Faculty of Science

Prospectus 2010 - 2011

Chemistry

Master

Radboud University Nijmegen

Preface

This is the prospectus for the masters programme of Chemistry. It contains information about the objectives, the goals and the contents of the programme. Furthermore a lot of practical information is given.
All information about being a student in Nijmegen, is available on the internet:
www.ru.nl/students
This prospectus has been made with great care. However, the authors are not responsible for inaccuracies. If you have comments or proposals for improvements do not hesitate to contact them.
July 2010
Mrs W.J.M. Philipse
Mrs E.A.L.M. Meijer

Contents

1 General information

1.1 Introduction

The Radboud University Nijmegen offers a Master of Science programme in Chemistry. This programme forms the connection between the Bachelors programme, taught in Dutch, and the state-of-the-art research that is being pursued at the different departments in the faculty. This Masters programme is of international standards. It is therefore of particular appeal to students of any nationality who qualify in terms of their preceding studies and want to graduate as a Master of Science at the highest standards.

The Radboud University Nijmegen is a general university, offering almost all possible academic programmes, ranging from Arts and Law, to Medicine and Science. This Masters programme allows a substantial choice of topics from all these areas, thereby offering the possibility to combine Chemistry with other studies.

A large part of the Masters programme is in the form of one or more traineeships, either in Chemistry departments at the Radboud University Nijmegen, or at an external institution, university or company. In this traineeship the student is confronted with current research and, moreover, actively takes part in ongoing frontier research. One of these traineeships results in a Masters thesis.

1.2 Admittance

The programme requires a Bachelors degree in Chemistry from the Radboud University Nijmegen, or an equivalent degree. A Bachelors degree in Chemistry from any Dutch (non-technical) university qualifies.

1.3 The Master's examination

Students should register for the Master's examination in Chemistry no later than the closing date. To register for the Master's examination, students must submit the following documents:

- valid student card and passport or identity card
- only for students who obtained their bachelor certificate elsewhere: bachelor certificate
- only for students who were registered as external students during part of their study: a confirmation of external student status. This is a statement from the institute confirming that the student in question did not receive any education during the period that he/she was registered as an external student.

The Student Administration/Examination Office will only register students for the Master's examination if all the results of the interim examinations are in the possession of and have been processed by the Student Administration/Examination Office.

The regulations governing the examinations in August are somewhat different. For these, students can register up to the end of May, and may do so even if several marks have not yet been obtained. These marks have to be delivered before August 31, 2010, 12:00 hours

There are approximately 10 examinations scheduled each year. The diplomas are presented once every month. If students need proof of graduation before the date of presentation (e.g. when applying for a job), they can obtain written proof of graduation from the examination committee (secretary Mrs W. Philipse, room HG01.059, e-mail: w.philipse@science.ru.nl).

Dates of masters examination
September 27, 2010 (final date of registration September 13, 2010)
October 25, 2010 (final date of registration October 11, 2010)
November 29, 2010 (final date of registration November 15, 2010)
December 13, 2010 (final date of registration November 29, 2010)
January 31, 2011 (final date of registration January 17, 2011)
February 28, 2011 (final date of registration February 14, 2011)
March 28, 2011 (final date of registration March 14, 2011)
April 18, 2011 (final date of registration April 04, 2011)
May 30, 2011 (final date of registration May 16, 2011)
June 27, 2011 (final date of registration June 14, 2011)
August 31, 2011 (final date of registration May 31, 2011)

Office of administration and exams for students
Mrs C. Hendriks and Mrs Y. Mulder, room: HG 00.134, tel.: (36)53392 or (36)52247.
The office is open: Monday through Thursday, 13:00-16:00 p.m. and Friday, 09:00-12:00 a.m.
E-mail: c.hendriks@science.ru.nl or y.mulder@science.ru.nl

1.4 Examination Appeals Board

With regard to examination-related matters, students can appeal to the Examination Appeals Board of the Radboud University Nijmegen. In addition to the Examination Appeals Board, there is a Higher Education Appeals Tribunal in The Hague. For more informatie see http://www.ru.nl/studenten

1.5 Student Association Sigma

V.C.M.W. Sigma is the Student Association for chemistry and molecular life sciences in Nijmegen. Its basic goal is to provide these students with the opportunity to get to know each other in an informal way. To achieve this Sigma doesn't only organize study-related activities but also a variety of social activities, for example: lectures, excursions, sports tournaments, the Sigma symposium, a weekend, a playback show, drinking bouts, parties and an exchange with students from the ETH Zurich.
Sigma shares a canteen with other student associations of the Faculty of Science where coffee, tea, candybars and snacks are sold during lunch hours. Besides its own magazine "G-

mi", a magazine that updates its readers on everything that is happening in Sigma and around the studies chemistry and molecular life sciences, Sigma also produces an almanac every five years. On the internet page you can find all activities and the names of the committees responsible for the various topics.

Membership for the whole study is 25 euro. You can also become a member for one year which is 10 euro. Membership for the whole study except the first year costs 18 euro. Masterstudents also pay 18 euro.
Sigma can be found in room HG00.150 from 12:30-13:30 on Tuesday and Thursday; telephone: 024-3652079; internet: http://www.sigma.science.ru.nl and e-mail sigma@science.ru.nl.

1.6 BBB Foundation

This annual career-event helps undergraduate and graduate students scouting the job-market. The event takes place in Spring semester at the Science Faculty. A great number of companies, organizations as well as follow-up degree programmes present themselves. As BBB has historic ties with chemists, the exhibition is very useful for chemistry students. Companies are present with a display and give lectures. You can gather information and talk with recruiters. Senior and PhD students can apply on-line around the time of the exhibition and make a chance to be invited by one or more of the companies for an interview. These interviews are organized by BBB a few weeks after the exhibition. The chances to be invited at that moment are much higher as compared to when you send an open application to a company.
The exhibition is renowned for its casual atmosphere and for its service to the visitors. Admission is free, no registering is needed and everybody receives the BBB-career guide. Prior to the exhibition, BBB organizes workshops on a variety of topics that are relevant for job-seekers and career-starters, such as: interview training, case studies, but also more light-hearted topics.
Address: Heijendaalseweg 135, HG00.154, 024-3652388, http://www.bbb-carrierebeurs.nl, e-mail: bbb@science.ru.nl

2 Programme

2.1 Final Qualifications of the Masters programme

"The Republic has no need of chemists and savants", were the words with which Antoine Lavoisier, one of the founders of modern chemistry, ended up on the guillotine during the French revolution. Fortunately, these days the importance of chemistry for the benefit of a sustainable society is well-recognized. As such chemistry has been designed a key area by the Dutch "innovatieplatform". So there will be many chemistry-related innovation initiatives in both industry and academia. This will be substantiated by a steering committee formed by the Association of Dutch Chemical Industries (VNCI) and the Chemical Science division of the Netherlands' Organization for Scientific Research (NWO/CW). These developments demand a continuous influx of well-trained chemists.
An undivided Chemistry program was set-up at the University of Nijmegen in 1962. The Master's degree program in Chemistry derives from the undivided program that was established in 1999.

Characterization of the Master's degree program Chemistry
The Radboud University Nijmegen aims to implement a Master's degree program in Chemistry at an internationally well-recognized level. The program is based on the research themes that exist within the Research Institutes for Molecules and Materials (IMM) and to a somewhat less extent, the Nijmegen Center for Molecular Life Sciences (NCMLS). In recent years, the IMM has focused it chemistry research in the areas of organic chemistry (synthetic, bio-organic, supramolecular and materials), nuclear magnetic resonance (solid state NMR and biophysical chemistry), and solid state chemistry. Furthermore, increasing research interactions with biology and physics groups emerge, which offers ample opportunities for new research and education. Based on this research, modern and high quality education can be provided within the Master's degree program.

More generally, the MSc programs in Chemistry in the Netherlands aim to:

- educate students to independent professional practice. More specifically, this means perform fundamental scientific research, be able to deal with existing scientific knowledge and apply this in new situations;
- actively stimulate interdisciplinary collaboration in the development of science;
- develop skills, knowledge and understanding in a specialization of a given field, with an accent on the understanding and approach to solve scientific questions;
- offer education that is focused on the students and that is of excellent, internationally recognized quality;
- acquire part of the knowledge and understanding in an international setting;
- offer an inspiring academic learning environment and feasible paths to a demanding and heterogeneous student population;
- develop the ability to pass on acquired knowledge to others.

These aims have led to 'final qualifications', as given below, that were broadly accepted by academia and industry. The draft of the objectives and final qualifications for the Master's degree in Chemistry has been a joint effort of all ten course providers in chemistry in the Netherlands. In August 2003, the MSc program directors, gathered under the auspices of the VSNU (Kamer Scheikunde), agreed with the text of the document "Final qualifications of the Master's degree program in chemistry and (bio)chemical engineering in the Netherlands (research specializations)". In April 2005, the MSc program directors accepted this same document as the domain-specific frame of reference for the assessment of the Master's degree programs Chemistry in the Netherlands. Importantly, also the professional field fully agreed with the reference function of the document.

Final qualifications of the Master's degree program, Chemistry
The final qualifications consist of a set of general qualifications (M1-M11) in combination with a set of specific qualifications, depending on the particular Master's degree variant (O-, C-, E- or MT) that a student intends to pursue.

GENERAL QUALIFICATIONS
The Master's of Science in Chemistry

- M1: has a thorough theoretical and practical knowledge of modern-day chemistry;
- M2: must be able to keep up with the literature in his/her field of science and must be able to use it;
- M3: must be able to acquire knowledge in other fields of chemistry in an acceptable time frame;
- M4: must be able to formulate a research planning on the basis of a general chemical question;
- M5: must be able to analyze results of investigations, interpret them and draw conclusions;
- M6: can be employed in functions in which chemical knowledge and research skills are needed;
- M7: is sufficiently aware of the role of chemistry in society to make a justified choice of profession and practice of profession;
- M8: can deal with safety and environmental issues of chemistry and has an adequate understanding of the role of chemistry in a sustainable society;
- M9: is able to present his/her work to specialists in the field, but also to a laymen audience, both orally and written and has adequate interpersonal skills, relating to the ability to interact with other people and to engage in team working;
- M10: is able to set up and perform relatively independently experiments and checks;
- M11: must be able to put new results in the framework of results obtained by others.

SPECIFIC QUALIFICATIONS FOR THE O-VARIANT
The Master's of Science graduating in the O-variant

- O1: is able to set up and perform independently experiments, design appropriate checks and evaluate the results in a given time frame;
- O2: is able to formulate a vision on the scientific developments in his/her field of chemistry;

- O3: can analyze independently experiments and chemical processes, interpret the results and present the outcome at different abstraction levels;
- O4: is able to write independently the basis for a scientific publication or research proposal.

SPECIFIC QUALIFICATIONS FOR THE C-VARIANT
The Master's of Science graduating in the C-variant

- C1: has knowledge and skills derived from communication studies;
- C2: is capable of designing, conducting, delegating and supervising communication research, independently and methodically;
- C3: is able to contribute to the analysis and approach to problems that occur in the interaction between science, technology and society;
- C4: has an overview of the interaction and communication processes that occur in social discourse;
- C5: is able to work effectively in a policy team with a broad composition (interaction between science, technology and society) and is open for other types of knowledge (intuitive and practical experience).

SPECIFIC QUALIFICATIONS FOR THE E-VARIANT
The Master's of Science graduating in the E-variant is able to fulfill the following roles as a teacher, and has the capacity to continued development within these:

- E1: the classroom instructor (didactic actions);
- E2: the expert (in science education);
- E3: the pedagogue (social aspects);
- E4: the reflective professional (skills for self-improvement as a professional);
- E5: the instructor outside the classroom (additional tasks, management and working with colleagues;
- E6: the developer and researcher (analyze and develop educational material).

SPECIFIC QUALIFICATIONS FOR THE MT-VARIANT

- MT1: is familiar with the language of management, in addition to the language of their own natural-science specialization;
- MT2: is capable of conducting research independently with regard to problems that occur at the interface of technology, organization and society;
- MT3: is capable of contributing to the solution of management problems;
- MT4: is capable of effectively cooperating and communicating in a multidisciplinary team.

2.2 Structure of the Masters programme

The Masters programmes at the Faculty of Science of the Radboud University Nijmegen are offered in four variants: a research (O) variant, a communication of science (C) variant, an education (E) variant, and a business and management (MT) variant.
The Masters programme in Chemistry aims at specialization (major) in one of the following fields:

- Analytical Chemistry
- Applied Materials Science
- Biochemistry
- Bioinformatics
- Biomolecular Chemistry
- Bio Organic Chemistry
- Biophysical Chemistry
- Human and Environmental Risk Assessment
- Molecule and Biophysics
- Molecular and Laser Physics
- Molecular Materials
- Molecular Pharmacology and Toxicology
- Protein Biophysics
- Scanning Probe Microscopy
- Solid State Chemistry
- Solid State NMR
- Supra Molecular Chemistry
- Synthetic Organic Chemistry
- Theoretical Chemistry

In addition, students may ask permission of the Examination Board for other specializations that are part of the Research Institute for Molecules and Materials.

Students may at any time follow more courses than the 120 study points (ec = ETCS = European Credits Transfer System) required to obtain the Masters degree.

Successful completion of the Masters programme (research variant is preferred), allows admission to a PhD programme.

Research Variant (O)

- *Major*
  Basic and advanced courses (compulsory and optional) 27 ec
  Research project (including master thesis, presentation, literature thesis and colloquium) 60 ec
- *Minor*
  Optional programme 24 ec
- *Free choice (allowed to be part of minor)* 6 ec
- *Philosophy* 3 ec

Communication of Science (C), Education (E) and Management & Application Variant (M&T)

- *Major:* Research project (including master thesis, presentation, and compulsory courses) 54 ec

- *C, E and MT Variant* 57 ec (see also chapter 6 for the contents of the C, E and MT variant)
- *Free choice* 6 ec
- *Philosophy* 3 ec

The department where the research project of the Major is done, is allowed to ask 6 ec mandatory courses to be done in the Bachelors programme. Students are allowed to take these courses in the optional programme of the Minor.

The department where the research project of the Major is done is allowed to ask up to 10 ec mandatory courses.

In the optional programme of the Minor second and third year Bachelor university courses of any programme are allowed.

6 ec free choice: these may also be first year Bachelor university courses of any programme.

3 Courses

Chemometrics II

Course ID: **SM103** *4 ec* in mutual agreement with student(s) prof. dr. L.M.C. Buydens

Teaching methods
- 10 hrs lecture
- 10 hrs problem session

Prerequisites
chemometrie 1

Contents
Students are given one subject, typically a lesser known chemometrical technique, which they have to study and apply. They should present the technique, and the results of applying them, in a classical lecture. Also the comparison with other alternatives is important. The course aims at deepening the knowledge in the field of chemometrics.
Subjects: modern chemometrical techniques.

Literature
Relevant references will be handed out.

Examination
Presentation.

Pattern recognition for the natural sciences

Course ID: **SM114** *6 ec* Fall/Winter prof. dr. L.M.C. Buydens
dr. G.J. Postma

Website
www.webchem.science.ru.nl/PRiNS

Teaching methods
- 32 hrs computer course
- 20 hrs lecture

Prerequisites
- Introductory statistics
- Basic knowledge of R (www.r-project.org)

- Basic linear algebra

Objectives
The students should be able to

- Visualize multivariate chemical data to maximize the information content of plots
- Formulate real-world research questions in terms of pattern recognition problems
- Select and apply the appropriate technique(s) for a specific case
- Apply these techniques using appropriate software
- Interpret the results using both domain knowledge and statistical insight
- Validate the results

Contents
The aim of the IMM is to conduct research in the field of functional molecular structures and materials. There is an emphasis on understanding and controlling complexity in order to be able to design new functionality in these systems. One of the focus areas of the IMM is the development and use of a host of spectroscopic techniques such as optical spectroscopy, scanning probe microscopies and nuclear magnetic resonance. This leads to increasingly complex data streams. In the analysis and interpretation of these data pattern recognition plays an increasingly important role. This will be illustrated by numerous examples, such as analysis of data from chemical sensors, clustering of microarray data, image segmentation of remote sensing images (for detecting and classifying tumours based on MRI data), efficient data processing and preprocessing in high-throughput analysis (e.g. in proteomics or metabolomics), data mining of large databases of chemical structures, etcetera.
Students will apply the theory by means of exercises and actual case studies from different departments. In this way, students should be able not only to grasp the principles and ideas behind the mathematics, but also to recognize and solve pattern recognition problems in an appropriate research setting.

Literature

- Reader, available from the course website
- Hastie, Tibshirani and Friedman, *The Elements of Statistical Learning*, Springer 2003.

Examination

Written exam.

Apoptosis

Course ID: **BM004C** *3 ec* August 30 - November 5, 2010 dr. W.C. Boelens
prof. dr. N.H. Lubsen

Teaching methods
- 20 hrs lecture

Prerequisites
Biochemistry and Molecular Biology II (BMB-II)

Objectives
After completing the course the student should be able to understand what apoptosis is, how it is regulated and in which way it is involved in the many different cellular processes. Apoptosis is a highly regulated process that is needed to kill a cell clean and neatly. For a very long time the process was neglected, but now the importance of the process is generally accepted. Apoptosis is involved in many different aspects of life, such as embryonic development, tissue homeostasis and regulation of the immune response. Deregulation of the apoptotic process plays an important role in the development of autoimmune diseases, cancer and viral infection.

Contents
- Introduction Molecular Aspects of Apoptosis
- Apoptosis and Cancer
- Apoptosis and Stress
- Apoptosis and Autophagy
- Regulation of Translation during Apoptosis

Literature
Hand-outs, distributed via blackboard

Examination
Written exam.

Extra information
contact: dr. W. Boelens, phone 36 16753, e-mail: w.boelens@ncmls.ru.nl

Cellular Imaging in Four Dimensions

Course ID: **BM016C** *3 ec* January 30 - April 15, 2011 dr. P.H.G.M. Willems
dr. W.J.H. Koopman
dr. J.A.M. Fransen

Teaching methods

- 20 hrs lecture
- 60 hrs individual study period

Objectives

Students gain knowledge into the fundamentals and applications of advanced cellular imaging techniques in biomedical research. The lectures will provide the students with practical examples of ongoing research in the Molecular Life Sciences.

Contents

'Cellular Imaging in Four Dimensions; principles and applications' (Coordinator P. Willems, p.willems@ncmls.ru.nl, 3614589)
I. Principles of fluorescence and electron microscopy
1. Introduction to microscopy (Jack Fransen)
2. Advanced microscopical techniques (Jack Fransen/Peter Friedl)
3. Proteinacious reporter molecules (Werner Koopman)
4. Chemical reporter molecules (Peter Willems)

II. Image processing and quantification in microscopy
5. Image processing and quantification (Werner Koopman)
6. Analysis of molecular complexes in cellular signal transduction (Roland Brock)
III. State-of-the-art applications in biology and medicine

7. Imaging of intracellular protein routing in health and disease (Jack Fransen)
8. 'Dyeing' mitochondrial shape and function in metabolic disease (Peter Willems/Werner Koopman)
9. Dynamic imaging of cancer (Peter Friedl)
10. Analysis of cellular import, residence time and breakdown of potential therapeutic molecules (Roland Brock)
Examination (Tentaminering)
The final written exam includes 10 assay questions, one question per subject.
Extra information (Bijzonderheden)
contact: mrs L. Brocatus, 024-3614259, L.Brocatus@ncmls.ru.nl

Examination

The final written exam includes both parts of the course.

Extra information

contact: mrs. J. Rullmann, 3652701, j.rullmann-freriks@science.ru.nl

Post-transcriptional regulation in health and disease

Course ID: **BM027C** *3 ec*

Contents

Examination
Written examination

Capita selecta: Metabolism, transport and motility

Course ID: **LM011** *3 ec*

dr. L.P.W.J. vanden Heuvel
prof.dr. P.M.T. Deen
mw dr. R. Masereeuw
prof. dr. B. Wieringa

Teaching methods

- 20 hrs lecture
- 60 hrs individual study period

Prerequisites

recommended: 'Biochemie en moleculaire biologie II' and 'Celbiologie der dieren'

Objectives

Make students familiar with the biomedical significance of energy and metabolites in the "small molecular world"and how the role of these compounds is integrated in the larger cellular network for metabolism, transport and motility. Specifically, students should be able to

- appreciate the significance of 'metabolic, transport and motion research' for molecular life sciences
- recognize current possibilities and developments in the field
- implement the newly obtained knowledge in future research activities

Contents

Students will be offered a comprehensive series of introductory lectures on the topics of interest that go beyond basic (bachelor) knowledge of biochemistry and cell-biology textbooks. They will be asked to read background literature and use information at websites to make themselves familiar with knowledge on the significance of metabolite profile analysis, the role of energy and redox metabolism in cell viability and mobility control, (reverse) genomics and proteomics for the study of transport proteins, channelopathies, mitochondrial diseases, and multifactorial disorders. Emphasis will be on the value of multi-disciplinary approaches.
Subjects:

- The essence of metabolic investigations
- Multifactorial disorders
- OXPHOS system diseases
- Proteomics and human pathology
- Water channels
- Body water homeostasis
- ABC transporters and solute carriers
- Regulation of drug transporters in health and disease
- Coupling of energy/redox metabolism to cell viability and motility control
- Biochemical adaptation to energy and redox stress

The course will be focused on aspects of metabolism, transport and motility in muscle, brain, kidney disease and cancer and other related health problems.

Literature
Literature assignments and hand-outs are distributed during the lectures

Examination
written examination.

Extra information
Contact: Dr. L. van den Heuvel (024-3617983 ot 024-3614428),
B.vandenHeuvel@cukz.umcn.nl

Capita Selecta: Molecular aspects of host defense, tissue destruction and repair

Course ID: **LM012** *3 ec* 11 March - 8 July 2011 prof. dr. G.J.M. Pruijn
Prof.dr. J. Schalkwijk
dr. P. van der Kraan
dr. R. Torensma

Teaching methods
- 22 hrs lecture

Prerequisites
- 'Biochemie' and 'Moleculaire Biologie II' (BB017C) required;
- 'Immunologie' (BB019B) recommended.

Objectives
After completing the course the student is aware of the molecular mechanisms underlying tissue destruction and repair and has knowledge of the various ways in which the immune system is challenged by both exogenous and endogenous triggers. The student has learned how the immune system responds to these triggers and understands the relationship with infectious and chronic diseases. The student has gained insight into the experimental approaches that are applied to study the molecular and cell biological aspects of infection, immunity and tissue repair.

Subjects
The course will be focused on two types of tissues: skin and cartilage
- Immune system
- Autoimmunity
- Inflammation
- Animal models
- Stem cells
- Tissue repair

Literature
Course material (hand-outs; review articles; scientific papers) will be distributed via blackboard.

Examination
written examination.

Extra information
Contact: Prof.dr. G. Pruijn, 024-3616847, G.Pruijn@ncmls.ru.nl

Course Working with Radionuclides Level 5B

Course ID: **BM007C** *2 ec* November 29 - December 3, 2010 A.L.M. de Leeuw W.P. Moerman

Website
http://www.ru.nl/amd

Teaching methods
- 5 hrs lecture
- 6 hrs laboratory course
- 9 hrs question session
- 1 hrs problem session

Objectives
The intended purpose of the course "Radiation expertise level 5B" is to impart to the student such competence and skills in the field of radiation protection that he/she, after having successfully completed the instruction course, has gained an adequate level of expertise to enable him/her to independently apply radioactive substances. This course is requested by legislation for all students and workers who will work with radioactive substances without direct supervision. This applies mainly to students in their masters study, but in some cases also to students in their bachelor study.

This one week course contains lectures and laboratory exercises dealing with most aspects of radiation safety, radiation protection or health physics, whichever term you prefer to use. Participants spend approximately 20% of their time performing laboratory exercises using radiation detection equipment. These laboratory exercises complement the health physics principles covered in lectures. Topics include: Radiation Physics, Radiation Detection and Measurement Techniques, Radiation Dosimetry, Radiation Biology, Assay Techniques, Shielding, Legislation and Health Physics Principles. The diploma examination is in multiple choice format. The diploma is valid in the Netherlands.

The course is not only open to students, part of the members are from hospitals and companies.

Contents
This five day course is necessary for working in a radionuclide laboratory.
The course will be given on Monday to Friday, 09:00 - 17:00.
The course will be given several times a year in Dutch. Once a year it will be given in English.

Subjects:
- radiation physics
- radiation risk and effects

- practical radiation safety
- legislation

More information: www.ru.nl/amd > cursussen > cursussen stralingsdeskundige

Literature

The reader in dutch will be sent to each student who applies for the course.
Cursistenhandleiding cursus Stralingshygiëne niveau 5B (dictaat)
The book should be bought by the participants:
Practische Stralingshygiëne, G. Brouwer en J. van den Eijnde (ISBN 9789077423097)
The English version: Practical Radiation Protection, by the same authors, (ISBN 9077423036)

Examination

There will be a written exam. By sufficient result the student will receive a certificate which is valid in Holland and gives you the right to work autonomous with radioactive materials.

Extra information

contact: Ria Hogenkamp (phone: 3613178, h.hogenkamp@amd.ru.nl)

Gene expression, chromatin and disease

Course ID: **BM009C** *3 ec* Not in 2010 - 2011 dr. C. Logie
dr. G.J.C. Veenstra

Teaching methods
- 24 hrs lecture

Prerequisites
Biochemistry and Molecular Biology II and Functional Genomics courses. This prior knowledge can be found in Lodish 6th edition, Chapters 4, 6, 7, 8, 20, 21.

Objectives
This course aims to showcase current insights in the role of gene expression with respect to cancer, congenital disease, embryonic development and establishing cellular identity. Special emphasis will be on epigenetics (heritable modifications of chromosomes), transcription factors and the molecular biology of tumor suppressors.

Contents
1. Introduction chromatin structure and function
2. Epigenetics as molecular memory
3. Chromatin and cancer
4. Imprinting and imprinting syndromes
5. Animal models for the pathology of chromatin dysfunction

Literature
Literature: Lectures, PowerPoint print-outs

Examination
Written Essay

Extra information
Contact person: dr. Logie tel: 3610525, c.logie@ncmls.ru.nl

Computational drug discovery

Course ID: **CMBI101** *3 ec* Spring dr. J. de Vlieg
dr. G. Schaftenaar
dr. S.B. Nabuurs

Teaching methods
Two weeks of lectures and computer practicals.

Prerequisites
Basic bioinformatics and (medicinal) chemistry knowledge; preferentially specific knowledge on 3D protein structures and ligands

Objectives
- The course will improve the participants understanding of how drugs are discovered, and the crucial role played by computational methods in this process.
- After attending this course students will be able to better understand why drug-receptor interactions and other physical-chemical characteristics are important to drug efficacy.
- Finally the course will provide a basic practical understanding of a number of standard and advanced computational drug design tools, such as applied molecular modelling, gene expression analysis, virtual screening, QSAR, molecular dynamics computer simulations, structure-based drug design, homology modeling, and so on.

Contents
It is the intent of the course to describe some of the recent advances in drug discovery informatics, with a focus on the application of *e-science* to real life problems. Topics include the process of in-silico gene hunting, toxicogenomics, pharmacogenetics, virtual screening and structure-based molecular design. Also, the tools and scientific concepts that are part of the modern genomics-based drug discovery pipeline from target discovery and validation to lead discovery and optimization will be discussed. The different hands-on sessions will provide participants with the opportunity to work with the various *in silico* tools and databases available to a modern *in silico* drug hunter. The course is given in close collaboration with the pharmaceutical company MSD.

Literature
Material is handed out during the course.

Examination
Presence at lectures and practicals mandatory.
There will be a final team presentation at the end of the course.

Bioinformatics of protein structure

Course ID: **CMBI103A** *6 ec* Spring prof. dr. G. Vriend

Teaching methods
Daily supervision by the teacher during the entire period of the project. Seminars as deemed necessary. Due to the intense supervision only maximally 4 students can participate.

Prerequisites
- basic bioinformatics knowledge, i.e. 'Methoden: bioinformatica'
- structuur, functie en bioinformatica (SB113B)

Objectives
- After this course the student will have a good impression of fundamental bioinformatics research.
- The student will be able to use (very) advanced bioinformatics tools.
- The student will have a good impression about the entire cycle of a fundamental bioinformatics project: Question -> Plan -> Method -> Results -> Interpretation -> Answers -> New Question.

Contents
The topic of the project will be discussed with the students. The topic will be a fundamental, protein structure related bioinformatics question.

Literature
Material is handed out during the course, and will normally consist of some articles that relate to questions underlying the research topic.

Examination
Written report.

Introduction Java to bioinformatics

Course ID: **CMBI110A** *6 ec* drs. M.L. Hekkelman

Teaching methods
- 120 hrs computer course
- 8 hrs lecture

Prerequisites
Basic bioinformatics knowledge, e.g. courses Bioinformatica A (MOL075), Bioinformatica (MOL029), Applied Bioinformatics (BB051B)

Objectives
- At the end of this course the student will be able to write simple programs in Java.
- The student will know how to build a Java program and has knowledge of some of the tools used to do so.
- The student will know how to apply often used bioinformatics techniques. Examples are reading and parsing flat file databanks and accessing web services to do calculations on biological data.

Contents
The goal of this course is to learn how to use Java in a bioinformatics environment. No prior programming experience is expected. The focus will be on using the right tools and techniques and some of the basics of the language. Students are expected to do most of the work individually and independently.

Literature
- Head First Java. ISBN: 978-0-596-00920-5.

Examination
Tijdens de cursus dienen enkele praktische opdrachten uitgewerkt te worden. De cursus wordt afgesloten met een eindopdracht die bestaat uit het maken en opleveren van een programma op basis van een verstrekte functionele beschrijving.

Extra information
Examination: Practical exercises will be handed out during the course. At the end of the course there is an exercise that consists of writing a program and accompanying documents needed to satisfy a given functional specification

Instrumental analysis for molecular chemistry

Course ID: **SM015A** *3 ec* September/October dr. M.C. Feiters

Teaching methods
- 16 hrs problem session

Prerequisites
organische chemie 1
- magnetic resonance I (recommended)

Objectives
Independent interpretation and evaluation of NMR and mass spectra, independent planning of strategy for purification by chromatography.

Contents
Important techniques for the characterization of compounds by instrumental analysis are treated. The emphasis is on NMR and mass spectrometry of organic compounds; in the integrated problems IR and the results of elemental analysis are also included. Furthermore chromatography is treated.

Literature
Handouts and papers will be distributed during the course.

Examination
Written examination.

Polymer chemistry

Course ID: **SM019A** *3 ec* January-February 2011 prof. dr. J.C.M. van Hest
prof. dr. E.W. Meijer

Teaching methods
- 18 hrs lecture

Objectives
After completing the course the student will be able to understand the most important polymer chemistry definitions and methodologies, of which synthesis and molecular aspects will receive most attention. The student can relate polymerization mechanism to polymer properties. Furthermore, with the aid of special topics, the student will become familiar with recent trends in polymer chemistry.

Contents
The course Polymer Chemistry will give insight in the chemical aspects of polymer science. Basic knowledge about polymerization mechanisms and polymer properties is combined with state of the art developments in this multidisciplinary field of science. The course is structured around 4 themes:
Controlled chain polymerization. This includes free radical polymerization, ionic polymerization and controlled radical polymerization techniques
Step polymerization. This includes traditional polycondensation chemistry (preparation of polyester and polyamides) and supramolecular polymerization
Stereoselective polymerization. This includes coordination polymerization, such as Ziegler Natta chemistry, and biosynthesized polymers, such as proteins
Conjugated polymers. This includes both the synthesis and application of these materials in devices such as solar cells
Furthermore case studies on the application of polymeric materials will be discussed based on the recent literature

Literature
- Hand-outs and lecture notes (handed out during the course).
- research papers
- Recommended: *Polymers*, Walton and Lorimer, Oxford Chemistry Primers, Oxford University Press, ISBN 019850389X.

Examination
Written examination. (70%)
case studies (30%)

Application of metal-catalysis in natural product synthesis

Course ID: **SM018A** *3 ec* March/April prof. dr. F.P.J.T. Rutjes

Teaching methods
- 16 hrs lecture

Prerequisites
Atoombouw, Moleculaire structuur, Synthese biomoleculen, Organische Chemie 1, and Metaalorganische chemie.

Objectives
After completing the course, the student can apply a variety of metal-catalyzed transformations for the stereoselective formation of CC-, CN- and CO-bonds. Furthermore, the student has developed a basic feeling for the general strategies that one can apply for the construction of complex molecular scaffolds that are present in natural products.

Contents
Topics:
Transition metal-catalyzed reactions are becoming increasingly important tools to the synthetic organic chemist. Various metals, combined with suitable organic ligands, provide catalysts that can be efficiently used for the formation of CC-, CN- and CO-bonds in functionalized organic molecules. In this course, an overview will be provided of recently developed transition metal-catalyzed reactions (involving a.o. Pd, Ru, Cu, Mn and Ti). Furthermore, an important aspect of this course is the application of these reactions in total syntheses of natural products and biologically active compounds of which various examples will be highlighted.

Literature
Lecture notes and scientific papers.

Examination
Assignment: writing a scientific proposal for natural product synthesis.

Molecular Materials

Course ID: **SM292A** *3 ec* second quarter prof. dr. A.E. Rowan
dr. P.H.J. Kouwer

Teaching methods
- 20 hrs lecture
- 10 hrs student presentation
- 30 hrs student project
- 20 hrs individual study period

Prerequisites
Organic chemistry 2

Objectives
To acquire a basic knowledge of the relationship between function and architecture of materials with particular emphasis on self-ordered systems and polymers for applications in OLEDS, OFETS, liquid crystal devices and nanoelectronics.

Contents
The basic concepts and chemistry of the molecular building blocks and their assembly into opto-electonic devices such as OFET (organic field effect transistors), solar cells, liquid crystalline devices will be discussed. The properties and synthesis of conductive materials viz. bucky balls, carbon nanotubes and organic polymers will be described. External expert guest speakers from companies and other universities will be invited to discuss the applications of these materials in house hold devices.

Literature
Handouts and scientific papers.

Examination
written examination, scientific report and presentations.

Advanced molecular structure determination

Course ID: **SM026A**	*3 ec*	The course will be give biannually, next course Spring 2012.	dr. M.C. Feiters dr. R. de Gelder prof. dr. A.E. Rowan

Teaching methods
- 22 hrs lecture

Prerequisites
- instrumental analysis (recommended)
- magnetic resonance I (recommended)

Objectives
Independent interpretation and evaluation of crystallography, molecular modeling, nuclear magnetic resonance (NMR), electron paramagnetic resonance (EPR), and X-ray absorption spectroscopy (XAS, EXAFS) data.

Contents
The basic principles of crystal structure determination by X-ray diffraction and the application of these principles in practice are explained. The mathematical treatment is kept at a relatively low level and the emphasis is on how X-ray crystallography fits within modern chemistry, why it is important and what it can do.
Important spectroscopic techniques (NMR, EPR, EXAFS) for structure determination are treated, with an emphasis on coordination and organometallic compounds. Molecular modeling techniques are treated in order to develop an insight in the feasibility and dynamics of molecular structures.

Literature
- W. Clegg, *Crystallography: Crystal Structure Determination*, William Clegg, Oxford University Press, ISBN 0-19-855901-1
- For other topics: handouts and papers will be distributed during the course.

Examination
written examination (95 %), exercise in molecular modeling (5 %)

Advanced organic chemistry

Course ID: **SM024A** *6 ec*

dr. M.C. Feiters
prof. dr. F.P.J.T. Rutjes
dr. F.L. van Delft
dr. P.H.J. Kouwer

Teaching methods

- 170 hrs problem session

Prerequisites

Organic chemistry 1.
The 'orange booklet' on basic organic chemistry. Will be provided the first course.

Objectives

After completing the course the student will be able

- to solve independently and critically most of the organic chemistry problems that he may come across during the master program in organic chemistry
- to provide mechanisms of important and complex reactions in organic chemistry and their regio-, stereo- and enantioselectivity
- to express himself with the proper chemical nomenclature
- to recognize and reproduce often applied name reactions

Furthermore, the students will be familiarized with more advanced physical organic chemical principles, such as free energy relations, kinetic analyses and the hydrophobic effect.

Contents

Main focus of the course advanced organic chemistry is to lift organic chemistry mechanisms and principles from a passive knowledge and perception to a level of thorough understanding and active application. To this end, you will be taught to solve organic chemistry problems by combining an increasing knowledge of organic chemistry principles with common sense. The instructor will help you whenever necessary, both in classical class-room form and on an individual basis.
Two specific approaches can be distinguished for the course. The first part involves a thorough repetition of the most important contemporary organic chemistry transformations as well as the physical organic principles underlying these reactions. A list of name-reactions will be provided that containing both reactions that are supposed to be known and popular reactions that will be discussed in detail. Further specific contents of the course will be highly dynamic, based on recent literature publications as well as on Anslyn and Dougherty. The second part of the interactive lecture discusses organic chemistry mechanisms and principles on the basis of chapters and problems of Clayden, with an emphasis on chapters 33 to 45. Before the course, the students are expected to familiarize themselves with chapters 1-31 of Clayden, which are considered to discuss the topics already covered in the bachelor phase (The contents of Chapter 32 are, among other things, treated in the Instrumental Analysis course SM015A). Also, the most important chemical transformations and protective groups are summarized in the 'orange booklet'. This booklet will be provided during the first course of the academic year.

Literature

- Clayden, Greeves, Warren and Wothers, *Organic Chemistry*, Oxford University Press 2001
- Anslyn and Dougherty, *Modern Physical Organic Chemistry*, University Science Books, 2006.

Examination

Written examination. Workshops and lectures are a preparation for the bimonthly exams. Each exam (of 2 EC) will be graded with an A (excellent), B (average-good), C (below average) or D (fail). In order to pass the full course, a student needs to pass at least 3 exams with A or B. Alternatively, two C's can count as a B.

Chemical Biology

Course ID: **SM025A** *6 ec* 4 weeks

dr. F.L. van Delft
dr. D.W.P.M. Lowik
prof. dr. G.J.M. Pruijn
dr. W.C. Boelens
dr. K.G. Blank
Brock

Teaching methods
- 20 hrs lecture
- 48 hrs laboratory course
- 20 hrs student presentation

Prerequisites
Synthesis of biomolecules

Objectives
After completing the course, the student will be able
- to deal with theoretical and practical aspects in the field of chemical biology
- to provide a comprehensive overview of current trends and important developments in this field
- to oversee the added value of combining chemical knowledge and strategies with molecular biology and biochemical tools
- to apply the current chemical biology tools in practice

Contents
The growth of research at the interface of chemistry and biology has emerged into an interely new scientific research field termed chemical biology; chemical tools and strategies are applied to approach biological problems or biological knowledge is used to inspire the development of new chemistry. As such, chemical biology is a highly interdisciplinary field that requires chemists and biologists to pool their skills and knowledge to maximize their ability to solve interesting problems.
The fundamental concept underlying this course involves the application of chemical tools to interfere with biology. In other words, how can we apply our chemical knowledge to influence or monitor biochemical processes, *in vitro* and even *in vivo*. Specific topics that will be discussed: 1. Chemical genetics and chemical ligation, 2. Fusion proteins and detection, 3. Enzyme probes and single enzyme studies, 4. Fluorescent probes and molecular imaging, 5. Protein engineering.

Literature
Handouts, scientific articles.

Examination
Presentations of case studies (5x, 50% of final grade), as well as the practical work during the

research project (25%) and the presentation thereof (25%).

Extra information

The full course covers a whole month that can be divided into two weeks of theory and two weeks of hands-on experience. The theoretical part consists of 5 cycles of 2 days, that begin with a lecture on a chemical biology topic, followed by case studies based on recent literature publications by two students (in groups of two). At the end of the second day, the case studies will be plenary presented.
Following the theoretical part, practical experience with chemical biology will be obtained by working 8 days on a chemical biology project (of choice) in one of the contributing research groups.
The course will be concluded by plenary presentations of the research projects.
Grading will involve the literature presentations (50%), as well as the practical work during the research project (25%) and the presentation thereof (25%).

Biocatalysis

Course ID: **SM294** *2 ec* Kwartaal 2

dr. M.C. Feiters
prof. dr. F.P.J.T. Rutjes
dr. K.G. Blank
prof. dr. A.E. Rowan

Teaching methods
- 8 hrs lecture

Prerequisites
Structuur Biomoleculen, Organische chemie

Objectives
At the end of the course, the student will have an overview of the newest developments in the area of biocatalysis; catalyst design, characterization, and synergy with homogeneous catalysis (biomimetics). In addition the student should be able to formulate his/her own research questions and be able to present his/her own research topic.

Contents
This is a 4-day course organized by Radboud University Nijmegen (2 days) and Delft University of Technology (2 days) with lecturers and students from the NIOK (Nederlands Instituut voor Onderzoek in Katalyse, a national research institute) groups active in Biocatalysis. The topics covered are
1) Biohybrids, Bioengineering
2) Enzyme Engineering/ Directed Evolution
3) (Time-resolved) spectroscopy/ modeling
4) Enzymes in Organic Synthesis

Literature
Handouts of the lectures

Examination
Assignments (case studies)

Industrial pharmaceutical chemistry

Course ID: **SM293** *3 ec* Fourth quarter prof. dr. P.H.H. Hermkens

Teaching methods
- 32 hrs lecture
- 16 hrs problem session

Prerequisites
A basic background in organic chemistry is a prerequisite for attendance.

Contents
This course has been developed by co-workers of Merck Sharp & Dohme (MSD) in close collaboration with the Institute for Molecules and Materials. The course is targeted at Msc and PhD students, and postdocs, who are interested in the chemical concepts practiced in drug discovery and development. In the pharmaceutical industry many different chemistry concepts and disciplines play an important role in as well the discovery as the development phase. From therapeutical concept to molecule (drug discovery) and from molecule to registered product (development) different chemistry disciplines and concepts play an important role. During the course these disciplines and concepts will be addressed in a process related order:
· Chemistry-driven hit discovery with the focus on compound properties & libraries (keywords are screening, sources for compounds, combinatorial chemistry, library design, natural products, lab automation)
· Chemistry-driven lead optimization were the balance between potency, physical chemistry,and stability is addressed (keywords are potency, selectivity, structural modifications principles, metabolism, safety, serendipity, aqueous solubility, pKa, permeability, lipophilicity and analytical chemistry
· Chemistry-driven development with topics such as process optimization, quality by design, lab automation (HTE, experimental design), radiolabeling, salt selection, polymorphism, formulation and Process Analytical Technology (PAT)

Literature
- *Drug discovery and development: technology in transition*, H.P. Rang: Elsevier, 2006
- *Real world drug discovery: a chemist's guide to biotech and pharmaceutical research*, R.M. Rydzewski, Elsevier, 2008
- *Drug-like properties: concepts, structure design and methods from ADME to toxicity optimization*, E.H. Kerns, L.Di: Elsevier 2008

Examination
This course consists of 25-30 hrs interactive teaching, followed by a written exam, spread over a period of two weeks.

Extra information

The lecture series are obligatory for students taking the minor Industrial Chemistry. The series can be part of the master programme in organic chemistry. The series can also be part of the variant Management and Technology.
This course which will be provided every other year and is intended for MSc- as well as PhD-students.

Advanced crystallography

Course ID: **SM155** *4 ec* second semester dr. R. de Gelder
dr. H.L.M. Meekes
dr. ir. V. Vonk

Teaching methods
- 30 hrs lecture
- 18 hrs problem session

Prerequisites
- FMM5
- Recommended: condensed matter

Objectives
After completing the course the student will have a working knowledge of the symmetry of crystals and its application in understanding the structure and properties of crystals. In addition, the student will be acquainted with modern developments in crystallography.

Contents
Symmetry plays a fundamental role in the structure and properties of crystals. This is a 'classic' subject that remains highly relevant, because crystals are used in a wide range of applications. All important symmetry aspects will be discussed, including point groups, crystal systems and space groups. The close link between symmetry and properties will be shown in examples like chirality, bi-refringence and piezo-electricity. These will be discussed using the mathematical tool of tensors. The course concludes with a survey of recent developments in crystallography, including synchrotron radiation, time-resolved crystallography, structure determination of polycrystalline materials, the use of coherent radiation and surface crystallography.

Literature
- C. Hammond, *The basics of crystallography and diffraction*, 3rd edition, Oxford University Press, 2009.
- Optional: J.F. Nye, *Physical properties of crystals - Their representation by tensors and matrices*, Oxford University Press, 1985.

Examination
Written examination.

Magnetic resonance II

Course ID: **SM023D** *6 ec* second semester prof. dr. A.P.M. Kentgens
prof. dr. S.S. Wijmenga

Teaching methods
- 50 hrs tutor session

Prerequisites
Mandatory: Magnetische Resonantie I and/or Structuur Biomoleculen
Advised: Structuur Biomoleculen, Structuur Functie en Bio-informatica, Vaste Stof Chemie

Objectives
At the end of this course the student knows the basic theory behind modern techniques for Biomolecular and Solid-State NMR. On the basis of this knowledge he/she can predict the outcome of NMR pulse sequences employed in modern liquid state NMR of moderately complex spin systems. The student recognizes the basic manifestations of single crystal and powder NMR spectra in the solid-state and can extract and interpret the interaction parameters contained in the spectra.

Contents
This course treats the basics of modern techniques for Biomolecular and Solid-State NMR. Various topics will be treated in view of advanced applications of NMR in Life Science and Materials Science. The themes that will be addressed are:
- Reprise: Larmor precession, rotating frame, Bloch equations;
- Basic NMR hardware and principle of the measurement;
- The density operator concept, QM approach of the rotating frame;
- The Operator Formalism, in order to be able to analyze the effect of NMR pulse sequences on coupled spin system;
- The nuclear spin Hamiltonian and its spectral manifestation in liquids, liquid crystals (alignment), single crystals and powders;
- Use of spherical tensor operators;
- Motion (coherent and incoherent): averaging, exchange;
- The mechanisms of spin-spin and spin-lattice relaxation;
- multi-dimensional NMR;
- phase cycling, selection of coherences, canceling unwanted signals;

Literature
- M. Levitt, *Spin dynamics*
- J. Cavanagh, *Protein NMR Spectroscopy. Principles and Practice*.

Examination
Written examination, open book.

Magnetic resonance IIIa, Advanced biomolecular NMR

Course ID: **SM024D** *4 ec* second semester prof. dr. S.S. Wijmenga

Teaching methods
- 30 hrs tutor session

Prerequisites
Structuur Biomoleculen and/or Magnetische Resonantie I and/or Structuur Functie en Biomoleculen and/or Magnetische Resonantie II.

Objectives
After the course the student *knows about* advanced applications of NMR in the field of Structural and Functional Biology. The student *knows* how advanced structure determination of biomolecules is carried out and knows its practical implementation. The student *knows about* advanced applications of NMR to study the dynamics and interactions of biomolecules. The student knows metabolomics/proteomics and related NMR/MS detection and analyses methods. The student knows about single molecule detection methods and application in the field of RNA and RNA protein interactions.

Contents
This course treats the practical aspects of the application of advanced multidimensional NMR to the study of biomolecular structure, function, and interactions as well as metabolomics/proteomics and single molecule detection methods. The first part includes structure determination of proteins and nucleic acids (spectral assignment, structure calculation, and structure validation). Recent novel BioNMR methods will be treated such as application of residual dipolar couplings and the study of dynamics. Also, the use of NMR in the characterization of interaction cellular processes will be discussed. In as far as the NMR background is concerned the course largely builds on Magnetic Resonance I and II and 'Structuur biomoleculen'. A major part of the course treats Metabolomics and Proteomics, the aims and methods are considered focussing on NMR detection and analysis of data using e.g. PCA; also Mass Spectrometry is discussed. Finally, single molecule analyses, via e.g. atomic force microscopy, is also treated focussing mainly on RNA and RNA-protein interactions. For students with a Molecular Life Sciences background and who have not followed Magnetic Resonance II, a differentiation can be set up.

Literature
Articles and reference books.

Examination
written examination, open book.

Magnetic resonance IIIb, Solid-state NMR

Course ID: **SM044** *3 ec* Second semester prof. dr. A.P.M. Kentgens

Teaching methods
- 30 hrs tutor session

Prerequisites
Magnetic Resonance I and Magnetic Resonance II

Objectives
After completing this course the student has an in-depth theoretical knowledge of advanced solid-state NMR as applied in contemporary materials science. The student is able to predict the outcome of complex experiments from first principles and knows when to resort to numerical simulations to fully describe the spectra and extract all meaningful interaction parameters. The student is capable of chosing the right approach to eliminate or enhance specific NMR interactions and is aware of the field of application of these techniques.

Contents
Based on the knowledge acquired in the courses Magnetic Resonance I and II, this course will give an in-depth treatment of a number of experiments which are at the heart of Solid State NMR and its applications in materials science and the study of bio(mimicking) materials. Themes will be:
- The nuclear spin Hamiltonian (in spherical tensors operators) and its spectral manifestation in single crystals and powders; homogeneous vs. inhomogeneous line broadening.
- Manipulation of spin Hamiltonians in real and spin space (sample spinning and multiple pulse techniques); Average Hamiltonian Theory.
- Study of molecular motions; line narrowing; multidimensional exchange spectroscopy.
- Double resonance; Cross-Polarization, SEDOR, REDOR.
- Homo- and heteronuclear correlation spectroscopy; recoupling of dipolar interactions under Magic Angle Spinning.
- Getting isotropic spectra for quadrupolar nuclei; DOR, DAS, MQMAS, STMAS.
- Power averaging; Herzfeld and Berger analysis.
- Numerical simulations using the SIMPSON simulation package.

Literature
- M. Duer, *An introduction to solid-state NMR*
- M. Levitt, *Spin dynamics*
- K. Schmidt-Rohr, H.W. Spiess, *Multidimensional solid-state NMR and polymers*.

Examination
Written examination, open book.

Quantum dynamics

Course ID: **SM295** *3 ec* fourth quarter dr. ir. G.C. Groenenboom

Website
www.theochem.ru.nl/quantumdynamics

Teaching methods
- 10 hrs computer course
- 16 hrs lecture
- 16 hrs problem session
- 24 hrs individual study period

Prerequisites
Quantum mechanics 1 & 2, chemical bonding, and quantum chemistry.

Contents
The topic of this course is the quantum mechanical description of nuclear motion. The quantum mechanical description of rotation and vibration of molecules results in discrete energy levels that may be observed spectroscopically. The quantum mechanical description of (photo)dissociation and collisions of atoms and molecules involves the continuum part of Hamiltonian of the system. The following topics are treated:
- Time-dependent vs time-independent Schroedinger equation.
- Nuclear motion and wavepackets
- Rotation and vibration of molecules
- Scattering (collisions) of molecules
- Photodissociation
- Symmetry in non-rigid systems: the molecular symmetry group

In the theory will be applied in the computer lab.

Literature
- E. B. Wilson, J. C. Decius, and P. C. Cross, *Molecular vibrations: the theory of infrared and Raman Vibrational spectra,* Dover New York, 1980

- Stephen Gasiorowicz, *Quantum physics*, Wiley, New York, 1974

Examination
Two tests of 2 hours and a computer test of 2 hours.

Extra information
website: www.theochem.ru.nl/quantumdynamics

Study Tour Chemistry

Course ID: **SM300** *4 ec* W.J.M. Philipse

Teaching methods
Preparation of the tour; writing preparatory and final reports; participate in presentations; participating in the study tour.

Prerequisites
Bachelor of Chemistry

Objectives
Participants: introduction to carreer possibilities in universities, research institutes, gouvernment and industry; getting to know the culture and history of an other country.
Members of the study tour committee: development of social and organisational skills, preparation of the study tour, maintaining relations with parties to be visited and with sponsors.

Contents
The study tour is being organized by students with guidance of and under the responsibility of 2 members of the academic staff. Participating students are members of the study tour committee. This committee organizes the entire study tour (planning, organizing and implementing the day-to-day programme; and, of course, fund-raising).
Participants prepare the study tour in small groups by means of organizing and attending lectures and making preparatory reports under the leadership of several members of the academic staff; groupreports are presented to all participating students.

Examination
Examination of and participation in making of preparatory and final reports, and presentations; participating in the study tour.

Evolution and the Mind

Course ID: **FFIL202A** *3 ec* fourth quarter prof. dr. C.H. Luthy
S.A.J. Segers

Teaching methods

- 2 hrs personal study counseling
- 14 hrs problem session
- 64 hrs individual study period

Objectives

The most immediate aim is to bring about an appreciation of the profound implications of evolutionary biology for a number of issues that don't inherently belong to biology, and to allow science students to view them in a philosophical and historical perspective. A secondary aim is to bring about an understanding of scientific questions as arising in particular historical circumstances. The particular skill that will be promoted in this course is the use of rational argument in oral and written presentations.

Contents

Darwin's Origin of Species (1859), whose 150th anniversary was extensively celebrated in 2009, claimed that all life forms had developed by means of a blind process of competition and natural selection. Famously, this claim has triggered a whole range of problems, many of which fall outside of the domain of biology. This course is devoted to one set of such problems, namely to the implications of evolutionary theory for the human mind. Questions that arose already in 1859 but have been discussed through the past 150 years up to our own Darwin year are: Doesn't evolutionary theory abolish the soul? And what role does it give to the mind? Are mental states nothing but highly determined instinctive patterns? If so, does free will exist, or is it a mere figment of imagination? And what are the implications of evolutionary biology for ethics, religion, and politics? Should we take "evolution into our own hands," as the eugenic movement has claimed and the transhumanists repeat? Should our legislation reinforce the survival of the fittest, or instead combat it? In this course, we will look at the answers that have been given to these questions, from Darwin's own time up to our own.

Examination

Each student will be asked to write three reaction papers and a concluding essay.
Course attendance is required.

Extra information

Foreign students should contact the teacher 6 weeks in advance.

Science & Literature (Philosophy 2)

Course ID: **FFIL205A** *3 ec* third quarter prof. dr. H.A.E. Zwart
drs. T.J. Idema
S.A.J. Segers

Teaching methods
- 2 hrs personal study counseling
- 14 hrs problem session

Contents
The course is devoted to analyzing literary documents in scientific research. These documents are interesting for at least two reasons. To begin with, they may tell us something about actual research practices (laboratory life). More importantly perhaps, they may help us to understand societal responses to scientific developments. In other words, literary documents may help us define what is so special about scientific knowledge (in comparison with other types of knowledge), but they may also assist us in addressing the societal dimensions of science (the interactions between scientific research activities and their social or cultural environment).
In 2008 the focus will be on the work of Michael Crichton, whose novels deal with recent developments in scientific research (notably fields such as genomics, ICT, nanoscience and environmental science) but also with the societal impact of science as well as with the way in which societal developments influence and shape the course of research fields and programs.

Literature
1. Monograph on science and literature by lecture
2. Lecture notes (ppt)
3. A literary document

Examination
Assignments, presentation, student paper

Extra information
Foreign students should contact the teacher 6 weeks in advance.

Environmental Ethics

Course ID: **FFIL209B** *3 ec*

dr. M.A.M. Drenthen
S.A.J. Segers

Teaching methods
- 24 hrs lecture
- 2 hrs personal study counseling
- 54 hrs individual study period

Prerequisites
Students are expected to have completed the bachelor course 'Inleiding in de Filosofie en Ethiek'

Objectives
After completing this course,
- the student is familiar with the major topics, approaches and concepts in environmental ethics and landscape philosophy
- the student can distinguish scientific reasoning form other forms of intellectual activity
- the student can take a substantiated position in ethical debates on issues of landscape and ecosystem management.
- the student can read, analyze and critically assess philosophical texts, and to apply them to actual cases
- the student can publicly present and discuss a philosophical text

Contents
This course will discuss major topics in environmental ethics and landscape philosophy:
- Basic attitudes toward and images of nature, anthropocentrism vs. ecocentrism,
- Should we recognize the 'intrinsic value of nature'?

- Subjective and objective value in environmental ethics. Does the value of nature depend on our taste?
- The ethics of large herbivores in the Oostvaardersplassen. How to solve the conflict between animal ethics and ecological ethics.
- Aesthetic reasons for environmental protection: does nature's beauty matter?

- Nature development, biodiversity and the concept of wildness - Why do we want nature to be wild?
- Bioregionalisme en the Ethics of Place- Which places matter to us and why?

Literature
texts will be provided via Blackboard

Examination

Attendance is mandatory. Grades will be based on group presentation, written assignments and participation in class discussions. There will be no final exam.
Students have to apply for this course via Blackboard, at least 4 weeks before the start of the course. **Maximum number of applicants: 20.**
This course will be taught in Dutch. Foreign students who are interested in this topic, are advised to sign up for the course 'Philosophy of watermanagement' (FFIL212).

Extra information

Seminars will be twice a week: on Monday 13.45-15.30 and Thursday 13.45-15.30. Attendance is mandatory!
The first meeting will be on Monday 15 November 2010; the final meeting Thursday 6 January 2011.
(CHECK THE OFFICIAL 'ROOSTER' SITE (http://rooster.ru.nl) FOR THE MOST RECENT TIMES AND PLACES)

This course can be substituted by other advanced philosophy courses (see the courses on offer from the philosophy department)
This course will be taught in Dutch. Foreign students who are interested in this topic, are advised to sign up for the course 'Philosophy of watermanagement' (FFIL212), that deals with similar questions.

Global Ethics and Sustainable Development

Course ID: **FFIL210A** *3 ec* third quarter prof. dr. F.W.J. Keulartz
drs. I.E.M. Dankelman
S.A.J. Segers

Teaching methods
- 20 hrs lecture
- 2 hrs personal study counseling
- 60 hrs individual study period

Objectives
Students should gain some basic insights in globalization processes and their ecological, economic and social impact. They should be able to indicate and discuss issues of global ethics such as climate change, poverty elevation, and sustainability.

Contents
In this course, the contribution of the newly emerged discipline of global ethics to a fair and equitable approach to global challenges will be examined. Three topics will be discussed: (1) climate change; (2) poverty and development; and (3) sustainable development.

Literature
Will be distributed.

Examination
Students should study the literature, participate in discussions, make at least one presentation, and write a brief essay.

Extra information
Foreign students should contact the teacher 6 weeks in advance.

Philosophy 2 (for Physicists)

Course ID: **FFIL211A** *3 ec* third quarter dr. M.A.M. Drenthen
S.A.J. Segers

Teaching methods
- 20 hrs lecture
- 2 hrs personal study counseling
- 58 hrs individual study period

Prerequisites
students are expected to have completed the bachelor course 'Inleiding in de filosofie'

Objectives
After this course the student:
- is able to read and analyze a philosphical text, to present a text, to lead a group discussion
- understands the epistemological shift from classical physics to quantumphysics and is familiar with the major positions in the debate between scientific idealism, realism, instrumentalism and positivism
- is aware of the specific nature of the scientific appraoch, and is able to demarcate the boundaries between physics and other fields of intellectual activity

Contents
The development of quantum mechanics has given rise to a number of epistemological, cultural historical, and philosophical debates. In this course, we will read some texts from the founding fathers of quantum mechanics. The main focus is on the relation between physical models and reality. What is the status of physical knowledge? What is the role of aesthetic judgments in the development of theoretical physics? What are the boundaries of the scientific approach? What can a theory of everything imply? What is the relation between scientific insights and religious or ideological outlooks on life?

This course will be taught in English. However, if there are less then 2 foreign students, it will be held in Dutch. In that case, non-dutch speaking students will get an alternative assignment.

Students who wish to follow this course have to SIGN UP AT LEAST 4 WEEKS BEFORE THE START OF THE COURSE. Please conform your subscription in Blackboard by pressing the 'group activation' button.

Students who do not speak Dutch are requisted to make themselves known as such AT LEAST 4 WEEKS BEFORE THE START OF THE COURSE, by sending an e-mail to: m.drenthen@science.ru.nl. This way, that the lecturer can decide in time if the course will be held in Dutch, or if it has to be taught in English.

Literature
Papers will be distributed.

Examination
During this course, student will have to read and analyze, present and discuss philosophical texts.
Students will be assessed on their home assigments, their presentation and their contributions to the discussions in class. There will be no final exam.
Attendance is mandatory.
Students who wish to follow this course have to SIGN UP AT LEAST 4 WEEKS BEFORE THE START OF THE COURSE.
Please conform your subscription in Blackboard by pressing the 'group activation' button.

Students who do not speak Dutch are requisted to make themselves known as such AT LEAST 4 WEEKS BEFORE THE START OF THE COURSE, by sending an e-mail to: m.drenthen@science.ru.nl. This way, that the lecturer can decide in time if the course will be held in Dutch, or if it has to be taught in English.

Philosophy of Watermanagement

Course ID: **FFIL212** *3 ec* jan (2 weeks) dr. M.A.M. Drenthen
prof. dr. H.A.E. Zwart
prof. dr. F.W.J. Keulartz
S.A.J. Segers

Teaching methods
- 10 hrs excursion
- 64 hrs lecture
- 8 hrs individual study period

Prerequisites
Students are expected to have completed the Bachelor philosophy course 'Inleiding in de filosofie en ethiek' or a similar introduction in philosophy

Objectives
After completing this course,
- the student is familiar with the major topics, approaches and concepts in environmental ethics and landscape philosophy
- the student can distinguish scientific reasoning form other forms of intellectual activity
- the student can take a substantiated position in ethical debates on issues of landscape and ecosystem management.
- the student can read, analyze and critically assess philosophical texts, and to apply them to actual cases
- the student can publicly present and discuss philosophical texts

Contents
In this course, we will deal with some philosophical aspects regarding water management. We will discuss the major topics from environmental ethics and landscape philosophy:
- The relation between environmental science and environmental ethics
- Basic attitudes toward and images of nature, anthropocentrism vs. ecocentrism
- Intrinsic value of nature: subjective? objective?
- Ecological restoration or faking nature?
- Conflict between animal ethics and ecological ethics
- Aesthetics and environmental protection
- The concept of wilderness
- Bioregionalism and Ethics of Place

There will also be a day-long excursion to a 'new' nature reserve.

Literature
Texts and assignments will be made available in Blackboard.

Examination

Grades will be based on written assignments, on oral presentations and on participation in group presentations and class discussions. There will be no final exam.

Extra information

This course will be int to weeks on a full time basis. Attendance is mandatory.
week 3: Monday 17 January - Friday 21 January 2011; week 4: Monday 24 January - Friday 28 January 2011.
(CHECK http://rooster.ru.nl/ FOR MOST RECENT TIMES AND PLACES)
Students who wish to follow this course have to SIGN UP AT LEAST 4 WEEKS BEFORE THE START OF THE COURSE. Please conform your subscription in Blackboard by pressing the 'group activation' button.
Maximum number of applicants: 20. TWM-students will have prior access; foreign language students have prior access over Dutch-speaking students.
Nederlandstalige niet-TWM studenten worden geadviseerd om te overwegen in plaats van deze cursus het vak Environmental Ethics (FFIL209B) te volgen.

Bioethics for Lifescientists

Course ID: **FFIL203B** *3 ec* fourth quarter dr. M.A.M. Drenthen
S.A.J. Segers

Teaching methods
- 20 hrs lecture
- 60 hrs individual study period

Objectives
After finishing this course:

- the student should be familiar with different approaches in bioethical theory (deontology, utilitarism)
- the student should be able to apply these ethical theories to relevant cases in modern life sciences
- the student should be able to take an argued position in ethical debates about these issues

Contents
This course offers an introduction to the field of bioethics for biosciences students. Students are introduced into the nature of bioethics and ethical theory. Next, we will discuss a broad range of bioethical issues relating to people, animals, plants, environment, and the practice of bioscience research. The focus is on developing the students' power of reasoning and judgement in ethical debates and discussion.

This course will be taught in English. However, if there are less then 2 foreign students, it will be held in Dutch. In that case, foreign students will get an alternative assignment.
For this course, is a maximum number of participants of 20 student.
Students who wish to follow this course have to SIGN UP AT LEAST 4 WEEKS BEFORE THE START OF THE COURSE. Please conform your subscription in Blackboard by pressing the 'group activation' button.

Students who do not speak Dutch are requisted to make themselves known as such, by sending an e-mail to: m.drenthen@science.ru.nl. This way, that the lecturer can decide in time if the course will be held in Dutch, or if it has to be taught in English.

Literature
Texts will be made available via Blackboard.

Examination
Attendance is mandatory, especially at the first meeting.
Maximum number of applicants: 20.
The examination and grading of the course is partly based on oral presentations and participation in class discussions. In addition, students will be asked to write an essay in which they apply the various ethical approaches to a particular case in life sciences,

preferably related to the topic of their Master thesis.

Students should sign up for the course via Blackboard, at least 4 weeks before start of the course.

Extra information

College: friday 13.30-15.30
Students who wish to follow this course have to SIGN UP AT LEAST 4 WEEKS BEFORE THE START OF THE COURSE. Please conform your subscription in Blackboard by pressing the 'group activation' button.

Students who do not speak Dutch are requisted to make themselves known as such, by sending an e-mail to: m.drenthen@science.ru.nl. This way, that the lecturer can decide in time if the course will be held in Dutch, or if it has to be taught in English.

History of Mathematics and Physics: "Does Nature Have a Mathematical Structure

Course ID: **FFIL300** *3 ec* third quarter prof. dr. C.H. Luthy
S.A.J. Segers

Teaching methods
- 20 hrs lecture
- 2 hrs personal study counseling

Objectives
* To provide an historical overview over a scientific riddle: Why can mathematics be used to describe the natural world?
* To sketch the common as well as the divergent answers given by physicists and mathematicians to this question.
* To instruct students in placing their "eternal" mathematical models and physical laws of nature into the context of the historical evolution of their respective fields.

Contents
Since ancient times, the question has been raised as to why it is possible to describe natural phenomena in terms of mathematical formulae. In each epoch, this question has been answered differently. In this course, we shall start with Plato's geometry and the Pythagoreans' number theory and end with quantum mechanics. Topics that will be discussed in this long story will include the dispute between Aristotelians and Platonists over the nature of mathematics, the Copernican and scientific revolutions, the 'invention' of the concept of mathematical laws of nature, Galileo's mechanics, Newton's *Principles*, Euler's theory of numbers, thermodynamics, and the status of natural constants. Prominent historians of science and mathematics will be invited to present some of the chapters in this enigmatic story.

Literature
Will be distributed on blackboard.

Examination
Students will be asked to write three discussion papers

Extra information
If all participants wish so, discussions will be lead in Dutch.

Business & Society

Course ID: **FMT001C** *5 ec* first semester dr. G.A.N. Vissers
dr. J.W. van Rooij
H. Vreugdenhil-de Klerk

Teaching methods
- 28 hrs lecture

Prerequisites
Master student FNWI

Objectives
Business & Society is concerned with the processes of mutual influence that exist between firms, the economy and society. It specifically focuses on three industrial revolutions that fundamentally reshaped firms, technologies, and societies. Business & Society tries to understand how companies work, and it places them firmly in their context. By doing so, Business & Society introduces theories, models and concepts that aim to understand the relations between firms, the economy, and society.
Business & Society has the following specific objectives:
1. After completing this course, students understand the effects of society on business, and the effects of business on society, i.e.
a. Students are able to relate the behavior and characteristics of firms to characteristics of societies.
b. Students are able to analyze this relation using theories, models, and concepts from management science, business history, and institutional economics.
2. After completing this course, students understand the relevance of history for understanding business and society, i.e.
a. Students are able to analyze how events of the past have enabled and constrained future events, and as such have shaped the present.
b. Students are able to evaluate the role of history in the theories, models and concepts used to explain the relations between firms, the economy and society.

Contents
The master track Management & Technology focuses on the interface between science, technology and business. Subsequent courses focus on one aspect of this interface, but in Business & Society we focus on the interface itself, and provide a helicopter view of firms in their environment. It is essential to take a broad view of the workings of business. Inside firms, different disciplines do not work in isolation, but work together to provide value on a market. Moreover, firms do not operate in a vacuum, but operate in a context that shapes them; vice versa, firms shape their environment. Business & Society sets the scene for the courses of Management & Technology that follow.
Business & Society focuses on four leading capitalist nations, and particularly on leading firms from those nations, over a the course of three industrial revolutions up to the twenty-first century. The study of history provides the means to understand how firms and their environments shape each other. The study of history also underlines that each firm and each

society is different, and underlines that firms and their environments change. In this way, students are introduced into the workings of business in its economic, technological and societal context.
Subjects that are covered in this course include:
· Industrial revolutions;
· Innovation systems, business systems, and varieties of capitalism;
· Business history, particularly of leading firms in the 19th and 20th centuries;
· Entrepreneurship;
· The role of the state in the economy.

Literature
T. K. McCraw, Ed. (1997). Creating modern capitalism: How entrepreneurs, companies, and countries triumphed in three industrial revolutions. Harvard University Press.

Examination
Written exam, group work and individual assignments make up the final grade for this course. More details will be announced on Blackboard at the start of the course.

Organization Theory

Course ID: **FMT002C** *5 ec* spring semester prof. dr. B. Dankbaar
H. Vreugdenhil-de Klerk

Teaching methods
- 30 hrs question session

Prerequisites
MT Course Business & Society

Objectives
- Students acquire knowledge of the main concepts and approaches in organization theory
- Students are able to apply this knowledge to issues of organizational design and change

Contents
This course offers an introduction into the fundamental insights of organization theory dealing with questions like: What are organizations? How are they structured? How do they interact with their environment? What is organizational culture? And how are organizations designed and managed? Organizations are complex systems and consist of people with different interpretation-schemes. As a result, organizations have to deal with a variety of problems and dilemmas. The course offers students methods and instruments to diagnose organizational problems and to deal with the problems and dilemmas of organizing.
Content:
Apart from studying and discussing a text on organization theory, the students will make presentations of their analysis and views on selected business cases

Literature
To be determined

Examination
Written examination and discussion of a business case

Innovation management

Course ID: **FMT003C** *5 ec* fall semester

prof. dr. B. Dankbaar
H. Vreugdenhil-de Klerk
ir. L.J. Lekkerkerk
dr. R.A.W. Kok

Teaching methods
- 32 hrs lecture

Prerequisites
- Master student FNWI
- BEM & Organisatiekunde in completion with a minimum of a 6

Objectives
The purpose of the course is for students to :
- Acquire knowledge in the field of innovation management including Research and Development and New Product Development
- Apply this knowledge in theoretical cases, eventually acquire sufficient knowledge to apply this knowledge in 'real life' settings
- Judge the value of scientific knowledge in the field of innovation management including Research and Development and New Product Development
- Learn how to design a research project in this field

Contents
Innovation determines the dynamics of the economy. Organizations innovate to stay viable. This course focuses on issues of innovation from a management perspective. The main issues concern the dilemmas of innovation management and innovation enhancement: how (and to what extent) are these processes manageable? In these processes different factors play an important role, such as creativity, enterpreneurship, structure, linkages, and a bit of luck. This course offers the student knowledge about the structure and nature of the innovation process (product as well as process innovation). Furthermore, it offers the students instruments to cope with the different dilemmas of innovation management.
Content:
The following themes will be treated:
- Managing for innovation
- Strategy
- Establishing effective external linkage
- Building effective implementation mechanisms
- Creating the innovative organization
- Assessing and improving innovation management

Literature
To be determined (See Black Board)

Examination
assignments and a written exam

Strategy & Marketing

Course ID: **FMT004C** *5 ec* fall semester dr. P.E.M. Ligthart
dr. ir. N.G. Migchels
H. Vreugdenhil-de Klerk

Teaching methods
- 30 hrs question session

Prerequisites
- Master student FNWI
- BEM & Organization Theory in completion with a minimum of a 6 ECTS

Objectives
After completion of the course, students are familiar with market oriented views of innovation and with several important forms of market research; they are able to describe the circumstances in which market orientation will influence innovation processes and to discuss the nature of such influence for business and product development. Students will also be familiar with strategy formation, with different types of strategy and the related perspectives, and with the relationships between general business strategy and innovation strategy.
Prime course objectives are that:
- participants acquire updated insights regarding challenges and opportunities in high-tech markets
- participants understand the virtue and limitations of traditional strategic marketing thinking and tools in emergent, high-tech markets, and
- participants apply their understanding of strategy and marketing concerning High-Technology to develop a well-founded business plan within their own technological discipline.

Contents
Description:
Marketing is the business function that deals with discovering and meeting customers' unfulfilled needs and wants. Strategy underlines the need to align this function to the objectives of the business, the other business activities and -last but not least- to the external market environment of the firm. Strategic marketing in high technology environments poses its own unique challenges due to the complexity and novelty of the technology. Some of those challenges include articulation of the value proposition, decision making with limited information on customers, and coordination with other market players. In order to succeed in this environment, firms need to be able to understand unarticulated needs, forecast the development of nascent markets, and position themselves appropriately in the competitive landscape.
High-tech firms operate under conditions characterized by high degree of market and technological uncertainty. Technological changes can occur rapidly. Products offered are novel and for buyers often difficult to evaluate. Moreover, high-tech firms often operate in emergent industries with "fuzzy"and rapidly changing industry boundaries. Such conditions - deviating from those captured in most marketing texts- represent specific challenges for high-

tech firms to survive and prosper. It should also be noted that the rapid developmentes in modern technologies within science (e.g. biotechnics, informatics, chemics, mathematics, etc.) exert influence on markets and marketing practices only superficially dealt with in traditional strategic marketing textbooks. The "driving question" that arises form the situation described above is: "Provides strategic marketing added value for firms operating in high-tech markets?"And, if so, "why and how ?"
The focus of this course will be on the strategic marketing to accompany a technology and not on the technical or scientific aspects of the high-tech products. Besides lectures, students will work on a group project (i.e. to set up a High-tech Business Development Plan) throughout the term to analyze the marketing strategy for a technology-based product or service.

This course focuses on issue related to strategy and marketing of firms, such as:
- Technology and market
- Relation between R&D and Marketing
- Business strategy and product strategy
- Market research
- Relation with customers
- Distribution, supply chain and pricing

Literature
Mohr, Sengupta, Slater (2005) **Marketing of High-Technology Products and Innovations** (2nd international edition) Pearson Prentice Hall, ISBN 0-13-123023-9
Reader (links of articles will be published at Blackboard)

Examination
- Written exam (literature)
- Business Development Project (presentation and report)

Finance & Accounting

Course ID: **FMT005C** *5 ec* spring semester drs. R.A. Minnaar
H. Vreugdenhil-de Klerk

Teaching methods
- +/- 15 lectures (see for detail Black Board)
- practices

Prerequisites
Master student FNWI

Objectives
The financial accounting part should give you a firm understanding and working knowledge of:
- The basic accounting terminology and the process for recording, summarizing and reporting economic events of a business enterprise;
- The interpretation and analysis of financial statements as a basis for business decisions.

The management accounting part is to develop the student's knowledge of the process of evaluating performance and decision making using accounting information as a basis. After taking this course you should be able to interpret, use and evaluate internal accounting information.

Contents
Accounting information is an integral part of the business environment and an understanding of accounting information is an essential tool in the process of making business decisions. The primary objective of this course is to develop the student's knowledge of accounting as a tool in making business decisions. The emphasis in this course will be on both the user and the preparation of accounting information in a business context.
Content:
This course consists of two parts. Financial- and management accounting.
In the financial accounting part, you will be introduced to accounting theory and practice using the models of sole proprietorships and corporations, with an emphasis on merchandising companies. The emphasis and focus of financial accounting is on financial information used by parties' external to the firm. Specific topics will include: the definition and scope of accounting; systems used to account for and control transactions; inventory costing; the measurement of income and equity; and a special emphasis on financial reporting and the analysis of financial statements.
The management accounting part of this course emphasizes the use of accounting information for internal planning and control purposes. As business managers, you will be involved in a variety of management decisions. Some examples of the issues that you might encounter include: "How much should we charge for this product or service?"; "What elements contribute the most to this business?"; "How is my company doing compared to the competitors?"; "Is this person a good manager?"; "Are my costs under control?" "Does this capital investment make sense?" A range of information may influence such decisions and management (internal) accounting information is among the most significant.

In this part, the fundamentals of managerial accounting, profit and cost accumulation are introduced. Specific topics covered include: cash flows, capital budgeting, cost allocation, product costing, differential costing for short and long-term decisions, performance evaluation, and the concepts related to the time value of money.

Literature

Horngren, Harrison and Oliver (2009). Accounting. Eighth edition. Pearson International Edition. ISBN: 0-136-11290-0

Examination

- A final written 3 hour exam with multiple choice questions.
- Online Assignments in MyAccountingLab

Projectmanagement

Vakcode: **FMT015B**	*3 ec*	eerste semester en tweede semester	drs. J.G.J. van den Broek H. Vreugdenhil-de Klerk

Werkvormen

Opzet/werkvorm

Theorie en inleiding opdrachten (16 u.), vaardigheidstrainingen (24 u.), zelfstudie en opdrachten (46 u.)

Inleidingen, zelfstudie, opdrachten, vaardigheidstrainingen, presentaties, werkstukken.

Vereiste voorkennis

Studenten die na hun afstuderen kiezen voor een baan buiten de wetenschap krijgen meestal direct te maken met een projectmatige manier van werken. Deze cursus is bedoeld voor studenten uit de laatste fase van hun betastudie (vijfdejaarsstudenten) ter voorbereiding op hun beroepstoekomst.

Leerdoelen

De cursus beoogt studenten op een actieve wijze te laten kennismaken met de uitgangspunten van projectmatig werken. Hierbij gaat het enerzijds om aan- en bijsturingsprincipes (faseren, plannen, bijsturen) en anderzijds om een aantal vaardigheden op het gebied van leidinggeven aan en professioneel samenwerken in projectteams.

Inhoud

Project Start Up
Faseren en plannen
Bijstuurtechnieken
Projecten met een afdwingbaar resultaat
Projectmanagement en de inrichting van adviestrajecten
Basisvaardigheden voor de beta als adviseur en/of projectleider
Problem solving
Vergadertechnieken en onderhandelen
Omgaan met weerstanden en conflicthantering
De persoonlijke effectiviteit van de projectleider

Beschrijving

Training is in Dutch.

Een deel van deze cursus bestaat uit vaardigheidstrainingen. Hierbij is de nuance in de interactieve processen cruciaal. Voor de diepgang en kwaliteit vereist dit van alle betrokkenen taal op het niveau van "native speaker". Daartoe bedienen we ons bij dit **keuzevak** van de **Nederlandse taal.**

Doelgroep.

Studenten die na hun afstuderen keizen voor een baan buiten de wetenschap krijgen meestal direct te maken met een projectmatige manier van werken. Deze cursus is bedoeld voor studenten uit de laatste fase van hun betastudie (vijfdejaarsstudenten) ter voorbereiding op hun beroepstoekomst.

Maximale groepsgrootte: inschrijving en plaatsing.

In verband met de vaardigheidstrainingen kunnen slechts **16 studenten per cursus** deelnemen. Aanwezigheid is verplicht. Plaatsing geschiedt aan de hand van de volgorde van inschrijving via Blackboard.

Tentaminering

Actieve participatie vaardigheidstrainingen (aanwezigheid verplicht), schriftelijke opdrachten en tentamen.

Bijzonderheden

Toetsing en beoordeling

Actieve participatie vaardigheidstrainingen (aanwezigheid verplicht), schriftelijke opdrachten en tentamen.

Cursusdata in studiejaar 2010-2011

Cursus 1	najaarsemester	vrijdagmiddagen (13.45 - 17.30 uur)
Cursus 2	voorjaarsemester	dinsdagmiddagen (13.45 - 17.30 uur)

Master-thesis Management & Technology-track

Course ID: **FMT010B** *27 ec* dr. J.W. van Rooij

Teaching methods

- 40 hrs personal study counseling

Prerequisites

The master thesis Management & Technology is open to master students who have successfully completed

- the compulsory courses of the master track Management & Technology, and
- the compulsory courses in their own discipline, including a research project if applicable.

Students need to show that they are eligible to enroll in the final research project by providing the coordinator with a list of completed courses.

Contents

The master thesis is the final step in the master track Management & Technology. Students perform research, focusing on problems on the interface of science, business and society. Preferably, students combine knowledge acquired in their discipline with knowledge acquired in the master track Management & Technology. We encourage students to perform their research in companies, but students can also work in non-profit organizations if they prefer, and if the problem fits with the objective, and contents of Management & Technology.
After students have shown that they are eligible to enroll, the project consists of the following stages.

- In the first stage, students find an organization willing to host and coach them, and, in consultation with this organization, write a research proposal. In the research proposal students outline the topic of the research and its goals, the research questions, and the methods that will be used to answer these questions. All parties need to reach an understanding of their respective roles and responsibilities; a standard contract is available to formalize this understanding. At the end of the first stage, finally, the coordinator assigns to the student a coach who will supervise the final two steps of the project.
- In the second stage, students perform research and write their thesis. In this stage, students meet regularly with their coaches from the host organization and the university to discuss progress and planning, as well as possible problems. At the end of stage 2, the coach from the university assigns an additional reader to the project; this reader acts as a quality check on the work of students and coaches.
- In the final stage, the results of the research are presented at the university, and at the host organization if desired.

A manual is available on Management & Technology's website with more details, help, examples and literature.

Literature
See the manual on the website of Management & Technology.

Examination
Coaches and reader together decide on the grade of the thesis. Coaches and reader determine their grade on the text of the master thesis, on the performance of the student during research and writing (stage 2), and on the form and content of the presentation (stage 3). The manual on the website of Management & Technology details the criteria that will be used.

Introduction Science Communication

Course ID: **FC001B** *3 ec* first quarter dr. J.G. van den Born
drs. E. van Rijswoud
S.A.J. Segers

Website
www.ru.nl/sciencecommunication

Teaching methods
- 14 hrs lecture
- 70 hrs individual study period

Prerequisites
This is the first course of the Mastertrack Science Communication. It is part of the obligatory programme of the Mastertrack. In addition the course is open as an optional course for all MSc. students.

Objectives
- Students are acquainted with science communication practices and theories
- students are able to use these theories to analyse classic examples of science communication
- Students are trained by a professional in presentation skills

Contents
Nowadays every scientist gets involved in science communication in his or her professional life. In this course we give an overview of science communication strategies and of seminal views on science communication practices and theories.
Focus is on communication with the public and with target groups within the general public on issues that involve scientific knowledge. Scientific communication (communication among scientists for instance at scientific meetings) is not the main issue, although the training in presentation techniques applies to those communication practices as well.
Students will also study and present classic examples of succesful popularization of scientific insights, in the shape of TV documentaries, films, fiction and non-fiction books, and 'visitables'.

Literature
Literature will be made available on blackboard

Examination
Written exam, participation and presentation

Extra information
This course will be taught in Dutch.

Science & Societal interaction

Course ID: **FC002B** *3 ec* third quarter dr. J.G. van den Born

Website
www.ru.nl/sciencecommunication/

Teaching methods
- 14 hrs lecture
- 1 hrs personal study counseling
- 69 hrs individual study period

Prerequisites
Basic articles from the reader of the course: 'Introduction Science communication'.

Objectives
The student:
1. develops knowledge and understanding in the field of public participation, regarding natural-scientific topics in societal processes.

2. applies this knowledge by developing a participation-plan. Attention is paid to different levels of participation and methods and tools of participation. Also, a distinction of the different stakeholders is made, and ways to reach them are explored.

3. is able to present this participation-plan to the group.

Contents
Science communication is usually not a linear process, but comes into being through interaction. In this course is dealt with ways to involve citizens and other stakeholders in an interactive process when scientific topics are on the agenda. Questions as why would you involve stakeholders and why not, who would you involve and on which level are under discussion. With regard to the question who to involve it is important to get a grip on 'the public'; who will and can be involved? And what are the benefits for people to participate in such a process? Finally, we learn about the different methods and tools that can be used in the planning of a participation project, such as debates and focus groups.

In this course the students are introduced in the basic principles of stakeholder participation, students design a participation plan themselves and debate with experts on the field of participation on an actual case.

Literature
Literature will be made available on Blackboard

Examination
An assignment.

Extra information
Thursday
Foreign students should contact the teacher 6 weeks in advance.

Risk Communication

Course ID: **FC003B** *3 ec* second quarter dr. R.P. Verhoeff
dr. J.G. van den Born
S.A.J. Segers

Website
www.ru.nl/sciencecommunication/

Teaching methods
- 1 hrs personal study counseling
- 20 hrs problem session

Prerequisites
The course builds on the introductory course on Science Communication from the Mastertrack Science Communication, and is part of the obligatory part of the Mastertrack. In addition, the course is open as an optional course for all MSc. Students.

Objectives
- Students are familiarised with the place of risk in society, its characterisation, and the implications for communication
- Students are familiarised with actual cases and practices in Risk and Uncertainty Communication
- Students are familiarised with determinants of public perception of Risk and Uncertainty
- Students are familiarised with the role of the different actors and stakes in Risk Communication (for instance companies, government, local population) and how to position themselves among these actors

Contents
Present day society has been characterised as a Risk Society. In the last decade, the risk society has been hugely influential, serving as a stimulus for academic, environmental and political dialogue. The communication of risk and the public understanding of risk have become important issues in Science Communication. This course aims to prepare students to actively engage in risk communication and to analyse, reflect on and assess risk communication practices (e.g. HPV-vaccination, the Mexican flu, global climate change). The course combines a practical and theoretical component. Discussions among students, teachers and guest speakers are matched with analyses of current scientific insights on issues of risk communication, risk perception and uncertainty.

Literature
Literature will be made available on Blackboard

Examination
assignment

Extra information
Thursday 15.30-17.30
Foreign students should contact the teacher 6 weeks in advance.

Boundary-Work: The Tension between Diversity and Sustainability

Course ID: **FC0041C** *3 ec* fourth quarter prof. dr. F.W.J. Keulartz
S.A.J. Segers

Website
www.ru.nl/sciencecommunication/

Teaching methods
- 20 hrs lecture
- 4 hrs personal study counseling

Objectives
Students should gain some basic insights in the tension between the heterogeneity of actors that (should) have a stake in natural resources management on the one hand and the need for an integrated approach and close cooperation among these various stakeholders on the other. They should be able to specify and discuss general strategies of so-called 'boundary work' to deal with this tension between diversity and sustainability.

Contents
Climate change, air pollution, deforestation, loss of biodiversity, stratospheric ozone depletion, land and freshwater degradation - all these environmental problems have effects that transcend national boundaries; they cannot be solved by the unilateral decisions of individual states but require international cooperation. Moreover, these problems are interconnected and cannot be solved in isolation but require an integrated approach. But such an approach is frustrated by the existing multiplicity of communities with diverse and sometimes diverging ethical visions and moral vocabularies. So, there is a strong tension between on the one hand the diversity of actors that have a stake in sustainable development and on the other hand the need for a close cooperation between these various stakeholders. This tension between sustainability and diversity can only successfully be resolved through processes of communication, conflict management and consensus building across the lines that separate communities and their social and moral worlds. Such 'boundary work' is the central topic of this course.

Literature
Will be distributed.

Examination
Students should study the literature, participate in discussions, make at least one presentation, and write a brief essay.

Extra information
Foreign students should contact the teacher 6 weeks in advance.

Framing Knowledge

Course ID: **FC0010C** *3 ec* first quarter dr. J.G. van den Born
S.A.J. Segers

Website
www.ru.nl/sciencecommunication/

Teaching methods
- 14 hrs lecture
- 70 hrs individual study period

Prerequisites
The course 'risk communication' is recommended.

Objectives

The student:
- will be introduced in the theory of frames and framing (knowledge)
- will have insight in the role of perceptions, interests and strategies in conflict situations (knowledge)
- can cooperate in a group of fellow students with regard to the assignment (skills)
- can design an interview guide, learn to interview, and to work out and interpret the interview results (skills)

Contents
Framing knowledge is an introduction into perceptions; frames that individuals use to look at and understand the world around them. It is important to be conscious of the fact that everyone has their own background and knowledge structures. For example, a farmer has a different idea of what nature is than a city dweller, and a scientist has a different perception of a laboratory animal than an ethicist. Besides, this so called cognitive approach, we distinguish the interactional paradigm. This approach centers on how parties negotiate meaning in interaction.
When looking closer at laborious and failed negotiations, it is not impossible that different perceptions are underlying the whole matter, perceptions the stakeholders are often stuck to. To recognize these frames is the first step of understanding and solving a conflict. Connected to these frames are individuals (or groups) interests and strategies to act and negotiate. In these negotiations frames may develop and shift during the process.
We work with a recent case study (closely connected with PhD research performed at our ISIS institute) to explore the idea of frames. In this course the students are also introduced to the basic principles of interviewing. They learn to design an interview guide and to perform an interview with a stakeholder in the case we investigate during the course.

Literature
Literature will be made available on Blackboard

Examination
An assignment.

Extra information
Foreign students should contact the teacher 6 weeks in advance.

Knowledge Society

Course ID: **FC0011C** *3 ec* third quarter

dr. R.P. Verhoeff
dr. J.G. van den Born
S.A.J. Segers

Website
www.ru.nl/sciencecommunication/

Teaching methods
- 7 hrs lecture
- 1 hrs personal study counseling
- 7 hrs problem session

Prerequisites
The course builds on previous courses from the Mastertrack Science Communication (especially Risk Communication), and is part of the obligatory part of the Mastertrack. In addition, the course is open as an optional course for all MSc. Students.

Objectives
- Students are familiarised with the different roles of scientists in the Knowledge Society
- Students are familiarised with the implications for science communication
- Students are familiarised with shifts in the knowledge infrastructure and with techniques and strategies to analyse these shifts
- Students are familiarised with the pro's and con's of multi-, inter-, and transdisciplinary-settings they will encounter in professional contexts

Contents
Present day society has been characterized as developing towards a 'Knowledge Society'. Scientific knowledge has become more important and new technologies have a sometimes unprecedented impact. At the same time, the position of (academic) science is under pressure and apparent shifts take place in the role and authority of science in society. Knowledge is an issue.
In this course we reflect on these changes and discuss the possible implications of these shifts for MSc. students in their future professional life. We ground these discussions in actual working practice brought to the classroom by guest speakers, and complement these by models and approaches that are currently used in assessments of the Knowledge Society.

The course primarily focuses on theoretical reflection, but features discussions among students, teachers and guest speakers. These are matched with analyses of current scientific insights on the Knowledge Society, mainly from the field of STS (Social Studies of Science). The course is completed with a written exam.

Literature
Literature will be made available on Blackboard

Examination
written exam

Extra information
The course is taught Thursday
Foreign students should contact the teacher 6 weeks in advance.

Science & Media: strategies and trends

Course ID: **FC0013C** *3 ec* second quarter drs. H.M. Dresen
drs. R.P.M.M. Welters

Website
www.ru.nl/sciencecommunication/

Teaching methods
- 1 hrs personal study counseling
- 20 hrs problem session
- 63 hrs individual study period

Prerequisites
This course is part of the Mastertrack Science Communication, and also open as optional course for all MSc. students.
In either case, having completed the course **Introduction Science Communication** is a **pre-requisite** for taking part in this course**.**
Dutch language:
Part of this course (i.e. the training in media-oriented writing) will be given and examined in Dutch, as it is aimed at gaining access to the Dutch media landscape. Participants who do not write Dutch need to **register six weeks in advance of the start of this course** by sending an email to the coordinating lecturer (H.M. Dresen) **asking for an English language arrangement**.
Limited number of participants:
The number of participants for this course is limited, due to the character of the training in media-oriented writing. Students will be accepted in the order of their registration. Students of the Science Communication mastertrack have priority in placement, if they **register six weeks in advance of the start of this course**.

Objectives
- students will increase their abilities in media-oriented writing.

- students will increase their knowledge of strategical considerations and ethical codes involved in the process of transmitting information from the academic to the public arena.

- students will get acquainted with academic perspectives on (a) the current state of science reporting in the media, and (b) developments and trends in reporting about science and technology over the last few decades.

- students will get acquainted with different methodologies for (a) studying trends in science reporting and (b) studying public responses to media content.
- students will increase their abilities in research design.

Contents
The course consists of two interrelated parts:
1. A training in media-oriented writing (given in Dutch), which will address both the process of writing itself and the broader considerations involved (both strategical and ethical) in the process of transmitting information from the academic to the public arena.
2. An introduction to the study of Science-in-the-Media, as a subfield within the academic field of Science Studies. We will look at classic and new studies that investigate the state of science reporting in the media. While studying these examples, students will also get acquainted with different methodological alternatives for researching how media represent scientific expertise.

Literature
Handbook on media-oriented writing (in Dutch; can be bought, or library copies can be used at the FNWI library)
Additional reading material will be made available at the start of the course

Examination
Journalistic writing assignment & research design assignment

Extra information
Classes once a week, Thursday 13.30-15.30 from november 11 (2010) till january 27 (2011). (Schedule details may be subject to change; always check http://schedule.ru.nl/ for latest version of schedule)

Visible Scientists

Course ID: **FC0040C** *3 ec* fourth quarter dr. B. Smelik
S.A.J. Segers

Website
www.ru.nl/sciencecommunication/

Teaching methods
- 16 hrs lecture
- 1 hrs personal study counseling

Objectives
After the course the student will be able to
- substantiate the terms 'visible' and 'invisible' in the framework of this course
- identify important scientists and to identify 'visible' and 'invisible' scientists in his own field of study and to argue why they are (in)visible.
- understand the way visibility works
- have a basic knowledge of qualitative content analysis as method of research

- substantiate benefits and restraints of visibility in the academic world (f.e. by addressing the reliability and relevance of research) and gain insight in the problematic nature of societal interaction

- find primary and secondary sources on scientists.

Students will be required to read carefully, to formulate clearly and unambiguous, to present the material in a systematic manner and to unfold a good solid argumentation based on a correctly defined problem. These academic skills will be involved when reading, writing and presenting research results during the course.

Contents
A highly influential stereotypical view of scientists depicts them as invisible laboratory researchers, working silently and at a safe distance from their societal and cultural environment, communicating their findings to a small circle of fellow experts. Reality is often completely at odds with this stereotypical view. Quite often, prominent scientists are acutely aware of the importance of societal communication and interaction, and sometimes they are quite good at it and / or invest a substantial amount of time in this aspect of their work. They know how to involve broad audiences in this research, how to gain public attention, how to raise public support. On the other hand, visibility may backfire on the scientists or make their involvement in societal interaction less or even counter productive. Societal interaction may also greatly affect the course of their research activities and the development of their research agenda. We will take a more or less biographical approach, focusing on the research as well as the societal communication of particular scientists, and the benefits and restraints of using (in)visible scientists in science communication.

Literature
p.m.

Examination
Essay & presentation
This is an elective course within the Science Communication track, but can be chosen in any master as elective course.

Extra information
Foreign students should contact the teacher 6 weeks in advance.

Research project (Masterthesis) Mastertrack Science Communication

Course ID: **FC0006B** *30 ec* dr. J.G. van den Born

Website
http://www.ru.nl/sciencecommunication/curriculum/graduation_project_0/

Prerequisites
Students who want to start with their research project, must have finished four of the seven obligatory courses of the Science Communication mastertrack and their (beta) bachelor thesis.

Contents
For more information see:
http://www.ru.nl/sciencecommunication/curriculum/graduation_project_0/

Environmental & Ecological Modelling

Course ID: **MM002A** *3 ec* 25-10-2010 t/m 5-11-2010 prof. dr. ir. A.J. Hendriks
prof. dr. J.C.J.M. de Kroon
dr. A.M.J. Ragas

Teaching methods

- 52 hrs computer course
- 16 hrs lecture
- 16 hrs individual study period

Prerequisites

BSc Environmental Science(s), Biology, Chemistry, Moleculair Sciences or Natural Sciences. The course is part of the MSc Biology and MSc Environmental Sciences.

Objectives

After completing the course the student should be able to

- Indicate why and where models are needed in research and management on environmental, nature and water issues.
- Classify and evaluate environmental and ecological models (analytical, numerical, stochastic, deterministic etc.)
- Identify and follow the stages in model development in a structured approach (from derivation to validation)
- Understand and apply a few elementary models that are often used in ecological and environmental issues (e.g. exponential, logistic, hyperbolic equations)
- Build and apply simple models critically in the context of his/her own research or management activities in internships and jobs

Contents

If we prepare an outdoor trip, we check the weather forecast, as projected by meteorological models. Political parties submit their programs for calculation of the expected economic benefits. Mathematical models have become indispensible in various parts of society, including ecological and environmental issues. Conclusions by scientists, recommendations by consultants and decisions by managers are often based on models.

Models allows one to
· connect causes to effects in long term, large scale and inherently complex issues, such as climate change or population development
· understand related phenomena in different fields, e.g. Michaelis-Mention kinetics of enzymes and Holling type II responses of predators
· combine confusing, contradicting or incomplete information, as obtained in the lab and field.
· circumvent practical, financial, ethical restrictions imposed by experiments and surveys
· provide quantitative predictions, including uncertainties, in addition to qualitative descriptions and explanations

· allow extrapolation knowledge outside the domain
· select models based on theoretical concepts for empirical curve fitting
The course starts with an introduction in modelling, discussing objectives, types and stages of models. Next, you will be made familiar with a few equations often used in ecological and environmental issues, by lectures and exercise demonstrating their behaviour. Next you will be trained in developing your own models, going through different stages, such translation of systems to models, calibrating parameters and a sensitivity analysis. You will become acquainted with different models used in different setting (research, management, consultancy) and different disciplines (ecology, chemistry, hydrology). The course ends with an exam testing all knowledge and skills acquired.

Literature
Study material will be made available via Blackboard

Examination
Combination of written exam and project.

Risk Management of Chemicals

Course ID: **MM014** *3 ec*

dr. A. Hollander
dr. M.A.J. Huijbregts

Teaching methods

- 4 hrs computer course
- 4 hrs excursion
- 9 hrs lecture
- 109 hrs student project

Prerequisites

For all students, except the Faculty of Medicine, the Bachelor course Human and Ecological Risk Assessment is recommended for gaining basic theoretical understanding of the risk assessment process. In case of indistinctness, the course coordinator takes the final decision on entry allowance.

Objectives

The student is able to produce a risk assessment report on human and environmental risks of a specific chemical and to communicate the results and conclusion of the analysis to various stake holders in a realistic setting.

Contents

The MSc course on Risk Management of Chemicals follows a project-oriented setting by evaluating the human and environmental risk of a chemical in a real-case setting, involving the company that produces the chemical under evaluation and the consultancy Haskoning with expertise on the evaluation of chemicals in daily practice. The course also familiarizes students with the institutions, policy and regulation involved.
In the first part of the course, important European legislation of chemicals with an emphasis on the Registration and Evaluation of CHemicals (REACH) will be discussed, including an overview of tools, implementation projects and risk management measures to assess and reduce chemical exposure. The main part of the course is devoted to assess and communicate the human and evironmental risks of a specific chemical in a realistic project setting.

Literature

The following study material will be provided:

- a student manual with general course information (downloadable via Blackboard);
- a reader with (additional) theoretical background documents (downloadable via Blackboard);

Examination

Evaluation of written project results and communication to stakeholders

Extra information

The co-ordinator of the course is dr. A. Hollander (e-mail: a.hollander@science.ru.nl).

This course will not be lectured in 2010-2011.

Sustainable production and consumption

Course ID: **MM020** *3 ec* 8-11-2010 till 19-11-2010 dr. M.A.J. Huijbregts
ir. R. van Zelm

Teaching methods

- 20 hrs computer course
- 6 hrs lecture
- 6 hrs question session
- 24 hrs individual study period

Prerequisites

Learning objectives
The learning objectives represent the endpoints for the course and are formulated as main competences, sub-competences and essential notions:
Main competences
1. The student understands the concepts and methods that are used to assess the sustainability of production and consumption patterns in our society.
2. The student is able to select and interpret relevant data from scientific research and to use these data to quantify the environmental pressure of human activities.
Sub-competences
1. The student has insight in the structure of sustainable consumption and production methods
2. The student is able to interpret the results of life cycle impact methods
3. The student is able to apply and analyse models to perform an ecological footprint analysis
4. The student is able to apply and analyse models to calculate characterisation factors for human toxicity.
5. The student is able to apply and analyse models to calculate characterisation factors for acidification.
6. The student is able to identify, quantify, and analyse uncertainties in life cycle impact assessment models.
Essential notions
1. The student understands the scientific principles underlying life cycle concepts.
2. The student is able to identify strong and weak points of life cycle concepts.
3. The student has insight in the modelling of environmental dispersion of substances and their effects on humans and ecosystems.
4. The student has insight in the contributions of scientific research, methods and techniques to the establishment of sustainable production and consumption.
5. The student is aware of the uncertainties in current sustainable production and consumption methods

Contents

Sustainable production and consumption is the use of goods and services, while minimizing the use of natural resources, toxic materials and emissions of waste and pollutants over the life cycle. The challenge is to improve the overall environmental performance of products throughout their life-cycle, to boost the demand for better products and production

technologies and to help consumers in making informed choices. All products cause environmental degradation in some way, whether from their manufacturing, use or disposal.The life-cycle of a product covers all the areas from the extraction of natural resources, through their design, manufacture, assembly, marketing, distribution, sale and use to their eventual disposal as waste.
The environmental assessment of production and consumption of products and services can be done in various ways. This course will give an overview and quantitative insights in the concepts and methods that are used to assess the sustainability of production and consumption patterns in our society.

Subjects

Life cycle concepts to assess sustainable production and consumption
- Life cycle thinking, three pillars of sustainability, producer or consumer responsibility, input-output analysis, process-based LCA

Life cycle impact assessment
- Methods to address environmental impacts of products/technologies/etc., i.e. energy/exergy analysis, footprinting (ecological, carbon, water),
Ecological Footprint
- Concepts and application of ecological footprinting

Acidification and eutrophication
- State-of-the-art inclusion of acidification and eutrophication in LCIA, i.e. generic and site-specific methods, critical load approaches and endpoint assessments.

Human toxicity
- Overview of the methods to include toxic impacts on humans in life cycle impact assessment, i.e. linear and non-linear approaches and the underlying assumptions behind the models employed.
Uncertainty
- Framework to address uncertainty (parameter, model, and scenario) and variability in LCA. Monte Carlo analysis to quantify uncertainty for a simple LCA system.

Literature

Manual and Reader to be donwloaded from Blackboard

Examination

The course is concluded with a written exam, which will be graded with a mark. The exam is a so-called ‘open-book’ exam: during the examination it is allowed to consult all the learning materials. A calculator is required during the examination. All course components and learning materials are part of the examination material, thus including the student manual, reader, self-tuition assignments, working group assignments, (guest) lectures and tutorials. The exam focuses on insight obtained in the subject matter and appliance of knowledge and skills. It is tested whether the student achieved the learning objectives of the different course components. A mark of at least 5.5 is required to pass the written exam.

Occupational Toxicology

Course ID: **5T004** *6 ec* 04-10 t/m 29-10-2010 P Scheepers

Prerequisites
The course is obligatory for students of the MSc Environmental Sciences which follow the research track Human and Environmental Risk Assessment (HERA).

Objectives
- In a series of self study assignments the following subjects will be covered: risk assessment, ambient exposure assessment, biological monitoring, polymorphisms in biotransformation, material safety data sheets, occupational disease, personal protective equipment, occupational exposure limits and skin absorption.

- Students will learn how to use knowledge of the chemical structure to predict toxicity characteristics also using Structure Activity Relationships laid down in rule-based decision support systems.

- Students will work in groups to derive an occupational exposure limit for a toxic substance human and experimental animal data.

- Students will learn to work with a computer system (PIMEX) that combines continuous exposure data with a video image. This application can be used to analyze exposure determinants and explore possibilities for interventions to reduce exposure.

- During a computer training students will obtain skills in modeling of skin absorption of chemicals (SkinperX) and a decision support system will be used to increase understanding of determinants of exposure and to model interventions to reduce exposure (EASE).

Contents
Workers in direct contact with industrial chemicals may suffer health consequences. These may be acute effects of an exposure to concentration peaks or health implications of low exposure levels that appear only after a very long exposure period such as cancer. In this course students will acquire research skills to identify possible occupational hazards, based on available material safety data sheets. The information of industrial products will be analyzed using toxicological databases on the Internet. As part of a risk assessment the students will learn how to obtain quantitative data on external and internal exposure during a survey in an industrial setting. Some toxic substances will be measured in air and (if possible) in biological samples. Exposure will also be modelled using computer applications. Attention will be given to strategies to reduce exposure to industrial chemicals such as substitution of chemical products, changes of process conditions, local exhaust ventilation and use of personal protective equipment.

Subjects

biological monitoring, exposure assessment, material safety data sheets, and occupational diseases, risk assessment.

Literature

C.D. Klaassen and J.B. Watkins, eds. (2003) Casarett & Doull's Essentials of Toxicology. McGraw-Hill, New York.

Gardiner K and Harrington JM (2005) Occupational Hygiene. Third Edition, Blackwell Publishing, Oxford, UK, 510 pp.

Extra information

This course is obligatory for students of the differentiation Human and Environmental Risk Assessment (HERA)
If possible and excursion will be organized to an industry to discuss their views on risk assessment of toxic substances used and show some of the working conditions related to handling of industrial chemicals.

Chemical mutagenesis and carcinogenesis

Course ID: **5T003** *5.5 ec* dr. R.P. Bos

Teaching methods

The role of the epidemiology and of animal experiments in the research of carcinogenic properties of chemicals will be compared. The student will study the several aspects of the working mechanism of chemical carcinogens. The student will develop a research protocol on basis of a scientific question and perform this study during practical work. The student can mention and describe some methods in use for the detection of mutagenic and possible carcinogenic properties of chemicals and can explain the usefulness of these methods. The student can mention methods in use for the measurement of exposure to possible carcinogenic agents. In a lecture the way mutagenic and carcinogenic risks can be estimated (qualitatively) will be explained. In addition, short term assays that are prescribed in the prescreening of chemicals with respect to mutagenic and carcinogenic properties will be elucidated.

Objectives

1. The student is able to explain the role of certain groups of chemicals in the induction of cancer. He/she is also able to explain the role of the organism in this process.
2. The student can describe the advantages and disadvantages of the several methods in use for the detection of mutagenic and carcinogenic properties.
3. The student can connect the policy in regard to handling carcinogenic compounds with the working mechanism of these compounds.
4. The students can describe several approaches in the determination of exposure to carcinogens or assessment of carcinogenic risks.

Contents

For the prevention of cancer it is important to have insight in the mechanism of chemical carcinogenesis. In this course the student will meet the several roles that xenobiotic chemicals may play in the occurrence of cancer. A number of aspects will be discussed in the form of self studies, group assignments and practical exercises. The different aspects of the course are following the leading thread in chemical carcinogenesis: the role that chemical compounds play in the induction of cancer, the methods that are used to detect cancer causing properties of chemicals, the role of animal experiments, the working mechanism especially biotransformation, the development of a mutation into a tumor, screening of carcinogens, the measurement of exposure to cancer causing chemicals and policy.
Next, there is enough evidence to suppose that exposure to certain chemicals may lead to the occurrence of hereditary malformations in the progeny. The origin of cancer and that of hereditary malformations due to exposure to chemical compounds is at least in part based on the same working mechanism. Changes in DNA play a crucial role in this. In the practical part of the course the mutagenicity of an industrial sample will be investigated. In addition attention will be paid to the relationship between research and legislation with respect to carcinogenic chemicals in the Netherlands.

key words

Carcinogenesis, mutagenesis, mitogenesis, genotoxicity, short term assays, animal studies,

toxification, detoxification, risk assessment, policy on cancer causing chemicals.

Literature
Cassarret & Doull's Toxicology; the Basic Science of Poisons (7e ed. 2008) and several scientific papers.

Ecological and environmental concepts

Course ID: **BM038A** *3 ec* September 13 - 24, 2010 dr. H.J.R. Lenders
prof. dr. ir. A.J. Hendriks
dr. R.S.E.W. Leuven

Teaching methods
Lectures, self study and discussion sessions

Objectives
The student is acquinted with the concept of sustainable development and can handle derived concepts and methods for environmental and ecological research and management.

Contents
In this 3EC course ecological and environmental concepts will be presented and discussed. Starting point will be the concept of Sustainable Development in its broadest sense (ecology/environment, economy and social aspects, otherwise known as the triple P concept: People, Planet and Profit). Emphasis will be on the historical context and on (handling) the unknown future of sustainable development. Subjects that will be passed in review are: Reference and Target Images, Ecology & Economy, Ecosystem Health, Novel Ecosystems, Cradle to Cradle, Scenario Analysis, and Multiple Criteria Analysis.
Presently, further details cannot be given since the course is still under construction yet.

Subjects
See course description. Details will be announced later.

Literature
To be announced later

Examination
Written examination

Extra information
The course is still under construction

Accidents and disasters involving hazardous substances

Course ID: **5MG02** *6 ec* P Scheepers

Objectives

The student will obtain skills to intervene in incidents and disasters with respect to mitigation of health risk of exogenous factors and conduct a study to evaluate the health effects in populations of victims and first aid personnel after an accident or disaster.

Contents

An incident or disaster is a major challenge for an expert in health sciences. In this course specific skills for dealing with the health consequences of both small incidents and large-scale incidents (disasters) will be taught. The focus will be on incidents with hazardous chemicals, but some attention is also paid to exposure to radiation and to biological agents. Public Health Advisors Hazardous Materials (GAGS) have an important role to support health authorities during and after a chemical incident. Important contributions are initial appraisal of health consequences, defining effective interventions on the location of the incident such as offering shelter or evacuation of the public at risk in the 'hot zone', and communication to the lay public about possible health effects following exposure on the short and on the long run.
After an incident, Public Health Advisors Hazardous Materials are involved in planning and conducting a health surveillance study among victims and other potentially exposed subjects such as by-standers and first aid personnel.

Subjects

- Some classical disasters such as the methylisocyanide-disaster in Bhopal (1984) and the nuclear disaster in Chernobyl (1986) will be analyzed using scientific publications.
- The participants will be trained to perform an initial appraisal of health risks using an internet portal with toxicity data (PATCHWORK) and computer programme to model dispersion of a toxic cloud (ALOHA).
- The participants will be trained how to make important decisions based on a limited set of information and under time pressure such as the decision to provide shelter or evacuate the population at risk.
- Predicaments of a health surveillance study will be discussed. What are possible goals and scientific hypotheses that can be studied and to what end? What are the consequences of such studies for the victims, health authorities and policymakers?
- The participants will receive a basic training how to deal with the victim(s) of a small-scale laboratory-based chemical incident.
- The most important skills in health risk communication will be addressed in a video training.
- The participants will have the opportunity to prepare a scenario, intervention and communication plan for a realistic large-scale disaster in the city or region of Nijmegen.

Literature

to be published

Extra information

Of the 20 days of the module 6 will be combined with the post-graduate course PIGOR for physicians and health experts in the field of GHOR (geneeskundige hulpverlening bij ongevallen en rampen). In this part of the module leading experts from different parts of The Netherlands will discuss their thoughts and experiences with the participants. This part also involves a one day field trip to the National Institute of Public Health and the Environment (RIVM) and three real-time training sessions on shelter and evacuation, decontamination of victims and on communication during a chemical incident.

Beroepsorientatie (in Dutch)

Course ID: **BM026B** *3 ec* 2x per jaar. In het najaar op dinsdagmiddag en in het voorjaar op vrijdagmiddag drs. J.G.J. van den Broek

Teaching methods
- 26 hrs lecture
- 54 hrs student project

Prerequisites
Studenten van de Faculteit NWI in de laatste fase (vijfde studiejaar) van hun studie

Objectives
Studenten
- krijgen meer inzicht in hun eigen competenties en ambities
- kunnen hun competenties en ambities relateren aan de eisen van het werkveld
- verzamelen op een interactieve manier informatie over relevante ontwikkelingen binnen hun zoekrichting
- verkennen de mogelijkheden om een passende baan te verwerven
- leren om zich in woord en geschrift te presenteren als "academisch professional"

Contents
Course in Dutch language
In this "training" we aim on the Dutch job market for (medical) biologists. For the sake of profundity and minor differences in personal reflections, analyses and feedback this training requires the use of language on the level of "native speakers". That's why this training will be given in Dutch.

Subjects
De cursus bestaat uit de volgende onderdelen:
1. Zelfverkenning en zelfanalyse
2. Arbeidsmarktoriëntatie en actieve verkenning van de zoekrichting
3. Vaardigheidstrainingen (met o.a. afstudeerplan) en sollicitatietrainingen (brief, cv en sollicitatiegesprek)

Examination
Schriftelijke opdrachten en mondelinge presentaties
Participatie
Eindpresentatie
Eindopdracht (schriftelijk verslag)
Geen tentamen

Extra information

Contact: drs. J. van den Broek, 53346, via n.poelen@science.ru.nl
In verband met de vaardigheidstrainingen is aanwezigheid verplicht!
Er is plaats voor 16 deelnemers per cursus.

4 Majors and minors in chemistry

4.1 Research in chemistry

Research in chemistry is mainly organized in the Research Institute for Molecules and Materials; research in chemistry is also found in the Centre for Molecular Life Science (NCMLS) and in the Institute for Water and Wetland Research (IWWR).

Majors in chemistry
A short description of majors in chemistry is given below. For more information: visit the website of the department or ask one of the staff-members of the department

4.2 Analytical Chemistry (IMM)

Head:	Prof.dr. L.M.C. Buydens
Scientific staff:	Dr. G. Postma, Dr. W. Melssen
Secretariat:	Ms. B. Loozen, room HG02.722, tel. 3653180, e-mail: b.loozen@science.ru.nl
website:	http://www.ru.nl/science/analyticalchemistry

Research:
Examples of current projects at the department:

- Developing methods to extract chemical and diagnostic information from Magnetic resonance spectroscopic (MRS) images to diagnose brain tumours (European Community project also in collaboration with UMC, department of radiology).
- Applying chemometrical techniques to the analysis and interpretation of Molecular profiling data (genomics, proteomics & metabolomics)
- Investigation of relations between molecular structure and biological or physical properties.
- Development and further optimisation of novel statistical modelling techniques.

The updated list of projects can be found on:
www.ru.nl/science/analyticalchemistry/education/master_courses

Description of research:
The research in the department of analytical chemistry focuses on chemometrics. Chemometrics is the discipline within Chemistry that develops methods to obtain relevant information from chemical data, by applying techniques such as multivariate statistics, neural networks and genetic algorithms. Increasingly, chemometrical methodologies and techniques are also applied in the optimization of molecular structures with respect to their properties and (bio)chemical activity and in the processing and interpretation of (medical) multivariate images. The research in this department is centred around three main research lines:
- Methodological chemometrics: methodological research on chemometrical techniques like global optimisation methods, neural networks and multivariate statistics.

- Spectroscopic image analysis: linking pixel-based quantification or classification techniques to image processing techniques.
- Molecular chemometrics: applying chemometrics to the analysis, optimisation and determination of molecular structure.

Opportunities for students:
Students are assigned to individual projects and work on their project under the guidance of a direct supervisor, typically a PhD student. On a regular basis, progress of the research is reported orally to the staff and other students. All students are encouraged to participate in an active way to these presentations and discussions. Depending on the specific apprenticeship of a student, specific courses (like 'Chemometrics II' and 'Capita Selecta') are included in the practical training. Finally, a comprehensive report must be written and an oral presentation (colloquium) should be given.
Suitable profile: Chemistry, Physical-Chemistry and Chemistry-Biology.

Mandatory course: Chemometrics I

4.3 Applied Materials Science (IMM)

Head:	Prof. Dr E. Vlieg
Scientific staff:	Dr P.R. Hageman, Dr Ir J.J. Schermer
Secretariat:	Ms A.L.A.M. Hendriks (ams-secr@science.ru.nl) room: HG 03.527; tel. (36)53353
Website:	www.ru.nl/ams
Research:	

- Solar cells
- Wide bandgap semiconductors

Research is aimed at the formation (growth and processing) and the study of thin-film materials and devices. For this purpose the AMS department has a state of the art clean room facility with all the required equipment for the deposition, processing and analyses of the thin-films. Of particular interest are the so-called III-V and III-nitride semiconductors. These are compound materials based on elements from the third (Al, Ga, In) and fifth (N, P, As) group of the periodic table. The physical and chemical properties of these materials can be tuned at will by variation of the element composition. Therefore, these materials are used to produce opto-electronic components of extremely high quality. Related to this, the research is generally conducted in close cooperation with companies, large institutes and other universities such as Philips, NXP, ESA, Dutch Space, ECN and the Technical University Eindhoven.

Description of research:

Solar cells
The III-V materials GaAs and InGaP are applied for the production of high efficiency solar

cells. These cells are produced at crystal wafers. Due to the high cost of these wafers, the III-V solar cells are presently only utilised for spacecraft. At the AMS department an Epitaxial Lift-Off (ELO) technique is being developed by which the solar cell layer with a thickness of about 2 μm can be released from the wafer on which it was formed. In this way the wafer can be reused, resulting in a large reduction of costs so that the cells can also be utilised for the generation of electric energy on Earth. Single junction solar cells produced with the ELO technique have already reached a world record efficiency of 24.5% and approach their theoretical maximum. Further developments aim for multi-junction solar cells and the use of lenses and mirrors to concentrate the light before it is converted into electricity. In this way theoretically efficiencies above 50% can be achieved.

Wide bandgap semiconductors
The recently developed group III-nitride materials (AlN, GaN and InN) have ideal properties (wide bandgap, high break-down voltage and electron mobility, etc.) to be used in high power opto-electronic components. As a result the application of these materials in e.g. LED-lamps and multi-media lasers increases rapidly. Because presently there are no wafers with a 'matching' crystal structure, the nitrides are produced on 'non-matching' wafers of sapphire. As a result of this, the nitride layers contain many defects which have a large influence on the performance of the electronic components made from these materials. At the department the formation and behaviour of these defects are studied with the aim to minimise their concentration. This has resulted in the realisation of High Electron Mobility Transistors with a European record power density. On the other hand the possibility to develop matching wafers is being investigated. Application of such wafers would reduce the defect density of the nitride layers with several orders of magnitude and further boost up the efficiency of the components produced from these materials.

Opportunities for students:
The department offers many possibilities for students to conduct scientific research. Together with a supervisor the student defines a project assignment that he/she can conduct independently after a short introduction period. The research is completed with a colloquium at the department and a final report (master thesis). Dependent on the result the project can lead to a publication in a scientific journal.

4.4 Biochemistry (NCMLS, UMC St. Radboud)

Head:	Prof.dr. R. Brock
Scientific Staff:	Dr. G.J.C.G.M. Bosman, Dr. W.F. Daamen, Prof. dr. W.J. de Grip, Dr. W.J.H. Koopman, Dr. T.H. van Kuppevelt, Dr. P.H.G.M. Willems
Secretariat:	Ms L. Brocatus, tel. 3614259, e-mail: l.brocatus@ncmls.ru.nl
website:	http://www.ncmls.nl/biochemistry/integrated/index.html; www.ncmls.eu/biochemistry/matrix/frames_1.html;

www.ncml/biochemistry/membrane/index.html

Research:

- signal transduction in T lymphocytes
- molecular aging in erythocytes
- cellular molecule import
- signal transduction and ion transport
- molecules of the extracellular matrix
- tissue engineering
- G protein-coupled receptors

Description of research:

Biochemistry of Integrated Systems (Bosman, Brock, tel. 3615390 resp. 3666213; www.ncmls.nl/biochemistry/Integrated/index.html)
This group joins two lines of research: (i) The molecular analysis of cellular signaling and (ii) the cellular import of molecules to specifically inhibit molecular interactions inside cells. In signaling, we address molecular signaling networks in T-lymphocytes as well as plasma membrane-located signaling mechanisms that regulate and mediate aging of the human erythrocyte. These activities relate to the development of new therapeutic approaches for autoimmunity and cancer, erythrocyte-related pathologies and the relationship of these processes with molecular and cellular aging and cancer. The activities are tightly connected to the other lines of research in the department: In the analysis of T-cell activity, there is increasing awareness of the role of energy metabolism. The interaction of drug molecules with glycoproteins and the extracellular matrix is a critical step controling their cellular uptake and bioactivity.

Matrix Biochemistry (Daamen, Kuppevelt, tel. 3614303 resp. 3616759; www.ncmls.eu/biochemistry/matrix/frames_1.html)
This group focuses on two lines of research (i) The biochemical analysis of extracellular matrix molecules and their role in pathological cascades, and (ii) the construction of biomatrices to induce tissue formation (tissue engineering). With respect to the biochemistry of the extracellular matrix, focus is on the sequence and function of glycosaminoglycan domains and their involvement in pathologies such as cancer and nephropathies. With respect to tissue engineering, focus is on the construction of "smart" scaffolds, which induce tissue/organ formation *in vivo* (skin, urogenital tissue, blood vessels).

Membrane Biochemistry (Koopman, Willems, tel. 3614589; http://www.ncmls.nl/biochemistry/membrane/index.html
lassically, mitochondria are famous for their role as powerhouses of the cell. What may be less known is, that mitochondria are also crucially involved in the cell's ability to cope with a variety of stress situations. This group uses a combination of biochemistry, molecular biology and high-content live cell imaging to get mechanistic insight into the relationship between mitochondrial structure, localization and function. Emphasis lies on the coupling between cellular calcium homeostasis and mitochondrial energy production. As a second line of

research, we study the cell biological consequences of life-threatening mutations in the oxidative phosphorylation system with the final aim to uncover targets for therapeutics that can improve the clinical condition.

Visual mechanisms (De Grip, tel. 3614263)
This research group addresses molecular mechanisms of selected G protein-coupled receptors, in particular photoreceptor proteins from the retina. For this purpose biotechnological production methodology, i.e. large-scale expression using recombinant baculovirus and his-tag based purification are employed.

Opportunities for students:
suitable for students with Biology, BMW, MLW and Chemistry background

4.5 Bioinformatics (NCMLS)

Head:	Prof.dr. G. Vriend
Scientific staff:	Dr. C. van Gelder, Prof.dr. M. Huijnen, Dr. G. Schaftenaar, Prof.dr. R. Siezen, Prof.dr. J. de Vlieg
Contact for education:	Dr. C. van Gelder, e-mail: c.vangelder@cmbi.ru.nl
Secretariat:	Ms B. van Kampen, CMBI 260 Room 0.02 (NCMLS building), tel. 3619390, e-mail: b.vankampen@cmbi.ru.nl
website:	http://www.cmbi.ru.nl/

Research:

- Bioinformatics of protein structures
- Bacterial Genomics
- Comparative Genomics
- Computational Drug Discovery

Description of research:

Bioinformatics of protein structures (Prof. dr. G. Vriend, e-mail: G.Vriend@cmbi.ru.nl)
Proteins are very complex molecules. Despite many years of research every day something new is discovered about their structure or function. We work on sequence - structure - function relation analyses of proteins, and on methods for gathering, disseminating, validating and mining data related to proteins (structures, sequences, mutations, ligand binding, expression profiles, etc). The prediction of protein structures and the effects of mutations as well as molecular visualisation are important aspects of our work. We often collaborate with biologists and medics to solve real problems with a real biomolecular origin, like a disease.

Bacterial Genomics (Prof.dr. R.J. Siezen, e-mail: R.Siezen@cmbi.ru.nl)
Gram-positive bacteria play an important role in different aspects of food fermentation, ingredient production, food safety and health. In collaboration with NIZO food research (Ede) and the Top Institute Food and Nutrition (Wageningen), bioinformatics tools are being used

to analyse and compare complete genomes of food-relevant gram-positive bacteria. Emphasis is put on the positive attributes of lactic acid bacteria (Lactococcus, Lactobacillus, Streptococcus) and the negative attributes of pathogenic and spoilage bacteria (Listeria, Bacillus cereus, Clostridium).

Comparative Genomics (Prof.dr. M. Huynen, e-mail: M.Huynen@cmbi.ru.nl)
The -omics era is characterized by tremendous amounts of data (genome sequences, single nucleotide polymorphisms, gene expression data, proteomics data, metabolite concentrations data), and by (relatively) little understanding of these data or of their value for biology. Within the computational genomics group we try to bridge the gap between experimental data and biological knowledge. We focus specifically on prediction of protein function, and protein-protein interactions such as observed in protein complexes or biochemical pathways. In doing that we are not only interested in the functions of the proteins and their interactions in man, but also how these interactions have evolved.

Computational Drug Discovery (Prof.dr. J. de Vlieg, e-mail:jacob.devlieg@merck.com and Dr. S.B. Nabuurs, e-mail: S.Nabuurs@cmbi.ru.nl)
Key goal of the Computational Drug Discovery (CDD) group is to develop computer-based techniques for structure-based drug design and translational sciences. The CDD group is working closely together with the Department of Molecular Design & Informatics (MDI) of MSD, resulting in a unique collaboration between academic research and industry. Computational techniques have created many opportunities to accelerate and rationalize the multidisciplinary drug discovery process, and provide novel approaches to the design of drugs. In silico technologies play a critical role in catalyzing the intensive "wet-dry" cycle and linking the chemistry and biology that characterizes modern drug design. In the CDD group a variety of scientific methods are developed and applied including molecular profiling analysis, text mining, computer-based simulation methodologies and integrative chem-bioinformatics techniques..

Opportunities for students:

- Suitable for Molecular Life Sciences, Chemistry and Natural Sciences students.
- For internships in the groups of Prof. Siezen or Prof. Huynen the course Vergelijkende Genoomanalyse (SB116B) is mandatory.
- For internships in the group of prof. Vriend the course Structuur, functie en bioinformatica (SB113B) is recommended.
- For internships in the group of prof. de Vlieg the courses Structuur, functie en bioinformatica (SB113B) and Computational Drug Discovery (CMBI101) are recommended.

Master track bioinformatics

Students who are interested in bioinformatics can follow the bioinformatics track (B-track) in the MSc programme of Molecular Life Sciences. They will receive a Masters degree in Molecular Life Sciences with specialisation Bioinformatics.
Within the B-track both research projects (stages) have to have a bioinformatics research topic. One of the stages has to be followed at the CMBI, the other can be followed at other departments of FNWI and UMC. B-track students have to follow in total (BSc and MSc

phase) 25 EC of bioinformatics classes. At least 16 EC of these courses needs to be at MSc level. There is a list of courses available which contains bioinformatics and bioinformatics-related (mainly statistics, data management and informatics) courses, both from the RU as well as from other universities. The student can also suggest courses for the B-track.
More information about the B-track can be found at www.cmbi.ru.nl/btrack or contact dr. C. van Gelder (C.vanGelder@cmbi.ru.nl).

4.6 Biomolecular Chemistry (IMM - NCMLS)

Head: Prof.dr. G.J.M. Pruijn
Scientific staff: Dr. W.C. Boelens, Prof.dr. N.H. Lubsen
Secretariat: Ms E. van Genne, room NCMLS 2.95, tel. 3614254,
e-mail: e.vangenne@ncmls.ru.nl
website: http://www.biomolecularchemistry.nl
The Department of Biomolecular Chemistry (Radboud University, Faculty of Science, IMM) is located at the Nijmegen Center for Molecular Life Sciences (NCMLS - 'Research Tower', floor 2), Geert Grooteplein 26-28 (route 271).

Research:

- Molecular aspects of autoimmunity: autoantigens and autoantibodies
- Cellular stress response: small stress proteins

Description of research:
Characterisation and function of autoantigens (Pruijn)
Patients who suffer from a connective tissue disease, such as rheumatoid arthritis, often show the phenomenon of autoimmunity. These patients produce antibodies to self-proteins, which are referred to as autoantigens. In general, such autoantigens are macromolecules which have important cellular functions. We primarily study the structure and function of autoantigens involved in the synthesis and degradation of RNA and proteins. Next to that we are interested in posttranslational modifications of proteins (phosphorylation, citrullination), because we believe that these play an important role in the initiation of autoimmunity. In this respect, we are also studying the mechanisms that lead to the breaking of immunological tolerance to self-proteins in autoimmune patients. Finally, we apply the knowledge obtained on the structure of autoantigenic molecules for the development of autoimmune diagnostics.

Small stress proteins: structure, function and pathology (Boelens/Lubsen)
The cell protects itself against stress, like heat, radicals or radiation, by synthesizing a set of special proteins, amongst which the 'small heat-shock proteins' (sHsps). The sHsps have *in vitro* chaperone activity: i.e., they prevent the aggregation of other proteins. *In vivo,* they enhance the stress-tolerance of cells. Man has ten different sHsps, which are most abundant in the eye lens, in heart and muscles. In the brain they become induced in Alzheimer's disease and multiple sclerosis. The three-dimensional structures and working mechanisms of the various sHsps are poorly understood. Our group explores by means of mutagenesis, protein-

interaction studies, and cell biological approaches the structure, chaperoning mechanism en cytoprotection of the sHsps, and their roles in diseases, ageing and apoptosis.

Opportunities for students:
In the aforementioned research topics several projects are available for (Medical) Biology, Chemistry, Molecular Life Science and Natural Science students. As a result of the ongoing research projects are constantly reformulated. We assign an experienced supervisor (PhD student; post-doc) to each individual student.
In our work we use modern (biochemical, molecular and cell biological) techniques such as recombinant DNA, selection of recombinant (human) antibodies by phage display, various proteomics techniques, DNA and protein microarrys, cell culture, RNA interference, the mammalian two-hybrid system, RNA-protein interactions, confocal microscopy etc.

Compulsory courses for major (if applicable), choose from the following:

- Apoptosis
- Chemical Biology
- Molecular aspects of host defense, tissue destruction and repair
- Signal transduction and transport

Mandatory course: Biochemie-Moleculaire Biologie II (BB017C)
Recommended courses: celbiologie van dieren (BB023B), structuur biomoleculen (SB101B) and immunologie (BB019B).

4.7 Bio Organic Chemistry (IMM)

Head:	Prof.dr.ir. J.C.M. van Hest
Scientific Staff:	Dr. D.W.P.M. Löwik, Prof.dr. E.W. Meijer
Secretariat:	Ms J. Versteeg, room HG03.028, tel. 3653389, e-mail: j.versteeg@science.ru.nl
website:	http://www.molchem.science.ru.nl/

Research:
Within the bio-organic chemistry group four lines of research are carried out: hybrid polymers and polymersomes, micro-reactors, peptides and amphiphiles, and protein-based materials.

Description of research:
Research within the bio-organic chemistry group is positioned at the interface of three disciplines: organic chemistry, polymer chemistry and molecular biology. Inspired by concepts found in Nature, we develop biomimetic materials and processes by application of advanced synthetic techniques.
Within our group we use different methods to prepare smart polymers. We combine polymer chemistry with organic and peptide chemistry to connect biomolecules to synthetic polymers. These hybrid polymers are applied as antimicrobial coatings and are assembled into capsules, which find their application in the biomedical field.
Micro-reactors are synthetic devices which are much smaller than regular reaction vessels, such as round bottom flasks. The big advantages of micro-reactors are that reactions are much

better controlled in a miniaturized environment, due to improved heat and mass transfer. Furthermore, only small amounts of reagents and catalysts are needed if you want to screen reaction conditions. Micro-reactors are becoming more and more important in the chemistry labs and therefore it is very interesting to get acquainted with this new type of technology.
Another area of research is peptide amphiphiles. By changing the hydrophobic-hydrophilic balance of a peptide its ability to fold and assemble will change drastically. This is then used to control both its functionality and/or structure. Via this approach we can make peptide fibres that can be perfectly aligned in magnetic fields. Switchable peptides can be used for targeted drug delivery. Also peptides are combined with polymers which provide us with new designer materials with adjustable properties.
Proteins are functional biomolecules which are designed by nature to perform specifically dedicated tasks. Within our group we want to extend the natural function of proteins by introducing additional functionality. By combining molecular biology (protein engineering) tools with organic chemistry methods, we develop smart self assembling enzymes and virus capsids as novel nano-containers.
You can find more information on: http://www.ru.nl/bio-orgchem.

Opportunities for students:
The student projects are interesting for every student who wants to be active at the interface of chemistry and biology. The work varies from synthesizing compounds, (physical) characterization studies, to both molecular and chemical biology type of experiments. Hence the research is suitable for Chemistry, Molecular Life Science and Natural Science students. Find more information on: http://www.ru.nl/bio-orgchem/education/student_projects.

Mandatory course: Organische chemie
Recommended course: Synthetic practical courses, Organische chemie in perspectief and Coördinatiechemie

4.8 Biophysical Chemistry (IMM)

Head: Prof.dr. S.S. Wijmenga
Scientific staff: Dr. H.A. Heus, Dr. M. Tessari
Secretariat: Ms M. de With, room HG03.344, tel. 3652678, e-mail: m.dewith@science.ru.nl
website: http://www.ru.nl/physchem.
Description of research:

- Structural and functional biology of regulatory RNA (e.g. riboswitches, HIV, HIV, poliovirus) by NMR, AFM and other biophysical methods
- Structural and functional biology by NMR of lipid-binding proteins (e.g. ApoA, C,E) and mis-folding proteins like Alzheimer peptide
- Metabolite and protein screening of body fluids and identification of liver metabolized medicines
- Developing of methods for improved structure determination of nucleic acids, proteins and metabolites

At the laboratory of biophysical chemistry NMR and other biophysical techniques are employed to study the structure and function of biomolecules, in particular RNA and proteins. In addition, the NMR methodology is further developed. NMR is ideally suited for functional studies, because it is the only method that can provide information at atomic detail on the three-dimensional structure, dynamics, and the interaction of biomolecules in solution under physiological conditions. It can also be used to identify and characterize small biomolecules in complex mixtures.

The main objective is to learn about biomolecular research, what it is and how it is done and at the same time learn the methods and techniques used in the field of Biophysical Chemistry. This is achieved by actively participating in one of the research projects at the department. Depending on your interest your own project can be more biologically oriented (e.g. expression and characterization of proteins or RNAs) or biophysically oriented (e.g. structural NMR) or even focused on methodology development (e.g. NMR methodology or developing computational methods for faster structure determination etc). Your research is usually under direct supervision of one of the PhD students or post-docs with regular discussion of progress to one of the principal investigators, who is ultimately responsible for the project. As a member of the department you are expected to participate in all its activities, which includes drinking coffee or 'tea' and joining work meetings. There is an open collaborative atmosphere in the group so that anyone can be approached for help and there are technicians who can help with lab work or with the NMR.

More information can be found at our website: www.ru.nl/physchem

Opportunities for students: It is our objective that students with a Chemical or Physics background as well as students with a Molecular Life Science background can successfully complete an internship at the laboratory of Biophysical Chemistry. A separate defined Molecular Life Science track has therefore been set up. Also students with a Biology background are welcome, but may require some extra training in chemical and physical subjects.

mandatory course*:* magnetic resonance I *or* structure biomolecules and single molecules studies
recommended courses*:* structure biomolecules and single molecules studies *and/or* magnetic resonance I, *and/or* structure, function and biomolecules

4.9 Green Chemistry (IWWR)

Head:	Prof.dr.ir. A.J. Hendriks
Scientific staff:	Dr. M.A.J. Huijbregts, Dr. A.M.J. Ragas
Contact:	Dr. M.A.J. Huijbregts, tel. 3652835
Secretariat:	Ms. G. Delmee, room HG02.711, tel. 3653281, e-mail: secres@science.ru.nl

website: www.ru.nl/hera

Research
Risk Assessment evaluates the risk of chemicals to human health and the environment. For 99% of the chemicals there is insufficient information about the effects on health and the environment, and how these chemicals need to be handled to be safe. The Department of Environmental Science offers, in collaboration with Biomedical Sciences, the possibility to gain expertise in the field of Risk Assessment, involving a variety of disciplines including green chemistry and (eco)toxicology. There is a great need for qualified personnel that can analyze human and environmental risks. We develop and apply models that allow for mechanistic understanding of fate, exposure and effects of stressors in the environment, with an emphasis on chemicals. Our research includes fate and exposure modelling of new chemicals, exposure and effect assessment of complex mixtures, the analysis of uncertainty in model predictions, and life cycle impact assessment. We participate in a number of national and international research projects that collaborate on these topics.

Description of research
The research focuses on three main topics.

Mechanisms of fate and exposure
Until recently, models that describe the exchange of substances between water, air, solids and biota have largely been tuned on substances of a neutral, stable, and hydrophobic nature. These models are not applicable to more complicated chemicals, such as perfluorinated compounds, metals, and nanomaterials. Enlargement of the model domain requires incorporation of new mechanistic knowledge concerning the properties of these chemicals. For this purpose, we develop and implement novel estimation routines for various chemical properties, including partitioning and degradation. We validate our work by comparing the model estimates with measurements and by assessing uncertainty and variability in the model calculations. For instance, we successfully related metal absorption rate constants to a metal specific property, the covalent index, and a species characteristic, the ventilation rate. This quantitative relationship holds for a wide range of organisms and metals, suggesting that a generic modeling approach of metal uptake kinetics is feasible for aquatic organisms. Another example is our attempt to predict the accumulation of the environmentally persistent perfluorooctane sulfonate (PFOS) in food webs. We showed that uptake of PFOS is comparable to moderately hydrophobic compounds and elimination is best described by elimination kinetics of metals. These observations indicate that the accumulation behavior of PFOS is comparable to that of short and medium chained fatty acids.

Cumulative chemical risk
Although many chemicals are in use, the environmental impacts have been assessed for only a few, usually on chemical-per-chemical basis. Uncertainty remains about the overall impact of multiple? chemicals. We investigate for both ecosystems and humans the cumulative impact of combined exposure to complex mixtures of chemicals. Our work includes the development of individual-based models to assess the cumulative exposure and risk for humans and ecosystems. This helps us to identify (cumulative) exposure patterns that cause high risks. We also derive novel calculation rules and indicators to estimate the combined effects of chemical exposure, depending on the mechanisms or modes of action of the

chemicals of concern. For instance, we quantified the cumulative risks from the use of pesticides and high production volume chemicals within the catchment of the rivers Rhine, Meuse, and Scheldt according to their potential toxic impact on the North Sea coastal ecosystem. Calculations were performed probabilistically to deal with parameter uncertainties. We found that only a few pesticides and high production volume chemicals dominate overall toxic pressure and the uncertainty appears to be caused largely by uncertainties in aquatic toxicities.

Sustainable production and consumption
Product-oriented policy (e.g. eco-labeling and eco-taxes) and technology optimisation by industries (e.g. eco-design) require methods to quantify the environmental impacts of the production and consumption of products and services. Although many environmental indicators exist, a common understanding of how to quantify the impact of various stressors on humans and the environment in a consistent way is grossly lacking. To decrease this gap of knowledge, new assessment models are developed for impact categories that are not (commonly) included in quantifying sustainable production and consumption patterns. Here, one of the scientific challenges is to derive consistent, mechanistic stressor-response functions for various impact categories, including toxicity. For instance, current practice in chemical hazard ranking is to focus only on the fate and effects of the parent compound, neglecting the potential impact of transformation products. We assessed the importance of including the potential impact of transformation products in the hazard ranking of chemicals. The inclusion of transformation products resulted in
a median increase in the impact of the chemicals included that varied from negligible to more than 5 orders of magnitude. This increase, however, can be highly uncertain, particularly due to a lack of toxicity data for transformation products and a lack of mode of action-specific data. Another example of our research in the context of 'Sustainable production and consumption' is a comparison of the cumulative energy demand of 498 commodities with the results of six frequently applied environmental life cycle impact assessment methodologies. Cumulative energy demand has been used as a methodology to assess life cycle environmental impacts of commodity production since the early seventies, but has also been criticized because it focuses on energy only. We showed that all impact assessment methods investigated often provide converging results, in spite of the different philosophies behind these methodologies. Fossil energy use is identified by all methodologies as the most important driver of environmental burden of the majority of the commodities included, with the main exception of agricultural products.

Opportunities for students
Students will receive advanced scientific training and are offered challenging internships at the department. Together with a supervisor the student selects a tailor-made project that fits his/her interest. The research is completed with an oral presentation (colloquium) at the department and a Master thesis report. Depending on the results of the research, the student is encouraged to publish the work in a scientific journal.

Mandatory courses
Environmental and Ecological Modelling, Risk Management of Chemicals *or* Sustainable Production and consumption

Recommended courses
Occupational Toxicology, Accidents and disasters involving hazardous substances, Chemical mutagenesis and carcinogenesis, Risk Communication, Environmental and Ecological Concepts

4.10 Molecule and Biophysics (IMM)

Professor:	Prof. Dr W.J. van der Zande
Scientific staff:	Prof. Dr W.L. Meerts, Prof. Dr Marc J.J. Vrakking (FOM-Institute AMOLF)
Secretariat:	Ms M.Speijers (m.speijers@science.ru.nl) room HG 01.719; tel. (36)52025
Website:	www.ru.nl/molphys

Research:

- Biomolecular structure and function.
- Molecular detection and recognition.
- Electrons and molecules.
- Instrumental developments

Description:

Biomolecular structure and function
Structure and functionality of biological molecules are strongly related. Biophysical processes take place at a well defined temperature. These molecules often change in structure during their reactions; hence stiffness and flexibility have to be accurately tuned. Laser spectroscopy and in particular high resolution laser spectroscopy is the most accurate tool to determine the structure of the molecules. Also the flexibility of these molecules is encoded in their spectra as a consequence of the rules of nature imposed by quantum mechanics. We use high resolution laser techniques to find very precise answers on the structure and flexibility of small size biomolecules with the long term aim to explore the limits of these techniques in the direction of 'real' biomolecules. Experiments are performed in close collaboration and in an exchange program with the Heinrich Heine University in Düsseldorf and in collaboration with the theoretical chemistry program at this university.

Molecular detection and recognition
Small molecules such as atmospheric species are easily recognized by their spectral structures. However, also these molecules have spectral features that are extremely weak, while at the same time these properties are highly relevant to atmospheric problems as a consequence of the enormous amounts of these molecules in our atmosphere. Using cavity ring down spectroscopy, absorption characteristics of small molecules are quantified in order to understand the effects of collisions and improve the use of these data. In the mid-infrared and far-infrared, large molecules reveal not only structure but also their internal flexibility. The study and generation of these spectra is a growing field in the group.

Electrons and molecules
In our upper atmosphere, molecules are often present as ions. The reaction of these ions with electrons is experimentally studied in a large scale storage ring experiment in Stockholm in collaboration with the University of Stockholm while we develop instrumentation and determine the properties of these reactions that are directly related to airglow and auroral phenomena in our upper atmosphere.

Instrumental developments
The group MBf is respossible for the design ansd constructor of a FIR or THz radiator source based on a free electrolaser. A large and ambitious project.

Opportunities for students:
The world around us contains molecules in all shapes, forms and size. Molecular processes dominate daily life. The understanding of molecular behavior, the detection and recognition of molecular behavior and in particular the interaction between the molecular world and electromagnetic radiation is central in the research themes of this group.
Therefore all students are welcome to perform or to join the scientific program in the department in all phases of their university program.

4.11 Molecular and Laser Physics (IMM)

Head: Prof. Dr D.H. Parker
Scientific staff: Dr F.J.M. Harren
Secretary: Ms M. Speijers (m.speijers@science.ru.nl)
room: HG 01.719; tel: (36)52025
Website: http://www.ru.nl/mollaserphys/
Research:

- Molecular dynamics of atmospherically relevant processes
- Development of new lasers and molecular beam techniques
- Trace Gas Research

Description:

Molecular dynamics of atmospherically relevant processes
Many processes are possible during a collision between a molecule and another molecule, electron or photon. Most simply, elastic scattering can take place, where the molecular internal energy remains the same but the velocity changes. Inelastic scattering is more interesting - here the rotational and vibrational energy changes, which can lead to non-equilibrium population distributions and even laser or maser action. Chemical reaction, the most complicated and important collision process, can also occur, often via a short-lived transition state complex. The same sort of transition state complex is directly prepared and probed in photodissociation studies of so-called 'half-collision' reactions.

In recent years quantum mechanical theory has been able to quantitatively describe a few of the simplest reactive and inelastic scattering processes. For the more complicated 'real-world' scattering systems laboratory work is essential. Experimental research on molecular

scattering dynamics has blossomed worldwide in the last years due to new powerful laser- and molecular beam-based techniques, especially the velocity map imaging technique developed here in our group in Nijmegen.

A general theme of our research centers on the dynamics of molecular processes relevant to atmospheric processes. The central molecule in this theme is molecular oxygen. We continue to deepen our understanding of the surprisingly complex molecule and, most recently, of Van der Waals clusters containing molecular oxygen. Another related species of interest is the hydroxyl radical. We have an active and synergetic collaboration with the Theoretical Chemistry Institute in Nijmegen in all of these studies.

In our current research on molecular scattering we use velocity map imaging and also the laser induced fluorescence technique in studies of photodissociation, inelastic scattering and most recently, reactive scattering. We are studying, for example, inelastic collisions between the OH and CO molecules, which is a key process in atmospheric chemistry and in combustion. Molecular beams of the reactants are formed and cross each other in a small region that is probed using laser induced fluorescence. With laser spectroscopy the precise quantum state distributions of both species can be obtained before and after collision. The results obtained are used to improve the theoretical potential energy surfaces describing the collision complex. In another related project the photodissociation dynamics of OH are studied using velocity map imaging. In this technique a laser is used to selectively photoionize the O and H atom dissociation products without changing the energy obtained from the initial photodissociation step. Carefully designed ion optics guides the ions onto a two-dimensional detector in a way that uniquely 'maps' the nascent product velocity. The full three-dimensional product velocity distribution can then be calculated from the experimental two-dimensional ion image. Up to now no such measurements have been possible for OH, despite it being the most important free radical in atmospheric chemistry. In collaboration with Prof. Ubachs of the Free University of Amsterdam we plan to chart out OH dissociation pathways for the ultraviolet to extreme ultraviolet (300-100 nm) spectrum.

Development of new lasers and molecular beam techniques
Progress in both fundamental and applied experimental research relies on increasingly better diagnostic techniques. Technique development is thus an important research line on its own in the group. As an example, two-dimensional velocity map imaging of ions and electrons has been improved over the last years and applied to the study of bimolecular collisions and photodissociation, surface scattering and chemical reactions.

An important drawback of present lasers systems in the infrared wavelength region is their lack of laser power and ability to generate every laser frequency in the infrared. The use of novel non-linear materials and the technique of parametric oscillation offer the possibility to avoid this and to generate continuous-wave, continuous tunable, narrowband radioation with high output powers at wavelengths between 2.5 and 10 micrometers.

Another state-of-the-art method under development includes proton transfer mass spectrometry with ion cyclotron trapping for signal enhanchement.

Trace Gas Research
The reliable sensing of minute quantities of trace gases in complicated gas mixtures is an innovative, highly important and most exciting task in practically all technical and life sciences. The Trace Gas Research Group is focused on the development and application of trace gas detection methods with lasers and mass spectrometers. For this we use laser spectroscopical methods such as photoacoustic spectroscopy, frequency modulation spectroscopy and cavity ring down spectroscopy, while within mass spectrometry proton transfer reactions are used to gain high sensitivity for volatile organic compounds. The focus is, thereby, on state-of-the-art detection of substances at sub-part per billion (volume) concentrations, on-line, non-invasive, with high selectivity and detection speed. See also www.ru.nl/tracegasfacility

Next to the research group we operate a Life Science Trace Gas Facility, in which scientists from Biological, Chemical and Medical fields are supported to perform trace gas research for which 'conventional' equipment lacks adequate sensitivity. The facility operates unique state-of-the-art trace gas detectors that allow real time measurements at unprecedented detection levels. Research areas are covered ranging from plant-pathogen interaction to the effect of smoking on the lungs and the study of the effect of tuberculosis.

Opportunities for students:
There are opportunities for students in fundamental molecular reaction dynamics, the development of new instrumental techniques with lasers and molecular beams or the trace gas research with applications in medical sciences. Much of the research is in cooperation with our research groups in Europe and the USA, at University level or with industry.

4.12 Molecular Materials (IMM)

Head:	Prof.dr. A.E. Rowan
Scientific Staff:	Dr. P.H.J. Kouwer
	Dr. K. Blank
Secretariat:	Ms P. Willems, room HG03.012, tel. 3653421, e-mail: Paula.Willems@science.ru.nl
website:	http://www.molchem.science.ru.nl/

Research:

Research in the department of Molecular Materials focuses on five subthemes in Nano Sciences:

- synergetic materials
- organo and bioelectronics
- magnetic materials
- liquid crystals
- single (bio)molecule kinetics

The aim of the group is to design, synthesise and characterise of novel polymers, self-organizing molecules and biomolecules and the subsequent investigation of their properties, always considering their use in potential devices. The relationship between the molecular structure and architecture at the nanometer level and the material properties are are key in the group.

Description of research:
Synergetic materials:
Synergetic materials are materials in which the properties are more than the sum of the individual components. For example, a reaction on one side of the molecule directly influences the reactivity on the other side.
Research in this area is divided into three areas:

- - allosteric materials (can we transfer information between molecules?)
- - molecular machines (can we mimic cascade enzymes or DNA polymerase?)
- - single molecule studies (how does an enzyme work?)

Organo and Bioelectronics:
Organic: The development of conducting polymers, light emitting systems and energy transfer materials are all fundamental requirements for the construction of working photovoltaics, OLEDs, OFETs and molecular wires. The arrangement of the building blocks in such polymers and materials has been found to be one of the governing factors of the resulting properties of the material. In order to correctly order and position these units a variety of approaches is being investigated.
Bio: A biofuel cell uses biocatalysts (like enzymes or bacteria) for the conversion of chemical energy to electrical energy. In this project we are trying to further explore this concept by confining redox enzymes inside conductive polymer spheres called vesicles. Because the enzymes are inside conductive vesicles, they should be able to transport their generated electrons across the vesicle membrane, thereby creating a current. These functional vesicles might then be applied in a nano biofuel cell.
The materials above will also be investigated for functionality in sensor devices.
Magnetic materials: The challenge is to use light for switching between either a paramagnetic (on) and a diamagnetic (off) state, or coupled spin states to give a prototype spintronics device. The department is developing a new type of molecular switch based on two coupled redox systems.

Liquid crystals:
Liquid crystals are widely applied in display devices. We look into new applications of liquid crystals, such as scaffolding self-assembly at various length scales (nm to mm!). A second aim is to use liquid crystal as the amplification mechanism for sensing devices. Together with the physics group of Theo Rasing, we are also studying liquid crystals in improved (faster, better) switching applications.

Opportunities for students:
The department is highly interdisciplinary in research. Cooperation with groups in Nijmegen and abroad entail a wide choice in research subjects for undergraduate students, from all subdivisions. We will tailor the internship to suit the needs of the student and will draft a specific educational plan for each individual. A whole host of techniques, ranging from

chemical synthesis to single molecule experiments, scanning probe microscopy, electron microscopy etc. is employed in the research into new materials. Students interested in one of the projects should contact the secretary in advance.

mandatory course: Organic chemistry 1 or Metal-organic chemistry
highly recommended course: Synthesepracticum Chemie and Organic Chemistry 2

4.13 Molecular Pharmacology and Toxicology (NCMLS, Radboud University Medical Centre)

Head:	Prof.dr. F.G.M. Russel
Scientific staff:	Dr. R. Masereeuw, Dr. J.B. Koenderink, Dr. R.P. Bos
Secretariat:	Ms L. Triebels, room 7.89 NCMLS, tel. 3613691, e-mail: e.triebels@pharmtox.umcn.nl
website:	http://www.ncmls.eu, http://www.umcn.nl/Research/Departments/PharmacologyandToxicology

Research:

- Transport processes and toxicity
- Multidrug resistance and malaria
- Regulation of renal drug transport
- Mechanisms of drug toxicity, cellular injury and protection
- Transport ATPases and digitalis-like compounds
- Molecular epidemiology and toxicity

Description of research:
The human body is continuously exposed to a great variety of xenobiotics via food, drugs, occupation and environment. Evolution has equipped the body with a plethora of protecting systems to defend itself against the potentially harmful effects of these compounds. One of the important defence mechanisms include the active extrusion of xenobiotics by commonly shared transport proteins, mainly located in kidney, liver and intestine. Similar transporters are also involved in multidrug resistance of tumour cells, microorganisms and parasites. In our research we investigate the molecular properties of transporters and their implications for the safety and efficacy of drugs.

Transporters in drug disposition and toxicity (Prof. Russel)
Research interests include pharmacokinetics, drug transporters and toxicity. Current projects study the role of membrane transporters in drug disposition and toxicity, with special emphasis on kidney, intestine, liver, brain, skeletal muscle and multidrug resistance in the malaria parasite. In addition we focus on the development of predictive urinary biomarkers for drug toxicity and the use of systems biology to study mitochondrial drug effects. An important goal is to translate molecular-based knowledge of drug transport and selective

toxicity to the clinical setting, to assist in the development of more effective and safer drug therapies.

Regulation of renal drug transporters (Dr. Masereeuw)
Research interests include the regulation of renal drug transport under physiological and pathological conditions. Current projects involve the identification of transporter proteins with differential abundances in urine and tissue samples after acute nephrotoxic injury and signalling pathways involved in the regulation of drug transporters in the kidney after injury. In addition, the role of drug transporters in renal regeneration is investigated, with an emphasis on the role of stem cells in kidney tissue repair. The studies include the use of epithelial cell lines, in vivo kidney injury models in rats and mice, transport protein knockout mice models, and pharmacokinetic analysis of transport activity.

Molecular interactions of transport ATPases (Dr. Koenderink)
Research interests include molecular interaction of membrane transport proteins and their ligands (substrates and inhibitors). Current projects are focused on the molecular interaction of digitalis-like compounds with the sodium pump (Na,K-ATPase) and multidrug resistance proteins (ABC transporters) (VIDI 2008). In addition the interaction between membrane transporters and novel and existing human drugs, as well as the multidrug resistance transport proteins of the plasmodium parasite are investigated. The studies include the expression of recombinant transport proteins and their biochemical and pharmacodynamic characterization.

Molecular epidemiology and toxicity (Dr. Scheepers)
There are tight links with the Research Lab Molecular Epidemiology (RLME, dr P.T.J. Scheepers, phone 024 36 16878, p.scheepers@epib.umcn.nl) of the Department of Epidemiology and Biostatistics (UMC St Radboud). The toxicological research of the RLME is directed to the development and use of methods for risk assessment of human exposure to chemicals present on the workplace or in the general environment. Focus is on the development of biomarkers by identifying metabolites and adducts of carcinogens and reprotoxic substances in body fluids and exhaled air with mass spectrometry, and to validate their use in health risk assessment.

Opportunities for students:
The labs of the department are housed in the preclinics building of the UMC St Radboud and the NCMLS research building. Students can participate in the research lines mentioned above; for specific projects see the website of the department or contact j.koenderink@pharmtox.umcn.nl.
mandatory course: Pharmacochemistry (MOL053) or Toxicology (MOL054)
recommended courses: Living cell, General physiology, Molecular basis of disease.

4.14 Physical-Organic Chemistry (IMM)

Head:	Prof.dr. W.T.S. Huck
Scientific staff:	Prof.dr. R.J.M. Nolte
Secretariat:	Ms D.D. van der Wey, room HG03.028, tel. 3652676,

e-mail: d.vanderwey@science.ru.nl
website: http://www.ru.nl/physicalorganicchemistry/
Research

Combining physics, chemistry and biology, the physical organic chemistry group exploits the platform of microdroplets in microfluidics in two major areas:

1) How does the physical environment in livings cell, which is dominated by crowding, small volumes, interfaces and low copy numbers, affect the chemistry that occurs within that cell?

2) Microdroplets provide picoliter compartments that can trap single cells and their environment and allows a quantitative chemical analysis of both. We aim to further develop this platform as '-omics' tool to study metabolic, epigenetic and signalling processes at the single cell level at very high throughputs.

Description of research

The physical organic chemistry of the cell

Microdroplets in microfluidics offer the opportunity to manipulate extremely small (picoliter) volumes. Droplets can be loaded with reaction mixtures and subsequently stored on chip, while monitoring the progress of reactions using sensitive fluorescence, NMR or mass spec. techniques. The microfluidics format allows us to study thousands of minute reactions in parallel, under identical conditions.

The droplet volumes are roughly comparable to the volume of cells and we are interested in mimicking some of the key parameters of the chemical environment of cells, such as the dominance of interfaces, the small number of molecules and the associated 'noise', and the crowding by other macromolecules present. Current projects involve both single enzyme studies as well as complex coupled enzymatic reactions present in the *in vitro* transcription and translation process.

Single cell cellulomics.

Cell biology experiments typically require tens of thousands of cells for a detailed study of signalling pathways, epigenetics, proteomics, and metabolomics. Although this approach has yielded a tremendous amount of information, our current understanding also points to more subtle regulatory processes that can only be revealed by studying single cells. However, due to the intrinsic variation between cells, large numbers of cells need to be studied and for this, we design new analytical tools. In collaboration with Prof. C. Figdor and other groups at the NCLMS, we are studying the initiation of the immune response by co-compartmentalizing T-cells and antigen presenting cells in single droplets.

Opportunities for students

Research in the group will suit students with a background in Chemistry, Natural Science or Molecular Life Science. As part of your project, you will learn a range of new techniques that have not been part of your undergraduate studies. The physical organic chemistry group is highly interdisciplinary and international, and you will collaborate with PhD students and postdoctoral researchers both in Nijmegen and at the University of Cambridge, UK (where Prof. Huck still runs part of his group). Within the framework of the research objectives of the group, students will be trained to work independently on projects of direct relevance to ongoing research. You will be a full member of the group and your work is expected to be published in high-impact journals. There will be opportunities to use the outcomes of the research as the foundation for a PhD project.

For more information see http://www.ru.nl/physicalorganicchemistry/, or contact Prof. Huck at w.huck@science.ru.nl for an informal overview of the science and projects.

4.15 Protein Biophysics (IMM)

Head: Prof.dr. G. Vuister
Contact: Prof.dr. G.W. Vuister, room NCMLS 0.25, tel. 3618940,
e-mail: g.vuister@science.ru.nl
website: http://proteins.dyndns.org/
Research:

1. Protein structure and function.
2. High-resolution NMR spectroscopy.
3. Protein structure validation.

Description of research:
Working at the crossroad of chemistry, physics and biology the Protein Biophysics group studies proteins, their interactions and their dynamical behavior. We use high-resolution Nuclear Magnetic Resonance (NMR) spectroscopy and sometimes X-ray crystallography, in conjunction with other biophysical techniques, such as isothermal titration calorimetry (ITC), surface-plasmon resonance (SPR) and Fluorescence Spectroscopy.

1. Protein structure and function
* Regulation of Ca^{2+} transport.
Ca^{2+} ions are crucial in many cellular processes, including neuronal response, muscle contraction, enzyme activity, gene transcription, cell death, proliferation and differentiation. We study the regulatory mechanisms that govern Ca^{2+} fluxes across membranes from a structural- and biophysical perspective. In particular, we focus on the Na^{+}/Ca^{2+}-exchanger, a highly ubiquitous ion transporter that constitutes the dominant Ca^{2+} efflux mechanism in heart and sensory neurons and the TRPV5/6 Ca^{2+} channels involved in Ca^{2+} homeostasis.
* Assembly of active biomolecular complexes.
Protein interaction domains play essential roles in the transport, localization, assembly and functioning of multi-protein complexes. We study the structure function relationships of the

five PDZ domains of the protein tyrosine phosphatase PTP-BL and the so-called PAH domains of the transcriptional co-repressor SIN3.

2. High-resolution NMR
NMR is extremely well-suited to study both the structure and fundamental properties of biomolecules, including dynamics on the time scale of pico-seconds to seconds. In this project, we develop sophisticated new NMR methodology to improve our detailed understanding of biomolecular interaction.

3. Protein structure validation (jointly with *Dr. Jurgen Doreleijers, Prof.dr. Gert Vriend (CMBI)*)
NMR structures should adequately reflect the experimental data and be reliable in terms of overall and local quality. Our recent analysis of a large set of NMR derived structures suggested serious flaws and illustrated that the quality of NMR structures cannot be reliably evaluated using only the commonly accepted structure validation tools. In this project we develop new tools that yield better structures and new tools that help to validate data and results.

Opportunities for students:
The multidisciplinary nature of our research allows for many possibilities for your master research period. When you are interested in structure and functioning of biological macromolecules, you can work both in the lab and use the biophysical techniques (NMR, ITC, SPR) as tools in your studies (project 1, suitable for Chemistry, Molecular Life Science and Natural Science). Those with an interest in biophysics can work on the development of biophysical techniques, in particular NMR spectroscopy (project 2, suitable for Chemistry and Natural Science). Finally, those with an interest in bioinformatics approaches, programming and computers can work on the tools for structure generation and analysis (project 3, suitable for Chemistry, Molecular Life Science and Natural Science).

Specific projects will be listed on the proteins.dyndns.org website.

Mandatory bachelors courses:
Project 1 or 3: Structuur Biomoleculen or Structuur, Functie, Bioinformatica
Project 2: Magnetische Resonantie 1.
Recommended bachelors courses: Structuur Biomoleculen; Structuur, Functie, Bioinformatica; Magnetische Resonantie 1
Mandatory courses major: Determined on an individual basis depending on bachelor track (MLW, NW or Chemistry) and project.

4.16 Scanning Probe Microscopy (IMM)

Head:	Ms Prof. Dr S. Speller
Scientific staff:	Dr. J.A.A.W. Elemans, dr.ir. B.L.M. Hendriksen
Secretariat:	Ms M.L. Beenen(mailto:r.gommers@science.ru.nl)

room HG 01.074; tel. (36)52121

Website: wiki.science.ru.nl/spm/Main_Page

Research

- Nanoprobing
- Molecular electronics and mechanics
- Nanoscale chemistry
- Bio-electronic coupling
- NanoLab Nijmegen

Scanning Probe Microscopy enables visualization of nanoscopic objects. Our interdisciplinary group is dedicated to the development of new modes operation to address nanoscale systems which couple physics, chemistry, and biology.

Description

In our research group Scanning Prob microscopy we are interested in phenomena on very small length scales. The long-term aim is to unravel mechanisms and processes which couple physical, chemical and biological structures. For this purpose advanced scanning probe microscopy methods are developped and applied. We are an interdisciplinary team of physicists, chemists, natural scientists, engineers, and biologists. We collaborate with the molcular cluster, the computational and theory groups, the biochemistry groups within the Institute for Molecules and Materials of the Faculty of Science. In addition, collaborations exist with a large number of international laboratories and industries.

Scanning Probe Microsocpy (SPM) methods represent a unique toolbox to study and manipulate systems locally and to address nano-objects individually. To some extent device-like conditions can be realized on nano-scale. Our aim is to enhance the applicability and selectivity of scanning probe microscopy methods. In our group we develop SPM modes for complex systems and environments. This includes functionalization of nanoprobes, correlative nano-probing, and local tunneling and ion currents in liquids and electrolytes, allowing us to explore heterogneneous systems, (spin)electronic and transport properties of nanoscale structures, correlation of structural and functional properties, and chemical reaction mechanisms.

Molecular electronics and mechanics

"How do molecules conduct electricity? " That is the central question of this research theme. Understanding the transport mechanisms of change carriers in organic molecules is relevant to molecular electronics, organic electronics and electron transport in biology. We use STM and conducting tip AFM to study charge transport (electrons/holes) through single molecules and between molecules in molecular assemblies. We focus on the coupling between the charge carriers transport with the mechanics of the molecules and the structure of the molecular assemblies.

Nanochemistry

During the past decades Scanning Probe Microscopy studies of molecular layers in ultra-high vacuum have provided substantial insight into chemical processes at the nanoscale. However, chemistry in industry and in the laboratory occurs under far more realistic conditions: often in a liquid, and under a controlled atmosphere. We have developed a sophisticated Liquid Scanning Tunneling Microscope, which allows the study of molecular layers under these practical conditions. In this setup we focus on studying dynamic processes at a surface, such as the step-by-step monitoring of chemical reactions in real-space. These studies can provide unique new insights in reaction mechanisms, since information is obtained about single molecules instead of at the ensemble level, where the behavior of millions of molecules is averaged. It is important to extend the apolar liquids we use to electrolytes, and it is our aim to combine the microscopy with advanced spectroscopy and optical techniques. The interdisciplinary research is done in a joint collaboration with the chemistry groups in the Molecular Cluster.

Interaction forces of individual biological structures

Interactions between biomolecules are of eminent importance in biology. For instance for improving and finding ways to cure diseases induced by viruses such as HIV and Hepatitis we need the physical knowledge of specific binding between protein and nucleic acids. Since in biology energetics of processes is close to *kT*, single molecule approaches are quite insightful. Atomic force microscopy modes have been developed to a powerful tool to assess biologic interaction. Individual biologic bonds can be exposed to organic agents and drugs and their effect can be assessed directly by the force characteristics. Also at the level of viruses and live cells force spectroscopy can reveal mechanisms of interaction.

Bio-electronic coupling

- Magnetite nanocrystals and their role in magneto reception

Magneto reception allows animals to navigate in the geomagnetic field. We study magnetite nanocrystals in the tissue. Our aim is to unravel transduction mechanisms of magneto reception in fish. Recently we achieved the correlation of Magnetic Force Microrscopy-Atomic Force Microscopy, transmission electron microscopy, and staining of neighboring epithelium slices. This allowed us to determine the distribution of nanoparticles among cells. We also study model systems such as Ferro fluids by Magnetic Force Microscopy.

- Ion current imaging of live cells

Cells are a stage of sparkling activity including numerous biochemical reactions and migratory processes. Typical examples are protein synthesis and regulation, repair, replication, molecular transport, export, and initiation of programmes such as division, activation and differentiation. Processes can be triggered or modified by internal and external stimuli and are accompanied by substantial fluctuations of analytes. We investigate local changes of ion concentrations in live cells using Scanning Ion Conductance Microscopy.

Opportunities for students

For students, there is ample opportunity to participate in the research of basically all the subjects mentioned above. Supervision is usually done by more experienced group members

such as Phd students, postdocs and faculty staff. There are also excellent possibilities for interdisciplinary internships.

4.17 Solid State Chemistry (IMM)

Head: Prof.dr. E. Vlieg
Scientific staff: Dr. W.J.P. van Enckevort, dr. H.L.M. Meekes
Secretariat: Ms E. Salem, room HG03.629, tel. 3653323, e-mail: e.salem@science.ru.nl
website: http://www.vsc.science.ru.nl/

Research:
The central research theme is crystal growth. Our goal is to obtain a fundamental understanding of the processes that occur during growth (or etching) of crystals and to apply this understanding to the prediction and control of crystal morphology and perfection. We use a wide range of topics (from academic to industrially relevant), materials (from diamond to steroids) and use a strong interaction between theoretical, computational and experimental methods.

Description of research:
The specific research topics vary from year to year; detailed examples can be found in the publication list on our website and include chiral separation, III-V nanowires, etching of silicon and the structure and growth of pigments. Some typical current activities are:

Modelling of crystal growth: In order to understand crystal growth it is important to make simplified models that allow a detailed analysis of the elementary growth processes. At the same time, we have developed software that allows the simulation of crystal growth of realistic crystals, in which the full complexity of bonding topology can be included. Computer simulations are used extensively in this research topic.

In situ observations: The most powerful means to test growth models is to perform in situ observations. We use advanced optical microscopy and atomic-force microscopy in order to observe the growth of crystals from the mm length scale down to the molecular scale.

Templates: Templates (both inorganic and organic) offer the possibility to control the nucleation and growth of crystals by providing an ordering field with a specific periodicity and with specific interactions. In collaboration with organic chemistry, we use self-assembled supramolecular templates for the growth of (2D) protein crystals.

Proteins: Protein crystallography is the standard method to derive the structure of proteins, but its main bottle-neck is the requirement of high-quality protein crystals. Several space-based research projects aim to grow better protein crystals under microgravity conditions where convection is absent. We have developed two earth-based methods that allow also growth without convection, but that are cheaper and far more convenient. One is based on high magnetic fields (in collaboration with the HFML) and one is based on a special growth geometry.

X-ray diffraction of interfaces: Using the intense X-ray beams from the synchrotron radiation facility ESRF in Grenoble, France, we apply X-ray diffraction to determine the atomic-scale structure of the growth interface. In the case of solution growth, the ordering of the interfacial liquid is of specific interest.

Opportunities for students:
The possibilities for practical work for undergraduate students follows the research topics of the group and covers theory, computer simulations, experimental work or a combination of these. In many cases the results lead to a publication in the scientific literature. A specific research topic is selected based on the interest of the undergraduate student and can vary from fundamental to applied. The research theme or the group is in the realm of physical chemistry, and thus the topics are most suitable for students in Chemistry, Natural Science and Physics. The course "inleiding in de kristalgroei" is mandatory, while the courses "practicum condensed matter", "advanced crystallography" and "materials science" are recommended.

4.18 Solid State NMR (IMM)

Head: Prof.dr. A.P.M. Kentgens
Scientific staff: Dr. P.J. van Bentum, Dr. E.R.H. van Eck
Secretariat: Ms M. de With, room HG03.344, tel. 3652678, e-mail: m.dewith@science.ru.nl
website: http://www.ru.nl/physchem
Research:
Solid-state nuclear magnetic resonance

Description of research:
Research goals: The overall aim of our group is to develop new solid-state NMR methods to study structure and dynamics of both crystalline and non-crystalline materials and to apply these methods in various materials science studies. We are active in a variety of fields studying functional materials e.g. in relation to energy conversion and storage, furthermore we investigate the structure of bio(mimetic) materials as developed within the Institute for Molecules and Materials (IMM). We use state of the art solid-state NMR equipment and techniques. A challenging goal is to enhance the sensitivity and resolution of our experiments while at the same time exploiting the information content contained in the anisotropic interactions encountered in the solid-state .

Opportunities for students:
Within the research group there are always opportunities for students to participate in one of the research projects discussed above. The research has a strong multidisciplinary character; physical tools are used to study chemically or biologically relevant materials and processes. The work involves experiments, computer simulations and theory. Depending on the students' background it is possible to give more emphasis to either experiment or theory. Furthermore, one can decide to focus more on the chemical or physical aspects of the research.
Students are treated as full members of the research group and are expected to carry out their assigned research task with an important individual contribution. Personal initiative and

creativity are therefore highly valued. Depending on the project the work is carried out under the direct supervision of a Ph.D. student, post.doc. or docent. There is an open atmosphere in the group where everyone is available to give support

Mandatory course: Magnetic resonance I
Recommended course: Atom and molecular spectroscopy, quantum chemistry

4.19 Synthetic Organic Chemistry (IMM)

Head:	Prof.dr. F.P.J.T. Rutjes
Scientific staff:	Dr. F.L. van Delft, Dr. M.C. Feiters, Prof. P.H.H. Hermkens
Secretariat:	Ms M. Versteeg, room HG03.028, tel. 3653389, e-mail: j.versteeg@science.ru.nl
website:	http://www.molchem.science.ru.nl/rutjes

Research
Main focus of the research is the synthesis of organic molecules (natural or designed) with specific (biological) properties. Synthesis proceeds by application of contemporary synthetic techniques or, if required, by development of novel methodology. Molecules of interest are usually applied in multidisciplinary research projects such as:

- Development of sensors for allergens and biomarkers (with prof. van Hest, prof. Zuilhof, WUR and Fraunhofer Institut, Duisburg)
- Conversion of biomass into high-end building blocks (with DSM)
- Application of enzymes in organic synthesis (with DSM, prof. Franssen, WUR and prof. Wever, UvA)
- Novel antimalarial compounds (with prof. Chibale, Kaapstad, Zuidafrika)
- RNA-targeting and toxicity studies of naturally occurring aminoglycosides (with Prof. Russel, NCMLS, prof. Ennifar, Strasbourg)
- Synthesis and evaluation of pan-cholecystokinin (CCK) receptor binding ligands for radionuclide targeting of CCK-receptor positive tumors (with Prof. Boerman, Dr. Laverman, UMC St Radboud)
- Development of bioorthogonal ligation methods (with Prof. van Hest, prof. Boons, Athens, USA)
- Design and synthesis of germination stimulants (with Prof. Zwanenburg and Prof. Bouwmeester, WUR)

Description of research
The research focuses on the synthesis of enantiopure, multi-functionalized heterocyclic molecules, predominantly amino acid-based structures and carbohydrate derivatives. Emphasis lies on the development of new 'chemical tools', with particular focus on catalytic methods under sustainable and mild reaction conditions. This includes the following areas:
- Biocatalysis: use of enzymes as mild and environmentally benign catalysts for modification of organic molecules. Besides application of hydrolytic enzymes (lipases, amidases, nitrilases, sulfatases), enzymes that are capable of forming synthetically useful carbon-carbon

bonds are investigated, such as hydroxynitrile lyases and aldolases. Synthetic challenges lie especially in the generation of enantiomerically pure compounds from racemic or non-chiral molecules. Furthermore, collaborations with molecular biology groups result in modified enzymes which are obtained via genetic engineering.
- Transition metal catalysis: transition metal-based catalyst systems (involving Pd, Ru, Cu, W, Ti) are applied in the functionalization and/or cyclization of highly functionalized molecules. For example, ring-closing metathesis is studied as a viable method for the synthesis of fluorinated building blocks, unnatural sugars, or conformationally constrained peptides. Pd-mediated processes are used for the synthesis of unnatural amino acids, and Cu-mediated reactions are explored to prepare triazole building blocks.
- Organocatalysis: in addition to bio- and metal-catalysts, also chiral amines (e.g. L-proline) can act as a catalyst to create enantiopure compounds. These types of reactions are being explored in a stereocontrolled approach to synthesize all possible stereoisomers of 1,3-aminoalcohols and diamines.

Technology development:
- Parallel synthesis: within our group, a fully automized synthesis robot and a semi-automated, modular parallel synthesis facility (in collaboration with the company Chiralix) are available for combinatorial synthesis development
- Synthesis in microreactors: in collaboration with the Bio-organic chemistry group, a microreactor platform has been established that can be used for reaction screening and optimization
- High pressure-mediated synthesis: dedicated high pressure equipment has been developed that can be used for exploring new reactions in a parallel fashion at a pressure of 15.000 bar

Opportunities for students:
Any of these topics, as well as additional projects, are open to Master students in Chemistry, Molecular Life Science or Natural Science. For additional information contact the secretariat or visit our website.

mandatory course: Organic chemistry 1
recommended courses: Synthetic practical courses, Organic chemistry 2 and Metal-organic chemistry

4.20 Theoretical Chemistry (IMM)

Scientific staff: Dr.ir. G.C. Groenenboom
Secretariat: Check website

website: http://www.theochem.ru.nl/
Research:

- Computation of intermolecular potentials
- Dynamics of molecular clusters and collision processes
- Theory of chemical reactions

The Theoretical Chemistry group extracts information from the solution of the Schrödinger equation that can be confronted with experiment. To be able to pursue this research, one needs knowledge of numerical and applied-mathematical methods, and a sufficient grasp of the experiment as well. The latter is necessary to understand and interpret the measured results. In particular the research of the group is aimed at (i) the computation of interactions between molecules that (ii) can be bound by van der Waals forces, (iii) can exchange energy by collisions, or (iv) can react chemically.

Description of research:

Computation of intermolecular potentials:

With the aid of modem quantum chemical computer methods, such as 'symmetry adapted perturbation theory', 'coupled cluster theory', 'many body perturbation theory', etc., the van der Waals forces are calculated between two or more molecules.

They may be closed- or open-shelI molecules. The concept of the van der Waals force is very broad, it comprises: long range attraction, Born (steric) repulsion and hydrogen bonding. The aim of the work is a reliable analytic description of these forces as a function of the relative orientation and distance of the molecules. These so-calIed potential energy surfaces are used subsequently in project 2.

Dynamics of molecular clusters and collision processes:

Infrared spectra of van der Waals molecules can be computed from potential energy surfaces as input. By definition a van der Waals molecule is a cluster, bound by van der Waals forces, consisting of two or more ordinary molecules. Currently much experimental research is being performed on these infrared spectra, among others by members of the department of Molecular and Laser Physics in Nijmegen. The main reason for this interest is that the IR spectra gauge very accurately the potential energy surfaces and therefore contribute to a fundamental understanding of the intermolecular forces. The van der Waals potentials are also applied in the computation of non-elastic collision cross sections. A cross section is a measure for the probability that a molecule makes a transition from one quantum state to another under the influence of the collision. Cross sections are measured in very many laboratories in the world, including the Molecular and Laser Physics Lab in Nijmegen.

The theory of chemical reactions:

Computer methods exist, and are being improved; these are tools in the study of chemical reactions at the level of molecular quantum states. This means that the reactive collision is studied between two atoms and/or molecules that are in known, well-defined quantum states. The probabilities are computed that the reaction products appear in certain quantum states after the reaction is finished.

The time-dependent, as well as the time-independent, Schrödinger equation yields this probability. However, under certain circumstances 'semi-classical' methods (a mixture of quantum and classical mechanics) can be applied very fruitfully as well.

This project also contains the study of photodissociation: the 'reaction' of a molecule and a photon leading to the dissociation of the molecule. The photodissociation of molecules by sunlight is of crucial importance in atmospheric chemistry. In Amsterdam and in Nijmegen experiments are being performed on photodissociation reactions that are important for the atmosphere. In close cooperation with these groups the theoretical chemistry department works on the interpretation and explanation of the measured results.

See http://www.theochem.ru.nl/ for recent references giving more details on the subjects mentioned above.

Opportunities for students:
The students participate in the projects mentioned above. They collaborate with a faculty member and a Ph.D student (AIO/OIO). The work is usually computer oriented. The group has access to a large cumputer cluster. The student is expected to have knowledge of quantum mechanics and some knowledge of mathematics, which must be apparent from succesfully taken exams. For each research project it is judged whether it is suitable for the Chemical/Chemical-Physical profile of the science curriculum.

mandatory courses: Quantum Chemistry and Quantum Dynamics
recommended courses: Quantum mechanics 2, Introduction to group theory, Linear algebra 2, Programming (bachelor courses from physics)

4.21 Minor Industrial Chemistry

Contact: Prof.dr. F.P.J.T. Rutjes
Secretariat: Ms J. Versteeg, room HG03.028, tel. 3653389, e-mail: j.versteeg@science.ru.nl

Goals
The student learns about working in an industrial environment and gains nsight in how fundamental chemical knowledge is applied in industry. Also the role and place of chemistry in its social-economic environment is explained. The practical course is mostly done as a trainee or internship at an industry or institute. The student takes part in on-going research or development including project meetings and presentations. The student learns about the way industry works and how R&D is being managed. Decision making on starting, running or terminating research projects is explained.
The student is working for a period of 5 months at an industry or institute. An additional month is available for a written report, including a presentation for the project group at the industry. Also the short course 'Industrial Chemistry' (written examination) is planned in this month.

Choice of internship
The student makes his choice for an industry together with one of the staff members of the IMM. The latter person will also function as the university contact person. The industry or institute chosen is responsible for the research proposal whereas the contact person at the university is responsible for its scientific quality. The final choice and practical arrangements are made by the student, the industrial contact and the university contact. During the traineeship these persons have a regular contact about progress of the traineeship, preferably at the institute or industry.

Report and presentation
A written report is required. Two copies should be available for the university. Oral presentation should be given during several occasions at the training period as this is an important tool in industrial R&D.

Secrecy
A secrecy agreement between university and participating industry is standard. The agreement will be signed by the university contact person, the student and the industry.

Costs/reimbursements
Many industries and institutes reimburse for costs connected to traineeships. This is an arrangement directly between student and industry or institute.

Examination/assessment
The university is responsible for the final judgement of the results. Practical work is judged by industry accounting for 45% of the overall result. The written report and oral presentations are judged by both parties (making up 40 and 15% of the total result, respectively). The course 'industrial chemistry' and a possible literature study and report are judged separately.

5 HLO/HTO vrijstellingsprogramma

5.1 HLO/HTO programme

5.1 Introduction

With a HLO-bachelors degree it is possible to obtain a university masters degree in chemistry. Before admittance to the masters programme is possible, students have to pass several courses of the university bachelors programme in chemistry. These courses are: mathematics 1, 2 and 3; linear algebra, thermodynamics 2, quantummechanics 1 and 2, chemical bonding 1, coordination chemistry, programming in Matlab, crystal structure, fourier analysis and philosophy. The department where the master research project will be done is allowed to ask up to 6 ec mandatory courses of the bachelors programme before students may start the masters research project. For more information on the pre-masters programme: see the bachelor study prospectus.

The masters programme is offered in four variants: a research (O) variant, a communication of science (C) variant, an education (E) variant, and a business and management (MT variant. A list of the specializations (major) of the masters programme in chemistry can be found in chapter 2.2.

Successful completion of the masters programme (research variant is preferred), allows admission to a PhD programme.

5.2A Programme of the master: Research Variant (O)

- research project in chemistry (including master thesis, presentation, literature thesis and colloquium): 60 ec
- basic and advanced courses (compulsory and optional): 27 ec

5.2B Programme of the master: Communication of Science (C), Education (E), and Management & Application Variant (M&T)

- research project in chemistry (including master thesis, presentation, theory, literature thesis and colloquium): 54 ec
- C, E and M&T (including theory and minor thesis): 57 ec (see also chapter 6 for the contents of the C, E and MT variant)

6 Examination regulations

6.1 OER master

Onderwijs- en examenregeling 2010-2011 Masteropleiding Chemistry FNWI
Deel 1: Algemeen deel

Paragraaf 1. Algemeen
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Paragraaf 5. Studievoortgang en studiebegeleiding
Artikel 5.1 Studievoortgang
Artikel 5.2 Studiebegeleiding

Deel 2: Opleidingsspecifiek deel: Masteropleiding Chemistry

Paragraaf 6. Bepalingen algemeen deel

Paragraaf 7. Programma masteropleiding

Paragraaf 8. Volgorde van tentamens van de opleiding

Deel 1: Algemeen Deel

Paragraaf 1. Algemeen

Artikel 1.1 Toepasbaarheid regeling

1. Deze onderwijs- en examenregeling is van toepassing op de masteropleidingen die in de Faculteit der Natuurwetenschappen, Wiskunde en Informatica zijn ingesteld en bevat de geldende procedures, rechten en plichten met betrekking tot het onderwijs, de tentamens en examens voor studenten die per 1 september 2010 voor de eerste maal voor de opleiding zijn ingeschreven. Deel 1 van de regeling omvat de bepalingen die van toepassing zijn op alle opleidingen; in Deel 2 zijn aanvullende specifieke bepalingen per opleiding opgenomen.

2. De onderwijs- en examenregeling wordt vastgesteld door het faculteitsbestuur nadat de FGV daarmee heeft ingestemd.

Artikel 1.2 Begripsbepalingen

De in dit reglement voorkomende begrippen hebben, indien die begrippen ook voorkomen in de Wet op het hoger onderwijs en wetenschappelijk onderzoek (WHW), de betekenis die deze wet eraan geeft
In deze regeling wordt verstaan onder:
a. de wet: de Wet op het Hoger onderwijs en Wetenschappelijk onderzoek afgekort tot WHW en zoals sindsdien gewijzigd;
b. opleiding: de masteropleiding bedoeld in artikel 7.3a, lid 1 onder a van de wet;
c. student: hij of zij die is ingeschreven aan de Radboud Universiteit Nijmegen voor het volgen van het onderwijs en/of het afleggen van de tentamens en de examens van de opleiding;
d. practicum: een praktische oefening als bedoeld in art. 7.13, lid 2 onder d van de wet, in één van de volgende vormen:
- het maken van een scriptie;
- het maken van een werkstuk of een proefontwerp;
- het uitvoeren van een ontwerp- of onderzoekopdracht;
- het verrichten van een literatuurstudie;

- het schrijven van een computerprogramma;
- het verrichten van een stage;
- het deelnemen aan veldwerk of een excursie;
- het uitvoeren van proeven en experimenten;
- of het deelnemen aan een andere onderwijsactiviteit, die gericht is op het bereiken van bepaalde vaardigheden;

e.tentamen: een onderzoek naar de kennis, het inzicht en de vaardigheden van de student met betrekking tot een bepaalde onderwijseenheid, alsmede de beoordeling van dat onderzoek door minstens één daartoe door de examencommissie aangewezen examinator;
f. examen: toetsing, waarbij door de examencommissie wordt vastgesteld of alle tentamens van de tot de master behorende onderwijseenheden met goed gevolg zijn afgelegd, voor zover de examencommissie niet heeft bepaald dat het examen tevens omvat een door haar zelf te verrichten onderzoek naar de kennis, inzicht en vaardigheden van de examinandus alsmede de beoordeling van de uitkomsten van dat onderzoek. (conform artikel 7.10 van de wet);
g. examencommissie: de examencommissie van een opleiding ingesteld conform artikel 7.12 van de wet. Zie ook Structuurregeling RU;
h. examinator: degene die door de examencommissie wordt aangewezen ten behoeve van het afnemen van tentamens, conform artikel 7.12 van de wet;
i. ec: studiepunten conform het European Credit Transfer System. Eén ec is gelijk aan 28 uren studie;
j. werkdag: maandag t/m vrijdag m.u.v. de erkende feestdagen;
k. studiegids: de gids voor één van de opleidingen genoemd in artikel 1 bevattende de specifieke informatie voor de masteropleiding;
l. de universiteit: Radboud Universiteit Nijmegen;
m. de faculteit: Faculteit der Natuurwetenschappen, Wiskunde en Informatica.

Artikel 1.3 De masteropleidingen en mastervarianten

1. In de faculteit zijn de volgende masteropleidingen met een studielast van 120 EC ingesteld:
a. Biology
b. Informatica (Computing Science)
c. Environmental Sciences
d. Medical Biology
e. Moleculaire Levenswetenschappen (Molecular Life Sciences)
f. Physics and Astronomy
g. Natuurwetenschappen (Natural Sciences)
h. Chemistry
i. Mathematics

2. In de faculteit is de volgende masteropleiding met een studielast van 60 EC ingesteld:
a. Informatiekunde (Information Science)

3. de in lid 1 aangeduide masteropleidingen van de faculteit kennen de volgende varianten:
a. O-variant (Onderzoek)
b. MT-variant (Management & Toepassing)
c. C-variant (Wetenschapscommmunicatie)
d. E-variant (Educatie), met uitzondering van de in lid 1b genoemde opleiding

4. De masteropleiding O-variant omvat de volgende onderdelen met de daarbij vermelde studielast:
a. opleidingsspecifieke onderdelen met een totale omvang van 111 ec
b. vrije keuzeruimte met een minimum omvang van 6 ec
c. één of meer vakken met een wijsgerig karakter met in totaal een minimum omvang van 3 ec

5. De masteropleiding MT-variant omvat, behoudens voor de in lid 1b genoemde opleiding, de volgende onderdelen met de daarbij vermelde studielast:
a. opleidingsspecifieke onderdelen met een totale omvang van 54 ec
b. verplichte MT-onderdelen met een totale studielast van 25 ec
c. MT-keuzevakken met een totale studielast van tenminste 5 ec
d. MT final research project van 27 ec
e. vrije-keuzeruimte met een minimum omvang van 6 ec
f. één of meer vakken met een wijsgerig karakter met in totaal een minimum omvang van 3 ec

6. De masteropleiding C-variant omvat de volgende onderdelen met de daarbij vermelde studielast:
a. opleidingsspecifieke onderdelen met een totale studielast van 54 ec
b. verplichte C-onderdelen in het eerste jaar met een totale studielast van 12 ec
c. verplichte C-onderdelen in het tweede jaar met een totale studielast van 9 ec
d. C-keuzevakken, goed te keuren door de voor de variant verantwoordelijke docent, met een totale studielast van 6 ec
e. stage en verslaglegging van in totaal 30 ec
f. vrije-keuzeruimte met een minimum omvang van 6 ec
g. één of meer vakken met een wijsgerig karakter met in totaal een minimum omvang van 3 ec

7. De masteropleiding E-variant omvat de volgende onderdelen met de daarbij vermelde studielast:
a. opleidingsspecifieke onderdelen met een totale studielast van 54 ec
b. E-onderdelen in de vorm van twee stages met een totale studielast van 57 ec
c. vrije-keuzeruimte met een minimum omvang van 6 ec
d. één of meer vakken met een wijsgerig karakter met in totaal een minimum omvang van 3 ec

8. De door de student gekozen samenstelling van de masteropleiding wordt uiterlijk 6 maanden voor de beoogde examendatum ter goedkeuring voorgelegd aan de examencommissie.

Artikel 1.4 Algemene doelstellingen van de opleidingen

De opleidingen beogen de studenten:
a. kennis, inzicht en vaardigheden op het desbetreffende gebied bij te brengen
b. academisch te vormen
c. voor te bereiden op een verdere (studie-)loopbaan
d. voor wat betreft de O-variant aanvullend aan het onder a, b en c genoemde: verdieping van

de kwalificaties op het terrein van zelfstandig wetenschappelijk onderzoek;
e. voor wat betreft de MT-variant aanvullend aan het onder a, b en c genoemde: kennis, inzicht en vaardigheid op relevante terreinen van de bedrijfskunde en bestuurskunde;
f. voor wat betreft de C-variant, aanvullend aan het onder a, b en c genoemde: kennis, inzicht en vaardigheid op relevante terreinen van de wetenschapscommunicatie;
g. voor wat betreft de E-variant, aanvullend aan het onder a, b en c genoemde: het verwerven van competenties als docent.

Paragraaf 2. Vormgeving der opleidingen

Artikel 2.1 Vorm van de opleidingen

De opleidingen worden uitsluitend voltijds verzorgd.

Paragraaf 3. Taal der opleidingen

Artikel 3.1 Taal der opleidingen

1. Het onderwijs in de masteropleidingen wordt in het Engels gegeven, de tentamens en het examen (de examens) worden afgenomen in het Engels. In afwijking hiervan wordt het onderwijs in de E-variant verzorgd in het Nederlands. Voor in het Engels verzorgd onderwijs is de "Gedragscode vreemde taal" van de universiteit van toepassing (zie appendix).

2. Voor deelname aan het onderwijs en tentamens in het Nederlands is voldoende beheersing van het Nederlands vereist. Voor niet-Nederlandstalige studenten geldt dat aan de eis inzake voldoende beheersing van de Nederlandse taal wordt voldaan door het met goed gevolg afleggen van het staatsexamen Nederlands als tweede taal, niveau 2, dan wel de interuniversitaire taaltoets Nederlands. De examencommissie kan in voorkomende gevallen beoordelen of een student de Nederlandse taal in voldoende mate beheerst.

3. Voor deelname aan het in het Engels verzorgde onderwijs en eventueel de tentamens is een voldoende beheersing van het Engels vereist. Aan deze eis is voldaan, als de student:
a. in het bezit is van een diploma voorbereidend wetenschappelijk onderwijs; of
b. in het bezit is van een diploma van voortgezet onderwijs, behaald aan een Engelstalige instelling van voortgezet onderwijs binnen of buiten Nederland; of
c. in het bezit is van een diploma van voortgezet onderwijs, behaald aan een Duitstalige instelling van voortgezet onderwijs, met Engels als Abiturvak ; of
d. in het bezit is van een diploma hoger beroepsonderwijs; of
e. in het bezit is van een bachelordiploma behaald aan een Nederlandse universiteit; of
f. een van de onderstaande toetsen heeft afgelegd:
- de TOEFL met een score van 550 of hoger voor de papieren versie;
- de TOEFL met een score van 213 of hoger voor de computer versie;
- de TOEFL met een score van 79 of hoger voor de internet versie;
- de IELTS met een score van 6,5 of hoger;
- de Cambridge CAE of CPE met graad C of hoger.
De examencommissie kan in voorkomende gevallen beoordelen of een student de Engelse taal in voldoende mate beheerst.

Paragraaf 4. Tentamens en examens

Artikel 4.1 De examens

De masteropleidingt wordt afgesloten met het masterexamen.

Artikel 4.2 Vorm van tentamens

1. Onderwijseenheden worden afgerond met een tentamen. Tentamens kunnen op de volgende wijze worden afgelegd:
a. schriftelijk en/of
b. mondeling en/of
c. practicum + verslag en/of
d. computerpracticum en/of
e. computertentamen en/of
f. mondelinge presentatie

2. Op verzoek van de student kan de examencommissie toestaan dat een tentamen op een andere wijze dan vorenbedoeld wordt afgelegd.

3. Aan studenten met een functiestoornis wordt de gelegenheid geboden de tentamens op een zoveel mogelijk aan hun individuele handicap aangepaste wijze af te leggen. De examencommissie wint zo nodig deskundig advies in alvorens te beslissen. Indien de betreffende studenten bij een tentamen bepaalde faciliteiten nodig hebben, dienen zij deze uiterlijk twee weken voor het tentamen bij de docent aan te vragen.

4. Mondeling wordt niet meer dan één persoon tegelijk getentamineerd, tenzij de examencommissie anders heeft bepaald.

5. Het mondeling afnemen van een tentamen is niet openbaar, tenzij de examencommissie in een bijzonder geval anders heeft bepaald, dan wel de student daartegen bezwaar heeft gemaakt.

6. Het mondeling afnemen van tentamens geschiedt zo mogelijk in aanwezigheid van een tweede examinator of een door de examencommissie aangewezen waarnemer. In bijzondere gevallen kan de examencommissie bepalen dat een geluidsopname wordt gemaakt van het tentamen.

7. Per vak wordt vóór het begin van het studiejaar bekend gemaakt op welke wijze de tentaminering zal plaatsvinden.

8. Studenten dienen zich tijdig conform de daarvoor geldende bepalingen in te schrijven voor een tentamen.

Artikel 4.3 Frequentie van tentamens

1. Tot het afleggen van de tentamens wordt ten minste tweemaal per jaar de gelegenheid gegeven, met uitzondering van practica of het praktische gedeelte van onderdelen, welke slechts eenmaal per studiejaar kunnen worden afgelegd. Tentamens worden afgenomen aansluitend aan het onderwijs alsmede gedurende een nader te bepalen periode. De "Regeling beperking tentamendeelname" is hierbij van toepassing (zie appendix).

2. In afwijking van het bepaalde in het eerste lid wordt tot het afleggen van het tentamen van een onderdeel, waarvan het onderwijs in een bepaald studiejaar niet is gegeven, in dat jaar ten minste eenmaal de gelegenheid gegeven.

3. Indien een tentamen twee of meer keren wordt herkanst, stelt de examencommissie aanvullende eisen vast ten aanzien het te herkansen vak.

Artikel 4.4 Geldigheidsduur tentamens

1. De geldigheidsduur van behaalde tentamens is onbeperkt.

2. In afwijking van het bepaalde in het eerste lid kan de examencommissie voor een onderdeel aanvullende dan wel vervangende eisen stellen, indien naar haar oordeel de eisen met betrekking tot dat tentamen aanzienlijk afwijken van die, gesteld ten tijde van het afleggen van het tentamen.

Artikel 4.5 Vaststelling en bekendmaking uitslag tentamens

1. De examinator stelt terstond na het afnemen van een mondeling tentamen de uitslag vast en reikt de student een desbetreffende schriftelijke verklaring uit.

2. De examinator stelt de uitslag van een schriftelijk tentamen vast binnen 30 dagen na de dag waarop het is afgelegd, of zoveel eerder als nodig is om 10 werkdagen voor de herkansingsdatum bekend te zijn, en verschaft de administratie van de faculteit de nodige gegevens ten behoeve van de uitreiking van het bewijsstuk omtrent de uitslag aan de student.

3. Voor een op andere wijze dan mondeling of schriftelijk af te leggen tentamen bepaalt de examencommissie tevoren op welke wijze en binnen welke termijn de student een verklaring omtrent de uitslag zal ontvangen. Deze termijn is niet langer dan 30 dagen na het afleggen van het tentamen.

4. Op de verklaring omtrent de uitslag van een tentamen wordt de student gewezen op het inzagerecht, bedoeld in artikel 4.6, eerste lid, alsmede op de beroepsmogelijkheid bij het college van beroep voor de examens.

5. De termijn waarin studenten tegen een beslissing van de examencommissie in beroep kunnen gaan bij het college van beroep voor de examens is vier weken.

Artikel 4.6 Inzagerecht

1. Gedurende ten minste 30 dagen na de bekendmaking van de uitslag van een schriftelijk tentamen krijgt de student op zijn verzoek inzage in zijn beoordeeld werk. Tevens wordt hem op zijn verzoek tegen kostprijs een kopie verschaft van dat werk.

2. Gedurende de in het eerste lid genoemde termijn kan elke belanghebbende kennis nemen van vragen en opdrachten van het desbetreffende tentamen, alsmede zo mogelijk van de normen aan de hand waarvan de beoordeling heeft plaatsgevonden.

3. De examencommissie kan bepalen, dat de inzage of de kennisneming geschiedt op een vaste plaats en op ten minste twee vaste tijdstippen. Indien de betrokkene aantoont door overmacht verhinderd te zijn of te zijn geweest op een aldus vastgestelde plaats en tijdstip te verschijnen, wordt hem een andere mogelijkheid geboden, zo mogelijk binnen de in het eerste lid genoemde termijn.

4. De examinator bewaart schriftelijke tentamens en andere schriftelijke onderdelen van tentamens die meetellen bij de bepaling van de uitslag zoals werkstukken, opdrachten en dergelijke, ten minste twee jaar nadat het tentamen heeft plaatsgevonden. Masterverslagen en -scripties dienen beschikbaar te blijven voor visitaties, accreditaties en de inspecteur en dienen vijf jaar te worden bewaard.

5. Studentendossiers met daarin tentamenbriefjes dienen na het behalen van een examen nog ten minste één volledig kalenderjaar bewaard te worden, met het oog op accountantscontrole.

Artikel 4.7 Vrijstelling

De examencommissie kan een student op diens verzoek, gehoord de desbetreffende examinator, geheel of gedeeltelijke vrijstelling verlenen van een tentamen indien de student:
a. hetzij een qua inhoud en niveau overeenkomstig onderdeel van een universitaire of hogere beroepsopleiding heeft voltooid,
b. hetzij aantoont door relevante werk- of beroepservaring over voldoende kennis en vaardigheden te beschikken ten aanzien van het desbetreffende onderdeel.

Artikel 4.8 Toelating tot en vaststelling van de uitslag van examens

1. Tot het afleggen van het examen wordt de gelegenheid geboden nadat de student voldoende bewijzen overlegt van door hem behaalde onderdelen van dat examen.

2. De examencommissie stelt de uitslag van het examen vast, alsmede de regelen met betrekking tot de wijze waarop de uitslag van het examen wordt vastgesteld.

3. Alvorens de uitslag van het examen vast te stellen kan de examencommissie zelf een onderzoek instellen naar de kennis van de student met betrekking tot een of meer onderdelen of aspecten van de opleiding, indien en voorzover de uitslagen van de desbetreffende tentamens haar daartoe aanleiding geven.

Artikel 4.9 Graad

1. Aan degene die het examen van de masteropleiding met goed gevolg heeft afgelegd wordt de graad "Master of Science (MSc)" verleend. De verleende graad wordt op het getuigschrift van het examen aangetekend.

2. Aan degene die de O-variant als bedoeld in artikel 1.4 met goed gevolg heeft afgelegd, wordt aan de mastergraad de differentiatie Onderzoek toegevoegd.

3. Bij degene die de MT-variant als bedoeld in artikel 1.4 met goed gevolg heeft afgelegd, wordt aan de mastergraad de differentiatie Management & Toepassing toegevoegd.

4. Bij degene die de C-variant als bedoeld in artikel 1.4 met goed gevolg heeft afgelegd, wordt aan de mastergraad de differentiatie Wetenschapscommunicatie toegevoegd.

5. Bij degene die de E-variant als bedoeld in artikel 1.4 met goed gevolg heeft afgelegd, wordt aan de mastergraad de differentiatie Educatie toegevoegd en wordt door het Instituut voor Leraar en School een eerstegraads docentbevoegdheid verleend.

Artikel 4.10 Volgorde onderwijs en tentamens

1. Binnen de MT-variant kan niet eerder worden deelgenomen aan de tentamens van de onderdelen Innovation management en Strategy & Marketing dan nadat de tentamens Business & Society en Organisation Theory zijn behaald.

2. Het afstudeerproject van de MT-variant kan niet eerder worden verricht dan nadat:
a. er een voldoende resultaat behaald is voor en/of vrijstelling is verleend van onderdelen van de desbetreffende masteropleiding met een studielast van tenminste 45 ec waaronder de praktische werkzaamheden in het kader van de onderzoekstage van de opleiding;
b. een voldoende is behaald voor het merendeel van de MT-basisvakken zoals bedoeld in artikel 1.3, lid5 onder b.

3. De stage van de C-variant kan niet eerder worden verricht dan nadat:
a. er een voldoende resultaat behaald is voor en/of vrijstelling is verleend van onderdelen van de desbetreffende masteropleiding met een studielast van tenminste 45 ec waaronder de praktische werkzaamheden in het kader van de onderzoekstage van de opleiding;
b. een voldoende is behaald voor het merendeel van de C-basisvakken zoals bedoeld in artikel 1.3, lid 6 onder b en c.

4. De stages van de E-variant kunnen niet eerder worden verricht dan nadat er een voldoende resultaat behaald is voor en/of vrijstelling is verleend van onderdelen van de desbetreffende masteropleiding met een studielast van ten minste 30 ec waaronder de praktische werkzaamheden in het kader van de onderzoekstage van de opleiding.

Paragraaf 5. Studievoortgang en studiebegeleiding

Artikel 5.1 Studievoortgang

1. De faculteit registreert de individuele studieresultaten van de studenten.

2. De faculteit verschaft elke student ten minste eenmaal per jaar een overzicht van de door hem behaalde studieresultaten.

Artikel 5.2 Studiebegeleiding

De opleiding draagt zorg voor de introductie en de studiebegeleiding van de studenten, die voor de opleiding zijn ingeschreven, mede ten behoeve van hun oriëntatie op mogelijke studiewegen in en buiten de opleiding.

Deel 2: Opleidingsspecifiek deel

Masteropleiding Chemistry

Paragraaf 6. Bepalingen algemeen deel

Op de masteropleiding is het bepaalde in het Algemeen Deel van dit reglement van toepassing voor zover daarvan in de navolgende bepalingen niet wordt afgeweken.

Paragraaf 7. Programma masteropleiding

1. O-variant
De masteropleiding omvat de volgende opleidingsspecifieke onderdelen met de daarbij vermelde studielast:
a. hoofdvak:
- basic en advanced courses (verplicht en keuze) zoals vermeld in de studiegids: 27 ec;
- research project inclusief master thesis, presentatie, literatuursciptie en colloquium: 60 ec;
b. bijvak: optional program (bijvak en/of keuzecolleges) zoals vermeld in de studiegids: 24 ec;

2. MT-variant
De masteropleiding omvat de volgende opleidingsspecifieke onderdelen met de daarbij vermelde studielast:
hoofdvak: research project inclusief master thesis, presentatie, en verplichte vakken zoals vermeld in de studiegids: 54 ec.

3. C-variant
De masteropleiding omvat de volgende opleidingsspecifieke onderdelen met de daarbij vermelde studielast:
hoofdvak: research project inclusief master thesis, presentatie, en verplichte vakken zoals vermeld in de studiegids: 54 ec.

4. E-variant
De masteropleiding omvat de volgende opleidingsspecifieke onderdelen met de daarbij vermelde studielast:
hoofdvak: research project inclusief master thesis, presentatie, en verplichte vakken zoals vermeld in de studiegids: 54 ec.

Paragraaf 8. Vooropleiding

Artikel 8.1 Toelatingseisen masteropleiding

Tot de opleiding worden, onverlet het bepaalde in artikel 9.3, toegelaten:
a. degene die het afsluitend examen van de bacheloropleiding scheikunde aan de RU Nijmegen dan wel de bacheloropleiding scheikunde of scheikundige technologie aan een andere Nederlandse universiteit met goed gevolg heeft afgelegd;
b. degene die in het bezit is van het bewijs van toelating, dat het College van Bestuur voor het desbetreffende studiejaar afgeeft (artikel 9.2);
c. degene met een hbo-diploma chemie of chemische technologie die voldaan heeft aan het schakelprogramma scheikunde van 30 ec.

Artikel 8.2 Bewijs van toelating

Voor het bewijs van toelating komt in aanmerking degene die:
a. in het bezit is van een getuigschrift dat ten minste gelijkwaardig is aan het diploma als bedoeld in artikel 9.1 onder a,
b. of anderszins naar het oordeel van de examencommissie blijk hebben gegeven van geschiktheid voor het volgen van de opleiding,
c. en het bewijs heeft geleverd van voldoende beheersing van de Engelse taal, zoals bepaald in artikel 3.1.

Artikel 8.3 Flexibele instroom in de masteropleiding

1. De examencommissie kan, voor zover de beschikbare onderwijscapaciteit dit toelaat, besluiten dat de student die is ingeschreven voor de bacheloropleiding scheikunde van de RU Nijmegen, kan worden toegelaten tot de masteropleiding chemistry voordat deze met goed gevolg het afsluitend examen van de bacheloropleiding scheikunde heeft afgelegd. Voor studenten die op of na 1 september 2008 zijn begonnen met de genoemde bacheloropleiding geldt daarbij als voorwaarde dat deze toelating alleen mogelijk is wanneer zij niet meer dan 4 jaar voor de betreffende bacheloropleiding staan ingeschreven. Voor de toepassing van het in de vorige volzin bepaalde worden de bacheloropleidingen Scheikunde, Moleculaire Levenswetenschappen en Natuurwetenschappen aan elkaar gelijk gesteld.

2. Toelating is voorts alleen mogelijk, als de student voldoet aan de volgende voorwaarden:
a. er is voldoende resultaat behaald voor en/of vrijstelling verleend van de onderdelen van het bachelorexamen met een studielast van 162 ec;
b. in afwijking van het bepaalde in lid 2.a geldt voor studenten begonnen op 1 september 2002 dat toelating mogelijk is wanneer er voldoende resultaat is behaald voor en/of

vrijstelling is verleend van de onderdelen van het bachelorexamen met een studielast van 150 ec;

3. De student die krachtens dit artikel is toegelaten tot de opleiding, dient uiterlijk een jaar na die toelating het afsluitend examen van de in het eerste lid bedoelde bacheloropleiding met goed gevolg te hebben afgelegd. Wanneer aan deze voorwaarde niet is voldaan wordt de student uitgesloten van deelname aan tentamens van de opleiding totdat het afsluitend examen van genoemde bacheloropleiding met goed gevolg is afgelegd.

Paragraaf 9. Slotbepalingen

Artikel 9.1 Vaststelling en wijzigingen

1. Deze regeling alsmede wijzigingen van deze regeling worden, na advisering van de opleidingscommissie van de opleiding en na instemming van de FGV, door het faculteitsbestuur bij afzonderlijk besluit vastgesteld.

2. Een wijziging van deze regeling heeft geen betrekking op het lopende studiejaar, tenzij de belangen van de studenten daardoor niet onevenredig worden geschaad.

3. Een wijziging kan voorts niet ten nadele van studenten van invloed zijn op enige andere beslissing, die krachtens deze regeling door de examencommissie van de opleiding is genomen ten aanzien van een student.

Artikel 9.2 Overstap van ongedeelde opleiding naar bachelor/master structuur

Een student die aan de opleiding begon vòòr 1 september 2002 kan onder de volgende voorwaarden deelnemen aan de opleiding krachtens deze onderwijs- en examenregeling:
a. behaalde studieresultaten kunnen worden gewaardeerd als vrijstelling voor overeenkomstige onderdelen "nieuwe stijl";
b. deelneming staat open voorzover de gefaseerde invoering van het onderwijs en de tentamens volgens deze regeling dat feitelijk toelaten.

Artikel 9.3 Bekendmaking

De decaan draagt zorg voor een passende bekendmaking van deze regeling, van de regelen en richtlijnen die door de examencommissie zijn vastgesteld, alsmede van elke wijziging van deze stukken.

Artikel 9.4 Voorrang van Nederlandstalige versie

In geval bepalingen in deze Nederlandstalige versie in tegenspraak zijn met hetgeen bepaald in de Engelstalige versie van deze Onderwijs- en Examenregeling, geldt de tekst zoals in deze Nederlandstalige versie is opgenomen.

Artikel 9.5 Hardheidsclausule

De examencommissie kan in bijzondere gevallen ten gunste van de student afwijken van hetgeen in deze Onderwijs- en Examenregeling is bepaald, wanneer toepassing leidt tot onevenredige benadeling of onbillijkheid van zwaarwegende aard.

Artikel 9.6 Inwerkingtreding

Deze regeling treedt in werking op 1 september 2010.

Aldus vastgesteld door het faculteitsbestuur op 12 juli 2010.

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APPENDIX

Gedragscode vreemde taal, als bedoeld in artikel 7.2 sub c WHW (vastgesteld door het College van Bestuur)

Binnen de RU geldt de onderstaande gedragscode:

Artikel 1
Binnen de Radboud Universiteit Nijmegen kan het verzorgen van onderwijs en het afnemen van tentamens en examens in een andere taal dan het Nederlands geschieden indien de specifieke aard, inrichting of kwaliteit van het onderwijs, dan wel de herkomst van de studenten daartoe noodzaakt.

Artikel 2
Een besluit tot het gebruik van een vreemde taal wordt genomen door de decaan van de desbetreffende faculteit, na advies ingewonnen te hebben van de opleidingscommissie. De decaan neemt daarbij de volgende uitgangspunten in acht:
- De noodzaak van het gebruik van een andere taal dan het Nederlands dient vast te staan;
- Tentamens en examens van Engelstalige opleidingen worden in het Engels afgelegd; tentamens van in het Engels gedoceerde vakken worden in het Engels afgelegd, tenzij de examencommissie van de desbetreffende opleiding anders beslist;
- Het anderstalig onderwijs voldoet aan dezelfde kwaliteitseisen als het onderwijs verzorgd in het Nederlands.

Artikel 3
In de onderwijs- en examenregeling van de opleiding wordt het besluit van de decaan verwerkt.

Artikel 4
De decaan van de faculteit brengt jaarlijks het College van Bestuur verslag uit van de door hem genomen besluiten.

Regeling beperking tentamendeelname

Op alle tentamens van de binnen de faculteit verzorgde opleidingen is onderstaande Regeling beperking tentamendeelname van toepassing.

- Studenten zijn verplicht zich voor het tentamen elektronisch aan te melden via KISS tot 7 dagen voor het tentamen. De surveillant dient e.e.a. te controleren en bijschrijvingen op de deelnamelijst worden niet toegestaan. De docent mag slechts tentamenopgaven uitreiken aan studenten, die vooraf aangemeld zijn.
- Studenten kunnen zich in uitzonderingsgevallen uiterlijk 1 dag voor het tentamen persoonlijk bij de facultaire studentenadministratie aanmelden voor het tentamen. De kosten hiervan bedragen € 15,- en dienen direct te worden voldaan. De student ontvangt een bewijs van inschrijving dat hij terstond bij de docent dient in te leveren.
- Studenten dienen zich af te melden als ze niet deelnemen aan een tentamen:
  - tot 7 dagen voor het tentamen in Kiss,
  - daarna tot 1 dag voor het tentamen wordt afgenomen. Deze afmelding geschiedt uitsluitend schriftelijk/elektronisch bij de docent.
  Als een student niet deelneemt zonder zich tijdig te hebben afgemeld, verspeelt hij/zij een tentamenkans (1 van de 2).
- Indien het tentamen na 2 keer nog niet is behaald, dient de student voor iedere volgende keer dat hij/zij aan het tentamen wil deelnemen minimaal 2 maanden voor de tentamendatum een schriftelijk verzoek in te dienen bij de examencommissie van zijn/haar opleiding. In de regels stelt de examencommissie bij de inwilliging van dit verzoek aanvullende eisen vast ten aanzien van de door de student te treffen voorbereidingen op dit tentamen.
- De studentenadministratie is verantwoordelijk voor het registreren van het aantal keren, dat een student heeft deelgenomen aan een tentamen.
- Deze regeling betreft zowel mondelinge als schriftelijke tentamens.
- Deze regeling geldt voor alle studenten van de Faculteit Natuurwetenschappen, Wiskunde en Informatica.
- Indien de student kan aantonen door overmacht verhinderd te zijn geweest deel te nemen aan het tentamen dan wel zich niet tijdig heeft kunnen afmelden, kan de examencommissie besluiten de inschrijving niet als deelname te beschouwen.
- Deze regeling treedt in werking met ingang van 1 september 2010 voor wat betreft tentamens waarvoor studenten zich na die datum voor de eerste maal inschrijven.

6.2 Rules and regulations of the Board of Examinees

Regels en richtlijnen van de examencommissie

artikel 1 - toepassingsgebied
Deze regels en richtlijnen zijn van toepassing op de tentamens en examens in de opleiding scheikunde van de Radboud Universiteit Nijmegen, hierna te noemen 'de opleiding'.

artikel 2 - begripsomschrijving
In deze regels en richtlijnen wordt verstaan onder:
- examenregeling: de onderwijs- en examenregeling voor de in artikel 1 genoemde opleiding,

vastgesteld door het faculteitsbestuur Natuurwetenschappen, Wiskunde en Informatica;
- examinandus: degene die zich onderwerpt aan een tentamen of examen;
- tentamen: het onderzoek naar en de beoordeling van kennis, vaardigheden en inzicht, ongeacht de vorm waarin dit onderzoek plaatsvindt;
- student: degene die als zodanig is ingeschreven voor de opleiding;
- examinator: examinator als bedoeld in artikel 7.12 lid 3 WHW.

artikel 3 - samenstelling examencommissie
Leden van de examencommissie zijn de docenten betrokken bij het onderwijs van de opleiding scheikunde. Zij worden benoemd door het faculteitsbestuur NWI.

artikel 4 - dagelijkse gang van zaken examencommissie scheikunde
De examencommissie wijst uit haar midden een lid aan dat belast is met de behartiging van de dagelijkse gang van zaken van de examencommissie.

artikel 5 - cijfers
De cijfers die voor de beoordeling van de tentamens uitsluitend gebruikt mogen worden zijn: 10,0; 9,5; 9,0; 8,5; 8,0; 7,5; 7,0; 6,5; 6,0; 5,0; 4,0; 3,0; 2,0; 1,0; voldaan.

artikel 6 - vaststelling uitslag examen
1. De examencommissie stelt de uitslag van het examen vast bij gewone meerderheid van stemmen.
2. Staken de stemmen, dan is de examinandus afgewezen.
3. Indien een tentamen meer dan eenmaal is afgelegd, neemt de examencommissie bij de vaststelling van de uitslag van het examen alleen de bij de laatste gelegenheid voor dat tentamen afgegeven uitslagverklaring in beschouwing.
4. Men is geslaagd voor het propedeutisch examen scheikunde:
a. indien de uitslagverklaringen van alle tentamens behorende bij het examen tenminste '6,0' of voldaan luiden;
b. danwel indien de uitslagverklaring van één van de tentamens behorende bij het examen '5,0' luidt en compensatie plaatsvindt doordat tenminste eenmaal de uitslagverklaring '7,0' of hoger luidt, en de uitslagverklaringen van de overige tentamens behorende bij het examen tenminste '6,0' luiden.
c. In alle overige gevallen is de geëxamineerde afgewezen voor het propedeutisch examen scheikunde.
d. In bijzondere gevallen kan de examencommissie afwijken van het bepaalde in het voorgaande lid.
5. Men is geslaagd voor het bachelor examen scheikunde:
a. indien de uitslagverklaringen van alle tentamens behorende bij het examen tenminste '6,0' of 'voldaan' luiden;
b. In alle overige gevallen is de geëxamineerde afgewezen voor het bachelor examen scheikunde.
c. In bijzondere gevallen kan de examencommissie afwijken van het bepaalde in het voorgaande lid.
6. Men is geslaagd voor het master examen indien de uitslagverklaringen van alle tentamens tenminste '6,0' of 'voldaan'luiden.
7. Vrijstellingsprogramma: men is geslaagd voor het masterexamen scheikunde indien de

uitslagverklaringen voor alle tot het vrijstellingsprogramma behorende tentamens tenminste '6,0' of 'voldaan' luiden.

artikel 7 - toelating tot afleggen van tentamens van het bachelor examen scheikunde
1. Een student die minder dan 45 ec heeft behaald van het propedeutisch examen kan toestemming vragen aan de examencommissie om toch tot practica en tentamens van het tweede jaar van de bachelor te worden toegelaten: deze toestemming wordt verleend wanneer tenminste 30 ec van het propedeutisch examen zijn behaald en nadat de student in overleg met de studieadviseur een studieplanning heeft gemaakt om binnen 2 jaar gerekend vanaf het eerste moment van inschrijving voor de scheikundestudie zijn propedeutisch examen te behalen.
2. In bijzondere gevallen kan de examencommissie afwijken van het bepaalde in het voorgaande lid.

artikel 8 - judicium
Aan de uitslag van een examen kan door de examencommissie een judicium worden toegevoegd. De toe te kennen judicia luiden: "bene meritum" bij een gemiddelde van alle onderdelen van 7,5 tot 8,0; "cum laude" bij een gemiddelde van alle onderdelen van 8,0 tot 9,0; "summa cum laude" bij een gemiddelde van alle onderdelen van tenminste 9,0. Bij de judicia "cum laude" en "summa cum laude" mag geen cijfer lager dan 6,0 op de cijferlijst voorkomen. Bij de judicia "cum laude" en "summa cum laude" bij de master dient het cijfer van de majorstage tenminste 8,5 te bedragen. Over toekenning van een judicium besluit de examencommissie bij gewone meerderheid van stemmen.

artikel 9 - aanmelding tentamen
1. Deelneming aan een schriftelijk tentamen kan pas plaatsvinden na deugdelijke en tijdige aanmelding bij de facultaire studentenadministratie.
2. Als tijdige aanmelding geldt een elektronische opgave tenminste 7 dagen voor het tijdstip waarop het desbetreffende tentamen zal worden afgenomen. De examencommissie kan in bijzondere gevallen toestaan dat een latere aanmelding niettemin als tijdig wordt aangemerkt.

artikel 10 - vrijstellingsverzoek
1. Een verzoek om vrijstelling van een tentamen of examen wordt schriftelijk met redenen omkleed ingediend bij de examencommissie.
2. De examencommissie beslist binnen 3 maanden na ontvangst van het verzoek. De verzoeker wordt onverwijld in kennis gesteld van de beslissing.

artikel 11 - orde tijdens een tentamen
1. De examencommissie zorgt, dat ten behoeve van de schriftelijke examinering surveillanten worden aangewezen, die erop toezien dat het tentamen in goede orde verloopt. De examencommissie kan deze zorg opdragen aan de desbetreffende examinator.
2. De examinandus is verplicht zich op verzoek van de surveillant te legitimeren door middel van zijn collegekaart.
3. De examinandus is verplicht de aanwijzingen van de examencommissie c.q. de examinator, die voor de aanvang van het tentamen zijn gepubliceerd, alsmede aanwijzingen die tijdens het tentamen en onmiddellijk na afloop daarvan worden gegeven, op te volgen.
4. Volgt de examinandus een of meer aanwijzingen als bedoeld in het voorgaande lid niet op,

dan kan hij door de examencommissie c.q. de examinator worden uitgesloten van de verdere deelname aan het desbetreffende tentamen. De uitsluiting heeft tot gevolg dat er geen uitslag wordt vastgesteld van dat tentamen en dat de examinandus wordt uitgesloten van deelneming aan dat tentamen. Voordat de examencommissie c.q. de examinator een besluit tot uitsluiting neemt, stelt zij de examinandus in de gelegenheid te worden gehoord.
5. De tentamenopgaven mogen door de examinandus na afloop van het tentamen worden meegenomen indien de aard van de opgaven dit toelaat.

artikel 12 - fraude
1. Er is sprake van fraude wanneer als gevolg van handelen of verzuim van handelen van een examinandus het vormen van een juist oordeel omtrent zijn kennis, inzicht en vaardigheden geheel of gedeeltelijk onmogelijk wordt.
2. In geval van fraude tijdens het afleggen van een tentamen kan de examencommissie de examinandus uitsluiten van verdere deelname aan het tentamen.
3. De beslissing inzake uitsluiting wordt genomen naar aanleiding van door de examinator of surveillant geconstateerde of vermoede fraude.
4. In spoedeisende gevallen kan de examinator een voorlopige beslissing tot uitsluiting nemen op grond van zijn constatering of, indien van toepassing, een mondeling verslag van de surveillant. Desgevraagd draagt de examinator er zorg voor dat, binnen een redelijke termijn, het verslag van de geconstateerde fraude op schrift wordt gesteld en in afschrift aan de examinandus wordt verstrekt.
5. De examinandus kan aan de examencommissie verzoeken de uitsluiting ongedaan te maken.
6. Voordat de examencommissie een beslissing neemt op een verzoek, als bedoeld in het vijfde lid, stelt zij de examinandus en de examinator in de gelegenheid te worden gehoord.
7. Een uitsluiting heeft tot gevolg, dat geen uitslag wordt vastgesteld voor het in het tweede lid bedoelde tentamen.

artikel 13 - wijziging regels en richtlijnen
Geen wijzigingen in deze regeling vinden plaats, die van toepassing zijn op het lopende studiejaar, tenzij de belangen van studenten hierdoor redelijkerwijs niet worden geschaad.

artikel 14 - onvoorzien
In gevallen waarin deze 'regels en richtlijnen van de examencommissie scheikunde' niet voorzien danwel twijfel bestaat over de interpretatie ervan, beslist de examencommissie scheikunde.

artikel 15 - inwerkingtreding
Deze regels en richtlijnen treden in werking op 30 augustus 2010 voor studenten die beginnen met de studie op 30 augustus 2010. Studenten begonnen voor het studiejaar 2010/2011 worden verwezen naar de 'Regels en richtlijnen' zoals die zijn opgenomen in de studiegids van eerdere studiejaren.

7 Important names and addresses

7.1 Important persons and committees

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Heyendaalseweg 135, 6525 AJ Nijmegen
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Director of Education for Chemistry
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Study coordinator chemistry/student advisor
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dr. R. de Gelder (René), director of education in chemistry
prof.dr. G. Martens (Gerard), director of education in molecular life sciences
prof.dr. J. van Opstal (John), director of education in natural science
3 student-assessors (1 student from each field of study)
secretary: dr. L. Laarhoven (Luc-Jan), e-mail: l.laarhoven@science.ru.nl

Committee of Advise for Molecular Sciences
3 students (1 student from each field of study)
dr. W. Boelens (Wilbert), mrs.prof.dr. L. Buydens (Lutgarde) and dr. N. Dam (Nico), (lecturers)
dr. L. Laarhoven (Luc-Jan), mrs.drs. G. Coppens (Gerrie) en mrs. W. Philipse (Wilma), (study coordinators),
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Board of Advise
dr.mr. J.H.A.A. Uitzetter (Senior legal advisor, Ministry of Economic Affairs, Directorate-general for Entrepreneurship and Innovation)
prof. dr. Pedro Hermkens (MSD, Medicinal Chemistry, Oss; also professor of Industrial Pharmaceutical Chemistry, Radboud University)
prof.dr. Edwin Cuppen (professor of human genetics and genome biology, Netherlands Institute for Developmental Biology, Hubrecht Laboratory, Utrecht)
dr. Wim-Jan Koot (Business Development, UMC, St. Radboud, Nijmegen
dr. Johan van de Ven (Consultant)

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dr. D. Löwik (Dennis)
dr. E. van Eck (Ernst)
dr. H. Meekes (Hugo)
Kess Marks
Pjotr Michels
Lise Schoonen
Anne Stultiens
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Board of Examinees of Chemistry
prof.dr. S. Wijmenga (Sybren), chairman
mrs.prof.dr. L. Buydens (Lutgarde)
prof.dr. A. Kentgens (Arno)
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prof.dr. A. Rowan (Alan)
prof.dr. F. Russel (Frans)
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room HG 00.134
tel.: 3652247/3753392

Student affairs offices
Comeniuslaan 4, tel.: 3612345
for more information: http://www.ru.nl/studenten

8 Appendix

8.1 Academic Calendar

From August 30, 2010, until August 31, 2011

First day of education: August 30, 2010
Last day of education: July 8, 2011

Period 1: August 30 until November 5, 2010
Period 2: November 8, 2010 until January 28, 2011
Period 3: January 31 until April 15, 2011
Period 4: April 18 until July 8, 2011

Autumn holiday: October 18 until 22, 2010
Christmas holiday: December 20, 2010 until January 2, 2011
Spring holiday: March 7 until 11, 2011
Good Friday: April 22, 2011
Easter Monday: April 25, 2011
May holiday: May 2 until 6, 2011
Ascension: June 2 and 3, 201
Whit Monday: June 13, 2011
Resit examination period: August 15 until 26, 2011

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