connect mechanical concepts to applications in biology, medicine, engineering, and everyday phenomena.

Description of the course
Mechanics is the discipline that studies the motion of objects and the forces that produce or alter this motion. This course provides a comprehensive introduction to the fundamental principles of classical mechanics, covering key topics such as kinematics, Newton's laws of motion, forces, work and energy, linear momentum and collisions, torque and angular momentum.
We will explore how concepts of mechanics apply not only to theoretical scenarios but also to real-world situations and in an interdisciplinary context, including applications to biology, medicine, and engineering. By the end of the course, students will have developed a strong foundation in mechanics and an appreciation for its relevance across the physical and life sciences.

Literature
There are plenty of great introductory physics textbooks covering the main topics of the course (see e.g. [1,2] and the open-access [3]); selected topics and applications to the (life) sciences are explored for instance in [4,5] among others.

[1] D. C. Giancoli (2014), *Physics: Principles with Applications Volume I* (7th ed.), Pearson Education.
[2] R. D. Gregory (2006), *Classical Mechanics*, Cambridge University Press.
[3] *University Physics Vol.* 1, OpenStax, available on openstax.org
[4] W.T. Griffith and J. W. Brosing (2021), *The Physics of Everyday Phenomena*, McGraw-Hill.
[5] P. Davidovits (2008), *Physics in Biology and Medicine,* Elsevier Science.

Instructional format
One lecture and two tutorials per week.

Assessment
- Weekly quizzes
- Weekly tutorial assessments
- Final exam

PHY2002 Thermodynamics and Statistical Mechanics

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

Pre-requisites
- ✓ MAT2006

Co-requisites
- ✓ None

Objectives
- To provide a molecular and mathematical understanding of basic concepts in thermodynamics;
- 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 physical, chemical and environmental processes;
- To derive via statistical thermodynamics important thermodynamic quantities (e.g. internal energy, enthalpy, entropy, Gibbs and Helmholtz energies, pressure).

Description of the course
This course aims to introduce the students to the core of 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 analyze the physical and chemical properties of gases, solutions and solids, with a focus on mathematical derivations of formulas. The course covers, *inter alia*, the laws of thermodynamics; chemical potentials; phase diagrams; mixing of solutions; properties of gases; the derivation of internal energy, enthalpy, entropy, equilibrium constants, pressure via the statistical thermodynamics.

Literature
- McQuarrie, Donald A.; Simon, John D. *Physical Chemistry: A Molecular Approach* (any edition). University Science Books.
- Atkins, Peter. *Physical Chemistry* (any edition)
- Andrew Maczek; Anthony Meijer. *Statistical Thermodynamics.* Oxford.

Instructional format
Lectures and tutorials.

Assessment
Assessment will be based on:
- Mid-term written exam covering topics of the first three weeks;
- Final written exam covering the entire course.

PHY2003 Vibrations and Waves

Course coordinator
Dr. Jessica Steinlechner, Gravitational Waves and Fundamental Physics, Faculty of Science and Engineering.
Contact: jessica.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 damped and forced vibrations, as well as normal modes.
- To identify and be able to use appropriate mathematical methods to solving problems relating to these phenomena, such as complex notation, differential equations, eigenmodes and Fourier analysis.
- To understand wave characteristics such as standing waves, beats and wave packets.

Description of the course
Vibrations and waves covers the behaviour of many physical systems, be it mechanical, acoustic, electromagnetic or optical oscillations. We will investigate simple harmonic oscillators and derive a differential equation that will allow us to use the same mathematical framework for any oscillating system. Oscillations can experience damping or can be driven by external forces. An investigation of coupled oscillators will lead us to normal modes, and furthermore to oscillations that propagate – we call those waves! Waves can overlap (interfere) with each other, leading to phenomena such as standing waves and wave packets, which are fundamental for optics as well as electromagnetism.

Literature
- Optional: Introduction to Vibrations and Waves, H.J. Pain, P. Rankin, Wiley, 1st Edition (2015)
- Optional: Vibrations and Waves, G.C. King, Wiley, 2nd edition (2009)

Instructional format
Each week of this course consists of a lecture and two tutorial meetings. During the lecture, we will develop together our physical and mathematical understanding of oscillating systems. In the tutorials, we will be revisiting the contents of the lecture and deepen our understanding through exercises and example calculations. The tutorials and lectures will also contain practical, and we will look at real-world phenomena in openly posed PBL-style problems. In parallel to these there will be individual exercises to be completed outside of the classroom.

Assessment
In accordance with the intended learning outcomes, there will be two points of assessment:

- the mid-term assessment will require you to demonstrate that you can identify and explain oscillation and wave phenomena in a presentation to your fellow students, involving either live experimental demonstration or a video;
- the final assessment will be in the form of a written exam, where you will be able to demonstrate that you understood and can apply the mathematical framework of the course.

PHY2004 Electricity and magnetism

Coordinator

dr. Stefan Danilishin, Gravitational Waves and Fundamental Physics, Faculty of Science and Engineering.

Contact: stefan.danilishin@maastrichtuniversity.nl

Pre-requisites

- ✓ MAT2009 Multivariable Calculus

Recommended

- ✓ MAT1002 or MAT2004 Linear Algebra, PHY1001 Elements of Physics

Objectives

- To acquaint the student with the basics of electricity and magnetism;
- To be able to solve problems of electro- and magnetostatics;
- Learn to apply vector calculus and theory of potentials to the problems of electromagnetism;
- Gain knowledge of electric and magnetic fields in matter and of properties of different materials;
- Understand the electromotive force and the general laws of current in electric circuits;
- To be able to apply this knowledge to concrete practical problems;

Description of the course

Electromagnetism, also known as Maxwell's theory, is the discipline that studies one of the four fundamental forces of nature, which action, together with Gravity, we most frequently encounter in daily life. Electromagnetism introduces the concepts of Electric and Magnetic Fields, the physical entities permeating the entire space and interacting with matter by means of its special characteristic, the Electric Charge. Electric and magnetic fields act on a charge in a different way yet appear to be manifestations of a single entity known as Electromagnetic Field. Its behaviour can be described by a set of eight Maxwell's equations. It is the goal of this course to arrive at this unified description of electromagnetism. It will be done by means of generalisation of experimental laws governing the behaviour of static charges and steady currents. The course will also touch on the interaction of electric and magnetic fields with matter, covering such classes of materials as conductors, dielectrics and dia-, para- and ferromagnets. Finally, the concept of electromotive force and the laws of current propagation in electric circuits will be covered:

1. Electromagnetism and its mathematical description (week 1)
2. Electrostatics. Gauss's law. Electric scalar potential and voltage. (week 2);
3. Electrostatics in Matter (week 3);
4. Magnetostatics of free fields (week 4);
5. Magnetostatics in Matter (week 5);
6. Electromotive force. Ohm's law (week 6).

Literature

- "Introduction to Electrodynamics", David Griffiths, 4th Edition (or higher).
- Handouts on specific texts during the lectures.

Instructional format

Lectures will be given in a traditional, white-board style every week. 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. All the exercises for each week will have to be completed by the dedicated homework teams of students and submitted for peer review at the beginning of the next week.

Assessment

- Midterm exam;
- Final exam;
- Peer-reviewed mark for homework.

PHY2005 Fundamentals of Quantum Mechanics

Course coordinator
Dr. Keri Vos, Gravitational Waves and Fundamental Physics, Faculty of Science and Engineering.
Contact:k.vos@maastrichtuniversity.nl

Pre-requisites
- ✓ At least one of the following: MAT2004 Linear Algebra, MAT2006 Calculus, MAT2008

Co-requisites
- ✓ None

Recommended
- ✓ MAT2006 Calculus
- ✓ MAT2004 Linear Algebra
- ✓ 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; solve eigenvalue problems;
- Calculate the non-classical behaviour resulting from the postulates of QM;
- Derive and analyze the wavefunctions of Hydrogen in 3D.

Description of the course
This course dives into the mathematical foundation of Quantum Mechanics. Prior knowledge of classical physics, calculus and linear algebra is therefore strongly recommended.

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 need Quantum Mechanics and its wave functions, probabilities of reality and Schrödingers equation.
We start by discussing the failings of classical physics, and the necessity to describe the world at small scales using Quantum Mechanics. We will calculate solutions to the Schrödinger for several analytically solvable systems like the square well potential and the harmonic oscillator.
In week 4, we will introduce the linear-algebraic description of Quantum Mechanics. We will compute commutation relations of operators and derive Heisenberg’s uncertainty principle. Then we discuss the concept of spin and Pauli’s exclusion principle. In the final week, we will calculate the orbitals of the hydrogen atom in 3 dimensions.

Literature
“Introduction to Quantum Mechanics”, David J Griffiths

Instructional format
Each week consists of a lecture and two tutorials. The lectures are used to derive these concepts and go through the mathematical foundations. The material is then further studied in the tutorials, which require several integration and differentiation techniques, matrix multiplications and solving eigenvalue problems.

Assessment
- Written Midterm exam
- Written Final exam covering all the material of the course.

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'llalso 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 youfunctions and we hope to pull apart some electronic devices to explore their inner workings.

Literature
To be confirmed.

Instructional format
1 x 2 hour lecture per week.2
x 2 hour tutorial per week.

Assessment
- Presentation;
- Tutorial contribution grade;
- Final exam.

PHY2007 Optics

Course coordinator
dr. Sebastian Steinlechner, Gravitational Waves and Fundamental Physics, Faculty of Science and Engineering.

Contact: s.steinlechner@maastrichtuniversity.nl

Pre-requisites
✓ None

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 to 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 the wave nature of light and use it to describe interferometers and diffraction gratings.
- To understand and describe effects of polarization.

Description of the course

The study of optics begins with a geometrical approach, modelling light as rays which follow a straight line until they interact with an optical element, such as a mirror or lens. Based on these principles, we can assess the behaviour of optical devices (telescopes, microscopes, cameras) but also begin to understand optical phenomena which occur in everyday life, for example rainbows. After the geometrical approach, we will move forward to physical optics where light is considered as a wave. In this part we will encounter the phenomena of polarization, interference, diffraction, and will look at their applications, such as anti-reflective coatings, interferometers and gratings.

Literature
- Y. Mejía-Barbosa, *Fundamentals of Optics*, SPIE open access ebook available at https://doi.org/10.1117/3.2660873.sup
- S. Konijnenberg, A.J.L Adam, H.P. Urbach, *BSc Optics*, 2nd edition, TU Delft, available at https://doi.org/10.59490/tb.91

Instructional format
Each week of this course consists of a lecture and two tutorial meetings. During the lecture, we will develop together our physical and mathematical understanding of optical systems and phenomena. In the tutorials, we will be revisiting the contents of the lecture and deepen our understanding through exercises and example calculations. The tutorials and lectures will also contain practical demonstrations as well as computer simulations, and we will look at real-world phenomena in openly posed PBL-style problems. In parallel to these there will be individual exercises to be completed outside of the classroom.

Assessment
In accordance with the intended learning outcomes, there will be two points of assessment:

- the mid-term assessment will require you to demonstrate that you can identify and explain optical phenomena to your fellow students in a presentation, held during the tutorials;
- the final assessment will be in the form of a written exam, where you will be able to demonstrate that you understood and can apply the mathematical framework of the course.

PHY2008 Solar System Astronomy

Course coordinator
Mr. Chad Ellington: Faculty of Science and Engineering, Maastricht Science Programme.
Contact: chad.ellington@maastrichtuniversity.nl

Pre-requisites
- ✓ None

Objectives
- Evaluate the usefulness of spectroscopic observations, including blackbody thermal radiation, emission/absorption spectra and how they 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;
- Understand the currently accepted formation scenarios of the solar nebula and how it accounts for the locations and properties of the various planetary types; as well as the retinue of minor bodies and their locations / orbital parameters;
- Introduce overall scientific understanding of our solar system, including the planets, their natural satellites, asteroids, comets, planetesimals and dwarf planets;
- Describe mechanisms that modify the surfaces of terrestrial planets: such as volcanism, impact cratering, tectonism (including geomagnetism) and erosion;
- Compare and contrast characteristics alongside the capabilities of various solar system bodies to retain various atmospheric constituents;
- Summarize physical properties and orbital characteristics of minor bodies, assessing whether their orbits deem them as being potentially hazardous to Earth.

Description of the course
The course expects students to independently review information concerning the spectrum of light from objects within our universe. Lectures begin with our nearest celestial neighbor, our Moon, continuing with historical observations of planetary motions, how it affected models of our solar system and our eventual increased understanding of the planetary laws of motion. We continue by investigating the formation of our solar system and physical characteristics (including surface/interior/atmospheric modification) of numerous solar system bodies; including: terrestrial planets, gas/ice giants & minor planet constituents such as natural satellites, asteroids, comets, planetesimals & dwarf planets.

Literature
- Ryden, B. & Peterson, B. (2020). Foundations of Astrophysics (1st ed.). Cambridge;
- Astronomy 2e, Retrieved via: https://openstax.org/details/books/astronomy-2e
- Selected articles and materials will be referenced/provided to the students.

Instructional format
Each week of this course focuses on various topics within our solar system, consisting of overview lectures and discussion group tutorials. The first meeting will introduce the weekly group assignments/exercises with discussion questions where results with further discussions occurs in the subsequent tutor group meetings. There are further individual mathematical exercises, which may include independent research and/or observations.

Assessment
- Conceptual assessments and diagnostics/surveys;
- Tutorial exercises/problems;
- Tutorial proposal;
- Midterm;
- Final examination.

PHY2009 Stellar Astronomy

Course coordinator

Mr. Chad 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 determine chemical composition, relative radial velocities, surface temperatures and 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 their physical properties, such as combined mass, individual mass, physical size and orbital separation (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 is 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, their 'lifetimes', 'evolution' & the many remnants they leave behind.

Literature

- Ryden, B. & Peterson, B. (2020). Foundations of Astrophysics (1st ed.). Cambridge;
- Astronomy, OpenStax College. Retrieved via: https://openstax.org/details/books/astronomy.

Instructional format

Each week of this course focuses on various topics concerning stars and stellar evolution, consisting of overview lectures and discussion tutorial group meetings. The first meeting may introduce the weekly group assignments/exercises with discussion questions where results with further discussions occurs in the subsequent tutor group meetings. There may be mathematical individual exercises, which may include independent research and/or observations.

Assessment

- Conceptual assessments and diagnostics/surveys;
- Tutorial exercises/problems and tutorial proposal;
- Midterm;
- Final examination.

PHY2010 Galactic Astronomy

Course coordinator
Mr. Chad 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 the likelihood of various astrophysical objects being found within the spiral, elliptical, peculiar & irregular galaxy types;
- Evaluate observational evidence to differentiate between the top-down and bottom-up models describing galactic formation;
- Critique the competing models explaining the presence of galactic spiral arms and central bars;
- Explain the methods of determining distances to galaxies within the cosmological distance ladder, applying them to various galactic structures;
- Compute the distances at which galactic systems tidally disrupt each other.
- Breakdown the historical classifications of active galaxies into the subcategories of: radio galaxies, Seyfert galaxies, quasars or blazars; understanding their impact on galactic evolution and why they are observed almost exclusively at cosmological distances;
- Describe the various pieces of evidence for dark matter within most galaxies and clusters of galaxies, computing galactic masses when possible;
- Relate how observations of distant supernovae led to the discovery that our universe is accelerating in its expansion rate;
- Identify the key predictions/observations for the origin of our universe.

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 Hot Big Bang theory itself.

Literature
- Ryden, B. & Peterson, B. (2020). Foundations of Astrophysics (1st ed.). Cambridge;
- Astronomy, OpenStax College. Retrieved via: https://openstax.org/details/books/astronomy.

Instructional format
Each week of this course focuses on various topics concerning our Milky Way, other galactic types, large-scale structure of our universe and conditions in the early universe, 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 occurs in the subsequent tutor group meetings. There may be mathematical individual exercises, which may include independent research and/or observations.

Assessment
- Conceptual assessments and diagnostics/surveys;
- Tutorial exercises/problems;
- Tutorial proposal
- Midterm;
- Final examination.

PHY2011 Special Relativity

Course coordinator

Gerco Onderwater: Faculty of Science and Engineering, Maastricht Science Programme.
Contact: gerco.onderwater@maastrichtuniversity.nl

Pre-requisites

- ✓ PHY2001 Classical Mechanics or PHY1003 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 exam
- Final exam

PHY2012 Structure of Matter

Course coordinator
Dr. Alex Amato, Gravitational Waves and Fundamental Physics, Faculty of Science andEngineering.
Contact: a.amato@maastrichtuniversity.nl

Pre-requisites
- ✓ PHY2002 Thermodynamics & Statistical Mechanics

Co-requisites
- ✓ None

Recommended
- ✓ None

Objectives
By the end of this course, students will be able to:
1. Understand the Composition and Structure of matter
2. Interpret the organization of the periodic table.
3. Explain the principles of chemical bonding.
4. Differentiate between the states of matter.
5. Explain the principles of some techniques used to investigate matter.

Description of the course
This course is designed to provide students with a basic understanding of the fundamental principles governing the composition, behaviour, and interactions of matter.
The historical evolution of atomic theory is examined, encompassing atomic models, the subatomic particles and the systematic organization of the periodic table.
The concepts of chemical bonding and molecular structure are thoroughly examined, providing a foundation for the exploration of various states of matter: solids, liquids, gases, and plasma. Emphasis is placed on their distinct properties, phase transitions, and the atomic and molecular configurations that define and distinguish these phases.
The most common techniques used to investigate matter are elucidated, with an emphasis on techniques that use the interaction of light with matter.

Literature
- Brehm, John J., and William J. Mullins. *Introduction to the structure of matter: a course in modern physics*.
- Goodstein, David L. *States of matter.*
- Pauling, Linus. General *chemistry*.
- Kittel, Charles, and Paul McEuen*. Introduction to solid state physics.*
- Additional references will be provided during the lectures/tutorials.

Instructional format
Lectures and tutorials.

Assessment
- Midterm exam.
- Final exam.

PHY3001 Quantum Mechanics

Course coordinator

Dr. Keri Vos, Gravitational Waves and Fundamental Physics, Faculty of Science and Engineering.
Contact:k.vos@maastrichtuniversity.nl

Pre-requisites

- ✓ PHY2005 Fundamentals of Quantum Mechanics

Co-requisites

- ✓ None

Recommended

- ✓ MAT2006 Calculus
- ✓ MAT2004 Linear Algebra

Objectives

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

- Demonstrate knowledge of modern topics in quantum mechanics;
- Calculate non-classical behaviour resulting from the postulates of QM;
- Derive the fine-structure of the hydrogen and understand its importance in physics;
- Apply perturbation theory to calculate the lowest-order approximations to problems which have no exact solutions;
- Understand quantum-mechanical tunneling;
- Predict the basic behaviour quantum processes in qubits and quantum circuits;

Description of the course

This course addresses some advanced concepts in Quantum Mechanics and builds on the fundamentals of Quantum Theory course (PHY2005). The course is organized around the following topics: quantum tunneling, approximation methods such as the variational principle and time (in)dependent perturbation theory, state transitions, basics of quantum entanglement and quantum computing. Each of these subjects is taught on a theoretical level as lecture, and on a practical level with exercises.

Literature

"Introduction to Quantum Mechanics", David J Griffiths

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 well 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

- Written Midterm exam
- Written Final exam covering all the material of the course.
- Participation in the course.

PHY3002 Theory of Relativity

Course coordinator

Dr. Gideon Koekoek, Gravitational Waves and Fundamental Physics, 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 exam;
- Final exam.

PHY3004 Elementary Particle Physics

Course coordinator

Prof. Marcel Merk and Dr. Jacco de Vries, Gravitational Waves & Fundamental Physics, Faculty of Science and Engineering

Contact: m.merk@maastrichtuniversity.nl and jacco.devries@maastrichtuniversity.nl

Pre-requisites

- ✓ PHY2005 Fundamentals of Quantum Mechanics
- ✓ MAT2004 Linear Algebra

Co-requisites

- ✓ None

Recommended

- ✓ MAT2006 Calculus
- ✓ PHY3001 Quantum Mechanics
- ✓ PHY3002 Theory of Relativity

Objectives

- To acquire a general understanding of key concepts in 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 elementary particle physics and serves as a preparatory course for a subsequent master study on Particle Physics.

Particle Physics provides us with an understanding of the fundamental particles in the universe and the interactions between them. Students will be taught which 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 spontaneous breaking via the Higgs mechanism. The course consists of six lectures and related tutorials: particles, forces, waves, symmetries, scattering and detectors. In the lectures the material will be presented, while skills will be applied to exercises in the tutorial classes. In the last weeks, time will be reserved to work on specific topics for the group projects. A seminar will be organized to present the group work to each other.

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.

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 Electrodynamics

Course coordinator

dr. Stefan Danilishin, Gravitational Waves and Fundamental Physics, Faculty of Science and Engineering.

Contact: stefan.danilishin@maastrichtuniversity.nl

Pre-requisites

- ✓ PHY2004 Electricity and magnetism

Recommended

- *MAT2009 Multivariable Calculus, PHY2011 Special Relativity*

Objectives

- To acquire general understanding of electrodynamics beyond stationary cases;
- 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 understand the physics of electromagnetic waves propagation and generation;
- To understand how conservation laws .

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 course will cover general time-dependent description of electromagnetic (EM) phenomena in termd of Maxwell's equations and in terms of scalar and vector potentials. General formulation of conservation laws for EM fields will be given, including Poynting's theorem, and the concepts of momentum and energy for the field will be introduced. We examine the motion of charged particles in EM fields as well as the fields generated by moving charges. Special emphasis will be given to electromagnetic wave propagation in both vacuum and matter. The course will conclude with the natural convergence of Electrodynamics and Special Relativity in the form of covariant (relativistic) rewriting of Maxwell's equation, which naturally follows from the finite speed of propagation of electromagnetic fields (speed of light) and Lorentz invariance of the laws of Physics.

The tentative plan of the course:

1. Subject of electrodynamics. Maxwell's Equations in static case. Scalar potential (week 1);
2. Scalar and vector potentials. Poisson's equations and multipole expansion of potentials (week 2);
3. Time-dependent Maxwell's equations and d'Alembert's equation for potentials. Retarded potentials and finiteness of speed of propagation of EM interactions. Liénard-Wiechert potentials for moving point particles. (week 3);
4. Dynamics of charged particles. Lorentz force. Conservation laws for EM fields. Poynting's theorem. Interaction of EM fields with matter (week 4);
5. Electromagnetic waves (week 5);
6. Covariant form of Maxwell's equations and relativistic description of electrodynamics (week 6)

Literature

- "Introduction to Electrodynamics", David Griffiths, 4th Edition (or higher).
- Handouts on specific texts during the lectures.

Instructional format

Lectures will be given in a traditional, white-board style every week. 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. All the exercises for each week will have to be completed by the dedicated homework teams of students and submitted for peer review at the beginning of the next week.

Assessment

- Midterm exam;
- Final exam;
- Peer-reviewed mark for homework.

PHY3006 General Relativity

Course-coordinator

Dr. Gideon Koekoek, Gravitational Waves and Fundamental Physics, Faculty of Science and Engineering
Contact: gideon.koekoek@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 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 thetheory 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 exam;
- Final exam;
- Peer review.

PHY3008 Cosmology

Course coordinator
Dr. Lorenzo Reverberi, Faculty of Science and Engineering, Maastricht Science Programme.
Contact: l.reverberi@maastrichtuniversity.nl

Pre-requisites
- ✓ MAT2006 Calculus
- ✓ PHY2001 Classical Mechanics

Recommended
- ✓ At least one Astronomy course (PHY2008/PHY2009/PHY2010)
- ✓ PHY3002 Theory of Relativity

Co-requisites
- ✓ None

Objectives
- Summarise the basic mathematics of spacetime and general relativity, and apply them to homogeneous and isotropic cosmological models (FLRW metric)
- Remember the Friedmann equations and use them to derive the cosmological expansion history given the nature and amount of energy/matter in the Universe
- Explain light propagation in an expanding Universe, ages, redshift, horizons and the cosmic distance ladder and apply these tools to cosmological observables
- Outline the main epochs and topics in the cosmological history, including inflation, Big Bang Nucleosynthesis, recombination, structure formation, late-time cosmic acceleration
- List the main theoretical and observational evidence for the ΛCDM model, particularly for the existence of Dark Matter and Dark Energy
- Research recent literature, and present your findings to an audience of peers and experts

Description of the course
This course will cover the basic topics in theoretical and observational cosmology. A background in (General) Relativity and Astronomy is useful but not strictly mandatory, but a solid understanding of calculus and algebra is assumed.
We will begin with a brief introduction to the mathematics of spacetime and General Relativity, and apply it to homogeneous, isotropic (FLRW) cosmological models. We will then study light propagation in an expanding Universe, discuss the cosmic distance ladder and the basics of observational cosmology.
After that, we will outline the cosmological expansion history and investigate in some depth the various epochs, their observational status and the underlying physical laws: the Big Bang, inflation and the generation of primordial fluctuations; the thermodynamics of the early Universe and Big Bang Nucleosynthesis (BBN); recombination and the Cosmic Microwave Background (CMB); structure formation and Dark Matter; the late-time cosmic acceleration and Dark Energy.
At the end of the course, you should be able to outline the basic theoretical motivation and observational support in favour of the ΛCDM model, the concordance cosmological model.

Literature
There is no official textbook for the course. All necessary study material will be provided and/or indicated during the course. For more advanced and in-depth reading, the interested student is referred to one or more of the excellent books on the subject, for instance:

[1] S. Dodelson, *Modern Cosmology*, Academic Press (2003).
[2] E.W. Kolb, M.S. Turner, *The Early Universe*, Avalon Publishing (1994).
[3] A. Liddle, *An Introduction to Modern Cosmology*, Wiley (2003).
[4] P.J.E. Peebles, *Principles of Physical Cosmology*, Princeton University Press (1993).

Instructional format
One lecture, two tutorials per week. The last tutorial of the course is replaced by a *Cosmology Symposium* with group presentations.

Assessment
Weekly quizzes/projects; final examination.

PHY3009 Lagrangian & Hamiltonian Mechanics

Course-coordinator

Dr. Gideon Koekoek, Gravitational Waves and Fundamental Physics, Faculty of Science and Engineering
Contact: gideon.koekoek@maastrichtuniversity.nl

Pre-requisites

- ✓ PHY2001 Classical Mechanics or PHY1003 Mechanics

Co-requisites

- ✓ None

Recommended

- ✓ PHY2011 Special Relativity
- ✓ A course containing quantum theory.

Objectives

- To acquaint the students with the Lagrangian and Hamiltonian and Hamilton-Jacobi formalisms of Nature, and to apply these to derive physical laws;
- To introduce the concepts of generalised coordinates and momenta;
- To derive the underlying mathematics, including the variational calculus and the Euler-Lagrange equations and Poisson brackets;
- To be able to derive conservation laws from Lagrangian and Hamiltonian formalism;
- To extend the formalism to also include non-conservative forces and field theory;
- To apply the formalism to the theory relativity and quantum theory.

Description of the course

Newtonian is one of the most successful theories of classical physics. It encompasses statics, kinematics, dynamics, and can be used to describe many applications, such as the motion of the planets around the sun, clouds in the sky, fluid dynamics, and the motion of every day objects. It is also the starting point of many subsequent theories of physics, including thermodynamics, quantum mechanics, and relativity theory.
It turns out that Newtonian mechanics is only one mathematical description of a much deeper formalism, that comes with advantages that make it much more suitable to describe all kinds of situations in which Newtonian mechanics is intractable. It allows for a clear and straightforward identification of constants of motion, can be applied to situations in which Newtonian formalism does not apply to begin with (such as systems in which the actors do not have mass), or are not even written in terms of positions and momenta. As such, analytical mechanics is the default formalism in which most modern physics is written, including relativity, quantum mechanics, field theory, and quantum field theory. It is an indispensable tool for every student or researcher who will work in modern physics.
In this course, we will derive the formalism of analytical mechanics by recasting Newton's Laws into the Lagrangian and Hamiltonian formalism and its conservation laws, and we will learn to apply it to many situations. These will include examples from Newtonian mechanics, relativity, and quantum mechanics, and field theory.

Literature

Classical Mechanics, Herbert Goldstein John Safko, 3rd edition, Pearson Education Limited.

Instructional format

The tutorials will consist of highly interactive sessions, in which we will solve and discuss exercises in a group-effort In parallel to these group-exercises there will also be 'individual exercises 'to be completed outside of the classroom.

Assessment

- Written midterm exam;
- Written final exam.

PRA1101 Introduction to Scientific Research I

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

Pre-requisites
- ✓ MSP1000 Introduction to MSP

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 usedin chemical, biological and 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 of several interactive sessions, practical lab work, and sessions on experimental design, research ethics, data analysis, and reporting of data.

Assessment
- Pre-lab;
- In-lab;
- Written lab assignments.

PRA1102 Introduction to Scientific Research II

Course coordinators

Suzan du Pree: Faculty of Science and Engineering, Maastricht Science Programme.
Contact: suzan.dupree@maastrichtuniversity.nl

Pre-requisites

- ✓ MSP1000 Introduction to MSP

Co-requisites

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

Objectives

At the end of this skills module, you will be able to …

- 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;
- Evaluate scientific fraud and evaluate resources critically;
- Generate valuable data from a scientific experiment;
- Conduct basic data analysis;
- Interpret and discuss experimental results;
- Write a basic 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 usedin chemical, biological or physics research, such as the accurate weighing, preparing solutions and dilutions, working with pipettes and volumetric glassware and performing simple analyses. Students will gain experience in how to design and set up anexperiment in order to answer a specific scientific question. During the laboratory sessions, students willexecute 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 in partial lab reports.
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.

Literature

Course manual and online instructions on the Student Portal.

Instructional format

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

Assessment

- Pre-lab;
- Post-lab assignments.
- Completion of training modules and reflection

PRA1003 Basic Physics Laboratory

Course coordinator

Suzan du Pree: Faculty of Science and Engineering, Maastricht Science Programme.
Contact: suzan.dupree@maastrichtuniversity.nl
Dr. Chris Pawley, Faculty of Science and Engineering, Maastricht Science Programme.
Contact: c.pawley@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ None

Objectives

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

Description of the 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 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 mathematicalphysics 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 module. Information on the individual experiments is providedin this syllabus and in separate detailed experiment descriptions. A suitable textbook for this module 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 any general physics textbook.

Instructional format

This module takes place in the physics laboratory. 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 partly based on these reports. During the modulestudents also learn more about the basis theory of Experimental Physics, like sources of errors and errorpropagation.

Assessment

Evaluation of student performance will be based on:

- Lab reports;
- In-lab assignments.

PRA1005 Data Collection Techniques in Neuroscience

Course coordinator
Dr. Mark Roberts: Faculty of Psychology and Neuroscience, Department of Cognitive Neuroscience.
Contact: mark.roberts@maastrichtuniversity.nl

Pre-requisites
- ✓ Laptop computer
- ✓ 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. Programming therefore forms a large portion of the course, you will learn the basic functionalityof MATLAB and the Fieldtrip toolbox. No previous programming experience is expected.

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;
- Lab report based on practical sessions.

PRA1008 Basics of Palaeontology

Course coordinator
Dr. Jesse Hennekam, Faculty of Science & Engineering, Maastricht Science Programme
Contact: j.hennekam@maastrichtuniversity.nl

Prerequisite
- ✓ none

Objectives
During this skill course, you will learn to identify major invertebrate and vertebrate fossil groups, distinguish between types of fossils and learn the basics of body plans. With these foundations, you will explore the potential of fossils in palaeoecology, stratigraphy and evolutionary studies in order to understand past dynamics of life.

Description of the course
This skill course offers the basics of palaeontology, providing you with the tools and knowledge to start unraveling our past. You will gain the skills to analyse and interpret fossils and ancient ecosystems in order to grasp evolutionary and climatic changes over time. Being equipped with the techniques to uncover Earth's past, you will become knowledgeable regarding the evolution of various forms of life and the transformation of habitats over billions of years. Palaeontology is more than just collecting fossils, this course shows how palaeontologists use a wide array of different techniques in order to analyse fossil evidence and reconstruct past environments and significant events in Earth's History.

Literature
Recommended, also for the other palaeontology courses offered at MSP:
Benton, M. & Harper, D. 2020. Introduction to Paleobiology and the Fossil Record, 2nd Edition. Wiley-Blackwell. 656 pp

Instructional format
This skill will predominantly take place in the dry labs at PHS, which may include visits to the Natural History Museum in Maastricht.

Assessment
- Presentation
- Weekly exercises
- Peer evaluation

PRA2003 Programming

Course coordinator

Panos Christakoglou, Faculty of Science and Engineering, Maastricht Science Programme.
Contact: panos.christakoglou@maastrichtuniversity.nl

Pre-requisites

✓ None

Co-requisites

✓ MAT2007 Introduction to Programming

Objectives

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

Description of the skill

This hands-on course aims at complimenting the course ``Introduction to Programming'' (MAT2007) with hands-on programming experience. Over the course of six weeks, students will engage in practical exercises aimed at reinforcing concepts covered in the lectures and developing skills in programming languages such as C++ and Python. Each week, students will tackle a set of exercises designed to enhance their problem-solving skills and apply programming techniques to various scenarios.

Literature

No specific text book is required, although students are referred to the literature used for the “Introduction to programming” course (MAT2007).

Instructional format

Each session will consist of 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 the packages that will be announced already pre-installed.

Assessment

The assessment will be based on:

- The programming lab tasks;
- Small homework tasks that work towards the final assignment;

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:
- ✓ 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 course
This course focuses on experimental research methods and reporting. 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 lab days, students will perform a set of biology and chemistry experiments. The different experiments areconnected and form one integrated experiment. Parts of the experiments have an emphasis on biologicalor biochemical aspects of molecular research, while other experiments focus more on chemical aspects. For the final lab day, students have to design their own protocol for an experiment in which the results of the earlier experiments will be combined. The course will be structured in the Research-Based Learning (RBL) format, with room for student initiatives and ideas.

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 and lab book use;
- Protocol development;
- 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 correctcomponents, supplies and measurement devices to check the circuit;
- Collect experimental readings using multimeters and oscilloscopes to fault find and comparedevice 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 theappropriate 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 applicableto 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 emphasison 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 & Engineering, Maastricht Science Programme
Contact: c.pawley@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

Objectives
This practical aims for students to 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 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 physics laboratory techniques and procedures. Furthermore, attention will be paid on data analysis and reporting.

Description of the skill
This skill will educate you on the following:
- Design, use and measurement in physics experimentation;
- Gathering data using automated processes;
- Data manipulation and analysis using modern tools;
- 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 weeks perform a different physics 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 than in PRA1003 Basic Physics Lab, but staff are available for support.

Assessment
The grade is based on:
- The submitted laboratory reports;
- The ability of the team members to design and execute a suitable experiment in physics asassessed 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

Recommended

- ✓ PHY2002 Thermodynamics and Statistical Mechanics
- ✓ CHE3007 Chemical Kinetics

Co-requisites

- ✓ None

Objectives

For this skill, students are expected to perform various physical chemistry experiments and analyze the obtained data, involving *inter alia* kinetics analysis, thermodynamics 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, 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 the lab reports;
- Lab notebooks;
- Results obtained;
- Error analysis;
- Answers to post-lab questions;
- Final paper.

PRA2009 Field Skills in Biology

Course coordinator
Dr. Phil Klahs: Faculty of Science and Engineering, Maastricht Science Programme
Contact: phil.klahs@maastrichtuniversity.nl

Pre-requisites
- ✓ PRA1102 Introduction to Scientific Research II

Co-requisites
- ✓ None

Objectives
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, and most importantly some basic means to plan for and interpret all that complex data.

Description of the skill
This skill will include:
- Use of GIS computer mapping tools;
- The means to identify species or higher taxa of certain environmentally or taxonomically important groups or indicator species in the field or lab;
- Methods to collect or count organisms in the field;
- Planning of field experiments;
- Interpretation of field results, including some statistical work and spatial analysis;
- How to represent spatial data on an appropriately formatted map.

Literature
Wheater, C.P., Bell, J.R. & Cook, P.A. (2021). *Practical Field Ecology: A Project Guide*, 2nd edition 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
Practical exercises online and in the field.

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 Advanced Molecular Lab Skills
- ✓ PRA2014 Genetics

Co-requisites:
- ✓ None

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

Description of the course
This course explores the relatively new and rapidly growing field of synthetic biology. Synthetic biology aims to construct genetic systems, change biological systems or even (re)design organisms, to solve real-life issues in, for example, environment, health, nutrition, … This is done by looking at biology from an engineering point-of-view and by using molecular biology, genetic engineering, and microbiology methods. This engineering approach focuses on four important principles: abstraction, modularity, standardization, and 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. Students will gain experience in growing and analyzing microbial cell cultures (plates/liquid cultures), perform some genetic engineering and cloning techniques and DNA analysis tools.

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. Phil Klahs: Faculty of Science and Engineering, Maastricht Science Programme
Contact: phil.klahs@maastrichtuniversity.nl

Pre-requisites
- ✓ None

Co-requisites
- ✓ BIO2003 General Botany

Objectives
In this skills-training you will get hands on experience with the diagnostic characteristics and important aspects of the biology of mosses, ferns, gymnosperms and angiosperms.

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. In this skill, you will explore plant morphology with the assistance of dissecting microscopes and prepare your own slides to further investigate the anatomy of plants with compound microscopes. We will take excursions into the field to observe plants in the wild (and urban environments), retrieve material for the lab component, and make voucher specimens to be included in the MSP Herbarium.

Instructional format
Weekly laboratory activities with microscope work and field trips

Assessment
There will be several points of assessment:

- Worksheets for each lab
- A practical exam

PRA2013 Practical Zoology

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

Pre-requisites
- ✓ PRA1102 Introduction to Scientific Research II
- ✓ BIO2004 General Zoology

Objectives
The skills will include:
- Carrying out experiments on physiology, behaviour and other aspects of zoology.
- Analysing zoological data;
- Writing up zoology experiments.

Description of the skill
The skill aims to provide a greater insight into how we study zoology experimentally in the laboratory. You will learn different methodological approaches used in zoology in including physiological testing and behavioural analysis. We aim to provide you with better skills in handling live animals and in interpreting what you see in a biologically relevant way. A portion of this skill is devoted to curating and presenting the zoological data you obtain.
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 textbook used for course BIO2004 General Zoology.

Instructional format
One whole-day (lab) instruction per week; museum visit

Assessment
- Lab performance
- Data presentation
- Reports

PRA2014 Genetics

Course co-coordinators

Dr. David Cortens: Maastricht Science Programme, Maastricht University.
Contact: david.cortens@maastrichtuniversity.nl

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

Pre-requisites

- ✓ Core 1000 level courses
- ✓ BIO2001

Co-requisites

- ✓ BIO2007

Objectives

- Able to understand/ use the most common experimental techniques in genetics.
- Able to report and discuss experimental data.
- Learn to make relevant calculations for genetic experiments.

Description of the skill

The skills training is aimed at obtaining a basic introduction and hands-on training on techniques and methods used in modern Genetics. These techniques are all relevant for the study of biological functions at the level of molecules, cells, and multicellular organisms, including humans. The skills take place at a designated skills laboratory at DUB30.

Literature

- A reader is provided at the start of the course, containing concomitant additional literature sources.

- Instructional videos on Canvas

Instructional format

Skills group meetings.

Assessment

There will be a minimum of two points of assessment. Assessment may include, but may not be limited to:

- Attendance at the skills meetings is required (cf. Rules and Regulations);
- A weekly assignment
- A written exam
- Lab report

PRA2015 Advanced Academic Skills

Course coordinator

Dr. Kyle Jazwa: Faculty of Science and Engineering, Maastricht Science Programme.
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Pre-requisites

- ✓ None

Co-requisites

- ✓ None

Objectives

- Read academic literature from outside your discipline and incorporate it in your own writing.
- Synthesize unfamiliar research to assess the state of a research field.
- Adapt your writing/research for different genres of academic/professional literature (literature reviews, abstracts, scientific reports, original research papers).
- Write professional and polished texts suitable for scientific/academic audiences.
- Provide peer feedback on academic writing.
- Incorporate given feedback in your writing.
- Collaborate with your peers to complete assigned tasks.
- Apply the IMRaD structure to your own research and effectively write each section.

Description of the skill

A good researcher not only knows a lot about their specific topic of study; they are also able to communicate their findings clearly and concisely to others. Advanced Academic Skills will improve your ability to do just this by focusing on you prose style, (written) organization, and argumentation. The course picks up where PRA1102 left off by asking you to develop your writing for various genres, including the Abstract, Literature Review, Research Proposal, and Research Paper. At the same time, you will collaborate with your classmates for peer review exercises and didactic presentations.

By the end of the course, you will be better prepared to complete your BTR thesis writing and participate in a scientific/academic career beyond MSP. Thus, Advanced Academic Skills is particularly suitable for students who are generally interested in the process of scientific communication and/or intend to continue their science education beyond the undergraduate level.

Literature

A selection of readings, videos, and "podcasts" will be assigned each week. All course materials are currently accessible (for free) online, via Canvas, or through the UM Library webpage.

Instructional format

Short, interactive lectures; assisted individual work/exercises; peer review

Assessment

- Write a Literature Review [solo];
- Write a Research Proposal [group];
- Write an "Introduction" and "Results" section for a Research Paper [solo];
- Other minor writing assignments/activities;
- Didactic group presentation.

PRA2018 Capita Selecta in Modern Sciences

Coordinator
Panos Christakoglou, Faculty of Science and Engineering, Maastricht Science Programme.
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Pre-requisites
- ✓ None

Co-requisites
- ✓ None

Objectives
- Examine contemporary scientific discoveries
- Acquire scientific insight into trending topics
- Develop critical thinking skills
- Promote effective communication
- Encourage collaboration between peers

Description of the skill
The course is designed to explore and discuss the forefront of scientific discoveries and advancements across various fields. From developments in the smallest systems e.g. elementary particle physics or molecular biology, to the largest e.g. results in cosmology, this course delves into the highlights of contemporary scientific research, providing students with a comprehensive understanding of cutting-edge topics shaping our world. The students will be engaging in discussions, presentations, and critical analysis, and will explore a wide array of scientific disciplines including health sciences, chemistry, physics, biology, astronomy, cosmology, computing science, and interdisciplinary studies. The course will focus on selected topics that represent pivotal advancements, emerging technologies, and unresolved questions in the scientific community.

Literature
The literature recommendation is of digital nature, and is listed below:
- https://www.nature.com;
- https://www.sciencemag.org;
- https://www.ncbi.nlm.nih.gov/pubmed/trending/;
- https://www.bbc.com/news/health;
- 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 continue with specialized journal clubs. In addition, students will work on the provided literature depending on the 'hot topics' and set up their own Pecha Kucha presentations, which they present to their peers and tutors in the following week.

Assessment
The students will be assessed individually by: Peer review, (Pecha Kucha) presentations.

PRA2019 Scientific Illustration

Course coordinator

Dr. Phil Klahs: Faculty of Science and Engineering, Maastricht Science Programme
Contact: phil.klahs@maastrichtuniversity.nl

Pre-requisites

- ✓ PRA2015 Advanced Academic Skills or PRA2027 Fundamentals of Science Communication

Co-requisites

- ✓ None

Objectives

After this skill, students should be able to:

- Accurately draw objects with precision for scientific communication and publications;
- Apply arrangement guidelines to produce pleasing compositions for illustrations;
- Produce illustrations with graphite, ink, and digital tools;
- Digitize illustrations and use them to construct scientific figures.

Description of the course

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.

Literature

Course manual and weekly instructions.

Instructional format

One class per week to practice techniques.

Assessment

The assessments will include:

- Weekly drawing assignments
- Quiz over materials / equipment / techniques
- Final illustration project

PRA2020 Practical Mass Spectrometry

Course coordinator

Dr. A. Mathew: Maastricht Multimodal Molecular Imaging Institute (M4i),
Faculty of Health, Medicine & Life Sciences
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Pre-requisites

INT2010 (Principles of Mass Spectrometry)

Objectives

- Basic understanding of ion physics and ion trajectories in mass spectrometers and vacuum technology.
- Familiarization and practical experience with ionization techniques; ESI, MALDI and SIMS.
- Familiarization and practical experience with the ion optics, mass analysers; Orbitrap, TOF, FT-ICR, and detectors.
- Optimization of mass spectrometry settings based on the biomolecule of interest, and specific biological research questions.
- Basic training in tandem mass spectrometry (MS/MS) for analysing biology and chemically relevant molecules, including the use of MS/MS prediction software.
- Ability to utilize various MS techniques for molecular structure analysis.
- Perform together with supervisor MS Imaging experiments.
- Basic experience with manipulation of advanced data processing software for effective data management.

Description of the course

Gaining experience with, and a fundamental understanding of mass spectrometer design, optimal parameter setting of ion optics, ionization, mass analysis, detection and fragmentation processes, together with hands-on experience with the MS analysis of lipids, peptides, proteins and many other molecules is the core objective of this course.
The practical assignments include the manipulation of experimental parameters for a variety of ionization technologies (SIMS, ESI, MALDI) combined with advanced multipole, TOF, FT-ICR and Orbitrap based MS systems. This approach will create a fundamental understanding of these techniques, and their potential in the characterization of various molecule classes. As such, optimization of tandem mass spectrometry methodologies will allow the students to recognize the importance of the physical foundations of gas-phase molecular collisions, the assessment of molecular structures. By developing MS imaging methodologies, a profound knowledge of laser technologies, particle beams and physical chemical processes at the surface of tissues or biomedical materials will be gained. As mass spectrometry plays an essential role in many R&D laboratories all over the world, a broad field of applications, including human tissues, endogenous compounds such as lipids and proteins, pharmaceutical drugs, biopharmaceutical, biomedical materials such as orthopaedic implants or even industrial chemicals will be used, giving the student a solid background and insight into the broad applicability of MS based technologies.

Literature

Mass Spectrometry Principles and Applications (De Hoffmann, Edmond, and Vincent Stroobant), power point slides, articles to be distributed. Students are requested to search literature for specific manuscripts.

Instructional format

This practical course is organized as a series of hands-on experiments, analyzing different small and larger (bio) molecules with various MS techniques. The students(in small groups) will work as a team, taking care that all participants will have hands-on experience with the technologies.

Assessment

The assessment on individual level will be based on:

- Skills training participation
- Laboratory report
- Viva voce

PRA2022 Integrated Sustainability Assessment of Climate Change -VSK2012

This course will take place at University College Venlo

Course coordinator

Prof. Dr. Pim Martens
Contact: p.martens@maastrichtuniversity.nl

Pre-requisites

None; Climate Change is recommended.

Objectives

- Understand climate and climate impacts models;
- Understand how these models are used to estimate future changes;
- Be able to design your own (conceptual)climate impact model;
- Understand the concept of Integrated Sustainability Assessment (ISA);
- Understand how various ISA tools and methods are used;
- Get hands-on experience in using several ISA tools (e.g. models, scenarios, games).

Description of the skill

An interdisciplinary study skill in Integrated Sustainability Assessment methodologies and concepts as an approach to address complex societal issues associated with the challenge of sustainable development, climate change in particular.
Integrated Assessment is an iterative, continuing process, where integrated insights from the scientific and stakeholder communities are communicated to the decision-making community, and experiences and learning effects from decision-makers form one input for scientific and social assessment. Multiple diverse approaches are needed, varying from analytical methods (such as Integrated Assessment Models) to participatory methods (such as focus groups). Global warming is perceived as one of the biggest global health risks of the twenty-first century which could have a range of effects. In this skills course, we will use climate change as an example to demonstrated various ISA methods and tools.
Theory is mixed with practice through lectures, discussions, ISA sessions and games.

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

Presentations, computer-based group practicals, interactive sessions, research-based learning.

Assessment

Graded IA exercises.

PRA2023 Astronomical Observing Techniques

Practical coordinator

Mr. Chad Ellington, Faculty of Science and Engineering, Maastricht Science Programme.
Contact : chad.ellington@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Recommended

- ✓ PRA 1003; PHY2008, PHY2009 or PHY2010

Objectives

This skill will prepare students to:

- Design, use and perform measurements in observational experiments;
- Manipulate and measure light;
- Carry out data reduction/analysis of astrometric, photometric and spectroscopic observations;
- Learn basics of various software routines for processing data and assembling figures;
- Communicate processes and findings to others;

Description of the practical

This practical is aimed at learning various aspects of observational astronomical techniques. This will be accomplished via hands-on exercises, laboratory experiments/analyses and via computer-based exploration. This practical will hopefully begin to prepare you for continuing to more professional astronomical instruments. Students in this practical will perform some observations on their own: beginning with simple naked eye observations and their interpretations, understanding optical systems of telescopes, move on to analyzing CCD or CMOS imagery (including archived and remotely acquired), acquire RGB images to ascertain atmospheric extinction coefficients, and finish up with acquiring & analyzing radio telescope observations of 21cm radiation within our Milky Way. Sub-topics may include learning about: celestial coordinate systems, celestial navigation, blackbody radiation, spectroscopy, image formation, diffraction, active/adaptive optics, various telescope types, tracking mounts, image acquisition (bias, flats, darks & science images), image processing, photometry, light curves, radio observations and interferometry.
Due to uncertain weather conditions and the fact that some observations will need to be performed outside of regular practical hours, some observations may be left up to students to perform on their own or will be of a simulated nature.

Literature

- To Measure the Sky (An Introduction to Observational Astronomy), F.R. Chromey, Cambridge University Press, 2010;
- AAVSO Observing Manuals, https://www.aavso.org/observing-manuals;
- AstroImageJ, https://www.astro.louisville.edu/software/astroimagej/;

Instructional format

In this skill, participants work together in small teams, as well as individually, and will perform different observations/laboratory exercises each week. Each exercise shall be thoroughly planned, executed, and analyzed by the team, with summary laboratory reports submitted. The final grade is primarily based on these lab reports as well as other assessments.

Assessment

The overall practical grade is based on a combination of:

- In-practical experimental design/application
- Weekly laboratory reports;
- Evaluation of an observing logbook/notes.

PRA2024 Geology

Course coordinator
Dr. Jesse Hennekam, Faculty of Science & Engineering, Maastricht Science Programme
Contact: j.hennekam@maastrichtuniversity.nl

Prerequisite
- ✓ INT1007 Introduction to Earth Sciences
- ✓ A bike to make field trips

Objectives
With its elevated landscape, prominent Pleistocene glacial deposits, and world-famous Cretaceous outcrops, Maastricht and its surroundings are situated in an exceptionally interesting geological environment. Furthermore, it marks a transition zone between the Ardennes in the south and the Rhine-Meuse delta in the north. The objective of this geology training course is to learn and utilise specific field skills, enabling you to investigate and understand the geology and geological history of an area.

Description of the course
Ever wondered why the south of Limburg is so distinctly different from the rest of the Netherlands? Being uniquely situated between foot of the Ardennes mountain range and the river delta in the low lands, Maastricht and surroundings are very interesting from a geological point of view. Moreover, the presence of the Maastrichtian Stage, a period demarking the end of the era of the dinosaurs, highlights the global importance of south Limburg to the study of geology. Millions of years of climatic variation, sea level changes, mountain building and erosion have formed the Limburg landscape into its current shape. This geological history has also a huge impact on the development of the area. The hills in the Limburg surroundings and their loess deposits, resulting in fertile grounds; the effects of the Meuse, dividing the city of Maastricht; and the ENCI quarry, excavating ancient sea deposits in order to provide building resources. During this course we will use various field techniques to investigate how these structures came into existences and how they have developed since. You will read and create geological maps, draw and measure outcrops, identify specific types of rock and learn how to look at a landscape in order to understand its geological past.

Literature
No textbook is required, although the literature used in the INT1007 Introduction to Earth Sciences course will be useful.

Instructional format
During this course we will go outside on multiple occasions. Most excursions will be in and around Maastricht city, for which a good bike will be necessary to reach the sites.

Assessment
- Presentation
- Portfolio
- Field report

PRA2025 Vertebrate Functional Morphology

Course coordinator

Prof. Dr. Leon Claessens, Faculty of Science and Engineering, Maastricht Science Programme.
Contact: leon.claessens@maastrichtuniversity.nl
Dr. Jesse Hennekam, Faculty of Science and Engineering, Maastricht Science Programme.
Contact: j.hennekam@maastrichtuniversity.nl

Pre-requisites

✓ None

Co-requisites

✓ BIO2008 Great Transformations in Vertebrate Evolution

Objectives

- To examine, interpret and understand the vertebrate body plan
- To gain a fundamental understanding of the vertebrate skeletal system, including its anatomy, its developmental and evolutionary history, and its physiology and function
- To be able to integrate musculoskeletal and other organ system function as it relates to the form and biomechanics of vertebrate skeletal system
- To gain an understanding of the wide disparity in vertebrate body design and function
- To understand the implications of functional morphological adaptations
- To interpret vertebrate morphology within an evolutionary context

Description of the skill

In this skill you will gain insight into the great diversity in form and function of your own biological lineage, the vertebrates. Since the origin of the vertebrate lineage in an aquatic environment in the earliest Paleozoic, the group has diversified and expanded into all major habitats on Earth. The evolution and development of the skeletal system has played a key role in the successful incursion of the aquatic, terrestrial and aerial realms. In the laboratory, we will focus on musculoskeletal structure, function, and development to examine disparities, commonalities, and convergences in vertebrate morphology within an evolutionary context. You will gain a broader understanding of vertebrate morphology and function, biomechanics, physiology, development, phylogeny, paleontology, and evolution. You will learn how to examine, contextualize, and interpret vertebrate morphology and function to help assess evolutionary changes in vertebrate life. Using comparative anatomy, we will analyse and evaluate the structure and function of the skeleton in both extant and extinct taxa. With this newfound understanding of the form and function of the skull, teeth, axial skeleton and limbs in different taxa, we will explore how animals adapted their physiology to new ecological conditions.

Literature

- Weekly handouts will be provided;
- Select scientific articles; access through the UM library.

Instructional format

Half and full day laboratory practicals.

Assessment

- Weekly lab exercises;
- Morphology project;
- Video presentation.

PRA2026 R programming language

Course coordinator

Dr. Phil Klahs: Faculty of Science and Engineering, Maastricht Science Programme
Contact: phil.klahs@maastrichtuniversity.nl

Pre-requisites

- ✓ None
- ✓ A laptop computer

Co-requisites

- ✓ None

Recommended

- ✓ MAT2007 Introduction to Programming

Objectives

The R programming language is an open-source free software environment designed for statistical computing. An extensive library of downloadable packages provides a wide range of statistical tools, and customizing scripts or creating new scripts is possible through coding. This skills training will provide an overview of the environment, demonstrations of specialty packages, examples of ways to analyze data, and experience with visualizing the results. The main objective is to enable you to use R to answer your own questions.

Description of the course

We will work in a user-friendly interface for R called RStudio. All software and packages used in the course are free to download. We will start with an introduction of the RStudio environment and how it interfaces with your computer. After learning to upload, manage, and clean data we will perform statistical analyses. Explanations of graphing and visualization will include examples, discussions of helpful packages, and peer review of rendered results. After navigating the work environment and standard capabilities of RStudio we will undertake several case studies that demonstrate the ability of specialized packages to address specific scientific questions.

Literature

This skill will use primary literature and documentation available through the RStudio help() function. No text book is required.

Instructional format

You will work on your own laptop computer. Some demonstrations will be provided as completed scripts and we will execute commands together sequentially; some examples will require you to copy lines of code and troubleshoot error messages; and other tasks will be completely self-constructed to cultivate your creative coding.

Assessment

- Development of personalized scripts;
- A report with intermittent peer review;

PRA2027 Fundamentals of Science Communication

Course coordinator
Dr. May Lee, Faculty of Science and Engineering, Maastricht Science Programme
Contact: may.lee@maastrichtuniversity.nl

Pre-requisites
- ✓ PRO1002: Project Period (1000-level)

Co-requisites
- ✓ None

Recommendations
- ✓ None

Objectives
- ✓ At the end of this skills course, students will be able to:
- ✓ recognize different models of science communication
- ✓ identify and describe different types of non-technical audiences
- ✓ apply the components of stories to create a science narrative for specific audiences
- ✓ collaborate with peers to use a science narrative (with their respective identified audiences) to create a short podcast, design a digital infographic, and write a feature article
- ✓

Description of the skill
- ✓ The skill involves learning to effectively communicate scientific ideas to audiences not familiar with the content by identifying the audience, constructing science-based narratives, and using traditionally non-academic forms of communications.

Literature
We will use primary literature as a basis for the tasks, which are accessible through the course Canvas/UM Library webpage. No textbook is required.

Instructional format
The sessions will start with short presentations that are followed by group/individual activities. Students will work in groups to complete three projects (infographic, podcast, feature article), which are all related to their interview of a scientist.

Assessment
The course grade is based on the students' portfolio (which documents their work on the podcast, infographic, and feature article) and ability to work in groups.

PRA2028 Mathematics and Art

Course coordinator

Dr. Mariet Hofstee, Faculty of Science and Engineering, Maastricht Science Programme.

Contact: mariet.hofstee@maastrichtuniversity.nl

Pre-requisites

None

Objectives

To explore the role of mathematics in art as well as use Mathematics to create art.

- To explore the role of mathematics in art
- To generate a piece of mathematical art

Description of the course

When experiencing the beauty of art, few people realise the role that mathematics plays in this experience. In this hands-on course we will explore the role of mathematics in art. This encompasses not just the graphical arts, but also topics like sculpture, architecture, cartography and music. Geometry plays a large role in both shaping art and nature, and some special numbers, such as pi, will be covered. Many other mathematical principles, such as symmetry, scaling, topology and fractals, will be discussed. Each week a different theme will be explored, and students are asked to analyse a work of existing art based on the mathematical principles discussed. Some of the work will also involve the use of math tools such as wolfram-alpha or geogebra, to analyse art and generate art based on math.
For the final project students will produce their own work of art or analyse an existing artwork, and give a brief presentation on the role of mathematics in its design.

Literature

Optional:

Mathematics and Art, Lynn Gamwel
Math Art: Truth, Beauty, and Equations, by Stephen Ornes (Author)
Imaginary Exhibit catalogue, https://www.imaginary.org/sites/default/files/imaginary-catalogue-edition-2014_0.pdf

Instructional format

Workshops

Assessment

List types of assessments.

- Weekly projects focussing on a mathematical aspect of art, or an artistic aspect of Math
- Final project and presentation on a topic of choice

PRA2029 3D Visualizations and Transformations

Course coordinator
Dr. May Lee, Faculty of Science and Engineering, Maastricht Science Programme
Contact: may.lee@maastrichtuniversity.nl

Pre-requisites
- ✓ None

Co-requisites
- ✓ None

Recommendations
- ✓ None

Objectives
At the end of this skills course, students will be able to:
- ✓ interpret, and be able to sketch, different 2D views of a 3D object (e.g., isometric, one- and two-point perspectives)
- ✓ apply geometric relations and constraints between shapes and forms (e.g., points, lines, angles) with respect to the origin planes (XY, YZ, and XZ) of a Cartesian coordinate system
- ✓ collaborate with peers to explain the science behind a physical object with respect to the (a)symmetries present in the objects
- ✓ decompose objects into their basic shapes and accurately recreate a scaled model from the corresponding 2D views using work features (planes, axes, points) and feature creations (extrude, revolve, sweep)
- ✓ learn about various methods to scan 3D objects (i.e., photogrammetry, 3D scanning)

Description of the skill
The skill involves interpreting images of various objects from 2D and 3D perspectives, in addition to analysing a chosen object's symmetries to explain the relations between its physical form and function. This analysis will involve explaining the analysis through an animated to be created with a 3D visualization software.

Literature
We will use primary literature as a basis for the tasks, which are accessible through the course Canvas/UM Library webpage. No textbook is required.

Instructional format
Each session is comprised of instructional presentations followed by time to practice those skills in group/individual settings, to contribute towards a final project. Working in groups, students will select an object to analyse and print, addressing the roles of symmetry with respect to the object's form and function.

Assessment
The course grade is based on a group presentation explaining their analysed object, quality of their portfolio documenting their analysis of an object from different perspectives, and ability to work collaboratively in groups.

PRA2030: Introduction in Mycology

Course coordinator
Dr. Alexander Umanets: Faculty of Science and Engineering.
Contact: a.umanetc@maastrichtuniversity.nl

Pre-requisites/ Co-requisites
- ✓ None

Recommended
- ✓ General biology

Objectives
After this practical, students should be able to:
- Isolate and cultivate fungi
- Perform microscopy and staining
- Give a morphological description of fungi micro- and macro- structure
- Identify isolated fungi using morphological and molecular methods
- Assess of enzymatic and antibacterial activity of isolated fungi

Description of the skill
Fungi play a pivotal role in environment, agriculture, and biotechnology. Fungi are a broad group of eukaryotic organisms with diverse functional and morphological characteristics. They are a gold mine of potent enzymes, antimicrobials, and bioactive compounds. However, it is a largely untapped mine since 90% of fungal species have never been isolated or characterized.
During this course, you will have a hands-on experience with the isolation, cultivation, identification, and characterization of fungi. Working in groups you will collect an environmental sample and will attempt to isolate pure cultures of different fungi species. After isolation, you will perform characterization and identification of isolated fungi and will learn about their morphology and corresponding laboratory techniques in the process. As the last step, you will assess the biotechnological potential of isolated cultures by performing substrate utilization and antimicrobial activity tests. At the end of the course, you will write a laboratory report regarding your findings and present it to the rest of the group.

Literature
Various primary literature articles and the course manual.

Instructional format
One laboratory session per week scheduled.

Assessment
- Work participation.
- Multiple choice questionnaire
- Laboratory report and final presentation.

PRA2031 Python Programming Language

Course coordinator

Dr. Ruth Großeholz: Faculty of Science and Engineering, Maastricht Centre of Systems Biology / Brightlands Future Farming Institute

Contact: ruth.grosseholz@maastrichtuniversity.nl

Pre-requisites

None

Recommendations

- ✓ Prior programming experience
  or
- ✓ MAT2007 Introduction to Programming

Objectives

- Learn to use the principles object-oriented programming and classes in python
- Explore using python to program, simulate and visualise a problem
- Learn basic, essential techniques to debug your code, using virtual environments and package managements
- Using GitHub repositories for version control, collaborative programming and code sharing

Description of the course

Python is one of the most popular programming languages in the world. It is a high-level programming language, which was designed to emphasize code readability. Its application ranges from web applications over scientific computing to artificial intelligence projects.
In this course you will expand your knowledge and understanding of python programming by working in groups on an example project from one of the scientific fields (biology, physics and chemistry). Together, we will learn the basics of object-oriented programming, take a closer look at methods within classes and code debugging methods. You will learn to identify and use relevant python packages for your project and to document your code so that is understandable to other people. Furthermore, this course will introduce git and GitHub repositories for version control, collaborative programming work, and code sharing.

Literature

No specific textbook is required. However, relevant literature will be provided on Canvas for each topic.

Instructional format

Each session will consist of a short lecture to introduce the week's topic, followed by short programming tasks to practice the introduced concepts. The rest of the session will be spent on the group project. Students should bring their own laptop.

Assessment

Your final grade will consist of these parts:

- Midterm exam,
- Individual tutor assessment,
- Peer review,
- Group grade on the GitHub repository,
- Group grade on the presentation of your project (with individual component for the presentation style and answering questions).

Next to this there are pass/fail assessments for the attendance and weekly Canvas quizzes on the course content.

PRA2032 Fundamentals of Organic Chemistry Laboratory

Course coordinator

Dr. Hanne Diliën, Faculty of Science and Engineering, Sensor Engineering Department.

Contact: hanne.dilien@maastrichtuniversity.nl

This course cannot be followed in case you already followed PRA2002 Chemical Synthesis

Pre-requisites

- ✓ None

Co-requisites

- ✓ CHE2009 Fundamentals of Organic Chemistry

Recommendations

- ✓ none

Objectives

- To be able to perform organic synthetic experiments in a structured and safe manner;
- To understand and be able to execute specific separation and purification techniques commonly used in organic chemistry;
- To learn basic and common analysis techniques in organic synthesis
- To gain skills in scientific research reporting, more in specific reporting results in a lab report.

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;
- Purifications and separations in chemistry;
- Characterization of organic compounds.

Literature

- Practical laboratory instructions;

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 introducedduring the tutorial group meetings of the co-requisite course: CHE2001 Organic Chemistry.

Assessment

- Lab assignments during lab;
- Pre-lab online assessment;
- Safety quiz;
- Lab report(s).

PRA2033 Organic Chemistry Laboratory

Course coordinator

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

Contact: hanne.dilien@maastrichtuniversity.nl

This course cannot be followed in case you already followed PRA2002 Chemical Synthesis + PRA3001 Advanced Organic Synthesis

Pre-requisites

- ✓ PRA2032 Fundamentals of Organic Chemistry Laboratory

Co-requisites

- ✓ CHE2011 Organic Chemistry

Recommendations

- ✓ CHE2004 Spectroscopy

Objectives

The main objective of this skill is to provide a solid foundation in organic synthesis. A sequence of reactions has to be designed to obtain materials. Some of these steps may require complex chemistry, very reactive intermediates or inert atmospheres. The course will focus on the development of organic synthetic procedures and techniques.

Description of the skill

This skill will contain:

- Advanced synthetic chemistry of various organic reaction types;
- Synthesis and handling of reactive compounds under inert atmosphere;
- To gain a practical understanding of the impact of the choice of reagents, solvents and conditions on the outcome of an organic reaction;
- Use of (spectroscopic) characterization (therefore it is recommended to already have experience in operating the IR and NMR in the labs).

Literature

- Practical laboratory instructions;

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 introducedduring the tutorial group meetings of the co-requisite course: CHE2011 Organic Chemistry.

Assessment

- The laboratory notebook with developed protocols;
- Lab reports;
- (Pre-)lab assignments.

PRA2034 General Chemistry Laboratory

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

Pre-requisites
- PRA1101/2 - Introduction to Scientific Research

Co-requisites
- CHE2010 - General Chemistry

Objectives
- Recognize standard laboratory glassware and analytical equipment.
- Correctly carry out common laboratory procedures.
- Measure and report quantities with appropriate precision.
- Convert raw data to a physically meaningful form for communication.

Description of the skill
This course focuses on topics in base skills needed in a chemistry laboratory. These topics will be taught using a series of lab experiments designed to develop a battery of lab skills needed for more advanced chemistry courses.

Literature
- The textbook from the pre-requisite course
- Manuals of the any instruments used will be available

Instructional format
Interactive laboratory sessions.

Assessment
- Lab reports, including theoretical background, procedures, data presentation and discussion
- Laboratory notebook and lab safety

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 reactiveintermediates 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 introducedduring the tutorial group meetings of the co-requisite course: CHE3001 Organic Reactions.

Assessment
- The laboratory notebook with developed protocols;
- Lab reports;
- Pre-lab assignments.

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

Objectives

- To acquaint the participants with an overview of the main areas in 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 datathat 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:

- Contribution within the lab;
- Quality of lab notes kept
- individual lab reports written following the laboratory session.

Each participant produces lab reports for the duration of the module. These are graded considering the quality of the experimental design as well as the report itself.

PRA3003 Molecular Biology

Course coordinator

Dr. Kathia Jimenez. Faculty of Science and Engineering, Maastricht Science Programme
Contact: k.jimenezmonroy@maastrichtuniversity.nl

Pre-requisites

- ✓ PRA2014 Genetics
- ✓ 1000-level core courses

Co-requisites

- ✓ BIO3001 Molecular Biology

Objectives

- Preparation and analysis of protein/nucleic acid interactions via an electrophoretic mobility shift assay (EMSA).
- Preparation and analysis of immunoprecipitation (IP) in leukocytes and learn about protein/protein interaction assays.
- Preparation and quantification of proteins that are lysed out from leukocytic samples.
- Application and analysis of molecular cloning techniques (e.g. restriction enzymes and ligation in a vector).
- Preparation of a variety of (electrophoretic) analysis methods to assess the EMSA, IP and cloning results.
- Get a deeper knowledge on how these techniques are applied in current molecular biology.

Description of the skill

The general aim of this skills course is to obtain detailed practical knowledge about the techniques that can be applied to address molecular processes in mammalian biology. Topics include the intracellular signaling pathways; cellular responses; nucleic acid vs protein interactions and recombinant DNA. The skills days are designed to provide a perspective on how molecular biological techniques are applied to tackle major research questions in modern biomedical research.

Literature

Online videos and additional literature sources are provided via Canvas.

Instructional format

Skills sessions.

Assessment

- Before you come to the lab, you have to prepare the experiments. This means that you have to read the lab instructions at least the day before the lab. Furthermore, you need to fill the instructions/calculations in your lab notebook already. Calculations of the buffers dilution, agarose gel, plasmid copy number and BCA protein quantification will be written in your individual laboratory book. It will be graded and the 4 tasks will account for 10% of your final grade.
- In CANVAS students need to fill the online quiz. Complete this before the lab (23h59 the day before the lab at the latest, no exceptions). There are in total 4 quizzes, one per week. The average grade of the 4 quizzes will account for 20% of the final grade.
- Attendance to the skills meetings is required (cf. Rules and Regulations). In case of any absence, a motivation is required via the Office of Student's Affairs. A final evaluation on skills (results EMSA and IP) is scored and will account for 20% towards the final grade.
- You have to prepare 2 laboratory reports per team. One report from practical 1 and one report from practical 3-4. The contents of the report can be find in the 4 appendix A part of the syllabus. Deadlines will be posted in CANVAS. The grade of the 2 reports will account for 50% to the final grade.

PRA3005 Polymer Processing

Note: This skill will require students to arrange their own travel to the Geleen Chemelot campus to attend laboratories.

Course coordinator

Eveline Maassen, CHILL.

Contact : eveline.maassen@chill.nu

Pre-requisites

- ✓ CHE2001 Organic Chemistry

Co-requisites

- ✓ None

Objectives

- Obtain an understanding of the processing of different thermoplastic polymers;
- Obtain skills in the processing of polymers e.g. (film)extrusion and injection moulding,compounding, etc.;
- Develop the skills to determine the physical and mechanical properties of polymers and to increase the understanding of the underlying characterization methods.

Description of the skills

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

- Thermoplastic polymers will be processed with blown film extrusion. Mechanical tests will be conducted on the produced films to get a better understanding of the effects of the processing on the properties of the material.
- Thermoplastic polymers will be processed via multiple pass extrusion. These materials will be characterized via Melt Flow Index (MFI) to determine the effect of multiple pass 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 strength analysis and impact tests.

The experiments are performed in groups and the group had to hand in a report discussing the experiments, the obtained results and theoretical background on the experiments.

Literature

Practical Manual, powerpoint with background information.

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 coordinators

Dr. Rianne Fijten [1], Dr. Egon Willighagen [2]
1. Department of Radiotherapy, FHML
2. Department of Translational Genomics, FHML

Contact: r.fijten@maastrichuniversity.nl

Pre-requisites

✓ MAT2007 Introduction to Programming **or** PRA2003 Programming

Objectives

- Develop and implement computational solutions to real-world problems, such as disease patterns, drug interactions, omics data, or environmental effects on health.
- Identify and analyze chemical. biological, medical, and ecological entities and understand their relevance to human health, healthcare systems, and environmental interactions.
- Retrieve, integrate, and process data from public life sciences databases to answer complex research questions.
- Apply programming concepts for data querying, processing, and visualization in biology, medicine, and environmental sciences.
- Use web technologies through programming to explore and analyze large-scale datasets from diverse sources.
- Communicate data-driven insights effectively through interactive visualizations and structured reports.
- Work with modern software development practices, including version control, collaborative coding, and documentation, to create reproducible and maintainable code.

Description of the course

Life sciences research increasingly relies on computational methods to explore complex biological, medical, and environmental questions. This course provides hands-on experience in using programming to analyze and visualize large-scale publicly available data relevant to biology, human health, biodiversity, and ecosystems.
Students will work in small groups to develop a website that applies computational methods to a research question of their choosing within the domains of biology, medicine, or ecosystems. This allows students to tailor the course to their interests while gaining practical experience in data-driven research. Example topics include:

- What are common symptoms and/or drug treatments across several (mental) health disorders?
- How do gene interactions and metabolic pathways contribute to disease progression?
- How does air pollution influence extinction rates in marine ecosystems?
- Are there patterns of chemical or physical properties of chemical substances?

Students will learn how to interact with public SPARQL endpoints to extract and analyze knowledge from large scientific databases. Using JavaScript and data visualization libraries like d3.js, they will develop interactive tools and visualizations to represent research findings in an intuitive way. The course also introduces modern software development practices and provides hands-on experience with GitHub for code storage and collaboration.

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. https://maastrichtuniversity.on.worldcat.org/oclc/428142652;
- "Semantic Web for the working ontologist: effective modeling in RDFS and OWL" by D. Allemang, J.A. Hendler. 2011. UB Library. https://maastrichtuniversity.on.worldcat.org/oclc/733936673;
- "Git from the Bottom Up" by J. Wiegley. https://jwiegley.github.io/git-from-the-bottom-up/.

Instructional format

Five hands-on practicals, literature review, and home assignments. Students will work in small groups on a website and should bring their own laptop.

Assessment

- Individual oral examination (60%); assesses each student's understanding of the code, including its functionality, structure, and their ability to modify and explain key components.
- Peer-weighted group assessment for the final product (40%); the base grade is assigned to the whole group but can be adjusted by a maximum of ±1.0 point based on peer evaluations.

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 analyzed 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 characterization. In the subsequent weeks, you will each analyze a potential outbreak forwhich you will need to determine the infectious agent, analyze the antimicrobial resistance pattern to propose therapy as well as the genetic composition of the micro-organism in order to determine geneticrelatedness. For this you will use the techniques that you have learned in the previous weeks. Finally you will need to present your results as a poster.

Literature
- Murray, *Medical Microbiology* (8th ed.), Elsevier Mosby;
- Primary literature.

Instructional format
Weekly laboratory experiments.

Assessment
You will be marked on the quality of
- Handing in the assignment for the first practical
- Your written research plan how to investigate the outbreak
- A poster presentation on the outbreak analyses (final week).

PRA3011 The Limburg landscape

Course coordinator

Dr. Phil Klahs: Faculty of Science and Engineering, Maastricht Science Programme
Contact: phil.klahs@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. While studying at Maastricht University you occupy this landscape and are surrounded by its distinct attributes. The main objective of this skills training is to familiarise you with the biological characteristics and geological history of the province so you can understand the evolution of its natural landscape.

Description of the course

The landscape of Limburg, like any other landscape, displays a variety of features. Some of these reflect the human endeavor to adapt the landscape. For instance, there has been a clear impact 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. The combination of these geological, geomorphological and climatic factors has endowed the province with its own characteristic wealth spanning from the current botanical variety to Mosasaurs. Topics covered in this skills training include 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. As part of this skill, you will also gain more in depth knowledge of 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 and paleobiology, river biology, fungal biology, nature conservation, plant/pollinator interations). During the weeks you will visit several field sites by bike. 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 includes several assignments:

- An individual review report on one of the excursions;
- A group review report on organisms witnessed on 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;

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;

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;
- An oral assessment.

PRA3014 Spectroscopic Methods

Course coordinator
Dr. Annelies van der Bok, Faculty of Science and Engineering, Maastricht Science Programme.
Contact: Annelies.vanderbok@maastrichtuniversity.nl

Pre-requisites
- 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, ^{13}C, ^{19}F, ^{31}P, COSY spectroscopy;
- Mass spectrometry using GC and LC;
- Differential Scan Calorimetry (DSC) and Thermogravimetric Analysis (TGA).

Literature
- The textbooks from the pre-requisite courses;
- Manuals for the different instruments will be available.

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
Dr. Silvia Bolognin: Dept. cBITE, MERLN Institute for Technology-Inspired RegenerativeMedicine; Faculty of Health Medicine and Life Science, Maastricht University.

Contact: silvia.bolognin@maastrichtuniversity.nl

Pre-requisites
- ✓ PRA2014 Genetics

Co-requisites
- ✓ None

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

Description of the skills
These skills will contain:
- Immunocytochemistry (ICC) on HIF translocation in hypoxia/Phenantroline treated and untreated cells;
- RT-qPCR using Sybr Green for anti- and pro-apoptotic markers;
- Metabolic assays (PrestoBlue assay);
- Microscopy;
- Computational analysis of obtained data (Use of CellProfiler to analyze ICC 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
- The attendance to laboratory practicals is mandatory (cf Rules and regulations).
- A written exam at the end of the practicals. This exam will contain questions related to the techniques seen during the course and information received during the lectures;
- Practical reports: students will prepare, in teams of three, a report for each of the sessions: cell culture, qPCR, and ICC.

PRA3018 Molecular Modeling

Course coordinator
Dr. Veaceslav (Slava) Vieru: Faculty of Science and Engineering, Maastricht Science Programme.

Contact: v.vieru@maastrichtuniversity.nl

Pre-requisites
- ✓ none

Co-requisites
- ✓ CHE3006 Quantum Chemistry

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 find 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 pre-lab questions and the final paper

PRA3021 Topics in Scientific Computing

Course coordinators
Dr. Marcin Pietrasik: Faculty of Science and Engineering, Department of Advanced Computing Sciences.
Contact: marcin.pietrasik@maastrichtuniversity.nl

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

Recommended
- ✓ KEN1540 Numerical Methods

Objectives
Students are expected to:
- Understand the role of computers to analyse and solve problems in various scientific domains.
- Learn several algorithms for scientific computing, the problems they solve, and why they are important.
- Gain experience implementing algorithms and applying them to scientific problems.

Description of the skills
Scientific computing concerns the use of computers to analyse and solve problems arising in a wide range of disciplines including biology, chemistry, and physics. In this course, students will gain and understanding for and develop solutions to a selection of these problems. Specifically, they will examine frequency domain analysis for signal processing; machine learning for cluster analysis; principal component analysis for dimensionality reduction; linear regression for regression analysis; finite-difference solvers for partial differential equations; and optimisation for graph construction. This course is complemented by KEN1540 Numerical Methods, a course in which students learn the basic algorithms of scientific computing in more depth. Python will be the language of instruction for this course.

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 practicals, problem-based learning. There are no separate tutor groups for this course.

Assessment
Five equally weighted assignments that include implementation (coding) and written report components. Assignments are to be performed individually. There is a 100% attendance requirement.

PRA3022 iGEM Competition

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 Competition

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. They will not only get experience in the practical application of molecular biology techniques, but will experience the full cycle of a research project.

Description of the course

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 Paris, in a poster session, by giving an oral presentation and by defending the project in front of a jury.

Literature

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

Instructional format

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

Assessment

Students will be assessed with a peer-review grade and with a supervisor grade that will be a combination of:

- The overall participation and contribution in the iGEM team (based on input in brainstorm sessions and project meetings);
- Practical work on the design and building of the biological system and the contribution to scientific presentations (oral, jury defence and/or poster).

PRA3023 Plant Physiology and Microbiomes

Course coordinator

Dr. Alexander Umanets: Faculty of Science and Engineering.
Contact: a.umanetc@maastrichtuniversity.nl

Pre-requisites

- ✓ BIO2003 General Botany OR a microbiology course

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 growing plants and microbes;
- Measure plant responses to biotic and abiotic stimuli;
- Correctly apply statistical tests to analyze a plant growth experiment;

Description of the skill

Millions of years of co-evolution created a tight bond between plants and microorganisms. In recent years, we have developed techniques to study intricate relationships between plants and their microbiome and discover the paramount importance of microbiome for healthy plant growth and adaptation. During this practical course, we will learn about foundational methods for studying plant-microbiome interaction. You will perform hands-on laboratory experiments, as well as learn how to analyze, interpret, and report obtained results. In particular, you will learn how to measure plants' physiological responses and functional traits, quantify common plant-microbe symbioses, and techniques for sterile plant and microbe propagation.

Literature

Various primary literature articles and the course manual.

Instructional format

One laboratory session per week.

Assessment

- In class participation
- Data analysis exercises
- Written report
- Results Presentation

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

- ✓ A handful of physics courses at level 2000/3000.

Objectives

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

- Experiment with code in python in a notebook-like setup;
- Recognize 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 large 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, astrophysical datasets and open machine learning datasets. This skill will introduce modern computing skills for data handling using open-source software packages and github. 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;

PRA3025 Science Communication: Curating Science Exhibits

Course coordinator
Dr. May Lee, Faculty of Science and Engineering, Maastricht Science Programme
Contact: may.lee@maastrichtuniversity.nl

Pre-requisites
PRA2027: Fundamentals of Science Communication

Co-requisites
None

Recommendations
None

Objectives
At the end of this skills course, students will be able to:
- address how museums function as mediums of memory
- analyse the narratives (object-centric, narrative-driven) constructed in exhibits with respect to the perspectives that are highlighted
- collaborate with peers to propose a design and implement it for a science exhibit
- properly select, care for, and manage museum artefacts
- reflect on and engage with trends and issues in curatorial practices

Description of the skill
The skill involves analysing the intersections between history and science/technology, especially with respect to the processes involved in exhibit curation, and applying those analyses towards the proposal and implementation of a design that makes use of the display cases on the ground floor of PHS1.

Literature
We will use primary literature as a basis for the tasks, which are accessible through the course Canvas/UM Library webpage. No textbook is required.

Instructional format
Each session is comprised of instructional presentations followed by time to practice those skills in group/individual settings, to contribute towards a class exhibit on Maastrichtian artefacts. Working in groups to design science exhibits around a theme chosen by the group as a whole and by the end of the course, students will implement their proposed designs in the display cases on the ground floor of PHS1.

Assessment
The course grade is based on the quality of the proposed designs, analysis paper on the curatorship of a local museum, ability to work collaboratively in small and large groups, and the implementation of those designs in the display cases on the ground floor of PHS1.

PRA3026 Science Teaching Skills

Course coordinator
Dr. May Lee, Faculty of Science and Engineering, Maastricht Science Programme
Contact: *may.lee@maastrichtuniversity.nl*

Pre-requisites
- ✓ INT2013: Fundamentals of Science Education

Co-requisites
- ✓ INT3012 Science Education: Model-Based Inquiry

Recommendations
- ✓ None

Objectives
At the end of this skill course, students will be able to:
- ✓ collaborate with peers to optimize teaching activities for assessment
- ✓ characterize students' engagement in learning science

Description of the skill
This skills course provides additional hands-on experience in designing and implementing phenomena-based activities that are aligned with the science education performance expectations and are responsive to the needs of diverse student populations.

Literature
We will use primary literature as a basis for the tasks, which are accessible through the course Canvas/UM Library webpage. No textbook is required.

Instructional format
The sessions will involve a variety of activities, including group/individual activities based on information presented during lectures and possibly assisting in local science classrooms.

Assessment
The course grade is based on the students' performances on various (individual and group) activities, such as short written assignments, teaching journal, and lesson plans/implementation/reports.

PRA3027 Advanced Functional Morphology

Course coordinator

Prof. Dr. Leon Claessens, Faculty of Science and Engineering, Maastricht Science Programme.
Contact: leon.claessens@maastrichtuniversity.nl
Dr. Jesse Hennekam, Faculty of Science and Engineering, Maastricht Science Programme.
Contact: j.hennekam@maastrichtuniversity.nl

Pre-requisites

- ✓ PRA2025

Co-requisites

- ✓ None

Objectives

- Examining and interpreting vertebrate form and function at an advanced level
- Realising a more comprehensive understanding of functional morphology in the animal kingdom
- To build an integrative view of functional and developmental morphology using modern imaging techniques
- Applying various methods for analysing inter- and intraspecific functional shape changes
- To construct lineage-specific evolutionary scenarios through the examination of morphology and function

Description of the skill

In this skill you will delve deeper into the great diversity in form and function within Animalia. You will use modern imaging and analytical techniques to examine vertebrate and invertebrate form and function. We will evaluate biomechanical, physiological, developmental, and phylogenetic relationships to understand the divergence in functional morphological solutions evolved throughout time. You will learn how to examine, contextualize, and interpret form and function to assess evolutionary changes. Through lineage-specific inquiries you will develop evolutionary narratives of functional morphological adaptations.

Literature

- Weekly handouts will be provided;
- Select scientific articles; access through the UM library.

Instructional format

Half and full day laboratory practicals. Access to a Windows laptop is recommended.

Assessment

- Weekly lab exercises
- Peer evaluation
- Report

PRA3028 Inorganic Synthesis

Course coordinator

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

Pre-requisites

- ✓ PRA2002 Chemical Synthesis or PRA2032 Fundamentals of Organic Chem Laboratory

Recommended:

- ✓ The practical complements perfectly Spectroscopy (CHE2004)

Co-requisites

- ✓ CHE3010 Inorganic Chemistry

NOTE: you cannot follow this lab if you have already passed PRA2004 Inorganic Synthesis

Objectives

- To implement in laboratory setting the principles of periodic properties, bonding, reactivity and macroscopic behaviour seen in the theory class;
- To learn the basic synthetic techniques in inorganic chemistry;
- To synthesize and study a range of inorganic compounds;
- To understand the scientific approach to characterization of products;
- To refine the scientific reporting skills on data presentation, analysis and discussion.

Description of the skill

This skills will focus in the synthesis and analysis of inorganic compounds, focusing primarily on coordination compounds, their isolation, purification, and spectroscopic characterization.
The students are expected to become familiar to how to gather methodological and characterization results, and reported in a scientific manner adequate for further training.
From this practical, the students can expect to gain not only the proper habit of working in the laboratory for synthetic purposes, but also to familiarise themselves with calculations (preparatory and result-related) and with instrumentation. You can expect to be exposed to instruments and techniques you have not seen before, and understand how to get information on your samples (even without having taken Spectroscopy!).
Report and proper plotting are an integral part of the laboratory experience: we will aim to standards that will allow you to produce professional reports for future courses and projects.

Literature

Girolami, Rauchfuss, Angelici: Synthesis and Technique in Inorganic Chemistry (University ScienceBooks).
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;

PRA3503 Microbiome Analysis

Course coordinator
Dr. Alexander Umanets: Faculty of Science and Engineering.
Contact: a.umanetc@maastrichtuniversity.nl

Pre-requisites
- ✓ INT3007 Systems Biology OR MAT2007 Introduction to Programming AND/OR
Basic familiarity with computer programming (R) and command line interfaces

Co-requisites
- ✓ None

Recommended
- ✓ BIO3003 Microbiology and/or BIO3010 Genomics and Proteomics and/or INT3007 Systems Biology

Objectives
After this practical, students should be able to:
- Process and analyze microbiome data from high-throughput sequencing;
- Correctly interpret microbiome data analyses;
- Assess the methodologies used in microbiome research publications;
- Contextualize their data analyses with knowledge of microbiome research and its applications.

Description of the skill
In the past decade, research has increasingly revealed the importance of relationships between macro-organisms (plants, animals) and complex communities of micro-organisms living inside and on them - their microbiota. Microbiota can consist of hundreds and thousands of distinct microbial species that form complex interactions with each other and their host. Due to the complexity and inability to isolate and culture many microorganisms, we had limited insides in microbiota composition and dynamics. Luckily, development of the next-generation sequencing (NGS) technologies gave the ability to retrieve an unprecedented amount of genomic information and to get insights into microbiota genetic makeup. However, processing of NGS data and extraction of useful information are not trivial tasks and requires the application of diverse computational and statistical methods. In this skill, you will learn how to process NGS data, extract information, and analyze microbiome datasets. You will also familiarize yourself with the literature in this field in order to explain the applications and importance of microbiome research.

Literature
Various primary literature articles and the course manual.

Instructional format
One computer laboratory session per week.

Assessment
- Data analysis training exercises;
- Multiple choice tests;
- Proposal and final paper for microbiome data analysis group project.

PRA3504 The Academic Life Cycle

Course coordinators

Dr. Kyle Jazwa, Maastricht Science Programme, Faculty of Science and Engineering.

Contact: k.jazwa@maastrichtuniversity.nl

Pre-requisites

- ✓ PRA2015: Advanced Academic Skills

Recommended

- ✓ None, but students should have already written a university-level paper.

Objectives

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

- Participate effectively in all stages of the academic lifecycle: from idea to publications.
- Engage expert and non-expert audiences with your work/research.
- Identify relevant funding sources and publication venues for their research.
- Responsible peer review scientific writing and incorporate feedback in your writing.
- Convince relevant stakeholders to support and/or fund their work.

Description of the skill

This skills course will complete your exploration of the academic life cycle—from idea to publication (and beyond!). The coverage includes: writing grant proposals, submitting academic papers for publication in scientific venues, reviewing the work of peer scientists, and developing the essential (and often untaught) interpersonal skills that are integral for professional and academic interactions. By performing and recreating many of these steps, you will gain the confidence and self-certainty to become a well-rounded participant in professional, scientific arenas.

Particular emphasis will be placed on two specific moments in the academic sequence: grant writing and the journal submission/review process. After having completed this course, PRA2015, and PRO1101, you will have practiced virtually all important steps in the Academic Lifecycle.

Literature

All assigned readings and other materials are available (free of charge) via the course Canvas page and/or the UM library webpage.

Instructional format

A combination of in-person meetings/tutorials, asynchronous activities, and flexible group work. The in-person meetings will often feature guestspeakers and discussion sessions.

Assessment

Several small assignments and activities, including:

- writing a grant proposal;
- mock submitting a revised/formatted research paper to an academic journal;
- peer review;
- short presentation.

PRO1101 Introduction to Project Period

Course coordinators

Dr. Kyle Jazwa, Maastricht Science Programme, Faculty of Science and Engineering.

Contact: k.jazwa@maastrichtuniversity.nl

Dr. May Lee, Maastricht Science Programme, Faculty of Science and Engineering.

Contact: may.lee@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Recommended

- ✓ None

Objectives

- **write** a literature review using appropriate academic language
- **relate** a research question to scientific theory
- **execute** search strategies to identify relevant academic literature
- **cite** sources and **organize** research references using a reference manager
- **design** a poster that highlights key aspects of the literature review and present them as the main talking points during the poster presentation
- **self-evaluate** your work and contributions towards group goals
- **provide** and **receive** constructive feedback to/from your peers, and incorporate that feedback into your academic writing

Description of the course

In PRO1101, you will integrate knowledge and skills from your foundational science and inquiry courses (PHY1101, CHE1101, BIO1101, INT1011, PRA1101, PRA1102) to write a collaborative literature review related to research topics from this faculty. Guided by the Information Literacy Framework, you will develop essential academic research competencies including resource discovery, information organization, critical assessment, and scholarly communication. Through this process, you will synthesize existing research, identify knowledge gaps, and build theoretical foundations—equipping you for future research work and academic writing in the sciences.

Literature

None

Instructional format

Interactive course meetings and small group meetings.

Assessment

- literature review
- poster presentation
- peer review
- self review
- small group/peer activities (e.g., search planning form)

PRO1000 Research Project

Course coordinator
Panos Christakoglou, Faculty of Science and Engineering, Maastricht Science Programme.
Contact: panos.christakoglou@maastrichtuniversity.nl

Pre-requisites
- ✓ None

Co-requisites
- ✓ None

Objectives
- Design and conduct a research project by developing a protocol, formulating a clear hypothesis, setting realistic goals, and managing time and resources effectively.
- Develop and demonstrate communication skills through the preparation of a scientific poster.
- Work safely and ethically in a research environment following safety protocols and scientific methods.
- Collaborate productively in a multidisciplinary research team, while also learning to work independently and take initiative.
- Critically engage with scientific literature, using peer-reviewed sources and preparing a scientific report.

Description of the course
Twice a year, the students of the Maastricht Science Programme conclude each semester with a three-week research project of their choice. During this period, they apply and integrate the knowledge and skills gained across their studies while working in small, multidisciplinary teams. The goal is to design and conduct an experiment or research activity and present their findings through a poster. Throughout the process, they learn to set research goals, find the relevant literature, work safely and ethically within a team and communicate their findings effectively while looking critically at their work as well as the work of their peers.

Instructional format
Group meetings, PBL

Assessment
- Attendance
- Participation
- Poster

PRO2000/3000 Research Project

Course coordinator

Panos Christakoglou, Faculty of Science and Engineering, Maastricht Science Programme.

Contact: panos.christakoglou@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ None

Objectives

- Design and conduct a research project by developing a protocol, formulating a clear hypothesis, setting realistic goals, and managing time and resources effectively.
- Develop and demonstrate communication skills through the preparation of a scientific presentation.
- Work safely and ethically in a research environment following safety protocols and scientific methods.
- Collaborate productively in a multidisciplinary research team, while also learning to work independently and take initiative.
- Critically engage with scientific literature, using peer-reviewed sources and preparing a scientific report.

Description of the course

Twice a year, the students of the Maastricht Science Programme conclude each semester with a three-week research project of their choice. During this period, they apply and integrate the knowledge and skills gained across their studies while working in small, multidisciplinary teams. The goal is to design and conduct an experiment or research activity and present their findings through an oral presentation. Throughout the process, they learn to set research goals, find the relevant literature, work safely and ethically within a team and communicate their findings effectively while looking critically at their work as well as the work of their peers.

Instructional format

Group meetings, PBL

Assessment

- Attendance
- Participation
- Presentation
- Written report

Bachelor Thesis Research (BTR)

Course coordinator

Panos Christakoglou, Faculty of Science and Engineering, Maastricht Science Programme.
Contact: panos.christakoglou@maastrichtuniversity.nl

Pre-requisites

- ✓ None

Co-requisites

- ✓ None

Objectives

- Design and plan a research project based on a scientifically relevant question, identifying suitable methodologies, and managing time and resources effectively.
- Apply appropriate scientific methods and techniques to perform the relevant scientific research within the context of their chosen field.
- Evaluate results and place their findings in the broader context of existing scientific knowledge.
- Communicate their research effectively through a structured thesis and a video presentation.
- Work independently and professionally, demonstrating responsibility and initiative, while following the ethical standards in scientific research

Description of the course

The Bachelor Thesis Research (BTR) is the last pillar of the curriculum of the Maastricht Science Programme and represents the final, independent proof-of-capability of students reaching the completion of their BSc degree. The BTR allows students to get involved in a scientific research project within a field of their choice, offering them the opportunity to specialise and demonstrate autonomy, creativity, and critical thinking. Over the course of one semester (30 ECTS), students will formulate a clear research question, develop and refine a research plan, carry out the research and document their findings in a written thesis. In addition to the written report, students are expected to produce a short video that highlights their research in a way that is accessible to a broader audience.
The BTR may be conducted within the university, in collaboration with external research institutes, or during an academic exchange abroad, provided the research meets the academic standards and is supervised by an approved mentor.

Instructional format

RBL, PBL

Assessment

- Attendance
- Participation
- Report
- Video

Available at University College Maastricht (UCM)

MSP students are welcome to register for the following courses, provided they meet the prerequisites, via the online course registration form. These requests will be automatically approved by the MSP Board of Examiners, pending scheduling conflicts. 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
SCI3003	Optimization Note: Students who took MAT2002, can no longer take SCI3003	1
SCI1016	Sustainable Development: Human impact on the Earth system Note: Students who took INT1006, can no longer take SCI1016.	2
SCI3005	Metabolism, Nutrition and Exercise	2
SCI3050	Advances in Biomedical Sciences	2
HUM2022	Digital Media	2
HUM2051	Philosophical Ethics *Note: this course fulfils the humanities or social science topic (MSLAS) requirement*	4
SCI2031	Immunology	4