Maastricht Science Programme

Core courses

Core courses

Maastricht Science Programme

Introduction to Natural Sciences: Chemistry

Full course description

The emphasis of this course will be on a number of essential topics in modern chemistry. The first part of the course will give 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 into 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.

Course objectives

• To have an understanding of the nature of various atoms and their organization in the periodic table of the elements. • To have the ability to recognize various classes of chemical compounds and to understand their basic physical and chemical properties. • To obtain an understanding of the basic physical chemistry of fundamental importance to most natural and chemical processes, with an emphasis on thermodynamics and kinetics. • To be familiar with the essentials of acid-base behaviour and electrochemistry. • To have sufficient background for further, more advanced, courses in chemistry, biochemistry and the life sciences.

Prerequisites

Co-requisites PRA1001 Research Methods

Corequisites

- Research Methods

Recommended reading

"Chemistry3: Introducing inorganic, organic and physical chemistry" Burrows, Holman, Parsons, Pilling, Price. Second Edition, Oxford University Press

CHE1001

Period 1
2 Sep 2019
25 Oct 2019
Period 4
3 Feb 2020
3 Apr 2020

Print course description

ECTS credits:
5.0
Instruction language:
English
Coordinators:
B. Blom
C.S. Bahn
Teaching methods:
Lecture(s), PBL
Assessment methods:
Attendance, Written exam, Assignment, Participation

Maastricht Science Programme

Introduction to Natural Sciences: Biology

Full course description

This course aims at introducing the students to the most fundamental biological principles of life. The cell as the basic unit of life will be studied as well as classification of organisms in order to understand the basic principles of the diversity of species. A basic understanding of photosynthesis and cellular respiration will be provided in this course. The ability to replicate, to multiply and produce offspring is studied in the field of genetics, and the basic Mendelean genetics will be studied. The basic principles of evolution will be introduced. How living organisms relate to each other will be explained and basic principles of ecology are presented.

Course objectives

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

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

Prerequisites

Co-requisites PRA1001 Research Methods

Corequisites

- Research Methods

Recommended reading

Campbell, Reece et al. (2015). Biology, A Global Approach (10th edition, global edition). Pearson (ISBN10: 1-292-00865-2 ISBN13: 978-1-292-00865- 3, ISBN 978-1-292-00875-2 is the same book but with access to online study material, which is NOT required for this course. The 9th global edition is also acceptable).

BIO1001

Period 1
2 Sep 2019
25 Oct 2019
Period 4
3 Feb 2020
3 Apr 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
J.M. Nelson
Teaching methods:
Lecture(s), PBL, Assignment(s)
Assessment methods:
Written exam, Attendance, Participation, Final paper

Maastricht Science Programme

Research Methods

Full course description

This course focuses on experimental research methods and reporting. In addition, it teaches the students the basic laboratory skills to perform experiments in a chemical or biological laboratory as well as the physics laboratory. Students learn to work in a safe manner, with respect for themselves, others and the environment. Basic techniques will be taught, such as the accurate measurement of volumes and weights. The students will gain experience in the logistics of setting up and doing an experiment with the final goal of communicating their findings in a report. Typical topics, which will be covered in this skills training are: • Chemical and biological separations and isolations (distillation, extraction, chromatography) • Acid and bases (measuring pH, using buffer solutions, titrations). • Chemical and biological kinetics (enzymes, reaction order) • Thermodynamic properties of compounds and reactions • Introduction into microscopy and imaging of biological samples

Course objectives

• To be able to perform basic chemical and biological laboratory research experiments in a safe and scientifically sound manner. • To understand the handling of materials and solutions (weighing, making solutions, handling solutions, working with pipettes and volumetric glassware). • To learn to

setup and execute a scientific research experiment. • To provide an introduction to scientific research reporting.

Prerequisites

Co-requisites BIO1001 Introduction to Natural Sciences: Biology CHE1001 Introduction to Natural Sciences: Chemistry

Corequisites

- Introduction to Natural Sciences: Chemistry
- Introduction to Natural Sciences: Biology

Recommended reading

"Practical skills in Biomolecular sciences" by Reed R, Holmes D, Weyers J, Jones a. (Pearson, 4th edition 2012; ISBN10 1408245523; ISBN13 9781408245521).

PRA1001

Period 1
2 Sep 2019
25 Oct 2019
Period 4
3 Feb 2020
3 Apr 2020

Print course description
ECTS credits:
2.5
Instruction language:
English
Coordinators:
L.I.N.N. van Griethuijsen
T.D. Steen Redeker
J.M. Nelson
Teaching methods:
Skills, Assignment(s)
Assessment methods:
Assignment

Maastricht Science Programme

Introduction to Liberal Arts and Sciences

Full course description

Introduction to Liberal Arts & Sciences introduces you to the intellectual skills, the generic skills and the development of values and ethics inherent in the liberal arts & sciences tradition. The first part of the course aims at providing you with an understanding of the natural sciences from a philosophical perspective. What is science? What is the scientific methodology? What are the norms and values in a scientific environment? The variety of perspectives that you are introduced to when answering these

questions will allow you to develop your critical thinking skills and will provide you with insights that you can use in your personal development as a scientist. After exploring the philosophy of science in the first part of the course, the second part of the course teaches you to apply and communicate your knowledge and ideas effectively by devoting attention to argumentation and science communication.

Course objectives

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

Prerequisites

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

Corequisites

- Research, Data analysis and Presentation Academic skills

Recommended reading

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

INT1001

Period 2
28 Oct 2019
20 Dec 2019
Period 5
6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
K.B.L. Eersels
Teaching methods:
Lecture(s), PBL, Assignment(s)
Assessment methods:
Participation, Assignment, Written exam, Attendance

Maastricht Science Programme

Research, Data analysis and Presentation Academic skills

Full course description

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

Course objectives

To familiarize students with the most basic skills required in science. These include: • Common statistical data analysis skills • Finding and selecting literature using Web of Science and Scifinder • Referencing literature using Endnote • Writing a scientific article

Prerequisites

Co-requisites MAT1001 Introduction to Natural Sciences: Calculus / PHY1002 Mathematical Foundations of Physics INT1001 Introduction to Liberal Arts and Sciences

Corequisites

- Introduction to Liberal Arts and Sciences
- Introduction to Natural Sciences: Mathematical Foundations of Physics

Recommended reading

For the writing skills part the book "A guide to academic writing skills" (2nd ed., Wilkinson & Hommes) will be used. This book will be provided via EleUM.

PRA1002

Period 2
28 Oct 2019
20 Dec 2019
Period 5
6 Apr 2020
5 Jun 2020

Print course description

ECTS credits:
2.5
Instruction language:
English
Coordinator:
R.H.J. Erkens
Teaching methods:
Lecture(s), PBL, Skills
Assessment methods:
Final paper, Assignment, Presentation

Maastricht Science Programme

Introduction to Natural Sciences: Mathematical Foundations of Physics

Full course description

Mathematics is inextricably linked to the understanding of science and this course is designed to cover the mathematical concepts that will prove fundamental tools for the natural science courses you will encounter at MSP, with an emphasis on physics. As new students to the MSP come from a diverse range of backgrounds, your knowledge of mathematics will vary considerably. As such, each of you will find that some of the material from this course acts as revision whereas some topics are completely new – please bare in mind that it's what you know at the end of the course that counts! It is important to note that maths is only useful if it can be implemented, and this skill is acquired by attempting to solve problems and perform calculations; this is the main aim of the weekly tutorials. The course will address complex numbers, differentiation, differential equations, integration, functions of two variables and multiple integrals. This course is part of the academic core in the natural sciences.

Course objectives

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

Prerequisites

Co-requisites PRA1002 Research Data Analysis and Presentation Academic Skills

Corequisites

- Research, Data analysis and Presentation Academic skills

Recommended reading

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

PHY1002

Period 2
28 Oct 2019
20 Dec 2019
Period 5
6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
C.K. Ellington
Teaching methods:
Lecture(s), PBL
Assessment methods:
Attendance, Written exam, Participation, Assignment

Maastricht Science Programme

Philosophy of Science

Full course description

During the four weeks of the course students will study the philosophy of science hand in hand with its application to a scientific case study: paleontology, or the study of fossils. Each week one tutorial will be devoted to the philosophical discussion of scientific issues and one tutorial to the implications of these discussions for how science is done in the context of fossil research. In week 1 an introduction to the philosophy of science will be given that will also address the empirical study of objects, logical positivism, the problems of inductivism, and issues concerning the (un) certainty of scientific claims. Parallel to that, students will investigate (in small groups) what kind of information different scientific disciplines (biochemistry; radiology; biology) can generate with respect to certain objects (fossils). Visits will be made to the Natural History Museum. Week 2 will be devoted to the idea of the theory-dependence of scientific observation and the philosophical concept of paradigms. Parallel to that, students will study the history of the (scientific) investigation of fossils, in order to investigate what role conflicting paradigms played in the past and present of fossil research. In week 3 a broader view on the production of scientific knowledge will be offered, placing science in a social context. The philosophical discussion will look at the role of worldviews in science and the ‘social turn’ that characterizes many of the recent approaches in the philosophy of science. Parallel to that, students will read primary sources that reveal the religious, political and epistemological presuppositions that shaped some of the most important developments of fossil research in the 19th century. In the fourth week students will write a short essay that should synthesize the insights gained during the first three weeks

Course objectives

The course aims at giving the students an overview of the main theoretical approaches within the

philosophy of science; and teaches them skills to apply these approaches to the study of a concrete scientific discipline.

Recommended reading

• The central textbook of the course is: Peter Godfrey-Smith, Theory and Reality: An Introduction to the Philosophy of Science (Chicago and London: The University of Chicago Press, 2003). ISBN 0-226-30063-3. This book is available as an e-book in the University Library Maastricht, so that it can be used by all students at the same time. • Background information of the history of fossils can be found in: Martin J. S. Rudwick, The Meaning of Fossils: Episodes in the History of Paleontology, 2nd edition (Chicago and London: The University of Chicago Press, 1985). ISBN 0-226-73103-0.

PRO1001

Period 3
6 Jan 2020
31 Jan 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinators:
E. Homburg
C.C.M. Mody
Teaching methods:
Lecture(s), PBL, Work in subgroups, Research
Assessment methods:
Assignment, Attendance, Written exam, Presentation

Elective courses

Biology courses

Maastricht Science Programme

Genetics

Full course description

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 recombination, mutation and selection; DNA repair and the genetic basis of disease inheritance; and evolutionary genetics.

Course 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 comprehend and be able to apply the concepts of genome structure, comparative genomics, and functional genomics. • To understand the molecular basis of single gene inheritance (Mendel's first law), sex-linked single gene inheritance and to interpret human pedigrees. • To use the above information to deduce the concepts of Darwin's theory of Natural Selection, molecular evolution and the origin of new genes and species. • To have sufficient background for more advanced courses in biochemistry and the life sciences.

Prerequisites

Pre-requisites BIO2001 Cell Biology Co-requisites PRA2014 Skills Genetics

- Cell Biology

Corequisites

- Genetics

Recommended reading

"Introduction to Genetic Analysis" by Griffiths, Wessler, Carrol, Doebley (W.H. Freeman, 10thedition, International Edition, 2012. bol.com price €64,99).

BIO2007

Period 1
2 Sep 2019
25 Oct 2019
Period 4
3 Feb 2020
3 Apr 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
L.J. de Windt
Teaching methods:
Lecture(s), PBL
Assessment methods:
Attendance, Written exam, Participation, Assignment

Maastricht Science Programme

General Zoology

Full course description

Animals are everywhere, on land, in water and in the air. They comprise an extremely diverse kingdom, with all species being a mixture of shared and unique biological characteristics. These characteristics are a product of evolutionary history and adaptation to particular features of the

abiotic and biotic environment. In this course you will focus on the major groups within the animal kingdom, what defines them, how they are organised and how they are related to each other; you will also examine the specific adaptations of certain animals in more depth. The question "What is an animal?" will be considered as will the issue of how animals are grouped and related to each other. This will be done in the context of the major phyla, their defining morphological, anatomical and physiological features and the sorts of adaptations and behaviours that they exhibit. You will also examine certain adaptations such as bright colouration, feeding or parental care in greater depth, using particular animal groups as a source of examples.

Course 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

Recommended reading

Miller, S.A & Harvey, J.P. (2012). Zoology, 10th edition. McGraw-Hill. ISBN 978-1259251740

BIO2004

Period 1
2 Sep 2019
25 Oct 2019

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
J.J. Sloggett
Teaching methods:
Lecture(s), PBL
Assessment methods:
Participation, Final paper, Written exam

Maastricht Science Programme

Molecular Biology

Full course description

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

provide a perspective of how cutting edge molecular biological techniques are applied to tackle major research questions in modern biomedical research.

Course objectives

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

Prerequisites

Pre-requisites BIO2001 Cell Biology BIO2007 Genetics Co-requisites PRA3003 Molecular Biology

- Genetics
- Cell Biology

Corequisites

- Molecular Biology

Recommended reading

A reader is provided at the start of the course. Other recommended literature source: "Molecular Cell Biology" by Lodish, Berk, Kaiser (W.H. Freeman, 7thedition, 2012. bol.com price €145, international Edition available at amazon.com for a lower price), "Introduction to Genetic Analysis" by Griffiths, Wessler, Carrol, Doebley (W.H. Freeman, 10thedition, International Edition, 2012. bol.com price €64,99), "Molecular biology of the Cell" by Alberts et al.

BIO3001

Period 2
28 Oct 2019
20 Dec 2019
Period 5
6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
P.A. Da Costa Martins
Teaching methods:
Lecture(s), PBL
Assessment methods:
Attendance, Participation, Written exam

Evolutionary Biology

Full course description

Evolution is the most important principle in biology. It is the only scientific biologically theory that unifies all phenomena of life from the level of (macro)molecules to ecosystems. Ever since the Modern Synthesis early last century (when Darwin's insights were combined with modern genetics), evolutionary research has expanded enormously. Subsequent developments – the birth of molecular biology, the ever increasing power of computers and the development of phylogenetics - have led to an enormous increase in our understanding of the processes and patterns of evolution. This course emphasizes the general principles of evolution, the hypotheses on the causes of evolutionary change (relevant for most organisms), and the large patterns which are visible in the history of the earth. This course is an excellent opportunity to obtain a base in evolutionary knowledge, regardless of the field you will work in (biology or elsewhere). The course zooms in from macro-evolutionary patterns to micro- evolutionary processes. You will look at the geological and paleontological history of the earth and how biologists use phylogeny to reconstruct deep past (the tree of life) using genetic data. A fundamental unit within biology is the species and therefore also theories of species and speciation will be discussed. Furthermore, how random changes in populations (genetic drift) and natural selection influence evolution will be investigated using simulation models. In relation to this you will look beyond alleles into quantitative genetics and the evolution of phenotypes, and also at the process of adaptation. Finally, evolution is used to 1) explain life history characters (e.g. how many children does an organism produce) and obtain a different view on human medicine, and 2) understand co-evolution between species.

Course 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).

Recommended reading

• Evolution, making sense of life. C. Zimmer and D.J. Emlen, 1st ed. 2013. Roberts & Company Publishers. • One modelule of Simbio’s evobeaker package (http:// http://simbio.com/products-college/EvoBeaker) for evolutionary simulations (exact module to be announced later).

BIO2005

Period 4
3 Feb 2020
3 Apr 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
L.I.N.N. van Griethuijsen

Teaching methods:
Lecture(s), PBL, Assignment(s)
Assessment methods:
Attendance, Written exam, Presentation, Assignment

Maastricht Science Programme

Human Anatomy and Physiology

Full course description

While Mathematics is seen as the father of science, Physiology is the mother. Physiology attempts to explain the physical and chemical factors that are responsible for the origin, development, and progression of life. Human physiology investigates the mechanisms of the human body making it a living being (Guyton). In the healthy human body it is of the utmost importance that the working conditions for all cells are kept "constant". In this respect it is worthy to note that essentially all organs and cells of the human body perform functions that help to maintain this constant nature or homeostasis. We will begin by discussing the physiology of the cell, and the function of the membrane in it. Furthermore, we will discuss renal, respiratory, and cardiovascular physiology, followed by endocrinology and gastrointestinal physiology, control and feedback.

Course objectives

• Membrane Physiology • Electrophysiology • Cardiac vascular physiology • Hormonal and neuronal control • Fluid and Salt balance • Gastrointestinal physiology

Prerequisites

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

Recommended reading

Books available from http://accessmedicine.mhmedical.com/Index.aspx

BIO2010

Period 4
3 Feb 2020
3 Apr 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
N.M.S. van den Akker
Teaching methods:
Lecture(s), PBL
Assessment methods:

Attendance, Assignment, Written exam, Participation

Maastricht Science Programme

Ecology

Full course description

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

Course 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

Prerequisites

BIO1001 Introduction to the Natural Sciences: Biology

Recommended reading

To be announced.

BIO2002

Period 5
6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
J.J. Sloggett
Teaching methods:
Lecture(s), PBL
Assessment methods:
Attendance, Assignment, Written exam, Participation

Maastricht Science Programme

Animal Behaviour

Full course description

This course will introduce you to how behaviour of animals is studied and the (relatively young) history of this field. We will look at the origins (ultimate cause) of behaviour; the function of behaviour in an animal's survival and reproduction, and how behaviours evolve over evolutionary time. We will also look at the proximate causes of behaviour; what triggers behaviours and what is the role of ontogeny (organismal development)? Although the basis of behaviour lies in neurobiology and the brain, these will not be discussed in detail in this course. We will discuss the role of memory and learning in relation to animal behaviour.

Course objectives

• Gain an understanding of how animal behaviour is studied • Understand what triggers behaviour and the importance of behaviour in an animal's chances of survival and reproductive success • Describe types of selective forces that shape the evolution of behaviour • Understand the role of memory, learning and imprinting in behaviour • 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 psychology

Prerequisites

BIO2005 Evolutionary biology BIO2004 General Zoology* * As this course is offered for the first time in Spring 2015, students can get a waiver if they did not (yet) take General Zoology.

- Evolutionary Biology
- General Zoology

Recommended reading

TBA

BIO3004

Period 5
6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
L.I.N.N. van Griethuijsen
Teaching methods:
Lecture(s), PBL
Assessment methods:
Assignment, Written exam

Maastricht Science Programme

Genomics and Proteomics

Full course description

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

Course objectives

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

Prerequisites

Recommended Basic knowledge about genetics, cell biology and gene expression

- Genetics

Recommended reading

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

BIO3010

Period 4
3 Feb 2020
3 Apr 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
E.C.M. Mariman
Teaching methods:
Lecture(s), PBL, Paper(s), Assignment(s)

Assessment methods:
Attendance, Participation, Final paper, Written exam

Maastricht Science Programme

Microbiology

Full course description

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

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

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

Course 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.

Prerequisites

Co-requisite: PRA3010 Microbiology

No pre-requisites

- Cell Biology
- Genetics

Corequisites

- Microbiology

Recommended reading

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

BIO3003

Period 5
6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
F.R.M. Stassen
Teaching methods:
Lecture(s), Research, PBL
Assessment methods:
Attendance, Presentation, Assignment, Written exam

Maastricht Science Programme

Cell Biology

Full course description

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

Course objectives

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

Recommended reading

There are two possibilities à one of these is mandatory: 1. "Molecular Biology of the cell" 6th edition (2014). B. Alberts, A. Johnson, J. Lewis, D. Morgan, M. Raff, K. Roberts, P. Walter; Garland Science: Taylor and Francis Group, New York, NY10017, USA (ISBN: 978 0 8153 44643) 2. "Essential Cell

Biology" 4th edition (2014). B. Alberts, D. Bray, K. Hopkin, A. Johnson, J. Lewis, M. Raff, K. Roberts, P. Walter. Garland Science: Taylor and Francis Group, New York, NY10016, USA (ISBN: 978 08153 44551) Number 1 is a more extensive book, which is recommended for those students who will continue in the molecular biology and/or cell biology direction. Number 2 is a shorter version of number 1, so it lacks some of the detailed description.

BIO2001

Period 1
2 Sep 2019
25 Oct 2019
Period 4
3 Feb 2020
3 Apr 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinators:
A.A. van Apeldoorn
M. van Griensven
Teaching methods:
Lecture(s), PBL, Presentation(s), Assignment(s)
Assessment methods:
Assignment, Written exam, Presentation, Attendance

Maastricht Science Programme

General Botany

Full course description

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

Course objectives

During this course you will gain insight in the importance of plants for life on earth and the unique adaptations that plants have. The course will illustrate all major aspects of plant form and function

(from the cellular level to the level of the organism), and plant development.

Corequisites

- Exploring the World of Plants

Recommended reading

Botany, an introduction to plant biology. J.D. Mauseth, 5th ed. 2014. Jones & Bartlett Learning. ISBN:978-1-4496-6580-7

BIO2003

Period 4
3 Feb 2020
3 Apr 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
R.H.J. Erkens
Teaching methods:
Lecture(s), Assignment(s), PBL
Assessment methods:
Attendance, Assignment, Written exam

Maastricht Science Programme

Tropical Ecology

Full course description

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

Course 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.

Prerequisites

BIO2002 Ecology

- Ecology

Recommended reading

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

BIO3007

Period 2
28 Oct 2019
20 Dec 2019

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
R.H.J. Erkens
Teaching methods:
Lecture(s), PBL
Assessment methods:
Attendance, Assignment, Written exam, Presentation

Maastricht Science Programme

Great Transformations in Vertebrate Evolution

Full course description

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.

Course 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.

Prerequisites

BIO2004 or BIO2005

- Evolutionary Biology
- General Zoology

Recommended reading

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

BIO2008

Period 2
28 Oct 2019
20 Dec 2019

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
L.P.A.M. Claessens
Teaching methods:
PBL
Assessment methods:
Attendance, Written exam, Assignment, Participation

Maastricht Science Programme

Ecophysiology

Full course description

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

Course objectives

• To understand what ecophysiology is and the role in plays in an academic and applied context. • To gain a basic knowledge of the physiology of certain non-human organismic groups • To understand in

detail the characteristics of different abiotic environments that impose strong adaptive pressures on organismal physiology • To understand specific direct physiological adaptations evolved in response to these environmental pressures • To gain an insight into physiological adaptations to the biotic environment • To understand the principle of convergent evolution and how different groups may have evolved different physiological solutions to the same evolutionary pressures

Prerequisites

BIO2001 Cell Biology

- Cell Biology

Recommended reading

Scientific papers

BIO3002

Period 2
28 Oct 2019
20 Dec 2019

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
J.J. Sloggett
Teaching methods:
Lecture(s), PBL
Assessment methods:
Attendance, Presentation, Participation, Written exam

Maastricht Science Programme

Hominin Paleontology

Full course description

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

Course objectives

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

interpreting them in the light of ecosystems and biogeography.

Prerequisites

BIO2005 Evolutionary Biology OR BIO2008 Great Transformations in Vertebrate Evolution

- Evolutionary Biology
- Great Transformations in Vertebrate Evolution

Recommended reading

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

BIO3008

Period 5
6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
J.C.A. Joordens
Teaching methods:
Lecture(s), PBL
Assessment methods:
Assignment, Attendance, Participation, Written exam

Chemistry courses

Maastricht Science Programme

Organic Chemistry

Full course description

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

Course objectives

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

Prerequisites

Co-requisite PRA2002 Chemical Synthesis

Corequisites

- Chemical Synthesis

Recommended reading

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

CHE2001

Period 1
2 Sep 2019
25 Oct 2019
Period 4
3 Feb 2020
3 Apr 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinators:
H. Diliën
M.B. Baker
Teaching methods:
Lecture(s), PBL, Assignment(s)
Assessment methods:
Written exam, Attendance, Participation

Maastricht Science Programme

Physical Chemistry

Full course description

This course focuses on advanced aspects in physical chemistry and how it contributes in solving problems encountered in biology, (bio)chemistry and the environment. Thermodynamics and electrostatics are two of the most important tools that can predict the behaviour of molecules, which can then lead to a broad spectrum of topics related to the life and environmental sciences, including

(i) (bio)energetics, (ii) phase transitions, (iii) ion and electron transport, (iv) chemical reaction, (v) (bio)macromolecules and self-assembly, and (vi)physical properties. PBL tasks are embedded to create an understanding how to apply general principles of physical chemistry to biological, (bio)chemical and environmental problems. Development of plausible models for physical or chemical mechanisms, incl. numerical analytical methods to solve the models and testing against observations/experimental evidence, are essential throughout the course.

Course objectives

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

Recommended reading

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

CHE2003

Period 2
28 Oct 2019
20 Dec 2019

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinators:
J.A.W. Harings
V. Vieru
Teaching methods:
Lecture(s), PBL
Assessment methods:
Attendance, Participation, Presentation, Written exam

Maastricht Science Programme

Biochemistry

Full course description

Biochemistry is considered the mother of all Life Sciences. Understanding Biochemistry will facilitate learning of more specialised Life Sciences such as Molecular and Cell Biology. This course addresses the biochemistry of the molecular components of cells. We will cover the structures, functions and interactions of the biomacromolecules, including proteins, lipids, carbohydrates, DNA and RNA, which perform many of the activities associated with life. We will provide insight in the specificity and action

of enzymes, the biocatalysts of the cell. Further, we will explain principles of the regulation of metabolic pathways that result in the generation of ATP, the major energy currency of the cell. We will highlight the biochemistry of the central dogma (gene --> protein). The theory studied in this course will be explained by examples of biochemistry in every day life. For instance how DNA profiling works in forensic science and how a mutation in a gene changes structure and function of proteins and causes diseases such as sickle cell aneamia.

Course objectives

At the end of the course you will be able to: • define Biochemistry and the science of Biochemistry. • describe the general structure and function of the biomacromolecules such as proteins, lipids, polysaccharides and nucleotides. • understand principles of synthesis and degradation of biomacromolecules. • explain the specificity and action of enzymes, the biocatalysts • enter higher level courses on Biochemistry and Molecular Biology to finally allow entrance to various Master programs in the Life Sciences.

Recommended reading

• Berg, J.M., Tymoczko, J.L., Stryer, L. (2015) Biochemistry. 8th ed. W.H. Freeman • Nelson, D.L. Cox, M.M. (2016) Lehninger Principles of Biochemistry. 8th ed. W.H. Freeman • Devlin, T.M. (2011) Textbook of Biochemistry with Clinical Correlations. 7th ed. John Wiley & Sons • Kuriyan, J. Konforti, B., Wemmer, D. (2013) The Molecules of Life. 1st ed. Garland Science • Garrett and Grisham. Biochemistry. (4th ed.). Thomson Brooks/Cole

CHE2006

Period 2
28 Oct 2019
20 Dec 2019

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinators:
C.P.M. Reutelingsperger
N.M. Deckers
Teaching methods:
Lecture(s), PBL
Assessment methods:
Attendance, Written exam, Presentation

Maastricht Science Programme

Modern Catalytic Chemistry

Full course description

This course will provide a comprehensive introduction to the topic of catalysis, with a focus on homogeneous catalysis mediated by organometallic compounds; and emphasis on modern chemistry

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

Course objectives

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

Prerequisites

Pre-requisite: CHE2001 Organic Chemistry Recommended CHE2002 Inorganic Chemistry CHE3001 Organic Reactions CHE3002 Transition Metal Chemistry

- Organic Chemistry

Recommended reading

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

CHE3004

Period 2
28 Oct 2019
20 Dec 2019

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
B. Blom
Teaching methods:
Lecture(s), PBL
Assessment methods:
Assignment, Presentation, Take home exam, Participation

Maastricht Science Programme

Inorganic Chemistry

Full course description

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

Course objectives

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

Prerequisites

Recommended CHE2001 Organic Chemistry PRA2002 Chemical Synthesis Co-requisites PRA2004 Inorganic Synthesis

Corequisites

- Inorganic Synthesis

Recommended reading

To be determined amongst: Huheey, Keiter, Keiter, Inorganic Chemistry (Harper Collins); Shriver and Atkins' Inorganic Chemistry (Oxford); and Wulfsberg, Inorganic Chemistry (University Science Books)

CHE2002

Period 1
2 Sep 2019
25 Oct 2019

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
B. Blom
Teaching methods:
Lecture(s), PBL
Assessment methods:
Assignment, Written exam, Participation, Presentation, Attendance

Maastricht Science Programme

Spectroscopy

Full course description

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

Course 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.

Prerequisites

CHE2001 Organic Chemistry

- Organic Chemistry

Recommended reading

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

CHE2004

Period 1
2 Sep 2019
25 Oct 2019

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
H. Diliën
Teaching methods:
Lecture(s), PBL
Assessment methods:
Attendance, Written exam, Participation

Maastricht Science Programme

Quantum Chemistry

Full course description

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

Course objectives

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

- Mathematical Tools for Scientists

Recommended reading

Physical Chemistry by Peter Atkins (please check edition with coordinator) Molecular Quantum mechanics by Peter Atkins (optional)

CHE3006

Period 5
6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
V. Vieru
Teaching methods:
Lecture(s), PBL
Assessment methods:
Attendance, Written exam, Participation

Maastricht Science Programme

Organic Reactions

Full course description

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 not only consist of comparatively simple molecules, such as alcohols, aldehydes, ketones, carboxylic acids and amines,

but will also be illustrated with examples from more complex biomolecules. Knowledge of the various types of organic reactions will provide the basic skills to design multistep synthesis sequences to obtain specific organic compounds. In this context special attention will also be paid to organometallic reactions and their importance for multistep organic synthesis. 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.

Course 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. • To provide insight into industrial processes to obtain organic chemicals.

Prerequisites

Pre-requisites CHE2001 Organic Chemistry CHE2004 Spectroscopy Co-requisites PRA3001 Advanced Organic Synthesis

- Organic Chemistry
- Spectroscopy

Corequisites

- Advanced Organic Synthesis

Recommended reading

“Organic Chemistry” by Paula Bruice (Pearson, 6th revised edition, 2010)

CHE3001

Period 2
28 Oct 2019
20 Dec 2019

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
H. Diliën
Teaching methods:
Lecture(s), PBL
Assessment methods:
Attendance, Final paper, Written exam, Participation

Maastricht Science Programme

Transition Metal Chemistry

Full course description

This course will build up on the student's knowledge about the d-block elements acquired in the inorganic chemistry course. The course will start with a review of the basic properties and electronic structure of transition metals, progressing into a deeper understanding of both. The review of crystal field theory will lead into a discussion on spectroscopic transitions and Jan-Teller distortions. A review on the basics of coordination chemistry will also be undertaken, rapidly progressing into a discussion on the different reactions undergone by transition metal coordination compounds and the kinetic and thermodynamic principles behind them. The student will be introduced to organometallic chemistry and its main principles. A selected number of organometallic catalytic cycles will be discussed and analysed.

Course objectives

• To build up on the student's knowledge of d-block elements acquired during Inorganic Chemistry • To allow the student to gain deeper understanding of the electronic structure and properties of d-block elements • To deepen the student's understanding of crystal field theory and its applications in spectroscopy and magnetochemistry • To provide the student with a complex understanding of the reaction types and mechanistic pathways in the coordination chemistry of d-block elements • To introduce the student to organometallic chemistry • To provide a descriptive survey of basic organometallic reactions and their mechanistic pathways • To give the student a brief introduction to molecular catalysis

Prerequisites

Pre-requisites: CHE1001 Introduction to Natural Sciences: Chemistry CHE2001 Organic Chemistry CHE2002 Inorganic Chemistry Recommended Courses: CHE3001 Organic Reactions Co-requisites: PRA3008 Transition Metal Chemistry

- Organic Chemistry
- Inorganic Chemistry

Corequisites

- Transition Metal Chemistry

Recommended reading

Shriver and Atkins' "Inorganic Chemistry"; 5th edition (Oxford, 2010)

CHE3002

Period 5
6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
B. Blom
Teaching methods:
Lecture(s), PBL

Assessment methods:
Attendance, Participation, Written exam, Assignment

Maastricht Science Programme

Advanced Physical Chemistry

- Mathematical Tools for Scientists

CHE3007

Period 2
28 Oct 2019
20 Dec 2019

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
V. Vieru

Maastricht Science Programme

Analytical Science and Technology

Full course description

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

Course objectives

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

with flow-NMR. • Obtain insight into different applications of analytical methodologies and acquire sufficient background for more advanced courses in polymer-, bio-chemistry and life sciences.

- Organic Chemistry
- Spectroscopy

Recommended reading

TBA

CHE3008

Period 1
2 Sep 2019
25 Oct 2019

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
M. Honing
Teaching methods:
Lecture(s), PBL
Assessment methods:
Attendance, Written exam, Assignment

Maastricht Science Programme

Solid State Chemistry

Full course description

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

Course 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 Oield • To give a stable foundation to pursue future master-level studies in the field

Recommended reading

P. A. Cox, "The electronic structure and chemistry of solids", Oxford Science Pub., 1999; A.R. West, "Solid State Chemistry and its applications", 2nd Ed, 2014. C. Kittel, "Introduction to solid state physics", John Wiley & Sons Inc., 8th Ed, 2005. (These books are advanced literature and the students can broadly refer to them for support. Additional references will be given on a lecture- by-lecture base)

CHE2007

Period 4
3 Feb 2020
3 Apr 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Teaching methods:
Lecture(s), PBL, Assignment(s), Presentation(s)
Assessment methods:
Attendance, Participation, Written exam, Presentation

Maastricht Science Programme

Crystallography

Full course description

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

Course objectives

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

Recommended reading

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

CHE3009

Period 5
6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:
0.0
Instruction language:
English
Teaching methods:
Lecture(s), PBL, Assignment(s), Presentation(s)
Assessment methods:
Attendance, Participation, Written exam, Presentation

Mathematics courses

Maastricht Science Programme
Linear Algebra

Full course description

Linear algebra is the branch of mathematics which is primarily concerned with problems involving linearity of one form or another. This is reflected by the three central themes of this introductory course. The first theme is concerned with what can be recognized without doubt as the most frequently occurring mathematical problem in practical applications: how to solve a system of linear equations. For this problem a complete algebraic solution procedure is developed which provides the student with a way to deal with such problems systematically, regardless of the number of equations or the number of unknowns. The second theme addresses linear functions and mappings, which can be studied naturally from a geometric point of view. This involves geometric ‘objects’ such as points, lines and planes, and geometric ‘actions’ such as rotation, reflection, projection and translation. One of the main tools of linear algebra is offered by matrices and vectors, for which a basic theory of matrix-vector computation is developed. This allows one to bring these two themes together in a common framework, in what turns out to be an exceptionally fruitful way. By introducing the notions of vector spaces, inner products and orthogonality, a deeper understanding of the scope of these techniques is developed, opening up a large array of rather diverse application areas. The third theme surfaces when the point of view is shifted once more, now from the geometric point of view to the dynamic perspective, where the focus is on the effects of iteration (i.e., the repeated application of a linear mapping). This involves a basic theory of eigenvalues and eigenvectors, which have many applications in various branches of science as will be discussed. For instance, important applications

in problems involving dynamics and stability, and applications to optimization problems found in operations research. Many examples and exercises shall be provided to clarify the issues and to develop practical computational skills. They also serve to demonstrate practical applications where the results of this course can be successfully employed.

Course objectives

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

Recommended reading

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

MAT2004

Period 5
6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
M. Staudigl
Teaching methods:
Lecture(s), PBL
Assessment methods:
Attendance, Assignment, Written exam

Maastricht Science Programme

Mathematical Tools for Scientists

MAT1007

Period 5
6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:
5.0
Instruction language:
English

Coordinator:
C.J. Pawley
Teaching methods:
Lecture(s), PBL
Assessment methods:
Attendance, Written exam, Final paper

Maastricht Science Programme

Statistics

Full course description

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

Course 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.

Recommended reading

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

MAT2005

Period 5

6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
G.M. Schoenmakers
Teaching methods:
Lecture(s), PBL
Assessment methods:
Attendance, Written exam, Assignment, Presentation

Maastricht Science Programme

Multivariable Calculus

Full course description

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

Course objectives

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

- Calculus

Recommended reading

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

MAT2009

Period 2
28 Oct 2019
20 Dec 2019

Print course description
ECTS credits:

5.0
Instruction language:
English
Coordinator:
R.L. Westra
Teaching methods:
Lecture(s), PBL, Assignment(s)
Assessment methods:
Attendance, Written exam

Maastricht Science Programme

Optimization

Full course description

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

Course objectives

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

Prerequisites

MAT1002 or MAT2004 Linear Algebra Recommended In addition it is useful to have a basic understanding of approximation by Taylor series. Student should have basic knowledge in calculus, especially in derivatives.

- Linear Algebra

Recommended reading

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

MAT2002

Period 1
2 Sep 2019
25 Oct 2019

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
R.L.M. Peeters
Teaching methods:
Lecture(s), PBL
Assessment methods:
Attendance, Assignment, Written exam

Maastricht Science Programme

Applied Statistics

Full course description

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

Course objectives

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

MAT1006

Period 5
6 Apr 2020
5 Jun 2020

Print course description

ECTS credits:
5.0
Instruction language:
English
Coordinators:
J. Schepers
A. Cassese
Teaching methods:
Lecture(s), PBL
Assessment methods:
Attendance, Written exam, Assignment

Maastricht Science Programme

Calculus

Full course description

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

Course objectives

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

Recommended reading

Hand-outs will be distributed during the course. Recommended literature: • Calculus, A Complete Course by A. Adams and C. Essex, 8th Edition – Pearson 2014 • Thomas’ Calculus' by M. Weir, J. Hass, and C. Heil, 12th Ed. Or newer -- Pearson

MAT2006

Period 4
3 Feb 2020
3 Apr 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
M.C. Popa
Teaching methods:
Lecture(s), PBL, Assignment(s)
Assessment methods:
Written exam, Attendance, Assignment

Maastricht Science Programme

Introduction to Programming

Full course description

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

Course objectives

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

Recommended reading

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

MAT2007

Period 1
2 Sep 2019
25 Oct 2019

Print course description
ECTS credits:
5.0
Instruction language:

English
Coordinator:
A. Zarras
Teaching methods:
Lecture(s), PBL
Assessment methods:
Attendance, Assignment, Written exam

Maastricht Science Programme
Differential Equations

- Calculus

MAT2008

Period 4
3 Feb 2020
3 Apr 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
A.J.A. Storcken

Physics courses

Maastricht Science Programme
Quantum Mechanics

Full course description

Quantum theory governs the universe at its most basic level but also relates to its largest scales. In the first half of the 20th century natural sciences were turned on its head by the radical discoveries of Einstein, Planck, Bohr, Heisenberg, and Schrödinger. An entire new logical and mathematical foundation —quantum mechanics— eventually replaced classical physics. We will explore the quantum world, including the particle theory of light, the Heisenberg Uncertainty Principle, and the Schrödinger Equation. This course aims at an understanding of the fundamental principles of Quantum Mechanics, and its applications to physics. The course is organized around the following topics: the non-intuitive nature of quantum mechanics; basic logic in classical and quantum mechanics; the time evolution of quantum systems; quantum entanglement and the nature of reality; particles moving in one dimension and their operators; the Heisenberg uncertainty principle. Each of these subjects is taught on a theoretical level as lecture, and on a practical level with exercises.

Moreover, Students collaborate in teams in a QM problem oriented project. This course relates to the practical skill courses Physics Laboratory PRA1003, PRA2007, and PRA3002.

Course objectives

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

Prerequisites

Prerequisite: MAT1005 Mathematics for the Natural Sciences Recommended: MAT1002 or MAT2004 Linear Algebra MAT2006 Calculus PRA1004 Scientific Computing

- Quantum Theory

Recommended reading

“University Physics”, Young Freedman, Pearson 13th International Edition. “Quantum Mechanics”, Susskind, Friedman, Basic Books, ISBN 0465036678

PHY3001

Period 1
2 Sep 2019
25 Oct 2019

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
J.A. de Vries
Teaching methods:
Lecture(s), Work in subgroups, PBL
Assessment methods:
Attendance, Written exam, Assignment

Maastricht Science Programme

Theory of Relativity

Full course description

The theory of relativity deals with the physical effects of high speed or curvilinear motion and gravity on the structure of space and time. This theory is the unique work of the physicist Albert Einstein, which overthrew earlier physical theories, and redefined the fundamental concepts of space, time, matter, energy, and gravity. Along with quantum mechanics, relativity is a central concept in modern physics. In particular, relativity provides the basis for understanding cosmic processes and the geometry of the universe itself. This intensive course intends to comprehensively train the

participants in the essential fundamentals of the theory of relativity. Here we address the major elements of this subject: special relativity, spacetime, mass and energy, Minkowski space, gravity, and cosmology. Each of these subjects is taught on a theoretical level as lecture, and trained on a practical level with group exercises which can be solved during PBL sessions.

Course objectives

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

Prerequisites

PHY2001 Classical Mechanics

- Classical Mechanics

Recommended reading

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

PHY3002

Period 2
28 Oct 2019
20 Dec 2019

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
G. Koekoek
Teaching methods:
Lecture(s), Assignment(s), PBL
Assessment methods:
Attendance, Assignment, Written exam

Maastricht Science Programme

Classical Mechanics

Full course description

Classical mechanics forms the central part of all physical science and engineering. It accurately describes the dynamical effects of forces under all conditions. It can be divided into statics: the study of equilibrium, and dynamics: the study of motion caused by forces. Though classical mechanics fails on the scale of atoms and molecules, it remains the framework for much of modern science and technology. This is an intensive course that comprehensively trains the students to the basic,

classical, and essential fundamentals of classical mechanics. The course aims at an understanding of the fundamental principles of Classical Mechanics and how to apply them in specific situations. Here we address the major parts of Classical Mechanics: statics and kinematics, Newton's laws, work and energy, momentum and collisions, rotational dynamics, and gravitation. Each of these subjects is taught on a theoretical level as lecture, and trained on a practical level with exercises and practical training sessions. Associated (but not co- required) to this course are skill courses Physics Laboratory 1-3, involving experimental practical training sessions.

Course objectives

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

Prerequisites

Pre-requisites MAT1001 Introduction to Natural Sciences: Calculus or PHY1002 Introduction to Natural Sciences: Mathematical Foundations of Physics PHY1001 Elements of Physics Recommended MAT1002 Linear Algebra

- Calculus

Recommended reading

1. University Physics with Modern Physics, H.D. Young & R. A. Freedman, Pearson Education (US), 13th International edition, May 2011 2. A course manual and title for the associated text book will be provided during the course.

PHY2001

Period 5
6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
R.L. Westra
Teaching methods:
Lecture(s), PBL, Assignment(s)
Assessment methods:
Attendance, Written exam, Assignment

Maastricht Science Programme

Relativistic Electrodynamics

Full course description

Electrodynamics is the first example of a field theory: charged particles create a field and this field acts on other charged particles. In other words electromagnetic forces are mediated by a field. This should put in contrast to Coulomb's law in electrostatics or even Newton's gravitational law. Both laws imply the objectionable notion of an action on a distance: moving a charge or mass at location A instantaneously gives rise to a different force at point B. How the electromagnetic field evolves in time is given by the 4 famous Maxwell equations. These equations for example state that light propagates at a constant speed, which eventually led to Einstein's theory of relativity. Electrodynamics is thus by construction a relativistic theory. This course will start at the Maxwell equations and their consequences: conservation laws, electromagnetic waves, radiation, etc... I will introduce the magnetic vector potential. We have a certain freedom in defining this vector potential, this freedom is more formally called "gauge invariance", an important concept in understanding any field theory. Evidently, I will also discuss the tight relation between electrodynamics and relativity and explain for example how magnetism can be understood as relativistic electric force.

Course objectives

● To acquire general understanding of electrodynamics. ● To be able to use Maxwell equations to solve practical problems such as transmission along coaxial lines. ● To understand the importance of gauge invariance and Lorentz invariance in field theories.

Prerequisites

PHY2004 Electromagnetism PHY3002 Theory of Relativity MAT1002 Linear Algebra MAT1001 / PHY1002 Mathematical Foundations of Physics OR MAT3004 Differential Equations

- Theory of Relativity
- Electromagnetism

Recommended reading

"Introduction to Electrodynamics", David Griffiths, 4th Edition: Chp. 7- 12

PHY3005

Period 4
3 Feb 2020
3 Apr 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
G. Koekoek
Teaching methods:
Lecture(s), PBL
Assessment methods:
Attendance, Assignment, Written exam

Maastricht Science Programme

Elements of Physics

Full course description

Physics is the study of all aspects of Nature, covering the behaviour of objects under the action of given forces and the nature and origin of gravitational, electromagnetic, and nuclear force fields. This is an introductory course in Physics intended for a broad audience with a scientific interest, that comprehensively trains students to the basic, classical, and essential fundamentals of physics. As such it is a prerequisite for most courses in the further Physics curriculum. The course aims at an understanding of the fundamental principles of Nature and how to apply them in concrete practical situations. The emphasis is on intuition rather than mathematical rigour; this is addressed in the follow-up physics courses. In this course we address the principal corner stones of Physics: 1. Elements of physical experimentation; 2. Elements of classical mechanics; 3. Elements of thermodynamics; 4. Elements of electromagnetism; 5. Elements of optics and waves; 6. Elements of modern physics. Each of these subjects is taught on a theoretical level as lecture, and on a practical level with exercises in practical training sessions. This course is a good preparation for the physics lab skills involving experimental and practical physics PRA1003, PRA2007, PRA3002.

Course objectives

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

Recommended reading

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

PHY1001

Period 4
3 Feb 2020
3 Apr 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
C.J. Pawley
Teaching methods:
Lecture(s), PBL, Assignment(s)
Assessment methods:
Written exam, Assignment, Attendance

Maastricht Science Programme

Thermodynamics and Statistical Physics

Full course description

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

Course objectives

• To acquaint the student with the basics of Thermodynamics and Statistical Physics • To acquire general understanding of theoretical and practical methods in Thermodynamics and Statistical Physics • To serve as sufficient basis for future education. • To be able to apply this knowledge in analysis and resolution of practical problems.

Prerequisites

MAT1001 / PHY1002 Mathematical Foundations of Physics

Recommended reading

Required Thermodynamics: from concepts to applications, A. Shavit & C. Gutfinger, CRC Press, 2nd Edition, December 2008 Recommended Statistical Thermodynamics, L.C. Fai & G.M.Wysin, CRC Press, 1st Edition, October 2012

PHY2002

Period 4
3 Feb 2020
3 Apr 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
J. Steinlechner
Teaching methods:
Lecture(s), PBL
Assessment methods:
Attendance, Final paper, Written exam

Maastricht Science Programme

Vibrations and Waves

Full course description

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

Course objectives

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

Prerequisites

PHY2001 Classical Mechanics

- Classical Mechanics

Recommended reading

Vibrations and Waves, A. P. French, W.W.Norton (US), 2nd edition, 1971 Vibrations and Waves, George C. King, John Wiley and Sons (UK), 1st edition, 2009

PHY2003

Period 1
2 Sep 2019
25 Oct 2019

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
C.J. Pawley
Teaching methods:
Lecture(s), PBL
Assessment methods:
Attendance, Participation, Assignment, Written exam

Maastricht Science Programme

Quantum Theory

Full course description

This courses serves as an introduction to the world of Quantum Theory, It provides a good basis for students who will require quantum mechanics either within physics or chemistry, as well as providing a good overview for students with a general interest in the subject. The course will commence with a discussion of the failings of classical physics, and will continue with an introduction to the postulates of Quantum Mechanics and Schrodinger´s equation. Throughout the course there will be a focus on applying the postulates of Quantum Mechanics to systems we are familiar with, for example the electron orbitals in a hydrogen atom and the harmonic oscillator.

Course objectives

• To acquire an understanding of the failings of classical physics and the important concepts in Quantum Theory. • To be able to apply the postulates of Quantum Mechanics to numerical calculations.

Prerequisites

MAT1005 Mathematics for Natural Sciences

- Linear Algebra

Recommended reading

"Introduction to Quantum Mechanics", David J Griffiths

PHY2005

Period 5
6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
J.A. de Vries
Teaching methods:
Lecture(s), PBL
Assessment methods:
Assignment, Written exam

Maastricht Science Programme

Optics

Full course description

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

Course objectives

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

- Elements of Physics

Recommended reading

TBD

PHY2007

Period 2
28 Oct 2019
20 Dec 2019

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinators:
C.J. Pawley
S. Hild
Teaching methods:
Lecture(s), PBL, Assignment(s)
Assessment methods:
Attendance, Written exam, Assignment

Maastricht Science Programme

Solar System Astronomy

Course objectives

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

PHY2008

Period 4
3 Feb 2020
3 Apr 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
C.K. Ellington
Teaching methods:
PBL, Assignment(s), Lecture(s), Research
Assessment methods:
Assignment, Attendance, Participation, Written exam

Maastricht Science Programme

Electromagnetism

Full course description

Electromagnetism, also known as Maxwell theory, is the science of one of the four fundamental forces in Nature and deals with the effects of electrical charge and the associated force fields and energies. Electromagnetism unites the concepts of electricity and magnetism. These two concepts and their relations form the core of this course, which ultimately can be expressed in the four fundamental laws of electromagnetism: Maxwell’s equations. Important components of the course are: 1. ELECTROSTATICS: Charge, electric forces, Coulomb’s law, the electric field, electric potential and energy; 2. (CLASSICAL) ELECTRODYNAMICS: Electrical flux, Gauss law; 3. MAGNETISM: Magnetic fields, magnetic flux, Gauss's law for magnetism; 4. MAXWELL’s LAWS: The four Maxwell equations and the Lorentz Force; 5. ELECTROMAGNETIC RADIATION AND WAVES; 6. ADVANCED TOPICS. These topics are divided over the six lecturing weeks of the course.

Course objectives

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

Prerequisites

PHY1001 Elements of Physics Recommended: MAT1002 or MAT2004 Linear Algebra

- Multivariable Calculus

Recommended reading

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

PHY2004

Period 4
3 Feb 2020
3 Apr 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
A.B. Poser
Teaching methods:
Lecture(s), PBL
Assessment methods:
Attendance, Assignment, Written exam

Maastricht Science Programme

Nuclear and Elementary Particle Physics

Full course description

This course provides an overview of the key concepts in nuclear and elementary particle physics. Nuclear physics is the study of complex nuclei. The following topics will be explored: basic nuclear properties, the nuclear force, models of nuclear structure, different types of nuclear decay, and nuclear fission and fusion and their applications. Particle Physics provides us with an understanding of the fundamental particles in the universe and the interactions between them. This course will provide an overview of the particles and interactions in the Standard Model of particle physics. Students will be taught how to use Feynman diagrams to calculate interaction cross-sectons for simple examples within Quantum Electrodynamics (QED), which describes the electromagnetic interaction. An overview of the development of the Standard Model through experimental observations will also be provided. This course requires a good understanding of Quantum Mechanics. Special relativity is also inherent in Modern Particle Physics, however for this course any necessary concepts will be taught in the lectures. Students should note that the format of the course will be slightly different in 2016 to

previous years. The first four weeks of the course will follow a standard but condensed format, such that all of the required theory is covered by the end of the forth week. For the last two weeks of the course there will be no lectures but students will be expected to work in groups and produce an extended literature review on an advanced topic in the field (although there will be no tutorials meetings with the course co-ordinator will be possible during this time). This course has no midterm exam, but there will be assessed problem sheets to complete throughout the period.

Course objectives

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

Prerequisites

PHY3001 Quantum Mechanics OR PHY2005 Quantum Theory No waivers will be given: students must have passed either of these courses

- Quantum Theory

Recommended reading

"Nuclear and Particle Physics", Martin B R, (2nd Edition Wiley 2009)

PHY3004

Period 2
28 Oct 2019
20 Dec 2019

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinators:
S.L. Williams
J.A. de Vries
Teaching methods:
Lecture(s), PBL
Assessment methods:
Written exam

Maastricht Science Programme

Electronics

Full course description

In this lecture 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,

transistors and MOSFETS. You'll also cover the basics of digital electronics (logic gates and Boolean algebra). We will look at how combinations of discrete devices can be used to build up more complex circuitry and you will have the opportunity to see how electronics can be used to build up the technology which we are most familiar today from flat-screen TVs and smartphones to mars rovers. Nearly everything we use in this day and age relies on electronics. We hope that throughout this course you learn to appreciate how the technology around you functions and we hope to pull apart some electronic devices to explore their inner workings.

Course objectives

• To acquaint the student with the basics of analogue and digital electronics, and their differences. • To understand how components in various direct and alternating current circuits behave. • To introduce semiconductor physics, particularly diode and transistor characteristics and their applications (although further detail can be found in PHY3003 Solid State Physics). • To provide an introduction to digital logic, its operations, principles and applications. • To describe the theoretical background required to successfully build and test circuits in the co-skill PRA2006. • To give an overview of how some everyday electronic devices and technologies function.

Prerequisites

Co-requisites: PRA2006 Electronics

Corequisites

- Electronics Lab

Recommended reading

Tba

PHY2006

Period 1
2 Sep 2019
25 Oct 2019

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
B.R.N. van Grinsven
Teaching methods:
Lecture(s), PBL
Assessment methods:
Attendance, Presentation, Participation, Written exam

Maastricht Science Programme

General Relativity

- Classical Mechanics
- Theory of Relativity

PHY3006

Period 5
6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
G. Koekoek
Teaching methods:
Lecture(s), PBL

Maastricht Science Programme

Stellar Astronomy

Full course description

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

Course objectives

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

variable stars, especially pulsating and cataclysmic variables and their contributions towards the cosmological distance ladder, being able to identify types based upon light curve and spectroscopic observations. • Apply the cosmological distance ladder to determine distances to particular types of stars. • Discuss stellar changes from formation to death, highlighting differences of low versus high mass stars from that of our Sun and how their remnants contribute to future star formation and planet formation.

Prerequisites

None

Recommended reading

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

PHY2009

Period 1
2 Sep 2019
25 Oct 2019

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
C.K. Ellington
Teaching methods:
PBL
Assessment methods:
Assignment, Attendance, Written exam, Participation

Maastricht Science Programme

Galactic Astronomy

Full course description

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

Course objectives

• Illustrate the size/structure of our Milky Way Galaxy, how we are able to measure motions of stars/gas clouds, map its overall structure and determine our place within which. • Compare/contrast the shapes, sizes & compositions of: spiral, elliptical, peculiar & irregular galaxies; being able to classify to which type they belong based upon imagery, orbital motions of bodies within which and/or physical content descriptions. • Evaluate observational evidence to differentiate between the top-

down and bottom-up models describing galactic formation. • Discuss competing models explaining the presence of galactic spiral arms. • Breakdown the historical classifications of active galaxies into the subcategories of: radio galaxies, Seyfert galaxies, quasars & blazars; understanding their impact on galactic evolution. • Explain the methods of determining distances to galaxies within the cosmological distance ladder, applying them to various galactic structures. • Describe the various pieces of evidence for dark matter within most galaxies and clusters of galaxies. • Relate how observations of distant supernovae led to the discovery that our universe is accelerating in its expansion rate. • Identify the key observations supporting the Big Bang as well as how problems with this model led to the inflationary hypothesis & the problems it solves. • Summarize the eras of our universe after the Big Bang, identifying various processes that occurred within each and/or differentiated them from each other.

Prerequisites

PHY2009

- Stellar Astronomy

Recommended reading

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

PHY2010

Period 2
28 Oct 2019
20 Dec 2019

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
C.K. Ellington
Teaching methods:
PBL, Research
Assessment methods:
Assignment, Attendance, Participation, Written exam

Neuroscience courses

Maastricht Science Programme

Cognitive Neurosciences: Biological Foundations of Behaviour

Full course description

Throughout our lives, we encounter an innumerable amount of situations. Each of these

circumstances requires a unique response. Our brain allows us to adapt our response to every new situation.

Course objectives

• Students will have a basic understanding of biological foundations of behaviour • Students will understand the basics of movement and memory • Comprehension of chemical control (neurotransmission and hormones) by the brain and dysfunctional control (e.g. addiction) • Student will have a basic understanding of language, sleep/wake behaviour, consciousness

Recommended reading

Required literature Neuroscience: Exploring the Brain – Bear, 3rd edition. Additional literature Principles of Neural Science – Kandel, 4th edition

NEU1002

Period 5
6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
P. van Ruitenbeek
Teaching methods:
Lecture(s), PBL
Assessment methods:
Attendance, Assignment, Written exam

Maastricht Science Programme

Neuroscience of Action

Full course description

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

Course objectives

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

Prerequisites

Pre-requisites • INT1004/NEU1002 Cognitive Neurosciences: Biological Foundations of Behaviour • INT2003/NEU2001 Cognitive Neurosciences: from Sensation to Perception

- Cognitive Neuroscience: from Sensation to Perception
- Cognitive Neurosciences: Biological Foundations of Behaviour

Recommended reading

Journal articles, book chapters.

NEU3001

Period 1
2 Sep 2019
25 Oct 2019

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
P.L.J. Stiers
Teaching methods:
Lecture(s), PBL
Assessment methods:
Attendance, Participation, Presentation, Written exam

Maastricht Science Programme

Neuropsychopharmacology

Full course description

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

Course objectives

• To know the basic principles of neurotransmission & the basic mechanism of drug-receptor

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

- Molecular Toxicology
- Introduction to Neuroscience

Recommended reading

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

NEU2002

Period 5
6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
E.L. Theunissen
Teaching methods:
Lecture(s), PBL
Assessment methods:
Attendance, Assignment, Presentation

Maastricht Science Programme

Cognitive Neuroscience: from Sensation to Perception

Full course description

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

Course objectives

To understand the physiologic basis of visual and auditory perception.

Prerequisites

INT1004/NEU1002 Cognitive Neurosciences: Biological Foundations of Behaviour

- Cognitive Neurosciences: Biological Foundations of Behaviour

Recommended reading

• E. Goldstein, 2010. Sensation to Perception, 8th Edition. Belmont, CA. Wadsworth publishing • E-reader

NEU2001

Period 2
28 Oct 2019
20 Dec 2019

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
L. Hausfeld
Teaching methods:
Lecture(s), PBL
Assessment methods:
Attendance, Participation, Presentation, Written exam

Maastricht Science Programme

Introduction to Neuroscience

Full course description

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.

Course 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.

Recommended reading

• M. F. Bear, B. W. Connors, M. A. Paradiso. Neuroscience, Exploring the Brain. Lippincott, Williams & Wilkins, 2006 (3rd edition). • E. R. Kandel, J. H. Schwartz, T. M. Jessell, S. A. Siegelbaum, A. J. Hudspeth. Principles of Neural Science, McGraw-Hill, USA, 2012 (5th edition). • L. H. Squire, H. E. Bloom, N. C. Spitzer, S. Du Lac, A. Ghosh, D. Berg. Fundamental Neuroscience. Academic Press, 2008 (3rd edition).

NEU1001

Period 4
3 Feb 2020
3 Apr 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
L.C.C. de Nijs
Teaching methods:
Lecture(s), PBL
Assessment methods:
Attendance, Written exam, Presentation

Interdisciplinary courses

Maastricht Science Programme

Systems Biology

Full course description

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

Course objectives

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

Recommended reading

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

INT3007

Period 2
28 Oct 2019
20 Dec 2019

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
M. Summer - Kutmon
Teaching methods:
Lecture(s), PBL
Assessment methods:
Attendance, Written exam, Assignment

Maastricht Science Programme

Biomaterials

Full course description

The ultimate goal of this course is to introduce the students to the field of biomaterials science. Biomaterials are (mostly synthetic) materials that are intended to improve treatment humans or animals. There are different classes of biomaterials, among which are synthetic and biobased (green) polymers, ceramics, fibers, etc. The exact structure and physico-chemical characteristics of these biomaterials will be explained. For instance, the exact composition, elasticity, biodegradation, chemical reactivity, stability, surface chemistry and topology are important parameters. The techniques that are used to evaluate the physical, chemical and biological characteristics of biomaterials are, consequently, an important subject in this course. Biomaterials are used in contact with tissues, the skin, or body-fluids and have to possess a number of special characteristics to be applicable. The response that is provoked from the contacting tissue is critically important. Therefore, the exact interaction between tissue and cells with the different biomaterials has to be studied. The concepts of biocompatibility, biosafety, toxicity, blood- and cyto- compatibility will be introduced and

explained in this course. Detailed information on the methods that are used to determine the biological response of a biomaterial will be provided. In the practical part of the course the students will be introduced to basic techniques involved in the characterization of biomaterials and determination of biocompatibility.

Course objectives

• To give an overview of all materials that are being applied as biomaterials. • To understand the synthesis and structure of different biomaterials; polymers, hydrogels, ceramics, fibers, etc. • To provide a detailed understanding of the interaction of biomaterials with surrounding tissues and the complete organism. • To introduce the student to the evaluation, characterization, and testing of biomaterials.

- Organic Chemistry

INT3003

Period 4
3 Feb 2020
3 Apr 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
C.M. Domingues Mota
Teaching methods:
Lecture(s), PBL, Research
Assessment methods:
Attendance, Written exam, Presentation, Final paper

Maastricht Science Programme

Regenerative Medicine

Full course description

Regenerative medicine has been defined as an interdisciplinary field that integrates principles of engineering and life sciences to develop biological substitutes that restore, maintain, or improve tissue and organ functions. Three main gears are generally needed to achieve tissue regeneration: cell-based therapies, tissue-inducing factors, and biocompatible matrices or scaffolds. These components have been investigated singularly or in combination to create engineered tissues. Regenerative medicine research includes the following areas: • Biomaterials: including novel biomaterials that are designed to direct the organization, growth, and differentiation of cells in the process of forming functional tissue by providing both physical and chemical cues. • Cells: including enabling methodologies for the proliferation and differentiation of cells, acquiring the appropriate source of cells such as autologous cells, allogeneic cells, xenogeneic cells, stem cells, genetically engineered cells, and immunological manipulation. • Biomolecules: including growth and other differentiating factors. • Engineering design aspects: including 2D cell expansion, 3D tissue growth,

bioreactors, vascularization, cell and tissue storage and shipping (biological packaging). • Biomechanical aspects of design: including properties of native tissues, identification of minimum properties required for engineered tissues, mechanical signals regulating engineered tissues, and efficacy and safety of engineered tissues In this course, we will introduce most of these elements through some examples that have already successfully reached the clinics and others that have still to be further improved to enter daily clinical practices.

Course objectives

The objectives of the course "Regenerative Medicine" are to introduce students to classic and novel concepts at the base of strategies to regenerate tissues and organs. The courses will briefly overview the biomaterial classes used to fabricate scaffolds and the processing technologies used for fabrication. Further insights on cell sources and cell nutrition will be explained. Different applications will be discussed spanning from skin to skeletal tissues and organ regeneration. After attending the course, students will be able to understand: • biomaterials and processing technologies used to fabricate scaffolds for tissue engineering; • cell sources and activity; • cell nutrient limitations in engineered tissues and technologies used to enhance cell viability; • successful and unsuccessful strategies to regenerate tissue and organs; • ethical principles revolving around regenerative medicine and clinical applications.

- Cell Biology
- Organic Chemistry

Recommended reading

"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).

INT3008

Period 4
3 Feb 2020
3 Apr 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
L. Moroni
Teaching methods:
Lecture(s), PBL
Assessment methods:
Attendance, Presentation, Written exam, Final paper

Maastricht Science Programme

Advanced Microscopy: Theory and Applications

Full course description

The use of advanced imaging techniques in light and electron microscopy is wide-spread, particularly in the fields of material science and biological imaging. In recent years, the resolution and/or functionality of such tools has been increased due to the development of fluorescence microscopy, two-photon excitation microscopy, correlative light-electron microscopy and stimulation emission depletion (STED) microscopy [first experimentally shown by the winners of the 2014 Nobel Prize in Chemistry]. In electron microscopy, rapid developments in aberration correction and in image filtering allow users to understand much more about the samples they are investigating. This course will introduce a number of advanced imaging techniques to participants, detailing theoretical aspects as well as practical considerations. This course is aimed any students from the programme with an interest in imaging and its principles.

Course objectives

• To acquaint the student with an understanding of principles of (light) microscopy and limiting factors in resolution • To introduce and detail a number of microscope designs and theory as to how they overcome the resolution limit • Introduction and understanding of electron microscopy and its application to material science and biological imaging • To explain sample preparation procedures and perform a demonstration of some of the equipment

Prerequisites

BIO1001 Introduction to Natural Sciences: Biology MAT1001 Introduction to Natural Sciences: Calculus or PHY1002 Introduction to Natural Sciences: Mathematical Foundations of Physics Recommended PHY1001 Elements of Physics

Recommended reading

TBC

INT3002

Period 5
6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinators:
M.A.M.J. van Zandvoort
D. Kapsokalyvas
Teaching methods:
PBL, Lecture(s)
Assessment methods:
Assignment

Maastricht Science Programme

Science and the Visual Arts

Full course description

Contemporary conservation of paintings, sculptures and other works of visual art is unthinkable without the natural sciences. Chemists investigate the behaviour of paints and other materials like plastics in order to prevent or repair degradation. Sophisticated spectroscopic techniques are employed to look through paint layers and discover hidden information. Building materials are subjected to artificial aging processes in order to better protect them from wear and tear. Time and again, however, the question is raised whether these techniques succeed in capturing the 'artiness' of the artworks. The introduction of scientific investigation methods has thoroughly changed the practice of fine arts conservation and restoration, but not without provoking debates with art-historically trained conservation professionals, who favour the educated eye of the connoisseur above the graphs of the spectrometer. This course will trace the growing impact of the sciences in fine art conservation since the late 19th century and how it has reframed the way museums define their task of preserving and presenting cultural heritage. Actual case histories, like the 'cleaning controversy' of 1947 and the recently completed Victory Boogy Woogy research project will illustrate both the tensions and the fruitful collaborations between the scientific and the aesthetic approaches to art. Visits to conservation laboratories (e.g. SRAL, RCE) and talks with practising conservators and conservation scientists will be part of the course. Parallel to the tutor meetings students work collectively on a practical conservation research assignment.

Course objectives

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

Prerequisites

None.

Corequisites

- Analytical Chemistry in the Art World

Recommended reading

Selected articles and chapters will be provided to the students

INT3010

Period 5
6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:
5.0
Instruction language:

English
Coordinator:
R. van de Vall
Teaching methods:
Lecture(s), PBL
Assessment methods:
Attendance, Participation, Presentation, Written exam

Maastricht Science Programme

Introduction to Biomedical Engineering

Full course description

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

Course objectives

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

Prerequisites

None.

Recommended reading

Various book chapters and research articles

INT1003

Period 4
3 Feb 2020
3 Apr 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
F. de Martino
Teaching methods:
Lecture(s), Assignment(s), PBL
Assessment methods:
Assignment, Attendance, Written exam

Maastricht Science Programme

Commercializing Science and Technology

Full course description

Commercialising Science & Technology helps you to understand and master the entrepreneurial process of turning science into products and products into businesses. University labs and corporate R&D department increasingly rely on professionals that help bridging the gap between science production (conference presentations, scientific publications, and patents) and commercial value creation (revenues, funding for scientific and applied research). Not only corporate research labs, also academic research groups increasingly need to be able to legitimize how their research might ultimately result in economic activity. For example, obtaining a research grant from public sponsors is (partially) dependent on the researchers' ability to explain the commercialization of the scientific insights that they seek to produce. In addition, industry-university collaboration has become more intense. As a result, researchers need to understand how their work relates to the functioning of companies. In this course you start building an understanding for the bridging of science to business. It provides insight in technology transfer and licensing as well as an understanding of the dynamics of science production and deployment. In addition, the course will provide insights into the characteristics of an "entrepreneurial spirit" and students will experience to what extent they themselves have an "entrepreneurial spirit".

Course objectives

• Primary goal: o To understand how and when research findings and technological breakthroughs can be transformed into new business. o To foster an entrepreneurial spirit • Secondary goals: o To understand how technology can be transferred from research labs to start-ups and established companies. o To understand the role of academic and other not-for-profit research labs in creating business opportunities. o To understand how the patenting process. o To appreciate the characteristics of the prevalent modes of science and technology commercialisation: licensing, spinning out and new business development.

Recommended reading

We will provide a reader with suggested papers and (at cost price) a reader with cases. In addition, the following handbook can provide useful background information for each of the topics covered in this course. Its reading is however not required. Shane, S. 2004. Academic Entrepreneurship: University Spinoffs and Wealth Creation. Aldershot: Edward Elgar.

INT1005

Period 5
6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinators:
C.L. Sparks

J.C. Kaminski

Teaching methods:

Lecture(s), PBL, Assignment(s)

Assessment methods:

Participation, Written exam, Final paper

Maastricht Science Programme

Philosophy of Technology

Full course description

Technology is everywhere. From smartphones to GMOs, from the internet to biomedicine – it helps shape how we communicate, what we eat, what we know and how we age. But can we even agree on what 'technology' is? Is it merely applied science? A neutral tool, that's used for better or worse? Or is it an autonomous force running on a logic of its own? Do we need to develop new concepts and tools in order to understand modern technologies? And what can technology tell us about what it means to be human? This course offers an overview of key approaches and issues in classic and modern philosophy of technology, in order to help students better reflect on what technology is and how specific technologies impact our society. We will explore important theoretical notions like 'technological determinism', 'technological solutionism', the 'co- constitution of technology and society', and the idea that technologies can have a politics – even a morality – 'designed into' them. We will see how these notions apply to some heated public debates, including human enhancement, privacy online, and smartphone etiquette. And we will consider such questions as 'what is the relationship between technology and the good life?', and 'how does technology shape our own experience of the world?

Course objectives

• To introduce a number of key thinkers, approaches and issues in the philosophy of technology. • To grasp the important contribution philosophy can make to understanding technological development and to making sense of contemporary debates and controversies surrounding technological innovations in society. • To further acquaint students, following course PRO1001, with humanistic interpretations and analyses of science and technology. • To provide philosophical tools to reflect on the political, ethical and social impact of technology on the contemporary world.

Prerequisites

PRO1001 Philosophy of Science

- Philosophy of Science

Recommended reading

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

INT3001

Period 1

2 Sep 2019

25 Oct 2019

Print course description

ECTS credits:
5.0
Instruction language:
English
Coordinator:
T.E. Swierstra
Teaching methods:
Lecture(s), PBL
Assessment methods:
Attendance, Participation, Presentation, Written exam

Maastricht Science Programme

Science in Action

Full course description

This course is situated in the field of Science and Technology Studies (STS) and analyses the social and cultural complexities involved in the production and dissimination of scientific knowledge. We wil take the idea that most knowledge production today happens in a context of multi- disciplinarity, as our point of departure. This perspective will help us to understand how science operates in today's complex world. To gain insight in science we zoom in on the organization of knowledge production and its collaborative character. We also study processes in which credible facts are established and published. Furthermore, this course also pays attention to the integrity of science and in particular its grey areas. Beside the immediate context in which scientific facts are established (i.e. the lab), the course also takes into account the wider socio-economic context in which science operates. This involves not only the commercialization of science, but also the way its promises and expectations are related to our hopes and fears. Finally, you will gain insights into the way the cultural-historical contexts affects the interpretation of facts. Based on discussions and analyses of these topics the course aims to make you reflect critically on 'common sense' views of the making and use of scientific claims. Besides tutorial meetings, the course also involves lectures, discussion meetings, video analysis, and a visit to a scientific lab for an interview. Students will engage in intensive hands-on project work during this course, whereby they will examine changes in the organization of scientific practice in a domain of their choosing.

Course objectives

• Students gain insight into the contemporary challenges and dynamics of knowledge production in the sciences. • Students gain insight into the complexities of how scientific knowledge is distributed and communicated in society. • Students reflect critically on 'common sense' views of the making and use of scientific claims.

Recommended reading

• E-Reader. • UM library.

INT2007

Period 2
28 Oct 2019
20 Dec 2019

Print course description

ECTS credits:

5.0

Instruction language:

English

Coordinator:

A.E.G. Jacobs

Teaching methods:

PBL, Lecture(s), Assignment(s)

Assessment methods:

Attendance, Assignment, Participation, Presentation, Observation

Maastricht Science Programme

Molecular Toxicology

Full course description

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

Course objectives

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

Prerequisites

INT1002 Basic Principles of Pharmacology CHE1001 Introduction to Natural Sciences: Chemistry

Recommended reading

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

INT2008

Period 4

3 Feb 2020
3 Apr 2020

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
G.J.M. den Hartog
Teaching methods:
Lecture(s), PBL
Assessment methods:
Attendance, Participation, Written exam, Presentation

Maastricht Science Programme

Biobased Materials and Technology

Full course description

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

Course objectives

• To understand what Biobased Materials are and what their impact is on society • To create an understanding of sources of Biobased intermediates, building blocks and materials • Get an insight in the synthesis and production methods of intermediates, building blocks and Biobased Materials • To deepen understanding of the relation between material composition, properties and material applications • To study the added value (if any) of Biobased Materials • To study the impact of Biobased materials and technologies on the environment (biodegradation, sustainability, CO2 footprint)

Prerequisites

CHE2001 Organic Chemistry

- Organic Chemistry

Recommended reading

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

INT3005

Period 2
28 Oct 2019
20 Dec 2019

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinators:
Y. van der Meer
K. Saralidze
Teaching methods:
Lecture(s), PBL
Assessment methods:
Assignment, Presentation, Written exam

Maastricht Science Programme

Sustainable Development

INT1006

Period 2
28 Oct 2019
20 Dec 2019

Print course description
ECTS credits:
5.0
Instruction language:
English
Coordinator:
W.J.M. Martens

Skills

Skills and Practical training

Maastricht Science Programme

Advanced Academic Skills

Full course description

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

Course objectives

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

Prerequisites

PRA1002 Research, Data Analyses and Presentation Academic Skills

- Research, Data analysis and Presentation Academic skills

Recommended reading

Literature via handouts. No mandatory textbook.

PRA2015

Period 1
2 Sep 2019
25 Oct 2019

Print course description
ECTS credits:
2.5
Instruction language:
English
Coordinator:
J.J. Sloggett
Teaching methods:
Skills, PBL
Assessment methods:
Attendance, Assignment, Presentation

Maastricht Science Programme

Practical Zoology

Full course description

The skill aims to provide a greater insight into the different aspects of zoology and how they are studied in the laboratory. You will learn different experimental approaches used in zoology in including physiological testing, behavioural analysis and measures of animals diversity. This course

aims to provide you with better skills in handling both live and dead animal samples and in interpreting what you see in a biologically relevant way. Please note that in this course you are required to carry out experimental work with live (invertebrate) animals, which may harm them.

Course objectives

The skills will include: • Carrying out experiments on physiology, behaviour, biodiversity and other aspects of zoology • Analysing zoological data • Writing up zoology experiments • Knowledge of conservation of zoological samples

- Research, Data analysis and Presentation Academic skills
- General Zoology

Recommended reading

Recommended is the book used for course BIO2004 General Zoology

PRA2013

Period 2
28 Oct 2019
20 Dec 2019

Print course description
ECTS credits:
2.5
Instruction language:
English
Coordinator:
J.J. Sloggett
Teaching methods:
Skills, Work in subgroups

Maastricht Science Programme

Advanced Physics Laboratory

Full course description

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

Course objectives

• To acquaint the participants with an overview of the main areas in high level experimental physics • To illustrate the relationship between observation, experiment and hypothesis • To give the

participants a better understanding of the laws of physics • To hone the skills required for planning and conducting experimental physics • To develop the skills of experimental design and the impact this has on the outcome.

Prerequisites

PHY1001 Elements of physics PRA1003 Basic physics laboratory PRA2007 Physics laboratory Note: Waivers are unlikely to be granted unless applicants show significant expertise in experimental physics or similar subject (equivalent to the two pre-requisite skills).

- Physics Laboratory
- Basic Physics Laboratory

Recommended reading

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.

PRA3002

Period 2
28 Oct 2019
20 Dec 2019
Period 5
6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:
2.5
Instruction language:
English
Coordinator:
C.J. Pawley
Teaching methods:
Work in subgroups, Skills, Research
Assessment methods:
Attendance, Participation, Assignment

Maastricht Science Programme

Polymer Processing

Full course description

In this practical course the processing and mechanical testing of polymers will be explored. The course will exist of four different experiments. In these experiments the processing and testing of a specific polymer will be conducted. Thermoplastic polymers will be compounded (pure and as a blend) and processed in a blow or flat film trough extrusion. By the use of injection moulding standard dog bones will be made for mechanical testing. Mechanical and physical properties of the product will be

determined by tensile and bending strength analysis, Melt Flow Index (MFI) and a notched test bar impact test. Thermosetting polymers will be processed into composites. Different techniques for constructing composite materials will be addressed. Attaching different composite parts to each other is complicated and different methods will be explored. Mechanical and physical testing will be performed using the above described techniques. Rolling and pressing techniques will be used to process elastomers and the process of vulcanisation will be studied. After processing mechanical and physical testing will be performed. Coatings/paints play are an important application area of polymers. A basic coating will be made and will be processed. Characteristics like scratch and impact resistance of this coatings will be tested.

Course objectives

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

Prerequisites

Pre-requisite: CHE2001 Organic Chemistry

- Organic Chemistry

Recommended reading

Practical Manual and SOP’s of the used equipment

PRA3005

Period 2
28 Oct 2019
20 Dec 2019

Print course description
ECTS credits:
2.5
Instruction language:
English
Teaching methods:
Skills, Research
Assessment methods:
Attendance, Participation, Assignment, Observation

Maastricht Science Programme

Advanced Electronics

Full course description

The course builds on the introductory electronics lab and is split into three, two-week long projects covering the following topic areas: • Digital electronics for computing: This project covers the basics of binary number systems, Boolean algebra, and logic devices. You will build a digital clock to provide

an appreciation of how digital devices can perform different functions. A similar device will be built using the Arduino microcontroller to better understand how an integrated microcontroller can achieve the same functions of many discrete logic components. • Analogue electronics with bioengineering applications: In this project you will build an ECG generator and measurement unit using analogue components with the aim of better understanding analogue electronics and their potential applications in biomedical engineering. Students will gain a more detailed insight into the charging and discharging characteristics of biological and technological capacitors as well as understanding the function of amplifiers, filters and counters. • Electrochemical impedance measurement and biosensor technology Impedance spectroscopy is an electronic read-out technology which emerged in the Nazi era, used to investigate the structural quality of U-boats. Through the decades the technology was optimized and is now an established technology, implemented in (bio) medical research. It has been used for the detection of proteins, neurotransmitters and even the detection of single nucleotide polymorphisms in DNA sequences. In this project you will mimic this last experiment and try to delineate impedimetric signals in way that DNA melting times can be calculated and based on this information you will try to distinguish between a full matching DNA sequence and a mutated DNA sequence.

Course objectives

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

Prerequisites

MAT1001 Introduction to Natural Sciences: Calculus or PHY1002 Introduction to Natural Sciences: Mathematical Foundations of Physics PRA1006 Electronics

- Electronics
- Electronics Lab

Recommended reading

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

PRA3012

Period 4
3 Feb 2020
3 Apr 2020

Print course description
ECTS credits:
2.5
Instruction language:
English
Coordinator:
B.R.N. van Grinsven
Teaching methods:
Skills, Work in subgroups

Assessment methods:
Assignment

Maastricht Science Programme

Spectroscopic Methods

Full course description

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 • 1H and 13C NMR spectroscopy • Mass spectrometry Depending on timing, interest and number of students, there may also be some time devoted to mechanical and thermal analysis (e.g. DSC, TGA, rheology), the use of electroanalytical techniques and the determination of physical-chemical properties of compounds, such as lipophilicity, solubility, optical activity, pKa and dissolution.

Course objectives

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

Prerequisites

CHE2001 Organic Chemistry CHE2002 Inorganic Chemistry CHE2004 Spectroscopy

- Organic Chemistry
- Spectroscopy

Recommended reading

The textbooks from the pre-requisite courses.

PRA3014

Period 4
3 Feb 2020
3 Apr 2020

Print course description
ECTS credits:
2.5
Instruction language:
English
Coordinator:
B. Blom
Teaching methods:
Skills, Research
Assessment methods:
Attendance, Presentation, Final paper, Written exam

Maastricht Science Programme

Data Collection Techniques in the Neurosciences

Full course description

The skills will cover relevant laws of sensory perception (Weber, Fechner, Stevens), and introduce testing procedures for the measurement of detection and discrimination thresholds. These will include constant stimuli methods, and various adaptive testing procedures. In addition, there will be an introduction to Signal Detection Theory and derived measures of detectability or discriminability. In order to make this knowledge concrete, students conduct experiments based on several of these testing procedures. The end goal is to test one of the colleague-students and determine a sensory threshold with provided software. Students will also be familiarized with the analysis (Brainvoyager QX) and interpretation of an fMRI dataset. In addition to the empirical data collection and analysis, relevant literature will be covered on specific testing procedures, and on particularly beautiful examples of current state of the art experiments.

Course objectives

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

Prerequisites

None.

Recommended reading

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

PRA1005

Period 4
3 Feb 2020
3 Apr 2020

Print course description
ECTS credits:
2.5
Instruction language:
English
Coordinator:
M.J. Roberts
Teaching methods:
Lecture(s), Work in subgroups, PBL, Skills
Assessment methods:
Attendance, Assignment, Participation, Presentation, Final paper

Maastricht Science Programme

Transition Metal Chemistry

Full course description

This course will focus on the synthesis of transition metal complexes and the experimental exploration of their chemical and physical properties. Some air sensitive techniques will be explored.

Course objectives

• To learn common techniques in inorganic synthesis • To perform synthesis of coordination compounds • To experimentally observe the principles of catalysis • To apply the knowledge gained in CHE3002 in a laboratory setting • To use the available instrumentation to spectroscopically analyse transition metal compounds

Prerequisites

Pre-requisites: PRA1001 Research Methods PRA2004 Inorganic Synthesis Recommended Courses: CHE3001 Organic Reactions Co-requisites: CHE3002 Transition Metal Chemistry

- Research Methods
- Inorganic Synthesis
- Chemical Synthesis
- Spectroscopy

Corequisites

- Transition Metal Chemistry

Recommended reading

A course manual will be provided

PRA3008

Period 5
6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:
2.5
Instruction language:
English
Coordinator:
B. Blom
Teaching methods:
Work in subgroups, Assignment(s), Research, Skills
Assessment methods:
Attendance, Assignment, Final paper, Participation

Maastricht Science Programme

Basic Physics Laboratory

Full course description

The aim of this course is understanding what physics means by performing instructive physical experiments that reveal fundamental physical principles, and also to attain a level of dexterity with experimental devices. Physics is an empirical science and not a mere collection of mathematical laws. In this sense this practical is an appropriate counterpart for the more theoretic and mathematical Physics courses. Moreover, the aim of this training is to train your ability to report and summarize your experimental work in a few pages. The course lasts six weeks, and consists of one full day of experimentation per week. The required attendance for this practicum is a full 100%. The practicum consists of a collection of 12 different experiments. Students cooperate in couples (of 2 students) and each week perform a different experiment. Each experiment consists of a theoretical and methodological preparation: i. Reading about the theory behind the experiment; ii. Determining what should be done and in what order; iii. Writing a plan containing the required steps for carrying out the measurements. Topics: MECHANICS: Newton's Laws Experiment, Conservation of momentum and impulse, Projectile Motion, Mechanical waves. THERMODYNAMICS: Thermal Energy, Equilibrium Temperature, Specific Heat, Ideal Gas Law LIGHT and OPTICS: Reflection and Refraction, Snell’s Law, index of refraction, Michelson’s interferometer.

Course objectives

• To acquaint the student with the basis of experimental physics. • 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.

Prerequisites

PHY1001 Elements of Physics

Recommended reading

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

PRA1003

Period 2
28 Oct 2019
20 Dec 2019
Period 5
6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:

2.5
Instruction language:
English
Coordinator:
C.J. Pawley
Teaching methods:
Research, Skills, PBL
Assessment methods:
Assignment, Attendance

Maastricht Science Programme

Chemical Synthesis

Full course description

This skills focuses on the development of a clear understanding of the synthesis of organic chemical compounds. It is important for the students to learn how to convert their theoretical knowledge on chemical reactivity to actual design and execution of synthetic chemical reactions. Typical topics, which will be covered in this skills training are: • Safe handling of organic reagents and safe execution of organic experiments. • Commonly used organic synthetic laboratory techniques. • Synthetic chemistry of various organic reaction types (e.g. nucleophilic substitutions and eliminations, electrophilic reactions and radical chemistry). • Stereochemistry in organic synthesis. • Purifications and separations in chemistry. • Spectroscopy and characterization of organic compounds.

Course objectives

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

Prerequisites

Pre-requisites: PRA1001 Research Methods PRA1002 Research, Data Analysis and Presentation Academic Skills Co-requisites CHE2001 Organic Chemistry

- Research Methods
- Research, Data analysis and Presentation Academic skills

Corequisites

- Organic Chemistry

Recommended reading

• 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.

PRA2002

Period 1
2 Sep 2019

25 Oct 2019
Period 4
3 Feb 2020
3 Apr 2020

Print course description
ECTS credits:
2.5
Instruction language:
English
Coordinator:
H. Diliën
Teaching methods:
Assignment(s), Work in subgroups, PBL, Paper(s), Skills
Assessment methods:
Observation, Participation, Assignment

Maastricht Science Programme

Inorganic Synthesis

Full course description

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

Course objectives

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

Prerequisites

Pre-requisites PRA1001 Research methods PRA1002 Research, Data Analysis and Presentation Academic Skills Recommended: CHE2001 Organic Chemistry PRA2002 Chemical Synthesis Co-requisites CHE2002 Inorganic Chemistry

- Research Methods
- Research, Data analysis and Presentation Academic skills

Corequisites

- Inorganic Chemistry

Recommended reading

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

PRA2004

Period 1
2 Sep 2019

25 Oct 2019

Print course description

ECTS credits:
2.5
Instruction language:
English
Coordinator:
B. Blom
Teaching methods:
Skills
Assessment methods:
Attendance, Assignment, Written exam

Maastricht Science Programme

Genetics

Full course description

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

Course objectives

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

Prerequisites

Pre-requisites BIO2001 Cell Biology Co-requisites BIO2007 Genetics

- Cell Biology

Corequisites

- Genetics

Recommended reading

"Introduction to Genetic Analysis" by Griffiths, Wessler, Carrol, Doebley (W.H. Freeman, 10thedition, International Edition, 2012. bol.com price €64,99).

PRA2014

Period 1
2 Sep 2019
25 Oct 2019
Period 4
3 Feb 2020
3 Apr 2020

Print course description
ECTS credits:
2.5
Instruction language:
English
Coordinator:
S.J.F. Olieslagers
Teaching methods:
PBL, Research, Skills, Work in subgroups, Assignment(s)
Assessment methods:
Participation, Assignment, Attendance

Maastricht Science Programme

Advanced Organic Synthesis

Full course description

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.

Course objectives

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

Prerequisites

Pre-requisites PRA2002 Chemical Synthesis Co-requisites CHE3001 Organic Reactions

- Chemical Synthesis

Corequisites

- Organic Reactions

Recommended reading

• 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.

PRA3001

Period 2
28 Oct 2019
20 Dec 2019

Print course description
ECTS credits:
2.5
Instruction language:
English
Coordinator:
H. Diliën
Teaching methods:
Research, Skills, Paper(s)
Assessment methods:
Assignment, Attendance, Final paper, Observation

Maastricht Science Programme

The Limburg Landscape

Full course description

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

Course objectives

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

Prerequisites

PRA1001 Research Methods PRA1002 Research Data Analysis and Presentation Skills PRA2009 Field skills in Biology A bike to make field trips!

- Field Skills in Biology

PRA3011

Period 5
6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:
2.5
Instruction language:
English
Coordinator:
R.H.J. Erkens
Teaching methods:
Working visit(s)
Assessment methods:
Assignment, Attendance

Maastricht Science Programme

Applied Cell Biology

Full course description

This skill will contain: • Cell culture • Immunohistochemistry • qPCR • Metabolic assays

Course objectives

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

- Cell Biology
- Laboratory Skills for Molecular Research

Recommended reading

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

PRA3017

Period 1
2 Sep 2019
25 Oct 2019

Print course description
ECTS credits:

2.5
Instruction language:
English
Coordinators:
M.M.J. Kamphuis
A.M.F. Carlier
Teaching methods:
Skills, Research, Assignment(s)
Assessment methods:
Attendance, Participation, Assignment

Maastricht Science Programme

Microbiology

Full course description

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

Course 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.

- Cell Biology
- Genetics

Corequisites

- Microbiology

Recommended reading

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

PRA3010

Period 5
6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:
2.5

Instruction language:
English
Coordinator:
F.R.M. Stassen
Teaching methods:
Skills
Assessment methods:
Attendance, Assignment, Final paper

Maastricht Science Programme

Exploring the World of Plants

Corequisites

- General Botany

PRA2011

Period 4
3 Feb 2020
3 Apr 2020

Print course description
ECTS credits:
2.5
Instruction language:
English
Coordinator:
R.H.J. Erkens

Maastricht Science Programme

Physics Laboratory

Full course description

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

Course objectives

This practical is aimed at obtaining a deeper understanding of physics by performing various key experiments in the areas of Classical Mechanics, Quantum Mechanics, and Electromagnetism. Examples are the photoelectric effect, blackbody radiation, angular momentum, Faraday's law, and the Coulomb's law. The focus will be on the design and execution of the experiments and their

relation to the fundamental laws and principles of physics. Another objective is the further training of physical laboratory techniques and procedures. Furthermore, attention will be paid on data analysis and reporting. This lab relates to level 200 physics courses such as Classical Mechanics, Quantum Mechanics, and Electromagnetism.

Prerequisites

PRA1003 Basic Physics Laboratory PHY1001 Elements of Physics Note: waivers are unlikely to be granted unless applicants can show their experience in experimental physics is equivalent to that of PRA1003.

- Basic Physics Laboratory

Recommended reading

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.

PRA2007

Period 2
28 Oct 2019
20 Dec 2019
Period 5
6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:
2.5
Instruction language:
English
Coordinators:
B.R.N. van Grinsven
C.J. Pawley
Teaching methods:
Assignment(s), Work in subgroups, Research, Skills
Assessment methods:
Attendance, Assignment

Maastricht Science Programme

Programming

Full course description

The course is intended to introduce students to more practical concepts involved with computer programming. The students will gain experience implementing these concepts in programming tasks described by each assignments. Topics include: • Implementing recursive methods • Basics of object-oriented programming • Basics of graphical user interface (GUI) programming • String manipulation

and parsing • File input and output • Introduction to data structures

Course objectives

To familiarize students with the practical skills required in computer programming

Prerequisites

MAT1004 Imperative Programming

- Introduction to Programming

Recommended reading

Relevant literature will be available online and referred to on the assignments.

PRA2003

Period 2
28 Oct 2019
20 Dec 2019

Print course description
ECTS credits:
2.5
Instruction language:
English
Coordinators:
M. Lanctot
C.B. Browne
Teaching methods:
Work in subgroups, PBL, Skills
Assessment methods:
Attendance, Assignment, Written exam, Computer test

Maastricht Science Programme

Field Skills in Biology

Full course description

This skills will include: • Training in the use of a diversity of methods to collect or count organisms in the field • Training on the measurement of some important environmental characteristics • The means to identify of species or higher taxa of certain environmentally or taxonomically important groups or indicator species in the field or lab • Planning of field experiments • Interpretation of field results, including some statistical work PLEASE NOTE: One of the classes in this course will be conducted in the evening until about 23.30. Attendance for this class is obligatory and if you register for this course, you must attend!

Course objectives

For an ecologist, the field is a much less controlled, though much more realistic environment than the lab, and a completely different set of practical skills are required. In this course you will learn how to

generate well controlled reliable, results in the field. You will be shown a diversity of methods to collect, count and identify animals and plants, both direct (e.g. collect plants in the field) and indirect (e.g. identifying bats using their ultrasonic squeaks). You will learn how to measure important environmental variables that can determine the results you get (e.g. soil characteristics, temperature, humidity) and most importantly some basic means to plan for and interpret all that complex data.

Prerequisites

* PRA1001 Research Methods * PRA1002 Research Data Analysis and Presentation Skills

- Research Methods
- Research, Data analysis and Presentation Academic skills

Recommended reading

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

PRA2009

Period 5
6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:
2.5
Instruction language:
English
Coordinator:
J.J. Sloggett
Teaching methods:
Research, Skills, Work in subgroups
Assessment methods:
Attendance, Assignment, Participation

Maastricht Science Programme

Programming in the Life Sciences

Full course description

In the life sciences the interactions between chemical entities is of key interest. Not only do these play an important role in the regulation of gene expression, and therefore all cellular processes, they are also one of the primary approaches in drug discovery. Pharmacology is the science studies the action of drugs, and for many common drugs, this is studying the interaction of small organic molecules and protein targets. And with the increasing information in the life sciences, automation becomes increasingly important. Big data and small data alike, provide challenges to integrate data from different experiments. The Open PHACTS platform provides web services to support pharmacological research and in this course you will learn how to use such web services from programming languages, allowing you to link data from such knowledge bases to other platforms, such as those for data analysis.

Course objectives

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

Prerequisites

PRA2003 Programming

- Programming

Recommended reading

"Rang and Dale's Pharmacology" by Rang et al. (Pearson, 7th edition, 2012). "JavaScript & jQuery: The Missing Manual" by D.S. McFarland (O'Reilly, 2nd edition, 2011) "Open PHACTS: semantic interoperability for drug discovery" by A. Williams et al. Drug Discovery Today, 2012, http://dx.doi.org/10.1016/j.drudis.2012.05.016

PRA3006

Period 2
28 Oct 2019
20 Dec 2019

Print course description
ECTS credits:
2.5
Instruction language:
English
Coordinator:
E.L. Willighagen
Teaching methods:
Skills
Assessment methods:
Participation, Attendance, Presentation, Assignment

Maastricht Science Programme

Molecular Biology

Full course description

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

molecular biological techniques are applied to tackle major research questions in modern biomedical research.

Course objectives

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

Prerequisites

Pre-requisites BIO2001 Cell Biology BIO2007 Genetics PRA2014 Genetics Co-requisites BIO3001 Molecular Biology

- Genetics
- Genetics
- Cell Biology

Corequisites

- Molecular Biology

Recommended reading

A reader is provided at the start of the course. Recommended literature sources: "Molecular Cell Biology" by Lodish, Berk, Kaiser (W.H. Freeman, 7th edition, 2012. bol.com price €145) and "Introduction to Genetic Analysis" by Griffiths, Wessler, Carrol, Doebley (W.H. Freeman, 10th edition, International Edition, 2012. bol.com price €64,99).

PRA3003

Period 2
28 Oct 2019
20 Dec 2019
Period 5
6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:
2.5
Instruction language:
English
Coordinator:
S.J.F. Olieslagers
Teaching methods:
Work in subgroups, Skills, Research
Assessment methods:
Attendance, Participation, Presentation, Written exam, Final paper

Maastricht Science Programme

Advanced Molecular Laboratory Skills

Full course description

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

Course objectives

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

Prerequisites

BIO1001 Introduction to Natural Sciences: Biology / CHE1001 Introduction to Natural Sciences: Chemistry / PRA1001 Research Methods

- Research Methods

Recommended reading

"Practical skills in Biomolecular sciences" by Reed R, Holmes D, Weyers J, Jones a. (Pearson, 3rd edition 2007).

PRA2005

Period 4
3 Feb 2020
3 Apr 2020

Print course description
ECTS credits:
2.5
Instruction language:
English
Coordinators:
T.J. Cleij
T.D. Steen Redeker
Teaching methods:
Work in subgroups, Assignment(s), Research, Skills
Assessment methods:
Attendance, Observation, Final paper, Written exam

Maastricht Science Programme

Electronics Lab

Full course description

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

Course objectives

• To acquaint the student with the basics of electronic fundamentals. • To master the principles of direct and alternating current electronics circuit analysis. • To make the student familiar with semiconductor physics, particularly diode and transistor characteristics and their applications, especially operational amplifiers. • To provide an introduction to digital logic, its operations, principles and applications.

Prerequisites

Co-requisites: PHY2006: Electronics

Corequisites

- Electronics

Recommended reading

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

PRA2006

Period 1
2 Sep 2019
25 Oct 2019

Print course description
ECTS credits:
2.5
Instruction language:
English
Coordinator:
B.R.N. van Grinsven
Teaching methods:
Skills

Assessment methods:
Attendance, Assignment

Maastricht Science Programme

Molecular Modelling

Full course description

Molecular modelling is an important part of chemistry for any industry but more particularly the pharmaceutical industry. It helps with determining the shape of molecules and therefore prevent problems down the line when those molecules need to react. It is also possible to study the reactivity of molecules as well as understand the pathway of certain reactions by determining the shape of the transition state. During these skill sessions, you will be using a piece of software called Gaussian® in order to perform various calculations on system that would apply in real life situations, solve problems as well as assess the validity of certain models.

Course objectives

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

Prerequisites

Prerequisite CHE3006

- Quantum Chemistry

Recommended reading

Atkins, P., Friedman, R. Molecular Quantum Mechanics (5th ed.) Oxford University Press. Cramer, J. Essentials of Computational Chemistry – Theories and Models (2nd ed.) Wiley

PRA3018

Period 1
2 Sep 2019
25 Oct 2019

Print course description
ECTS credits:
2.5
Instruction language:
English
Coordinator:
V. Vieru
Teaching methods:
Skills, PBL
Assessment methods:
Attendance, Assignment, Final paper

Maastricht Science Programme

Synthetic Biology

Full course description

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

Course 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

Prerequisites

PRA2005 Molecular Lab Skills PRA2014 Genetics

- Genetics
- Laboratory Skills for Molecular Research

Recommended reading

Course manual

PRA2010

Period 2
28 Oct 2019
20 Dec 2019

Print course description
ECTS credits:
2.5
Instruction language:
English
Coordinator:
T.D. Steen Redeker
Teaching methods:
Skills, PBL
Assessment methods:
Attendance, Assignment

Maastricht Science Programme

Physical Chemistry

PRA2008

Period 5
6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:
2.5
Instruction language:
English
Coordinator:
V. Vieru

Maastricht Science Programme

Analytical Chemistry in the Art World

- Organic Chemistry

Corequisites

- Science and the Visual Arts: Conservation and its Histories

PRA3020

Period 5
6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:
2.5
Instruction language:
English

Maastricht Science Programme

Topics in Scientific Computing

Full course description

Scientific computing concerns the use of computers to analyze and solve problems arising in biology, chemistry and physics. This generally involves the construction of a mathematical model of the scientific problem, and solving the mathematical problem using computational algorithms. The

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

Course objectives

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

- Programming
- Linear Algebra
- Calculus

Recommended reading

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.

PRA3021

Period 1
2 Sep 2019
25 Oct 2019

Print course description
ECTS credits:
2.5
Instruction language:
English
Coordinators:
P.J. Collins
G. Stamoulis
Teaching methods:
Assignment(s), Lecture(s), Skills, PBL
Assessment methods:
Attendance, Final paper, Participation

Maastricht Science Programme

iGem Project

Full course description

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

Course objectives

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

Recommended reading

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

PRA3022

Period 1
2 Sep 2019
25 Oct 2019

Print course description
ECTS credits:
2.5
Instruction language:
English
Coordinator:
T.D. Steen Redeker
Teaching methods:
PBL, Skills, Work in subgroups, Research
Assessment methods:
Participation, Attendance, Presentation

Maastricht Science Programme

Plant Physiology and Microbiomes

Full course description

As research on microbes living in and on plants has accumulated in recent years, it has become increasingly clear that plants' success and responses to their abiotic environment are mediated by their microbiomes. A number of approaches exist to investigate the impacts of microbes on plant

physiology; one particularly powerful method is to use gnotobiotic growth systems in which plants are grown sterile, then exposed to a known set of microbes. In this skill, you will conduct a project in which you inoculate sterile plants with a set of microbes and measure their effects on plant growth and success. You will learn how to collect and analyze growth data, practice techniques for sterile plant propagation and measure plant responses to abiotic stimuli.

Course objectives

• Become familiar with plant microbiome research and its applications in agriculture and ecology • Conduct an experiment on plant growth and physiological responses microbes • Practice techniques for gnotobiotic plant growth systems • Learn to measure plant responses to biotic and abiotic stimuli • Learn how to statistically analyze a plant growth experiment • Learn to use ImageJ to analyze data images

Prerequisites

BIO2003 General Botany

- General Botany

Recommended reading

Various primary literature articles and the course manual

PRA3023

Period 5
6 Apr 2020
5 Jun 2020

Print course description
ECTS credits:
2.5
Instruction language:
English
Coordinator:
J.M. Nelson
Teaching methods:
Skills, PBL
Assessment methods:
Assignment, Attendance, Participation

Maastricht Science Programme

Analysis of Big Data in Physics

Full course description

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

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

Course objectives

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

- Introduction to Programming

Recommended reading

TBD

PRA3024

Period 4
3 Feb 2020
3 Apr 2020

Print course description
ECTS credits:
2.5
Instruction language:
English
Coordinator:
J.A. de Vries
Teaching methods:
PBL, Skills, Paper(s), Work in subgroups

Maastricht Science Programme

Natural Science Illustration

Full course description

The iGEM competition is a prestigious international student competition on synthetic biology and is organized yearly by the Massachusetts Institute of Technology (MIT). In this competition student teams from all over the world try to tackle real-world problems by using synthetic biology. In this project, several important aspects of science will be experienced. Students will brainstorm and decide on their own biological design. This design will then be modelled and built by using standard,

interchangeable parts. In addition to the practical aspects, students will also be responsible for project management, funding, media attention and communication to the general public. At the end of the competition, the team will present the project at the iGEM jamboree in Boston in a poster session and by giving an oral presentation.

Course objectives

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

Prerequisites

PRO2019

Recommended reading

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

PRA2019

Period 1
2 Sep 2019
25 Oct 2019

Print course description
ECTS credits:
2.5
Instruction language:
English
Coordinator:
T.D. Steen Redeker
Teaching methods:
Skills, Work in subgroups
Assessment methods:
Attendance, Participation, Presentation