Faculty of Science

Prospectus 2008 - 2009

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.
Part of this guide is written in Dutch.

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.

August 2008
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 obtained their bachelor certificate elsewhere: an extract from the population register or register of persons, or a copy of the birth 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, 2009, 12:00 hours

There are approximately 10 examinations scheduled each year. The diplomas are presented once every three months. 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 examinations
September 29, 2008 (final date of registration September 15, 2008)
October 27, 2008 (final date of registration October 13, 2008)
November 24, 2008 (final date of registration November 10, 2008)
December 15, 2008 (final date of registration Dember 1, 2008)
January 26, 2009 (final date of registration January 12, 2009)
February 16, 2009 (final date of registration February 2, 2009)
March 30, 2009 (final date of registration March 16, 2009)
April 20, 2009 (final date of registration April 6, 2009)
May 25, 2009 (final date of registration May 11, 2009)
June 29, 2009 (final date of registration June 15, 2009)
August 31, 2009 (final date of registration May 29, 2009)

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. The procedure to be followed is described in the Vademecum. In addition to the Examination Appeals Board, there is a Higher Education Appeals Tribunal in The Hague (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: Heyendaalseweg 135, HG00.154, 024-3652388
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
The Master's of Science graduating in 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 Material Science
- Biochemistry
- Biomolecular Chemistry
- Bio-Organic Chemistry
- Biophysical Chemistry
- Bioinformatics
- Molecular Pharmacology and Toxicology
- Molecular Materials
- Molecular and Laser Physics
- Supra Molecular Chemistry
- Synthetic Organic Chemistry
- Solid State Chemistry
- Solid State NMR
- 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.

Basic and advanced courses of the Major are to be done in the Research Institute; 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.

Capita selecta: Analytical Chemistry

Course ID: **SM104** *3 ec* in mutual agreement with student(s) prof. dr. L.M.C. Buydens

Teaching methods
- 8 hrs lecture
- 8 hrs problem session

Prerequisites
Chemometrie 1

Objectives
After completing the course, the student should be able to
- critically assess the content of scientific papers and lectures
- summarise the main points of scientific papers
- present these clearly and concisely in a lecture

Contents
Students are given three recent overview papers on one subject from analytical chemistry, and present these in two lectures. The course aims at broadening the background in analytical chemistry.

Subjects:
- modern analysis techniques
- new applications of analysis techniques

Literature
Relevant papers will be handed out.

Examination
Presentation, and participation in discussion.

Pattern recognition for the natural sciences

Course ID: **SM114** *6 ec* Fall/Winter dr. H.R.M.J. Wehrens
prof. dr. L.M.C. Buydens

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

Teaching methods
- 20 hrs lecture
- 32 hrs computer course

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
- "The Elements of Statistical Learning", by Hastie, Tibshirani and Friedman (Springer 2003)

Examination
Written exam.

Capita selecta: Apoptosis

Course ID: **BM004B** *3 ec* september 12 - november 28, 2008 dr. F. van Kuppeveld
dr. W.C. Boelens
dr. H. Dolstra

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
- Suppression and Induction of Apoptosis by Viruses
- Apoptosis and Inflammation

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

Capita selecta: Signal transduction and transport

Course ID: **BM016B** *3 ec* march 27 - july 3, 2009 dr. P.H.G.M. Willems
dr. A.P.R. Theuvenet

Teaching methods

- 20 hrs lecture
- 60 hrs individual study period

Objectives

Students gain knowledge and insight into the biophysical aspects of signal transduction by polypeptide growth factors, neurotransmitters and hormones. Emphasis lies on the use of patch-clamp and cellular imaging techniques in biomedical research. Lectures will be based on most recent scientific papers.

Contents

Part A.'Electrical aspects of Signaltransduction'
(Coordinator Theuvenet, a.theuvenet@science.ru.nl, 3652013)

1. Bioelectricity and cellular growth regulation
2. Cell communication via gap junctions and cancer
3. Ion channels as signal transducers
4. Ion channels and apoptosis
5. Ion channels and disease, channelopathies

Part B.'Cellular Imaging in Four Dimensions'
(Coordinator Willems, p.willems@ncmls.ru.nl, 3614589)

I. Principles of fluorescence and electron microscopy

1. Introduction in microscopy
2. Genetically-encoded green fluorescent proteins

II. Microscopy: Applications in biology and medicine

3. Imaging of Intracellular Protein Routing in Health and Disease
4. Imaging of Cellular Ion Homeostasis in Health and Disease
5. Imaging of Mitochondrial Plasticity in Health and Disease

Examination

The final written exam includes both parts of the course.

Extra information

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

Capita selecta:
Post-transcriptional regulation in health and disease

Course ID: **BM027B** *3 ec* march 27 - july 3, 2009 dr. N.H. Lubsen
prof. dr. G.J.M. Pruijn

Teaching methods
20 hrs interactive lectures
60 hrs individual study period

Prerequisites
Biochemistry and Molecular Biology II (BMB-II)

Objectives
After completing the course the student is aware of the identification of post-transcriptional regulation as a major factor in control of health and disease and has knowledge of the various ways in which the levels of gene products can be regulated post-transcriptionally. The student has learned that cell responses to environmental changes are fine-tuned by subtle modifications of RNA and proteins, and that disturbance of the fine-tuning may promote acute and chronic disease (inflammation, auto-immunity, cancer).

Subjects
The course will be focussed on five subjects selected from the following list:
Error-prone macromolecular synthesis:
- molecular misreading
- leaky scanning during translation initiation

RNA modifications and processing:
- Post-transcriptional modification of structural RNAs
- RNA editing
- Alternative splicing of pre-mRNA
- Nonsense mediated decay
- Regulation of gene expression by microRNAs; RNA granules, P-bodies

Translation regulation during stress
Protein modifications and processing
- Post-translational modifications and subcellular localization
- Post-translational modifications and disease
- Proteolytic activation of enzymes and cellular signaling

Literature
Hand-outs, distributed via blackboard

Examination
Written examination

Extra information
contact: Prof.dr. N.H. Lubsen, 3616850, N.Lubsen@science.ru.nl

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

Course ID: **LM012** *3 ec* March - June 2009

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.

Contents
The course will be focused on two types of tissues: skin and cartilage

Subjects
- 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

Course Working with Radionuclides Level 5B

Course ID: **BM007B** *2 ec* first semester A.L.M. de Leeuw
W.P. Moerman

Website
www.ru.nl/amd

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

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 following materials in dutch will be sent to each student who applies for the course.
- Cursistenhandleiding cursus Stralingshygiëne niveau 5B (dictaat)
- Practische Stralingshygiëne, G. Brouwer en J. van den Eijnde (ISBN 9031333352)

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)

Capita selecta:
Molecular biology: Gene expression, chromatin and disease

Course ID: **BM009B** *3 ec* september 12 - november 28, 2008 C. Logie
dr. G.J.C. Veenstra
dr. M.A.E. Lohrum

Teaching methods
2x12 hrs of lectures, 2x28 hrs study time

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** *4 ec* Spring prof. dr. J. de Vlieg
dr. G. Schaftenaar

Teaching methods
- 17 hrs lecture
- 25 hrs computer course

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/CoMFA, 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 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 several 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 NV Organon, part of Schering-Plough corporation.

Literature
Material is handed out during the course.

Examination
Presence at lectures and practicals mandatory.
Team presentation for those who do the 3.0 ec variant.
After completing the course, there is a supplement of 1.0 ec; examination is a presentation (code CMBI102).

Bioinformatics of protein structure

Course ID: **CMBI103** *4 ec* Spring prof. dr. G. Vriend

Teaching methods
- 24 hrs lecture

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.

Bioinformatics seminars: data, techniques and applications

Course ID: **CMBI104** *4 ec* Autumn prof. dr. G. Vriend

Teaching methods
- 24 hrs lecture

Prerequisites
BSc in chemistry or molecular life sciences or natural sciences

Objectives
- After following the seminar series, the students will have a broad overview over the molecular and biomolecular bioinformatics possibilities, and the research fields of the four bioinformatics groups of the CMBI.
- The students will be able to apply the theory explained in the seminars to solve simple problems from the every day practice of molecular and biomolecular informatics.

Contents
There are 12 seminars of 2 hours (6 EC), but students can also follow 6 seminars (3 EC) or 8 seminars (4 EC).
The topics are (see also website www.cmbi.ru.nl/edu/seminars):
- Bacterial Genomics
- Comparative Genomics
- Homology modelling and structure validation>
- Computational Drug Discovery
- Genome annotation and regulation
- Exploring Protein Sequences
- Force Fields
- Quantum mechanical calculations
- Docking techniques
- Genome rearrangements
- Phylogenomics
- Systems Biology

Literature
Material is handed out during the course

Examination
An assigment is handed out after each seminar. The final grade for the seminar series is determined by averaging the grades from the 12 assignments.

Instrumental analysis for molecular chemistry

Course ID: **SM015A** *3 ec* Autumn dr. M.C. Feiters

Teaching methods
- 16 hrs problem session
- 10 hrs lecture

Prerequisites
- SRM4
- 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.

Physical organic and supramolecular chemistry

Course ID: **SM023B** *3 ec* November-December 2008 prof. dr. R.J.M. Nolte
dr. J.J.L.M. Cornelissen

Teaching methods
- 18 hrs lecture

Contents
This course gives an overview of modern developments in physical organic and supramolecular chemistry, and is meant as an extension of the 'Advanced Organic Chemistry' course. The topics are based on the recent literature. Subjects that will be discussed include self assembling molecular systems, host-guest chemistry, supramolecular materials and biomimetic catalysis.

Literature
Lecture notes and original literature.
Anslyn & Dougherty 'Modern Physical Organic Chemistry', University Science Books, 2006

Examination
Written examination.

Polymer chemistry

Course ID: **SM019A** *3 ec* January-February 2009 prof. dr. ir. 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 first part of the course Polymer Chemistry will give an introduction into different aspects of this multidisciplinary area, such as history, properties and applications of polymers. The preparation of the most common polymers will be discussed from a molecular point of view. The relationship between synthetic methodology and macromolecular properties and, as a result, between synthesis and applications will be emphasized. The second part deals with some special topics of recent developments in the field of polymer chemistry.
Topics:
- chain polymerization
- radical polymerization
- ionic polymerization
- coordination polymerization
- step polymerization
- ring opening polymerization

Special topics, such as
- controlled polymerization mechanisms
- dendrimers
- biopolymers

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

Examination
Written examination.

Application of metal-catalysis in natural product synthesis

Course ID: **SM018A** *3 ec* March/April 2009 prof. dr. F.P.J.T. Rutjes

Teaching methods
- 16 hrs lecture

Prerequisites
SRM1, SRM2, SRM3, Syntheseconcepten 2, Organische Chemie 1, or the equivalent thereof.

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* May-June 2009 prof. dr. A.E. Rowan
dr. R. de Gelder
dr. P.H.J. Kouwer

Teaching methods
- 30 hrs lecture

Prerequisites
Organic chemistry 3, Supramolecular chemistry

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 optoelectonic 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. As part of the course expert guest speakers from companies and other universities will 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* dr. M.C. Feiters

Teaching methods
- 26 hrs lecture

Prerequisites
- SRM4
- organische chemie 1
- 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
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

Advanced organic chemistry

Course ID: **SM024A** *6 ec* September 2007-June 2008

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

Teaching methods

- 170 hrs problem session

Objectives

After completing the course the student will be able to solve independently and critically most of the organic chemistry problems that they may come across during the master program in organic chemistry, in particular those relating to mechanisms of important and complex reactions in organic chemistry and their regio-, stereo- and enantioselectivity.
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 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. 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 31 to 42.
Before the course, the students are expected to familiarize themselves with chapters 1-30 of Clayden, which are considered to discuss the topics already covered in the bachelor phase.

Literature

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

Examination

Written examination. Workshops and lectures are a preparation for the bimonthly exams. A minimum of 3 passed exams is required to pass the course.

Chemical Biology

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

dr. F.L. van Delft
prof. dr. F.P.J.T. Rutjes
dr. J.J.L.M. Cornelissen
dr. D.W.P.M. Lowik
dr. W.C. Boelens
Prof.dr. R. Brock

Teaching methods
- 20 hrs lecture
- 16 hrs problem session
- 400 hrs laboratory course

Objectives
After completing the course, the student will be able to deal with theoretical and practical aspects in the field of chemical biology. He has a comprehensive overview of current trends and important developments in this field, and is able to apply them 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. Molecular imaging and virus chemistry, 4. Fluorescent probes, 5. Protein engineering.

Literature
Handouts, scientific articles.

Examination
Presentations (both case studies and research project), as well as the practical work during the research project.

Extra information
The full course covers a whole months 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 individually 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 presentations (both case studies and research project), as well as the practical work during the research project.

Advanced crystallography

Course ID: **SM155** *4 ec* Spring dr. R. de Gelder
dr. H.L.M. Meekes
prof. dr. E. Vlieg

Teaching methods
- 30 hrs lecture

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", second edition (Oxford University Press, 2001)
- 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: **SM023C** *5 ec* second semester prof. dr. A.P.M. Kentgens
prof. dr. S.S. Wijmenga

Teaching methods
- 30 hrs lecture
- 10 hrs question session

Prerequisites
Mandatory: Magnetische Resonantie I
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: **SM024** *3 ec* Spring prof. dr. S.S. Wijmenga

Teaching methods
- 30 hrs lecture

Prerequisites
Structuur Biomoleculen, Magnetische Resonantie I, Structuur Functie en Biomoleculen, 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.

Contents
This course treats the practical aspects of the application of advanced multidimensional NMR to the study of biomolecular structure, function, and interactions. This 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'. 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 lecture

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.

Group theory for physical chemists

Course ID: **SM124** *5 ec* Spring or Autumn in mutual agreement with student(s) dr. ir. G.C. Groenenboom

Teaching methods
- 30 hrs lecture
- 30 hrs problem session

Prerequisites
lineaire algebra

Objectives
Recognition of molecular symmetry and its use in solving the Schrodinger equation.

Contents
- Introduction to point groups and their irreducible presentations.
- Application to molecular orbital theory.
- Concept of feasible permutations and the permutation-inversion group.

Literature
- F.A. Cotton, 'Chemical applications of group theory', 3rd ed., 1990, Wiley.
- P.R. Bunker, P. Jensen, 'Molecular symmetry and spectroscopy, 1998, NRC Research Press.

Spectroscopy and theory of molecular vibrations and rotations

Course ID: **SM124A** *5 ec* Spring or Autumn in mutual agreement with student(s) dr. ir. G.C. Groenenboom

Teaching methods
- 15 hrs lecture
- 15 hrs problem session

Prerequisites
quantummechanica en chemische binding 1, 2, 3

Objectives
A deeper understanding of the relation between nuclear motion and spectra.

Contents
Subjects:
- Spectroscopy of igid rotor and harmonic oscillator.
- Wilson's GF method.
- Eckart conditions and Watson's hamiltonian.
- Extension to floppy molecules and their large amplitude motion.

Literature
D. Papousek, M.R. Aliev, 'Molecular vibration - rotational spectra', 1982, Elsevier.

Angular momentum theory

Course ID: **SM136** *4 ec* in mutual agreement with the student(s) dr. ir. G.C. Groenenboom

Teaching methods
- 24 hrs lecture

Prerequisites
Chemische binding 1, 2 en 3 and moleculaire quantum mechanica;
Group theory is helpful but not required.

Objectives
The student is able to exploit rotational symmetry to solve atomic and molecular quantum mechanical problems.

Contents
Symmetry can often be exploited to simplify or solve Atomic and Molecular quantum mechanical problems and "group theory" is the mathematical tool that is used. In quantum mecha-nics there is a connection between symmetries and observables. In this course we study ro-tational symmetry and the associated observable angular momentum. The mathematical groups related to this symmetry are known as SO(3) (rotation in three dimensions) and SU(2) (electron spin). The following topics are treated:
- Rotations, infinitesimal rotations, SO(3), SU(2)
- Angular momentum operators and their commutation relations
- Spherical harmonics and rotations of molecules
- Rotation operators and their irreducible representations (Wigner D-matrices)
- Clebsch-Gordan coupling of angular momenta
- Spherical tensor operators
- The Wigner-Eckart theorem
- 3-j, 6-j, and 9-j symbols
- density matrices and observables

Literature
- R. N. Zare, 'Angular Momentum', (1988, Wiley, New York)
- D. M. Brink and G. R. Stachler, 'Angular Momentum', (1962, Clarendon, Oxford)
- L. C. Biedenharn and J. D. Louck, 'Angular Momentum in Quantum Physics', (1981, Addison-Wesley, Reading)
- K. Blum, 'Density Matrix Theory and Applications', (1981, Plenum, New York)
- G. C. Groenenboom, 'Angular Momentum Theory and Applications', lecture notes (pdf online)
- P. E. S. Wormer, 'Angular Momentum Theory', lecture notes (pdf online)

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

Study Tour Chemistry

Course ID: **SM300** *4 ec*

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* first 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 address them in a philosophical way. 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
By claiming that all life forms have developed from lower forms thanks to a blind process of natural selection, Darwin's *Origin of Species* (1859) opened up a whole box of implicit problems. This course is devoted to studying one set of them, namely to the implications of evolutionary theory for the human mind. Questions that Darwin's readers understood to be pressing are: Doesn't evolutionary theory abolish the soul? If so, what then is the mind? Are mental states just inactive shadows of brain states? And what then of free will? Is it a figment of imagination? But if there is no free will, what then should we do with ethics, which is based on the assumption that we are free to choose between different courses of action? In this course, we will look at the very diverse 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 two reaction papers and a concluding essay.

Extra information
College: 05/09/08 tm 28/11/08 friday 08.45-10.30

Science & Literature (Philosophy 2)

Course ID: **FFII205** *3 ec* third quarter prof. dr. H.A.E. Zwart
S.A.J. Segers

Website
www.filosofie.science.ru.nl

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

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
Thursday 08.45-10.30

Philosophy of Landscape and Nature

Course ID: **FFIL209A** *3 ec* first quarter dr. M.A.M. Drenthen
S.A.J. Segers

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

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

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:
- The relation between environmental science and environmental ethics
- Basic attitudes toward and images of nature, anthropocentrism vs. ecocentrism
- Intrinsic value of nature: subjective? objective?
- The 'social construction of nature'
- Holism and deep ecology
- The conflict between animal ethics and ecological ethics
- Aesthetic reasons for environmental protection
- Nature development, biodiversity and the concept of wildness
- Bioregionalisme en the Ethics of Place

Examination
Attendance is mandatory. Grades will be based on group presentation (40%), written assignments (40%) and participation in class discussions (20%). There will be no final exam. Students have to apply for this course via Blackboard, at least two weeks before the start of the course. Maximum number of applicants.
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
This course can be substituted by other advanced philosophy courses

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

Objectives
Students should gain some basic insights in globalization processes and their impact on the possibilities and problems of sustainable development in its ecological, economic and social dimensions. They should be able to indicate and discuss issues of global ethics such as climate change, world trade, and food security.

Contents
Sustainable development should at least encompass three dimensions, the environmental dimension (conservation), the economic dimension (growth), and the social dimension (equity), or Planet, Profit, People. These dimensions or pillars of sustainable development will be studied through the 2002 book *One World. The Ethics of Globalization* by famous philosopher Peter Singer. In this book, Singer argues that in an era of globalization we should develop an ethics without borders - a 'one-world-ethics'. To examine the most pressing issues of such a global ethics, texts of Thomas Pogge, Martha Nussbaum and others will be studied in addition to Singer's book. To provide these issues with concrete substance, lectures about these texts will be alternated with lectures on the impact of globalization on local communities in developing countries with respect to water management, land use, food security and so on.

Literature
Peter Singer, *One World. The Ethics of Globalization*. Yale University Press. 2004 (2nd edition).
Plus papers from Pogge, Nussbaum and so on.

Examination
Van studenten wordt verwacht dat zij de literatuur lezen en bestuderen, een presentatie verzorgen en een bijdrage leveren aan de organisatie van een afsluitende discussie met vertegenwoordigers van milieu-organisaties zoals Greenpeace, Milieudefensie en Natuur en Milieu.
Students should study the literature, participate in discussions, make at least one presentation, and write a brief essay.

Extra information
Friday 10.30-12.30 06/02/09 - 24/04/09

Philosophy 2 (for Physicists)

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

Teaching methods
- 2 hrs personal study counseling
- 20 hrs lecture
- 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 but do not speak Dutch are requisted to sign up for this course in time, and to make themselves known as such.

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.

Philosophy of Watermanagement

Course ID: **FFIL212** *3 ec* week 5 (January 26 - 30) and week 6 (Februari 2-6)

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.
Students have to apply for this course via Blackboard, at least one month before the start of the course.
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 Philosophy of Landscape and Nature (FFIL209) te volgen.

Business & Society

Course ID: **FMT001B** *5 ec* fall semester dr. G.A.N. Vissers
prof. dr. B. Dankbaar

Teaching methods
- 28 hrs lecture

Prerequisites
Master student FNWI

Objectives
The aim of this course is for students to:
- Develop an understanding of the processes of mutual influence that exist between science, technology, economy, and society, and get acquainted with concepts and theories from economics and social sciences that seek to explain these processes.

Contents
Of the courses within Management & Technology curriculum, Business & Society is the first to be given. The course will provide students with an overview of theories and perspectives concerning the position and the functioning of firms and industries in the wider economy, national and international, and in society. In particular, themes from industrial history and industrial economy will be explored, but also issues related to current concepts like 'knowledge economy' and 'globalization'. These subjects will be discussed, partly on the basis of project assignments, and their implications for the university, firms, and government will be considered.
Content:
- Economic history, especially industrial development in the 19th and 20th century
- Industrial revolutions and economic change
- National and regional differences within and between market economies
- National and sectoral systems of innovation
- The interactions between technology and organization
- The interactions between politics, society, and economic developments

Literature
Thomas K. McCraw (ed.), Creating Modern Capitalism. How Entrepreneurs, Companies, and Countries Triumphed in Three Industrial Revolutions, Harvard University Press, 1997

Examination
Written assignment and group presentation

Organization Theory

Course ID: **FMT002B** *5 ec* spring semester prof. dr. B. Dankbaar

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
Gareth Jones, Organization Theory, Design and Change, 5th edition

Examination
Written examination and discussion of a business case

Innovation management

Course ID: **FMT003B** *5 ec* fall semester ir. L.J. Lekkerkerk

Teaching methods
- +/- 15 interactive lectures, or workshops (see for detail Black Board)
- assignments

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: **FMT004B** *5 ec* fall semester dr. P.E.M. Ligthart
dr. ir. N.G. Migchels

Teaching methods
- 30 hrs question session

Prerequisites
- Master student FNWI
- BEM & Organisatiekunde 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
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: **FMT005B** *5 ec* spring semester drs. R.A. Minnaar

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.

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

Needles, Powers & Crosson; Principles of Accounting 2008e, Tenth Edition; Houghton Mifflin; ISBN 0-618-73661-1989-4

Examination

- A final written 3 hour exam with open questions.
- Bonus points based on assignments, cases, participation and mid-term test.

Research Strategy and Management

Course ID: **FMT011A** *3 ec* spring semester prof. dr. J. de Wit

Teaching methods
- 20 hrs question session

Prerequisites
Master student FNWI

Objectives
The student will be informed on the following aspects of Research Strategy and Management:
- career development possibilities
- industrial strategies
- research strategy and management (from 1st to 4th generation)
- organization of research
- project management
- knowledge management
- cooperation between university and industry
- case studies on radical innovation
- the Balanced Score Card method
- project selection methods
- roadmapping
- measurement of R&D performance
- innovation and venturing
- sustainable development in the 3rd world

All information will be illustrated with examples from the practical experience of the teacher during more than 20 years in industrial research management.

Contents
Research Strategy and Management is an important discipline in many forms of research. It is the intention to inform Master students and junior researchers on all aspects of R&D management in relation to business strategies. The class is mainly intended for students who want to start a research management career relatively soon after getting their MSc or PhD diploma and therefore follow the MT variant as their Master education. This career can start in industry but also in government, a consultancy firm or as owner of a private company. The class is also suited for students whose first choice is not the MT variant but still want to receive general information on the aspects of modern R&D management

Literature
After each lecture a task is formulated consisting of usually 3 questions. To answer the questions use can be made of Internet or of a list of books that will be given during the first lecture of the series. Other forms of knowledge gathering are of course also possible.

Examination
One week after the last lecture a written examination is given. This examination takes 3 hours. One month later there is an oral exam of about 1 hour for those who failed the written exam.

Science and Entrepreneurship

Course ID: **FMT012A** *3 ec* spring semester prof. dr. J.T.P. Derksen

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

Prerequisites
Minimum of three years of academic training in one of the sciences

Objectives
The goal of the course is to provide insight in aspects of the commercial utilization of results from scientific research to advanced (3rd year or higher Bachelor, Master or PhD) students. The course has a particular emphasis on issues around starting up a commercial (high-tech) enterprise. Also various entrepreneurial skills are addressed. At the end of the course students will be able to write a concise business plan.

Contents
For a knowledge-driven economy, such as the EU, it is of prime importance to apply scientific findings and new technologies as starting-points for commercial activities. Evidently, also research results from universities can contribute to the economic growth of our society. How this commercialization and valorization of knowledge can be realized in practice is the main topic of this course.
Subjects:
- Research and development in academic versus industrial setting
- Entrepreneurship ("unique selling proposition", business plans, legal and financial aspects of start-up companies, entrepreneurial skills and mentality)
- Market-orientation (marketing plan, sales pitches, how to find customers, pricing of products & services)
- Funding of start-up companies (ROI, (inter-)national government funding programs, venture capital, informal investors, banks)
- Intellectual property rights (patents, confidentiality and pitfalls)
- Help in Nijmegen (financial and other support specifically for Radboud spin off companies, coaching)

Literature
During the lectures hand-outs of the presented subjects will be supplied.

Examination
- At the end of course students will be required to submit a business plan on an idea of choice. This proposal will be judged primarily on how convincing it is, but also on originality and thoroughness
- Written assignment

Extra information
- Training exercises in various commercial skills
- Internet desk studies on business-related issues
- This course will be taught in Dutch only

Industrial Chemistry

Course ID: **FMT013A** *3 ec* will be scheduled every other year in May-June starting 2009 prof. dr. P.H.H. Hermkens

Teaching methods
- 30 hrs lecture

Contents
This course will focus on pharmaceutical aspects of industrial chemistry. In the process of drug development, several phases can be distinguished: 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 topics such as combinatorial chemistry, library design, compound collections, synthetic chemistry, natural product chemistry, lab automation, desired properties
- Chemistry-driven lead optimization with topics such as synthetic chemistry & small molecules, chirality, enabling technologies (i.e. parallel chemistry, lab automation), physical chemistry & desired properties (aqueous solubility, pKa, lipophilicity), DMPK parameters, analytical chemistry
- Chemistry-driven development with topics such as process chemistry, lab automation (HTE, experimental design) , radiolabeling, salt selection, polymorphism, formulation, analytical chemistry

This course which will be provided every other year and is intended for MSc- as well as PhD-students. This course consists of 25-30 hrs interactive teaching, followed by a written exam, spread over a period of two weeks.

Examination
Written examination.

Extra information
25-30 hrs interactive teaching and training during 1 week.
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.

Algemene managementvaardigheden

Course ID: **FMT014A** *2 ec* Coursedate: June-July drs. J.G.J. van den Broek

Teaching methods
- Vaardigheidstraining (32 uur), zelfstudieopdrachten (24 uur)
  Inleidingen, zelfstudieopdrachten, vaardigheidstrainingen, presentaties
- Cursusdata in studiejaar 2008-2009
  18/06 (nm), 25/06 (nm), 29/06 (hele dag), 30/06(hele dag) en 01/07 (hele dag)

Prerequisites
Deze cursus heeft het karakter van een training. 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**.
Voor studenten uit de afstudeervariant Management & Toepassing (afstudeervariant MT) kan deze cursus gelden als een keuzevak.
Maximale groepsgrootte: inschrijving en plaatsing
In verband met de vaardigheidstrainingen kunnen slechts 14 studenten per cursus deelnemen. Plaatsing geschiedt aan de hand van de volgorde van inschrijving. Studenten uit de afstudeervariant MT krijgen voorrang.

Objectives
De training beoogt een aantal vaardigheden (zie Inhoud) verder te ontwikkelen.
Studenten leren strategieën en technieken, die toepasbaar zijn in diverse professionele situaties.

Contents
- Strategisch denken en handelen
- Problem solving
- Projectmatig werken
- Adviesvaardigheden
- Het creëren van win-win situaties
- Onderhandelen
- Omgaan met weerstanden en conflicthantering
- Vergadertechnieken
- Zelfreflectie en het persoonlijke ontwikkelingsplan van de startende academicus

Examination
Actieve participatie vaardigheidstrainingen en schriftelijke eindopdracht.

Master-thesis Management & Technology-track

Course ID: **FMT010B** *27 ec* prof. dr. B. Dankbaar

Teaching methods
- 50 hrs personal study counseling

Prerequisites
- The master thesis for the MT-track is the final part of the Master curriculum for Master-students from the Faculty of Science of the Radboud University
- who have finished the required courses and 'master-research' in their own discipline; and
- who have successfully completed the required courses of the MT-track: Business & Society, Organization Theory, Innovation Management, Strategy & Marketing, and Finance & Accounting.

Contents
The master-thesis consists of performing a research project on the interface of science, technology, society and organization. This research project will be performed in a profit or non-profit organization. It is important that the student is performing research contributing to the solution of an organizational or practical problem for which a combination of knowledge from natural science and management science is required or at least useful. The duration of the project should normally not exceed six months, from the start until final presentation of the thesis.

Examples of research topics are:
- Diagnosing the implementation of technological innovation in organizations;
- Developing a business plan for a new product;
- Doing market research for a high tech product;
- Developing and/ or evaluating instruments for assessing and developing HRM-policy in R&D departments;
- Developing instruments to improve collaboration between university and companies;
- Developing en/ or evaluating public policy-instruments on innovation, science, and environmental issues;
- For inspiration, see also the MICORD-research program (see ISIS- web site)

Project stages:
The project consists of the following stages, which are all closed with a specific activity:
- Preparation of research, resulting in a research proposal
- Performing research, resulting in a research report
- Presenting the results of your research at the organization involved
- Defending your research report at the university

Literature

- Guidebook of the final MT research project (presently only available in Dutch), see the MT- web site

We advise you to use books about how to do business research, for example:
Saunders, M. et al. (2003), ***Research Methods for Business Students*** *(3th ed.).* Harlow: Prentice Hall.
Cooper, R., Schindler, P., S. (2006) ***Business Research Methods*** *(9th ed.), McGrawhill, New York*

Examination

- See guidebook

Introduction Science Communication

Course ID: **FC001B** *3 ec* first quarter dr. J.G. van den Born

Website
www.betacom.science.ru.nl

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 familiarised with science communication practice
- Students are familiarised with science communication theory
- Students are trained by a professional in presentation techniques

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.
Thursday 15.30-17.30

Science & Societal interaction

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

Website
www.betacom.science.ru.nl

Teaching methods
- 14 hrs lecture Thursday 15.30-17.30
- 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 introduced in and applies the methods and tools for the design of an objective and research questions of a research plan.
4. is able to formulate an advice by means of a group discussion and to present and argue this advice in front of experts in the field of participation.

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.

Risk Communication

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

Website
www.betacom.science.ru.nl

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

Prerequisites
The course builds on previous courses 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 specific characteristics of Risk Communication in relation to Science 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. The communication of risk and the public understanding of risk have become important issues in Science Communication. The course aims to prepare students to actively engage in risk communication and to analyse, reflect on and assess risk communication practices.
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
To be announced

Extra information
Thursday 15.30-17.30

Boundary-Work: The Tension between Diversity and Sustainability

Course ID: **FC0041C** *3 ec* fourth quarter prof. dr. F.W.J. Keulartz
drs. I.E.M. Dankelman
S.A.J. Segers

Website
www.betacom.science.ru.nl

Teaching methods
- 4 hrs personal study counseling
- 20 hrs lecture Thursday 13.45-15.30

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. For instance, climate change can lead to depletion of the ozone layer, loss of biodiversity, land degradation, desertification, and alteration of the global hydrological cycle. These negative impacts in turn reinforce each other through feedback loops, which results in a serious threat to land productivity, food supply, and freshwater availability. Because they are so closely connected, these global environmental threats 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
J. Keulartz: Werken aan de grens - een pragmatische visie op natuur en milieu. Damon, 2005.

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

Framing Knowledge

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

Website
www.betacom.science.ru.nl

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 field of cognitive psychology (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)
- can debate (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 patterns of thought. 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.
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 this course the students are also introduced to the basic principles of interviewing, they learn to design an interview guide and finally interview a stakeholder in the case we investigate during the course.

Literature
Literature will be made available on Blackboard

Examination
An assignment.

Extra information
This course will be taught in Dutch
Thursday 13.30-15.30.

Knowledge Society

Course ID: **FC0011C** *3 ec* third quarter dr. J.G. van den Born
S.A.J. Segers

Website
www.betacom.science.ru.nl

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

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
- Students are trained in essay-writing

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 combines a practical and theoretical component. Discussions among students, teachers and guest speakers are matched with analyses of current scientific insights on the Knowledge Society. A professional training in essay-writing completes the course.

Literature
Literature will be made available on Blackboard

Examination
Essay

Extra information
The course is taught Thursday 13.30-15.30

Science & Media: strategies and trends

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

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, finishing 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 of this course (H.M. Dresen) asking for an English language arrangement.
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.
Two versions of media-oriented writing
The training in media-oriented writing will be offered in two different versions, to cater for different levels of previous training among students (esp. whether 'Effectief Schrijven' within CEM has been followed or not). Please read the details that will be given about this on Blackboard six weeks in advance of the start of the course, so that you may be placed in the appropriate group.

Objectives

- students will increase their abilities in media-oriented writing, and will be shown ways how to further increase these abilities in the near future.
- students will increase their knowledge of the strategical considerations and ethical codes involved in the process of transmitting information from the academic to the public arena.
- student will gain understanding of a) the current state of science reporting in the media and b) ways in which the representation of science and technology in the media has changed over the last few decades.
- students will get acquainted with several methodological alternatives for studying trends in science reporting in the media (as a subfield within the Social Studies of Science)

Contents
The course consists of two interrelated parts:
1. A training in media-oriented writing (given in Dutch), which will adress both the process of writing itself and the broader strategical and ethical considerations involved in the process of transmitting information from the academic to the public arena.
2. An introduction to the academic field of studying Science-in-the-Media, as a subfield within the Social Studies of Science. The examples we will study are intended to increase the students understanding of the current state of science reporting in the media. While studying these examples, the students will also get acquainted with different methodological alternatives for studying trends in how the media represent scientific expertise.

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

Examination
Journalistic writing assignment & analytical assignment

Extra information
Classes once a week, Thursday 13.30-15.30 from november 13 2008 till january 29 2009.

Visible Scientists

Course ID: **FC0040B** *3 ec* fourth quarter dr. B. Smelik
S.A.J. Segers

Website
www.betacom.science.ru.nl

Teaching methods
- 26 hrs lecture

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 network theory
- 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. 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 & 2 ppt presentations. This is an elective course within the Science Communication track, but can be chosen in any master as elective course.

Research project (Masterthesis) Mastertrack Science Communication

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

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

Contents
For more information see: www.betacom.science.ru.nl .

4 Majors and minors in chemistry

4.1 Research in chemistry

Research in chemistry is organized in the Research Institute for Molecules and Materials.

Research Institute for Molecules and Materials
The aim of IMM is to conduct research and train undergraduate and graduate students 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. This research area can roughly be divided into two main themes: bio-inspired systems and nano/mesoscopic structures. Covering both experimental and theoretical physics and chemistry, and harboring skills in state-of-the-art analytical and synthetic techniques, the groups that constitute the IMM possess expertise in all areas needed to explore these fields.
The Institute has set itself a number of ambitious goals, attainable within the next 5 to 10 years including: Controlled functional physical and chemical self-assembly; Dynamics of chemical and physical processes on a molecular scale; Full structural resolution of living-cell organels The ability to monitor and control processes on an intracellular level and to master intracellular chemistry will lead to important new spectroscopy, pharmaceutical chemistry and micro-scale techniques such as 'lab-on-a-chip'. One of the ambitions it to make artificial cell-structures.

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

4.2 Analytical Chemistry (IMM)

Head: Prof.dr. L.C.M. Buydens
Scientific staff: Dr. H.R.M.J. Wehrens, Dr. W. Melssen, Dr. G. Postma
Secretariat: Ms. B. Loozen, room HG02.722, tel. 3653180, b.loozen@science.ru.nl
website: www.cac.science.ru.nl

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 DNA-micro-array data.
- Investigation of relations between molecular structure and biological or physical properties.
- Development and further optimisation of novel statistical modelling techniques.

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, room HG03.527, tel. 3653353, e-mail: ams-secr@science.ru.nl
website:	www.ru.nl/ams

Research:
- Classical III-V semiconductors like GaAs, AlGaAs, GaInP, and AlGaInP (Dr.ir. J.J. Schermer)
- III-Nitrides like GaN and AlGaN (Dr. P.R. Hageman)

Description of research:
The department is the centre of knowledge for crystal growth by Metal Organic Vapour Phase Epitaxy (MOVPE) in The Netherlands. The group is specialised in the deposition of crystalline materials as well as the study of their material properties by the use of microscopic techniques (SEM, TEM), X-ray diffraction and different spectroscopic techniques. The research focuses on two different groups of materials:
- Classical III-V semiconductors like GaAs, AlGaAs, GaInP, and AlGaInP
- III-Nitrides like GaN and AlGaN.

The study of the properties of these materials forms the fundament for application-oriented research on solar cells and substrates for large bandgap materials for which advanced processing techniques (photolithography, sputtering, reactive ion etching, etc.) are utilised at the department.

The research activities aim to increase the efficiency of III-V solar cells by the development of a monolithic InGaP/GaAs tandem cell, which utilises the solar spectrum much better than a single junction solar cell. Parallel to the research on efficiency increase, studies are performed to reduce the amount of material (thus costs) presently used by the production of high-efficiency III-V solar cells. Secondly, we try to develop GaN substrates which are currently not commercially available. The use of GaN substrates is expected to boost the efficiency of blue lasers and GaN based electronics considerably. Not only the deposition of thick GaN layers but also the development and modelling of suitable reactors is studied.
The application-oriented research is performed in close comparison with a number of industries and organisations as well as other universities in and outside of The Netherlands.

Opportunities for students:
Suitable for Physical, Chemical and Physical-Chemical students.
Cooperation: with Applied Molecular Physics (Prof.dr. J.J. ter Meulen), Solid State Chemistry (Prof.dr. E. Vlieg), Spectroscopy of Solids and Interfaces (Prof.dr. T.H.M. Rasing), Scanning Probe Microscopy (Prof.dr. S.E. Speller), and Condensed Matter Science/High Field Magnet Laboratory (Prof.dr. J.C. Maan).

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 C. Teunissen, tel. 3614259, c.teunissen@ncmls.ru.nl
website: www.ncmls.nl/biochemistry/integrated/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 Biomolecular Chemistry (IMM)

Head:	Prof.dr. G.J.M. Pruijn
Scientific staff:	Dr. W.C. Boelens, Prof.dr. N.H. Lubsen, Dr. J.M.H. Raats
Secretariat:	Ms E. van Genne, NCML 2.95, tel. 3614254, e.vangenne@ncmls.ru.nl
website:	www.biomolecularchemistry.nl

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

Description of research:
Characterisation and function of autoantigens (Pruijn/Raats)
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.

Mandatory courses for major, choose from the following:
- Apoptosis
- Chemical Biology
- Molecular aspects of host defense, tissue destruction and repair
- Post-transcriptional regulation in health and disease
- Signal transduction and transport

Mandatory BSc course: biochemie-moleculaire biologie II (BB017C)
Recommended courses: celbiologie van dieren (BB023B), structuur biomoleculen (SB101B) and immunologie (BB019B).

4.6 Bioinformatics (IMM)

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, room NCMLS 010, tel. 3619390, b.vankampen@cmbi.ru.nl
website:	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@organon.com and Dr. G. Schaftenaar, e-mail: G.Schaftenaar@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 medicine. The CDD group is working closely together with the Department of Molecular Design & Informatics (MDI) of Schering-Plough, forming a unique collaboration between academic research and applied research. 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 that characterizes modern drug design. At CDD a variety of scientific methods are developed including micro array analysis, structure-based molecular design and simulation technologies.

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.

4.7 Bio-Organic Chemistry (IMM)

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

Mandatory course: Organic chemistry 1
Recommended course: Synthetic practical courses, Organic chemistry 2 and Metal-organic chemistry

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, m.dewith@science.ru.nl
website: 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
recommended courses*:* structure biomolecules *or* magnetic resonance I, *and/or* structure, function and biomolecules

4.9 Molecular and Biophysics (IMM)

Professor:	Prof.dr. W.J. van der Zande
Scientific staff:	Prof.dr. W.L. Meerts, Prof.dr. M.J.J. Vrakking (FOM-Institute AMOLF)
Secretariat:	Ms E. Gouwens, room HG 01.712, tel. 3653010, email: e.gouwens-vanoss@science.ru.nl
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.

4.10 Molecular and Laser Physics (IMM)

Head: Prof.dr. D.H. Parker
Scientific staff: Dr. F.J.M. Harren
Secretariat: Ms M. Speijers, room HG01.719, tel. 3652025, m.speijers@science.ru.nl
Website: www.science.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.

4.11 Molecular Materials (IMM)

Head: Prof.dr. A.E. Rowan
Scientific Staff: Dr. R. de Gelder
Secretariat: Ms P. Willems, HG03.012, tel. 3653421, Paula.Willems@science.ru.nl
website: www.molchem.science.ru.nl

Research:
- synergetic materials
- organo and bioelectronics
- magnetic materials
- chemical crystallography

The Molecular Materials group focuses on the construction of a variety of functional systems for application in the fields of:
- catalysis (organic and inorganic)
- molecular electronics (bio & organic)
- liquid crystals
- optoelectronic, conductive and magnetic materials.

The aim of the group is the design and synthesis of novel polymers, self-organizing molecules and ordered crystals and the subsequent investigation of their properties. The relationship between the molecular structure and architecture at the nanometer level and the material properties are studied. The group is divided into four overlapping themes.

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.

Chemical Crystallography:
Knowledge of the three-dimensional structure of molecules and materials is of crucial importance in many fields of chemistry and physics. The accurate determination and detailed atomistic understanding of the interactions that play a leading role in the formation of molecular assemblies is an essential step in the process of design and synthesis of new (supra)molecular compounds and materials. The chemical crystallographic research is focused on the determination of molecular structures and ordering in the solid state by X-ray diffraction methods and on the development of methods which translate structural information into new directions for design and synthesis of new compounds and materials.

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
recommended course: Synthetic practical courses and Organic chemistry 2

4.12 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, 7.89 NCMLS, 3613691, e.triebels@pharmtox.umcn.nl
website: www.ncmls.eu

Research:
- Transport processes and toxicity
- Mechanisms of drug toxicity, cellular injury and protection
- Molecular epidemiology and toxicity

Description of research:
Transport processes and toxicity
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 defense mechanisms include the active extrusion of xenobiotics by commonly shared transport proteins, mainly located in kidney, liver and intestine. In our research we investigate the molecular properties of transporters belonging to the ATP Binding Cassette (ABC) and Solute Carrier (SLC) superfamilies, with special reference to their role in drug efficacy and safety.

Mechanisms of drug toxicity, cellular injury and protection
Adverse drug reactions (ADRs) related to organ toxicity, and drug hypersensitivity are responsible for the top 3 of drug withdrawals due to toxicity. Today, no adequate translational strategies are available to predict safety. We are interested in studying the molecular mechanisms of drug toxicity in the kidney and vascular system, and developing predictive translational biomarkers by proteomic profiling of blood and urine samples from animal studies and selected patients. In addition we focus particularly on the heme oxygenase system as a novel therapeutic target in tissue protection and regeneration.

Molecular epidemiology and toxicity
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 R.Masereeuw@ncmls.ru.nl.
Mandatory course: Pharmacology
Recommended courses: Living cell, General physiology, Molecular basis of disease

4.13 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.salem@science.ru.nl
website: 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.

Mandatory course: Introduction to crystal growth
Recommended courses: Practical course condensed matter

4.14 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, m.dewith@science.ru.nl
website:	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, Molecular quantummechanics

4.15 Supramolecular Chemistry (IMM)

Head: Prof.dr. R.J.M. Nolte
Scientific staff: Dr. J.J..M. Cornelissen, Dr. M.C. Feiters, Prof.dr. E.W. Meijer
Secretariat: Ms D.D. van der Wey, HG03.028, 3652676, d.vanderwey@science.ru.nl
website: www.molchem.science.ru.nl

Research:
- Biohybrid amphiphiles
- Processive catalysts
- Molecular electronics
- Biomimetic chemistry

Description of research:
Since the first synthesis of an organic molecule (urea) by Woehler in 1827 the size and complexity of molecular structures have increased steadily. Organic molecules and macromolecules (polymers) are traditionally made by covalent synthesis. Since the introduction of Supramolecular Chemistry by Pedersen, Cram and Lehn (1970's) new routes have become available for the design and construction of large molecular structures, nowadays even reaching the nanometer range (1-500 nm). These large molecules are prepared by different techniques, an important one being self-assembly. Self-assembly, some-times described as 'molecular programming', is a two-step process: the first step involves the synthesis of building blocks, which have specifically designed shapes and properties. In a second step these building blocks are (self)-assembled by using non-covalent interactions, e.g. hydrogen bonding, pi-pi stacking, electrostatic interactions, metal-ligand coordination bonds and van der Waals interactions. The outcomes of this process are amazing, complex architectures, which are reminiscent of the majestic structures found in Nature. They are studied in house with different techniques, including NMR, electron microscopy, atomic force microscopy, and scanning tunneling microscopy. The challenge is to optimize the design process in such a way that functional structures, e.g. having special materials properties or specific catalytic properties, are obtained.

Projects that are currently in progress include:
- *Biohybrid amphiphiles*. Amphiphiles are molecules that possess both a hydrophilic and a hydrophobic part. Well-known examples are the phospholipids molecules, which are components of cell membranes. In this project so-called super-amphiphiles and giant amphiphiles are synthesized. These molecules are composed of a hydrophobic polymer (polystyrene) and a hydrophilic polypeptide or a protein (enzyme). When dispersed in water a self-assembly process takes place leading to nanostructures, e.g. fibers, complex helical structures and spheres. The latter structures can encapsulate enzymes and are used as nano-reaction vessels (artificial cells).
- *Processive catalysts*. DNA polymerases are complex enzyme systems that are used by Nature to make copies of DNA. Many of these 'processive' enzymes have a toroidal shape and completely enclose the biopolymer while moving along its chain. The overall architecture of these systems resembles that of rotaxanes, in which a long molecule is threaded through a macromolecule. We have taken this example from Nature as a source of inspiration to design synthetic catalytic systems that can bind to polymer chains and make changes in this chain (e.g. addition of oxygen atoms) while moving along it (artificial motors).
- *Molecular electronics.* Electronic devices are becoming increasingly smaller and chip structures are approaching the limits of what is possible by top-down lithographic techniques.

A new strategy is to design and construct electronic components by bottom-up self-assembly techniques. In this project molecules (e.g. special types of phthalocyanine and porphyrin dyes), that spontaneously self-assemble to form micrometer-long cables and ring-like structures, are designed and synthesized. They are studied with respect to their energy and electron conducting properties by different physical techniques (in collaboration with the Department of Physics and the HFML institute in Nijmegen).
- *Biomimetic chemistry*. Cationic lipids are developed for condensation with DNA and applied in gene therapy, an approach to replace or add a functional copy of a defective gene to a cell in a diseased organism. Cyclodextrins, water-soluble cavity-containing molecules, are functionalized for the development of unidirectional molecular wires, to be applied in a synthetic self-assembled system for photocatalysed hydrogen evolution.

Opportunities for students:
suitable for Chemistry and Natural Science students.
Mandatory course: Organic chemistry 1
Recommended courses: Organic chemistry 2, Metal organic chemistry, Synthetic practical courses

4.16 Synthetic Organic Chemistry (IMM)

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

Research:
Main focus of the research is the synthesis of existing or newly designed molecules with specific desired (biological) properties by application of modern organic synthesis techniques or, if required, by development of novel methodology. Molecules of interest are usually applied in multidisciplinary research projects such as:
- RNA-targeting based on naturally occurring aminoglycosides
- Development of new drugs against rheumatoid arthritis (with NCMLS, Prof. Pruijn), LUMC (Dr. Drijfhout), Chiralix and ModiQuest.
- Synthesis and biological evaluation of carbohydrate building blocks as 'chain stoppers' in anticancer therapy (with NCMLS, Dr. van Kuppevelt)
- Synthesis and evaluation of pan-cholecystokinin (CCK) receptor binding ligands for radionuclide targeting of CCK-receptor positive tumors (with UMC St Radboud, Prof. Boerman, Dr. Laverman)
- Development of bioorthogonal ligation methods (with Dr. Cornelissen)
- 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. 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

4.17 Theoretical Chemistry (IMM)

Scientific staff: Dr.ir. G.C. Groenenboom
Secretariat: Ms P. Willems, HG03.012, tel. 3653421, Paula.Willems@science.ru.nl
website: 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 mernbers 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 the '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 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 owns six 4 processor Linux workstations. Further the group has access to the national supercomputing center in Amsterdam.
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 course: molecular quantummechanics
recommended courses: Quantummechanica 1b, Introduction group theory, Linear algebra 2, Computer programming (all 2nd year physics)

4.18 Minor Industrial Chemistry

Contact: Prof.dr. F.P.J.T. Rutjes
Secretariat: Ms J. Versteeg, room HG03.028, tel. 3653389, 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

Inleiding

Voor afgestudeerden van een HLO-opleiding aan een instelling voor HBO of van de afdeling chemie of chemische techniek (technologie) van een HTO bestaat de mogelijkheid om zich via een verkorte opleiding van nominaal 2 jaar of 2 jaar en 3 maanden (130 ec of 156 ec (= ECTS ofwel europese studiepunten) afhankelijk van de keuze van afstudeervariant) op het masterexamen voor te bereiden. Deze opleiding vergroot de kansen van HBO-afgestudeerden om na het masterexamen als promovendus aangesteld te worden en deze aanstelling met een academische promotie (doctorsgraad) af te sluiten. Hierbij dient opgemerkt te worden dat het programma van de verkorte opleiding beslist niet als licht beschouwd mag worden, zodat alleen de goede en gemotiveerde studenten, bij voorkeur in 4 jaar aan het HBO afgestudeerd, in staat worden geacht dit programma in 2 jaar (respectievelijk 2 jaar en 3 maanden) af te werken.

Met een HBO-diploma kan men zich alleen inschrijven voor de bacheloropleiding. Na het behalen van 30 ec van het programma genoemd onder A in paragraaf 5.3 wordt door de examencommissie een verklaring afgegeven waarmee de student zich kan inschrijven voor de masteropleiding.

Achtergrond van het programma

Bij het opstellen van het programma, dat overigens tot een volwaardig masterexamen opleidt, zijn de volgende overwegingen als uitgangspunt genomen:
- in een HLO/HTO-studie komen vele elementen uit het programma van de universitaire scheikunde studie ook reeds aan de orde. Wat ontbreekt is de meer diepgaande theoretische scholing in sommige vakken, zoals bijvoorbeeld quantummechanica en chemische binding. Vandaar dat deze vakken tot het verplichte gedeelte van het vrijstellingsprogramma behoren;
- essentieel voor een universitaire chemie-opleiding is de onderzoeksstage (met bijbehorende tentamens, werkbesprekingen, literatuurstudie, colloquia en verslaggeving) in een chemische hoofdrichting. Deze dient dan ook in het programma te worden opgenomen. In hoofdstuk 2.2 van de masterstudiegids scheikunde staan de hoofdrichtingen vermeld waaruit gekozen kan worden;
- het doorstroomprogramma is samengesteld uit bestaande onderdelen van het reguliere 5-jarige curriculum (3 jarige bachelor + 2 jarige master).

Inhoud van het programma

Op basis van bovengenoemde overwegingen is het programma als volgt samengesteld. Voor een beschrijving van de inhoud van de onderdelen wordt verwezen naar hoofdstuk 4 van de bachelorgids en hoofdstuk 3 van deze gids.

Dit HBO-doorstroomprogramma ziet er voor 2007/2008 als volgt uit:

1. *ONDERZOEKSVARIANT: totaal 130 ec*

A. Verplichte onderdelen (eerste jaar van het doorstroomprogramma)
- wiskunde 1 (4 ec)1
- wiskunde 2 (4 ec)2
- lineaire algebra (3 ec)5
- thermodynamica (4 ec)7
- programmeren in Matlab en project (4 ec)5+6
- quantummechanica en chemische binding 1 (3 ec)6
- quantummechanica en chemische binding 2 (3 ec)7
- quantummechanica en chemische binding 3 (4 ec)8
- SRM 4 en project (4 ec)5
- FMM 5 en project (3 ec)6
- condensed matter (4 ec)8
- filosofie 1 of 2 (3 ec)11+12

B. Major
- Basic and advanced courses (compulsory and optional) inclusief eisen hoofdrichting (maximaal 6 ec) totaal 27 ec
- Research project (hoofdrichting) inclusief master thesis, presentation, literatuur scriptie en colloquium, totaal 60 ec

1 t/m 12: = kwartaal uit het reguliere studieprogramma

2. *WETENSCHAPSOMMUNICATIE-, EDUCATIE- OF MANAGEMENT EN TOEPASSING-VARIANT: totaal 156 ec*

A. Verplichte onderdelen (eerste jaar van het doorstroomprogramma)
- wiskunde 1 (4 ec)1
- wiskunde 2 (4 ec)2
- lineaire algebra (3 ec)5
- thermodynamica (4 ec)7
- programmeren in Matlab en project (4 ec)5+6
- quantummechanica en chemische binding 1 (3 ec)6
- quantummechenica en chemische binding 2 (3 ec)7
- SRM 4 en project (4 ec)5
- FMM 5 en project (3 ec)6
- condensed matter (4 ec)8
- filosofie 1 of 2 (3 ec)11+12

1 t/m 12: = kwartaal uit het reguliere studieprogramma

B. keuzecolleges (vrije keuze binnen scheikunde of verplicht gesteld door de hoofdrichting) 6 ec (1e en/of 2e jaar van doorstroomprogramma)

C. Major: Research project (hoofdrichting) inclusief master thesis, presentation, en compulsory courses, totaal 54 ec (2e jaar van doorstroomprogramma)

D. C-, E, of MT-variant: omvang 57 ec (alle jaren van het doorstroomprogramma)

Toelichting
Bij de basic and advanced courses dient men rekening te houden met de eisen die worden gesteld door de hoofdrichting. Maximaal 6 ec kunnen verplicht worden gesteld als keuze voorafgaand aan een hoofdrichting. In hoofdstuk 2.6 van de bachelorgids staan bij elke hoofdrichting de eisen. Sommige keuzevakken kunnen pas in het tweede studiejaar worden gedaan omdat de vereiste voorkennis ontbreekt. Keuzecolleges zijn de derdejaars keuzevakken uit het reguliere studieprogramma.
Aan de hoofdrichting mag pas worden begonnen nadat, naast de voor een hoofdrichting verplicht gestelde vakken, alle verplichte vakken op 2 na behaald zijn.
Extra vakken mogen worden toegevoegd aan het programma; hiervoor is toestemming nodig van de examencommissie.

Het vastgestelde programma voor de O-, C-, E- en MT-variant is een minimum programma waarbinnen geen vrijstellingen worden geaccepteerd, behalve na goedkeuring door de examencommissie.

Voor alle tot het programma behorende vakken moet minimaal een 6 worden behaald.

6 Examination regulations

6.1 OER master

Onderwijs- en examenregeling scheikunde *voor studenten vanaf 2002; studenten die voor 1 september 2002 zijn begonnen met de scheikundestudie: zie artikel 6.1*
Deel II - Masteropleiding

Paragraaf 1 Algemene bepalingen

Artikel 1.1 Toepasbaarheid van de regeling

Deze regeling is van toepassing op het onderwijs en de examens van de masteropleiding scheikunde, hierna te noemen: de opleiding.
De opleiding wordt verzorgd door het onderwijsinstituut Moleculaire Wetenschappen (hierna te noemen: het onderwijsinstituut) binnen de faculteit Natuurwetenschappen, Wiskunde en Informatica (hierna te noemen: de faculteit).

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 b 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. bacheloropleiding: de opleiding, genoemd in artikel 7.3a van de wet;

e. 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.

f. 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.

g. examen: toetsing, waarbij door de examencommissie wordt vastgesteld of alle tentamens van alle 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).

h. examencommissie: de examencommissie van een opleiding ingesteld conform artikel 7.12 van de wet. Zie ook Structuurregeling RU.

i. examinator: degene die door de examencommissie wordt aangewezen ten behoeve van het afnemen van tentamens, conform artikel 7.12 van de wet;

k. EC: studiepunten conform het European Credit Transfer System

l. werkdag: maandag t/m vrijdag m.u.v. de erkende feestdagen.

m. studiegids: de gids voor één van de opleidingen genoemd in artikel 1 bevattende de specifieke informatie voor de masteropleiding

n. instelling: Radboud Universiteit Nijmegen

Artikel 1.3 Doel van de opleiding

Met de opleiding wordt beoogd:
a. kennis, vaardigheid en inzicht op het gebied van scheikunde;
b. academische vorming;
c. management- en toepassingvariant (MT-variant), aanvullend aan het onder a en b genoemde: kennis, vaardigheid en inzicht op relevante terreinen van de bedrijfskunde en bestuurskunde;
d. wetenschapscommunicatievariant (C-variant), aanvullend aan het onder a en b genoemde: kennis, vaardigheid en inzicht op relevante terreinen van de communicatie;
e. educatievariant (E-variant), aanvullend aan het onder a en b genoemde: het verwerven van competenties als docent.

Artikel 1.4 Vorm van de opleiding

De opleiding wordt voltijds verzorgd.

Artikel 1.5 De examens van de opleiding

1. In de opleiding kunnen de volgende examens worden afgelegd:

a. het master examen.

Artikel 1.6 Studielast

1. De studielast wordt uitgedrukt in EC. Eén EC is gelijk aan 28 uren studie.
2. Het masterexamen heeft een studielast van 120 EC.

Artikel 1.7 Taal

1. Het onderwijs wordt in het Engels gegeven, de tentamens en het examen (de examens) worden afgenomen in het Engels. Het onderwijs kan in het Nederlands worden gegeven indien de herkomst van de studenten geen Engelstalig onderwijs vereist.

2. Voor in het Engels verzorgd onderwijs is de Gedragscode vreemde taal van de RU Nijmegen van toepassing. (zie appendix)

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:
   1. in het bezit is van een diploma voorbereidend wetenschappelijk onderwijs; of
   2. in het bezit is van een diploma van voortgezet onderwijs, behaald aan een Engelstalige instelling van voortgezet onderwijs binnen of buiten Nederland; of
   3. in het bezit is van een diploma hoger beroepsonderwijs, of
   4. in het bezit is van een bachelordiploma behaald aan een Nederlandse universiteit, of
   5. 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 215 of hoger voor de computer versie;
      * de IELTS met een score van 6 of hoger.

De examencommissie kan in voorkomende gevallen beoordelen of een student de Engelse taal in voldoende mate beheerst.

Paragraaf 2 De Masteropleiding

Artikel 2.1 Samenstelling masteropleiding (O-variant)

De masteropleiding omvat de volgende onderdelen met de daarbij vermelde studielast:

1. opleidingsspecifieke onderdelen met een totale studielast van 111 EC als volgt gespecificeerd:
a. major bestaande uit:
- basic en advanced courses (compulsory and optional): 27 EC;*
- research project (hoofdrichting) inclusief master thesis, presentation, literature thesis en colloquium: 60 EC;**
b. minor: optional program (bijvoorbeeld bijvak en/of keuzecolleges): 24 EC.***

*Basic en advanced courses worden aangeboden door het onderzoekinstituut waarvan de hoofdrichting deel uitmaakt; de hoofdrichting kan van deze courses 10 ec verplicht stellen.
**De hoofdrichting kan tot 6 EC aan cursussen uit de bachelor verplicht stellen; de student heeft de mogelijkheid deze 6 EC alsnog te halen in de minor.
***In de minor kunnen tweede- en derdejaars universitaire bachelorcursussen gekozen worden.

2. vrije-keuzeruimte met een minimum omvang van 6 EC;

3. een of meer vakken met een wijsgerig karakter met in totaal een minimum omvang van 3 EC

Artikel 2.2 Samenstelling masteropleiding (MT-variant)

De masteropleiding MT-variant omvat de volgende onderdelen met de daarbij vermelde studielast:

1. opleidingsspecifieke onderdelen met een totale studielast van 54 EC als volgt gespecificeerd: research project (hoofdrichting) inclusief master thesis, presentation en compulsory courses.

2. MT-onderdelen met een totale studielast van 57 EC:

a. verplichte onderdelen:
- Bedrijf & Maatschappij (5 EC),
- Organisatiekunde (5 EC),
- Innovatiemanagement (5 EC),
- Strategie & Marketing (5 EC),
- Financieel economisch management (5 EC).

b. MT-keuzevakken (5 EC) te kiezen uit:
- Kennis en ondernemerschap (3 EC)
- Research strategie en management (3 EC)
- Industriële fijnchemie (3 EC)
- Algemene managementvaardigheden (2 EC)
- dan wel een onder goedkeuring van de voor de variant verantwoordelijke docent vrij te kiezen vak;

c. een afstudeerproject (27 EC)

3. vrije-keuzeruimte met een minimum omvang van 6 EC;

4. een of meer vakken met een wijsgerig karakter met in totaal een minimum omvang van 3 EC

Artikel 2.3 Samenstelling masteropleiding (C-variant)

De masteropleiding C-variant omvat de volgende onderdelen met de daarbij vermelde studielast:

1. opleidingsspecifieke onderdelen met een totale studielast van 54 EC als volgt gespecificeerd: research project (hoofdrichting) inclusief master thesis, presentation en compulsory courses.

2. C-onderdelen met een totale studielast van 57 EC:

a. Verplichte vakken in het eerste jaar:
- Introduction science communications (3 EC) (voorheen: inleiding massacommunicatie)
- Science and societal interaction (3 EC) (voorheen: communicatie en verandering)
- Risk communication (3 EC) (voorheen: crisis en risicocommunicatie)
- Boundary work (3 EC) (voorheen: grenswerk)

b. Verplichte vakken in het tweede jaar:
- Framing knowledge (3 EC) (voorheen: kaders en beelden)
- Knowledge society (3 EC) (voorheen: kennis in context)
- Science, media and strategy (3 EC) (voorheen: strategieën en wetenschapscommunicatie)

c. C-Keuzevakken, goed te keuren door de voor de variant verantwoordelijke docent, met een totale studielast van 6 EC

d. Stage en verslaglegging (30 EC)

3. vrije-keuzeruimte met een minimum omvang van 6 EC;

4. een of meer vakken met een wijsgerig karakter met in totaal een minimum omvang van 3 EC

Artikel 2.4 Samenstelling masteropleiding (E-variant)

De masteropleiding E-variant omvat de volgende onderdelen met de daarbij vermelde studielast:

1. opleidingsspecifieke onderdelen met een totale studielast van 54 EC als volgt gespecificeerd: research project (hoofdrichting) inclusief master thesis, presentation en compulsory courses.

2. E-onderdelen met een totale studielast van 57 EC: 2 stages met een totale studielast van 57 EC. Deze stages zijn integrale leertrajecten, waarin een continue wisselwerking van theorie , praktijk, intervisie en supervisie plaatsvindt.

3. vrije-keuzeruimte met een minimum omvang van 6 EC;

4. een of meer vakken met een wijsgerig karakter met in totaal een minimum omvang van 3 EC

Artikel 2.5 Goedkeuring samenstelling master opleiding

De door de student gekozen samenstelling van de masteropleiding wordt vooraf ter goedkeuring voorgelegd aan de examencommissie.

Paragraaf 3 Tentamens en examens van de opleiding

Artikel 3.1 Volgorde van tentamens

1. O-variant: de volgorde van de bij de O-variant behorende onderdelen is vrij.

2. MT-variant:

Aan de tentamens van de onderdelen Innovatiemanagement en Strategie & Marketing kan niet eerder worden deelgenomen dan nadat de tentamens Bedrijf & Maatschappij en Organisatiekunde zijn behaald.

Het afstudeerproject van de MT-variant kan 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 tenminste 45 EC waaronder de praktische werkzaamheden in het kader van de onderzoekstage van de opleiding;
- een voldoende is behaald voor het merendeel van de vijf MT-basisvakken zoals genoemd in artikel 2.2.

3. C-variant:

Het afstudeerproject van de C-variant kan 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 tenminste 45 EC waaronder de praktische werkzaamheden in het kader van de onderzoekstage van de opleiding;
- een voldoende is behaald voor het merendeel van de verplichte vakken van de variant zoals genoemd in artikel 2.3.

4. E-variant:

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 tenminste 30 EC waaronder de praktische werkzaamheden in het kader van de onderzoekstage van de opleiding.

Artikel 3.2 Tijdvakken en frequentie tentamens

1. Tot het afleggen van de tentamens van de in de artikel 2.1 t/m 2.4 genoemde onderdelen wordt tenminste 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 bij voorkeur direct voor het begin van het volgende studiejaar. 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 tenminste eenmaal de gelegenheid gegeven.

Artikel 3.3 Vorm van de tentamens

1. De tentamens van de onderdelen, genoemd in artikel 2 kunnen op de volgende wijze worden afgelegd:

a. schriftelijk en/of
b. praktische oefening + verslag en/of
c. computerpracticum en/of
d. computertentamen en/of
e. 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.

Artikel 3.4 Mondelinge tentamens

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

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

Artikel 3.5 Vaststelling en bekendmaking tentamenuitslag

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 herkansings-datum 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.

4. Op de verklaring omtrent de uitslag van een tentamen wordt de student gewezen op het inzagerecht, bedoeld in artikel 3.7, eerste lid, alsmede op de beroepsmogelijkheid bij het college van beroep voor de examens.

5. De termijn waarop studenten in beroep kunnen gaan bij het College van Beroep voor de Examens tegen een beslissing van de examencommissie is vier weken (zoals vastgesteld in de Structuurregeling RU).

Artikel 3.6 Geldigheidsduur

1. De geldigheidsduur van behaalde onderdelen 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 onderdeel aanzienlijk afwijken van die, gesteld ten tijde van het afleggen van het tentamen.

Artikel 3.7 Inzagerecht

1. Gedurende tenminste zes weken 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 tenminste 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.

Artikel 3.8 Vrijstelling

De examencommissie kan de student op diens verzoek, gehoord de desbetreffende examinator, 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 werk- c.q. beroepservaring over voldoende kennis en vaardigheden te beschikken m.b.t. het desbetreffende onderdeel.

Artikel 3.9 Examen

1. Tot het afleggen van het examen wordt de gelegenheid geboden nadat de student voldoende bewijzen overlegd heeft 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 3.10 Graad

1. Aan degene die het masterexamen met goed gevolg heeft afgelegd, wordt de graad 'Master of Science' verleend.

2. De verleende graad wordt op het getuigschrift van het examen aangetekend.

3. Aan degene die de O-variant als bedoeld in artikel 2.1 met goed gevolg heeft afgelegd, wordt aan de mastergraad de differentiatie Onderzoek toegevoegd.

4. Aan degene die de MT-variant als bedoeld in artikel 2.2 met goed gevolg heeft afgelegd, wordt aan de mastergraad de differentiatie Management & Toepassing toegevoegd.

5. Aan degene die de C-variant als bedoeld in artikel 2.3 met goed gevolg heeft afgelegd, wordt aan de mastergraad de differentiatie Wetenschapscommunicatie toegevoegd.

6. Aan degene die de E-variant als bedoeld in artikel 2.4 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.

Paragraaf 4 Vooropleiding

Artikel 4.1 Toelatingseisen masteropleiding

Tot de opleiding worden, onverlet het bepaalde in artikel 4.3, toegelaten:

1. 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;
2. degene die in het bezit is van het bewijs van toelating, dat het College van Bestuur voor het desbetreffende studiejaar afgeeft (artikel 4.2).
3. degene met een hbo-diploma hlo of hts chemie of chemische technologie die voldaan heeft aan het schakelprogramma scheikunde van 30 EC.

Artikel 4.2 Bewijs van toelating

Voor het bewijs van toelating komt in aanmerking degene die:

1. in het bezit is van een getuigschrift dat ten minste gelijkwaardig is aan het diploma als bedoeld in artikel 4.1. onder a,
2. of anderszins naar het oordeel van de examencommissie blijk heeft gegeven van geschiktheid voor het volgen van de opleiding,
3. en het bewijs heeft geleverd van voldoende beheersing van de Engelse taal, zoals bepaald in artikel 1.7.

Artikel 4.3 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 scheikunde van de RU Nijmegen, voordat deze met goed gevolg het afsluitend examen van de bacheloropleiding scheikunde van de RU Nijmegen heeft afgelegd.
2. Toelating is 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 verlend van de onderdelen van het bachelorexamen met een studielast van 150 EC.

3. De student die krachtens dit artikel is toegelaten tot het onderwijs van 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.eeft niet het recht het afsluitend examen van de opleiding af te leggen zolang als hij niet in het bezit is van het getuigschrift van het met goed gevolg afgelegd afsluitend examen van de in het eerste lid bedoelde bacheloropleiding.

Paragraaf 5 Studiebegeleiding

Artikel 5.1 Studievoortgangsadministratie

1. De faculteit registreert de individuele studieresultaten van de studenten.
2. Zij verschaft elke student tenminste 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.

Paragraaf 6 Overgangs- en slotbepalingen

Artikel 6.1 Tentamens en examens voor studenten begonnen voor 1 september 2002

1. Tot 1 september 2008 wordt aan studenten die voor 1 september 2002 zijn begonnen de gelegenheid geboden de tentamens alsmede het doctoraalexamen van de opleiding scheikunde af te leggen zoals vastgesteld in de OER die in werking trad op 1 september 2002.
2. In bijzondere gevallen kan de examencommissie aan andere studenten dan die bedoeld in het eerste lid, toestemming verlenen tentamens en examens af te leggen volgens de in het eerste lid bedoelde onderwijs- en examenregeling. Het bepaalde in het eerste lid blijft daarbij onverminderd van kracht.

Artikel 6.2 Overstap van ongedeelde opleiding naar bachelor/master structuur

Een student, als bedoeld in art. 6.1, 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 6.3 Vaststelling OER/ Wijzigingen

(NB: zie ook Structuurregeling artikelen 11 en 18 en Reglement UGV en FGV artikel 3.3.1.)

1. Deze regeling en wijzigingen van deze regeling worden door de decaan, na advisering door de opleidingscommissie scheikunde en na instemming van de FGV, bij afzonderlijk besluit vastgesteld.
2. Een wijziging van deze regeling heeft geen betrekking op het lopende studiejaar, tenzij de belangen van de studenten daardoor redelijkerwijs niet 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 is genomen ten aanzien van een student.

Artikel 6.4 Bekendmaking

1. 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.
2. Elke belangstellende kan op het faculteitsbureau een exemplaar van de in het eerste lid bedoelde stukken verkrijgen.

Artikel 6.5 Inwerkingtreding

Deze regeling treedt in werking op 1 september 2008.
Aldus vastgesteld door de decaan op 29 augustus 2008.

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 kunnen op verzoek van de student in het Nederlands worden afgelegd; tentamens en examens van Engelstalige opleidingen worden in het Engels afgelegd, tenzij de examencommissie van de desbetreffende opleiding anders beslist;
- Het gebruik van een vreemde taal mag niet leiden tot verzwaring van de studielast van de opleiding;

- 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.

Opleidingscommissie

Overeenkomstig art. 9.18 WHW is er een opleidingscommissie. Deze commissie heeft tot taak:
1. advies uit te brengen over de onderwijs- en examenregeling,
2. het jaarlijks beoordelen van de uitvoering van de onderwijs- en examenregeling, en
3. het desgevraagd of uit eigen beweging advies uitbrengen aan de onderwijsdirecteur en de decaan over alle aangelegenheden betreffende het onderwijs in de opleiding.

Regeling beperking tentamendeelname

Op alle tentamens van de binnen de faculteit verzorgde opleidingen is onderstaande Regeling beperking tentamendeelname van toepassing. Deze is op 7 januari 2004 vastgesteld door de faculteitsleiding na advies van het Onderwijsmanagementteam.

- Studenten mogen maximaal 3 keer aan een tentamen deelnemen. Studenten zijn verplicht zich voor het tentamen elektronisch aan te melden via KISS tot 5 werkdagen 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 dienen zich af te melden als ze niet deelnemen aan een tentamen:
  - tot 5 werkdagen voor het tentamen in Kiss,
  - daarna tot 1 werkdag 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 3).

- Indien het tentamen na 3 keer nog niet is behaald, dient de student voor iedere volgende keer dat hij/zij aan het tentamen wil deelnemen een schriftelijk verzoek in te dienen bij de examencommissie van zijn/haar opleiding.
- 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 februari 2004 voor wat betreft tentamens waarvoor studenten zich na die datum voor de eerste maal inschrijven.

Nadere regels voor de goede gang van zaken tijdens tentamens (ex art. 7.12 lid 4 WHW)

De examencommissie stelt regels vast met betrekking tot de goede gang van zaken tijdens tentamens en met betrekking tot de in dat verband te nemen maatregelen. Die maatregelen kunnen inhouden dat in geval van fraude door een student door de examencommissie, gedurende een door de examencommissie nader te bepalen termijn van ten hoogste één jaar, aan die student het recht wordt ontnomen een of meer daarbij aan te wijzen tentamens of examens aan de instelling af te leggen.

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' luiden;
b. danwel indien de uitslagverklaring van één van de verplichte tentamens behorende bij het examen '5,0' luidt en compensatie plaatsvindt doordat van één van de verplichte tentamens 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 bachelor examen scheikunde.
d. 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' luiden.
7. Vrijstellingsprogramma: men is geslaagd voor het masterexamen scheikunde indien de uitslagverklaringen voor alle tot het vrijstellingsprogramma behorende tentamens tenminste "6,0" 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 5 werkdagen 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 1 september 2007.

Aldus vastgesteld door de examencommissie voor de opleiding scheikunde op 28 juni 2007

7 Guidelines for writing an academic report

How to write an academic report

Algemeen

Het verslag is bedoeld om:
- een overzicht te geven van het verrichte onderzoek;
- een proeve van bekwaamheid te leveren in het kritisch weergeven van wetenschappelijke activiteiten.

Een goed verslag is bondig, overzichtelijk en in goed Nederlands (of Engels) geschreven. Het verslag, vooral dat van een hoofdrichtingstage, is een visitekaartje bij menige sollicitatie. Het belang van een goed verslag kan daarom moeilijk worden overschat.

Structuur van het verslag
Bij het schrijven van het verslag dient een wetenschappelijk artikel in een vooraanstaand tijdschrift als leidraad. Een dergelijk artikel heeft een grove en een fijne structuur, die duidelijk moeten worden onderscheiden.
A. *Grove structuur:* de grove structuur is het formele kader, waarbinnen ieder artikel en dus ook ieder verslag moet zijn opgesteld. Dit kader omvat de algemene indeling en een beschrijving in grote lijnen van wat er in de verschillende onder-delen wordt besproken.
Ieder verslag bestaat uit de volgende delen:
1. Samenvatting
2. Inleiding
3. Experimentele methoden of Theorie en methoden
4. Resultaten
5. Discussie
6. Literatuur
7. Bijlage

B. *Fijne structuur:* naast de grove structuur is er een fijne structuur, die veel meer ruimte laat voor eigen voorkeur en fantasie. Het is de bedoeling, dat deze ruimte ook wordt benut: uit het verslag moeten de eigen stijl en het karakter van de auteur blijken.

De volgende paragrafen behandelen alle onderdelen van het verslag.

1. Samenvatting: de samenvatting, op ongeveer een halve pagina, geeft een beknopt overzicht van de onderzoeksresultaten en de voornaamste conclusies daaruit. In overweging wordt gegeven de samenvatting behalve in het Nederlands ook in het Engels te schrijven.
2. Inleiding: de inleiding is bedoeld om de lezer in te leiden in de probleemstelling en om duidelijk te maken waarom die probleemstelling van belang is. In vele artikelen en verslagen begint de inleiding met een korte beschrijing van het algemene kader waarin het onderzoek door de auteur(s) wordt geplaatst. Door het aangeven van dit kader wordt het belang van het onderzoek in groter verband duidelijk gemaakt. Vanuit dit algemene kader wordt vervolgens naar de specifieke probleemstelling toe geredeneerd. Daarbij wordt herhaaldelijk verwezen naar de literatuur om duidelijk te maken welke deelproblemen binnen het kader al zijn opgelost en welke nog om nader onderzoek vragen. Tenslotte komt de auteur aan bij de specifieke probleemstelling, waarover de rest van het artikel of verslag zal gaan.

3. Experimentele methoden of Theorie en methoden: in dit deel worden de algemene methoden van onderzoek beschreven. Voor de algemeen gebruikte, bestaande technieken wordt alleen verwezen naar de beschrijving in de toegankelijke literatuur (publikaties, doctoraalverslagen). Nieuwe methoden en veranderingen in bestaande methoden worden zodanig beschreven, dat zij bij voortzetting van het onderzoek nagedaan kunnen worden. Bereidingswijzen en rekenvoorbeelden worden in de bijlage verwerkt.
   Bij 'Methoden van onderzoek' worden de algemene methoden beschreven die tenminste in een aantal experimenten zijn gebruikt. Methoden die toegepast zijn in één experiment, en ook protocollen van individuele experimenten horen thuis onder Resultaten (bijvoorbeeld legendes van figuren).
4. Resultaten: in het deel 'Resultaten' worden de onderzoeksresultaten gepresenteerd in de vorm van grafieken, tabellen en, wanneer van toepassing, tekeningen en foto's. De tekst dient als de rode draad, die van het ene experiment naar het andere voert. Alle figuren zijn voorzien van een onderschrift, en alle tabellen van een kop. Beide presentaties moeten los van de tekst kunnen worden begrepen.
   De tekst van het deel 'Resultaten' begint waar de 'Inleiding' ophoudt: bij de probleemstelling. De grens tussen 'Inleiding' en 'Resultaten' is niet scherp: de analyse van de probleemstelling kan in de 'Inleiding' zijn uitgevoerd, maar kan ook plaats vinden aan het begin van de 'Resultaten'.
   Terwille van de overzichtelijkheid is ook het deel 'Resultaten' vaak ingedeeld in verschillende paragrafen. Geef deze paragrafen een probleem-gerichte titel, die duidelijk laat blijken waarom het gaat. Resultaten van een experiment worden getoond in een grafiek of in een tabel, maar nooit dubbel. In de meeste gevallen verdienen grafieken de voorkeur, omdat zij beter verbanden zichtbaar maken. Grafieken op millimeterpapier zijn vaak te groot. Verklein ze door fotokopiëren met het bijschrift. Daardoor krijgt dit laatste een andere lettergrootte, waardoor de leesbaarheid toeneemt.
   De tekst is bedoeld om de resultaten aan elkaar te praten. Bij elk experiment wordt verteld waarom het wordt uitgevoerd. Hierop volgt een beknopte beschrijving van de uitvoering en van de uitkomst. Een conclusie wordt alleen getrokken voorzover nodig is om het volgende experiment in te leiden. Op deze manier komen de experimenten in een logische volgorde te staan; de tekst wordt daardoor een betoog met een logische opbouw. Het is absoluut niet nodig en vaak zelfs ongewenst om experimenten in chronologische volgorde te beschrijven.
5. Discussie: in de 'Discussie' worden de algemene conclusies getrokken en vergeleken met de gegevens in de literatuur.
   Juist in de 'Discussie' is de vrijheid van de auteur groot. Een vorm die vaak voorkomt, is de volgende: - De eerste alinea's bevatten de redenering, die leidt tot de algemene conclusie(s). Bij deze redenering worden tussen de experimenten zo veel mogelijk verbanden gelegd, zodat het maximum aan informatie uit de proeven wordt gehaald. Bij het trekken van de conclusies kunnen literatuurgegevens worden gebruikt.
   - Vervolgens worden de getrokken conclusies met de literatuur vergeleken. De auteur probeert een verklaring te vinden voor eventuele verschillen. Hierdoor worden de conclusies in een algemeen kader geplaatst, waardoor hun belang wordt onderstreept. Het aangeven van dit kader kan ook meer expliciet gebeuren en ook hierbij kunnen literatuurgegevens worden gebruikt. Vele artikelen en verslagen eindigen met suggesties voor verder onderzoek. Dit ligt ook voor de hand, omdat onderzoek altijd weer nieuwe vragen oproept.
   De grens tussen 'Resultaten' en 'Discussie' is niet scherp. De auteurs zijn min of meer vrij te bepalen hoeveel conclusies zij na ieder experiment in het deel 'Resultaten' willen trekken. In het extreme geval worden 'Resultaten' en Discussie samengevoegd. Dit geschiedt vaak

bij korte mededelingen (Short communications). Eventueel worden 'Conclusies' en 'Suggesties voor verder onderzoek' apart vermeld.

6. Literatuur: onder het kopje literatuur wordt de aangehaalde literatuur vermeld. De wijze van vermelden en van het aanhalen van de literatuur in de tekst kan worden overgenomen uit een vooraanstaand tijdschrift.
7. Bijlage: de bijlage bevat aanvullende gegevens over: - methoden: bereidingswijze en rekenvoorbeelden. - resultaten: alle primaire meetresultaten van de experimenten die in het verslag staan vermeld en van belang kunnen zijn: tellingen, metingen, foto's, recorderpapier, etc.
   Het ligt voor de hand de onderwerpen in de bijlagen te beschrijven in de volgorde, waarin zij voorkomen in het eigenlijke verslag.
   Verwijs bij alle gegevens naar de passage in de tekst waarbij zij thuishoren.

Slotopmerkingen

- Merk op dat speciaal de bovenbeschreven fijne structuur aan het verslag een cyclisch karakter geeft. In de 'Inleiding' gaat de auteur van het algemene kader naar een specifieke probleemstelling van het onderzoek.
In de 'Discussie' gebeurt het omgekeerde: 'Inleiding' en 'Discussie' zijn elkaars spiegelbeeld. Deze vorm wordt bij zeer veel artikelen aangetroffen.
- Begin bij het maken van een verslag met het gemakkelijkste: 'Experimentele methoden'. Schrijf daarna, met een goed gespecificeerde probleemstelling in het achterhoofd, het deel 'Resultaten'. 'Inleiding' en 'Discussie' kunnen vanwege hun overeenkomst in structuur tegelijkertijd geschreven worden. Een goed alternatief is de 'Inleiding' te schrijven na de 'Discussie'. Lees het geheel verschillende malen goed door. Let vooral op of het hele verhaal logisch en samenhangend is. Vorm je een beeld van de kern van de zaak en schrijf deze neer in de 'Samenvatting'.
- De titel van het verslag is de vlag die de lading moet dekken. Geef in deze titel zo concreet mogelijk het onderzoeksthema aan. Vermijd aanduidingen met weinig informatie-inhoud zoals: 'Enkele aspecten'. De titelpagina vermeldt, naast de titel, de naam van de auteur, en verder waar, wanneer en onder wiens leiding het onderzoek is uitgevoerd.

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Student Council of the Faculty of Science (FSR)
fsr@science.ru.nl
www.ru.nl/fnwi/fsr

Council room for students
room HG 00.150
open: Monday, Tuesday and Thursday: 12.30 - 13.30 hr.
For complaints on education, faculty and facilities. During opening hours a student-member of the FSR or one of the OLC's will be present.

Office of administration and exams for students
open: Monday-Thursday: 13.00-16.00 hr, Friday: 09.00-12.00 hr
room HG 00.134
tel.: 3652247/3753392

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

9 Appendix

9.1 Academic Calendar

The academic year starts September 1, 2008, and ends August 31, 2009

First day of lectures: September 1, 2008
Last day of lectures: July 10, 2009

Period 1: September 1 until November 7, 2008
Period 2: November 10, 2008 until January 30, 2009
Period 3: February 2 until April 17, 2009
Period 4: April 20 until July 10, 2009

Autumn holiday: October 13 until 17, 2008
Christmas holiday: December 22, 2008 until January 2, 2009
Spring holiday: February 23 until 27, 2009
Good Friday: April 10, 2009
Easter Monday: April 13, 2009
May holiday: April 27 until May 5, 2008 (including Queens Day and Liberation Day)
Ascension: May 21 and 22, 2009
Whit Monday: June 1, 2009
Resit examination period: August 17 until 28, 2009

9.2 List of lecturers

Name	Email	Phone	Room
Boelens, Dr. W.C.	w.boelens@ncmls.ru.nl	16753	NCMLS 3.93
Born, Dr. J.G. van den	r.vandenborn@science.ru.nl	52730	HG 02.826
Brock, Prof.dr. R.	R.Brock@ncmls.ru.nl	66213	NCMLS
Broek, Drs. J.G.J. van den	j.vandenbroek@science.ru.nl	53346	HG 00.109
Buydens, Prof. dr. L.M.C.	l.buydens@science.ru.nl	53192	HG 02.721
Cornelissen, Dr. J.J.L.M.	j.cornelissen@science.ru.nl	52381	HG 03.016
Dankbaar, Prof. dr. B.	b.dankbaar@fm.ru.nl	52684	HG 02.809
Dankelman, Drs. I.E.M.	i.dankelman@science.ru.nl	52150	HG 02.827
Delft, Dr. F.L. van	f.vandelft@science.ru.nl	52373	HG 03.022
Derksen, Prof. dr. J.T.P.	h.derksen@science.ru.nl		HG 02.831
Dolstra, Dr. H.	h.dolstra@chl.umcn.nl		
Drenthen, Dr. M.A.M.	m.drenthen@science.ru.nl	52730	HG 02.826
Dresen, H.M.	l.dresen@science.ru.nl	52269	HG 02.814
Feiters, Dr. M.C.	m.feiters@science.ru.nl	52016	HG 03.021
Gelder, Dr. R. de	r.degelder@science.ru.nl	52842	HG 03.009
Groenenboom, Dr. ir. G.C.	g.groenenboom@theochem.ru.nl	53034	HG 03.044
Hest, Prof. dr. ir. J.C.M. van	j.vanhest@science.ru.nl	53204	HG 03.015
Kentgens, Prof. dr. A.P.M.	a.kentgens@nmr.ru.nl	52078	HG 03.343
Keulartz, Prof. dr. F.W.J.	j.keulartz@science.ru.nl	52851	HG 02.823
Kouwer, Dr. P.H.J.	p.kouwer@science.ru.nl	52464	HG03.011
Kraan, Dr. P. van der	p.vanderkraan@ncmls.ru.nl	16568	NCMLS
Kuppeveld, Dr. F. van	F.vanKuppeveld@ncml.ru.nl	17574	NCMLS
Leeuw, A.L.M. de	t.deleeuw@amd.ru.nl	19656	
Lekkerkerk, Ir. L.J.	h.lekkerkerk@fm.ru.nl	11931	TvA1 01.35
Ligthart, Dr. P.E.M.	p.ligthart@fm.ru.nl	12020	TvA1 01.34
Logie, C.	c.logie@ncmls.ru.nl	10525	NCMLS 3.93
Lohrum, Dr. M.A.E.	m.lohrum@ncmls.ru.nl	10541	NCMLS 3.87
Lowik, Dr. D.W.P.M.	d.lowik@science.ru.nl	52382/53185	HG 03.016
Lubsen, Dr. N.H.	n.lubsen@science.ru.nl	16850	NCMLS 3.89
Luthy, Prof. dr. C.H.	luethy@phil.ru.nl	15750	
Meekes, Dr. H.L.M.	h.meekes@science.ru.nl	53200	HG 03.625
Meijer, Prof. dr. E.W.	b.meijer@science.ru.nl		
Migchels, Dr. ir. N.G.	n.migchels@fm.ru.nl	11613	TvA1 01.53
Minnaar, Drs. R.A.	r.minnaar@fm.ru.nl	11765	TvA1 02.24
Moerman, W.P.	w.moerman@amd.ru.nl	16434	
Nolte, Prof. dr. R.J.M.	r.nolte@science.ru.nl	52143	HG 03.025
Pruijn, Prof. dr. G.J.M.	g.pruijn@ncmls.ru.nl	16847	NCMLS 2.93
Rowan, Prof. dr. A.E.	a.rowan@science.ru.nl	52323	HG 03.020
Rutjes, Prof. dr. F.P.J.T.	f.rutjes@science.ru.nl	53202	HG 03.024
Schaftenaar, Dr. G.	g.schaftenaar@cmbi.ru.nl	19674	NCMLS 0.18
Schalkwijk, Prof.dr. J.	J.Schalkwijk@ncmls.ru.nl	14094	NCMLS
Scholten, P.H.T.	p.scholten@science.ru.nl	52427	HG 02.829
Segers, S.A.J.	s.segers@science.ru.nl	53201	HG 02.832
Smelik, Dr. B.	bsmelik@cs.ru.nl	52204	HG 02.045
Theuvenet, Dr. A.P.R.	a.theuvenet@science.ru.nl	52013	HG 02.205
Torensma, Dr. R.	r.torensma@ncmls.ru.nl	10544	NCMLS

Veenstra, Dr. G.J.C.	g.veenstra@ncmls.ru.nl	10541	NCMLS 3.87
Vissers, Dr. G.A.N.	g.vissers@science.ru.nl	52686	HG 02.830
Vlieg, Prof. dr. E.	e.vlieg@science.ru.nl	53070	HG 03.628
Vlieg, Prof. dr. J. de	j.devlieg@organon.com		
Vriend, Prof. dr. G.	g.vriend@cmbi.ru.nl	19521	NCMLS 0.27
Wehrens, Dr. H.R.M.J.	r.wehrens@science.ru.nl	52053	HG 02.730
Welters, Drs. R.P.M.M.	r.welters@honours.ru.nl	11354	
Wijmenga, Prof. dr. S.S.	sybrenw@science.ru.nl	53384	HG 03.345
Willems, Dr. P.H.G.M.	p.willems@ncmls.ru.nl	14589	NCMLS 7.39
Wit, Prof. dr. J. de	j.dewit@science.ru.nl	52684	HG 02.809
Zwart, Prof. dr. H.A.E.	h.zwart@science.ru.nl	52038	HG 02.808

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