Faculty of Science

Prospectus 2010 - 2011

Natural Science

Master

Radboud University Nijmegen

Preface

This prospectus provides information on courses as well as on research departments that are relevant to Master students of Natural Science.

The goal of a Masters study is quite simple: Find joy in becoming an expert in a field that you like to work in, whether that be biophysical chemistry, theory of solid state physics, or science communication, every student here has a chance to study in a top-research environment, follow state-of-the art courses and participate in front-line research with world class researchers.
Masters students of Natural Sciences choose to become experts on the interface between disciplines, the surface where scientific development finds new ways. A Master in Natural Science is able to work with concepts and methodology of two trades. This prospectus offers a sample of subjects available at Radboud University. But be sure to also venture out further in the information provided by other tracks, faculties and other universities.
There are four choices for the starting master student:
Research (O), Communication (C), Management (MT), and Education (E). All of these are described in this Masters prospectus.
Although the masters programme of Natural Sciences is intended to offer an all english curriculum, some information may still be available only in Dutch.
More information, and the most recent education and examination regulations (OER) can be obtained from the web-sites www.ru.nl/natuurwetenschappen and www.ru.nl/moleculairewetenschappen.
Important information about being a student in Nijmegen is available through http://www.ru.nl/students/general/.
The contents of this guide were made and assembled with great care, however, errors and inaccuracies cannot be ruled out and no rights can be derived from this document.
Suggestions for improvement and corrections are warmly welcomed.
July 2010,
Dr. L.J.J. Laarhoven, email: L.Laarhoven@science.ru.nl
Ms. E.A.M.L. Meijer

Contents

1 Introduction

1.1 Introduction

Master in Natural Sciences
Radboud University Nijmegen (RU) offers a Master of Science programme in Natural Sciences. This is the official master that follows the bachelors programme 'Natuurwetenschappen' at this university. These bachelors and masters programmes are unique in The Netherlands; they offer a programme that is both broad and in-depth in the three main disciplines of Science: Physics, Chemistry and Biology.

The master comprises a theoretical component and extensive practical training, which prepares the student for a PhD-position or a career in fundamental or applied research in industry or institutions. Also the training for a teaching position with a first-degree licence is possible in the second year. The master Natural Science even offers the possibily to obtain a double licence for chemistry and physics.
Aside from these classic masterprogrammes there are two other possibilities: Communication and Management.

Admission
Both the bachelors and the masters programmes in Natural Sciences at Radboud University are intended to train the student broadly, but deeply into the three disciplines Chemistry, Physics and Biology and specifically the boundaries between these. For this reason admission to the master programme is limited to those students who have a thorough background in more than one discipline.

For admission a Bachelor degree in Natuurwetenschappen is required. In some cases bachelor students Natuurwetenschappen may enter the master programme before graduating, but only after approval of the examination board.
Students with a BSc in Chemistry or Physics from Nijmegen or other universities may be admitted after a check of their curriculum, and will usually have to follow some additional courses (max. 30 ec) to relieve deficiencies. Bachelor students who wish to enrol in the master Natural Science are advised to contact the student counsellor timely. It is usually possible to limit deficiencies by choosing the right electives during the bachelor programme.

Bachelors in related subjects (Chemistry, Physics) from foreign universities will be checked for their level of knowledge in the three core disciplines before they can be admitted.

Students with a BSc in Biology, Molecular Life Sciences, or graduates from HBO Physics or Chemistry cannot enrol the master Natural Science. Their deficiencies exceed 30 ec. They may however be able to follow a shortened bachelor education track.

Structure of the Masters programme
The masters programmes at the Science Faculty of Radboud University are offered in four variants: a research (O) variant, a communication (C) variant, an education (E) variant, and a

management and technology (MT) variant. At this moment, only the research variant has a complete programme in the English language. The other variants are at present primarily aimed at the Dutch market and the Dutch educational system, and are therefore primarily in Dutch.

The masters programme aims at specialization in a particular field between Physics, Chemistry and Biology. Students will have to take courses and one or two internships such that multidisciplinarity is obvious. At Radboud University many research groups of various denomination in science cooperate and there is ample opportunity to enter a multidisciplinary research specialisation of choice.

This prospectus
This prospectus describes the various opportuniteis and offers a choice of elective courses. Students are encouraged to venture into other study guides as well and look outside the boundaries of the Faculty. An extensive description of multidisciplinary research going on in the various research groups is given in Chapter 4.
At the end some practical information is supplied.

2 Master Programme

2.1 Masters programme

All masters programmes at the Faculty of Science offer four variants: Research (O), Communication (C), Education (E), and Management (MT). Common aspects in all variants are a Natural Sciences programme consisting of elective and specialization courses and one or two research internships. In this chapter the different variants are described. The next chapter offers descriptions of the courses for C and MT variants, and a number of courses from Physics, Chemistry and Biology that may function as electives for the Natural Science programme.
Bachelor students Natuurwetenschappen graduate in one of three specializations:

- physical and chemical,
- biological and physical, or
- chemical and biological

In the master Natural Sciences, students can continue into the same direction of specialization, but this is not strictly required. Students entering the master with a different bachelor for instance will not have specialized according to these three yet. Students do have to make a choice, though, in any variant (O, C, E, MT) it is important to find a specialization for graduation and, accordingly, a matching programme of courses. Electives can be chosen freely, but the total package has to be approved by the examination board. The direction of internship determines which courses are compusory and with which specialization a graduate enters the job-market.

Always a specialization on the interplay of Physics, Chemistry and Biology must be chosen and every Natural Science internship (major, minor or within the variants) has to be approved by the Programme's board (see Chapter 5).

The Variants:

- The Research Variant (O-variant), trains students for fundamental and applied research and is required for people persuing a PhD position or a position in industrial or institutional research. The programme offers two research internships part of which can be fulfilled externally;
- The Communication Variant (C-variant), trains students in the direction of communication of science. The programme consists of one research internship in science, and one project in communication;
- The Education Variant (E-variant), educates students toward becoming a first-degree teacher in Chemistry, Physics, or both. During the first year a Natural Science internship is taken, the second year is completely dedicated to education;
- The Management and Technology Variant (MT-variant), prepares students for a management position as an academic professional. Again: one Natural Science internship and one MT-project;

2.2 O - Research Variant

Masters programme
Basically, the masters programme for the research variant contains 6 months (30 ec) of elective and specialization courses and a Philosphy course, 6 months (30 ec) for a Minor and 1 full year (60 ec) for a Major.
Minor and Major comprise an internship and a number of specialization courses/capita.
Requirements are that Major and Minor are within research groups from different disciplines (Chemistry, Physics, Biology) and that both are multi-disciplinary.
Approval regarding this has to be obtained from the Examination board for both.
The Research Variant comprises:

- Philosophy II 3 ec
- Science Electives 12 ec or more
- Electives 15 ec
- Minor 30 ec, including a maximum of 6 ec of specialization courses
- Major 60 ec, including a maximum of 12 ec of specialization courses

Requirements for internships
Internships need to be taken in two different disciplines along the lines of the chosen specialization.
The subject of both Minor and Major internship will have to be approved for interdisciplinarity by the Steering Board of Natural Science.
A form can be obtained at the study coordinator or on the website:
www.ru.nl/natuurwetenschappen.

Written approval has to be obtained before starting an internship.
See also the regulations in Chapter 5 of this prospectus.

Internships can also be taken abroad, or at a company, but always under supervision of a Radboud University professor. For internships or courses abroad funding bodies are available such as the Erasmus programme. If you want to pursue an external internship, contact your student cousellor.

Most research groups will require certain courses to be taken before starting an internship, and some courses to be taken during, or as a part of the internship. It may also be possible that a literature sudy has to be made. Make sure you inquire timely with the leader of the group of choice.

Generally the duration and order of internships is: Major of 60 ec first, then Minor of 30 ec, both including specialisation courses. However, after consulting the Examination Board, alternatives are possible, such as a combined internship on an interdisciplinary subject at two research groups (from different disciplines). A list and descriptions of research groups with multi-disciplinary research can be found in Chapter 4 of this guide.
Both Major and Minor internship will entail participation in a research project. Usually under supervision of a PhD-student or a post-doc. Internships are always concluded with a report and an oral presentation.

You are required to hand a (preferably digital) copy of the research reports and thesis to the study coordinator.
These will be needed for the examination board and education assessments by the government.

Electives
Electives can be chosen from all the courses given within and outside the faculty of science. Requirements are that there should be some cohesion between at least part of the electives and that the level is sufficient.
The total package of electives should be approved by the examination board, preferably together with an indication of the intended internship. Usually this causes no problems, but when in doubt about the applicability of certain courses, make sure to check with the coordinator and the examination board before entering.
A form to submit your programme can be obtained on the website: www.ru.nl/natuurwetenschappen.

2.3 C, E, and MT variant

C, E, and MT-variant

In the **C** and the **MT** master programmes, the first year and a small part of the second are used to finalise the Natural Science education with 9 ec in Science electives and one internship of 45 ec.
The variant-specific courses are mainly given in the second year and the master is concluded with a C or MT project or internship. This internship cannot be started before most of the science courses are taken and the science internship is completed.

In the **E** master programme the entire second year is dedicated to education training with courses and two internships in a school. This means that the whole Natural Science education should be *finished* in the first year. Students who wish to obtain two teaching licences (for physics and for chemistry) will recieve an additional training of 15-30 ec after the second year. There are no other requirements for a double licence than this additional training.

If you wish to pursue a teaching licence, be sure to timely contact the ILS that organises this training.

Only one science internship
In these three programmes there is only one Natural Science research internship of 45 ec, to be fulfilled in a research department at the university on an interdisciplinary subject. The same requirements apply as for the internships in the research variant. **This internship must be approved by the Examination Board.** For further details see the regulations in Chapter 5.

C - Communication

The C-programme:
- Philosophy II 3 ec
- Electives 15 ec

- Natural Science internship 45 ec
- Communication courses 57 ec:

Communication courses in the first year are:
Introduction Science Communication 3 ec
Science & Societal interaction 3 ec
Risk Communication 3 ec
Boundary Work 3 ec

Communication courses in the second year are:
Framing Knowledge 3 ec
Knowledge Society 3 ec
Science, Media, and Strategy 3 ec
Electives 6 ec
Project 30 ec

Electives in the communication programme should be chosen after consulting the C-coordinator, the total masters programme should be approved by the Examination Board of Natural Science.

More information and contact adresses can be found via http://www.betacom.science.ru.nl/

E - Education

The E-programme:

- Philosophy II 3 ec
- Electives 15 ec
- Natural Science internship 45 ec
- Education programme 57 ec
- Optional 15 ec extra for second licence

Note that the whole natural science education, certainly the research internship should be completed before the Educational programme can be started.
The educational programme is completely organised by the ILS, the Instituut voor Leraar en School and will be entirely in Dutch. The programme starts in September and in January. This training is part of the master programme and the Science Faculty is responsible for this variant.

Students who wish to obtain a licence in both chemistry and physics will have to take an additional 15 ec (approximately) of internship and courses after the second year.

Alternatively, it is also possible to enrol in the education training ***after*** completion of the masters programme (O, C, or MT). Students with a master in Natural Science can enter the ILS for a 1 year training to obtain a licence. Again, 15 more ec of training should be added for a double licence. This training is independent from the Faculty of Science and coordinated entirely by the ILS.

Enrolling in the E-programme:
Natural Science students should consult the ILS at an early stage, in order to check their programme for deficiencies.

The **Physics track** is open to Natural Science students with a Physical-Chemical or a Biological-Physical specialization.
Additionally, the following courses should be taken in Bachelor or Master:

- NP007B Speciale Relativiteitstheorie, 3 ec
- NB042B Optica: de manipulatie van licht, 3 ec
- NP024B Newtoniaanse kosmologie, 3 ec
- NB 007C Deel: experiment Röntgenstraling, 1 ec, ir. R. van Haren

The **chemistry track** is open for all Natural Science students who have had at least 120 ec in chemical courses and internships.

The address of the ILS is:

Secretariaat Instituut voor Leraar en School,
Erasmusplein, tel. 024-35 15572
http://www.ru.nl/ils/

For Physics, contact: dr. Rob van Haren r.vanharen@ils.ru.nl
For Chemistry, contact: dr. Michiel Vogelenzang m.vogelenzang@ils.ru.nl

MT - Management and Technology

The MT-programme

- Philosophy II 3 ec
- Electives 15 ec
- Natural Science internship 45 ec
- Management programme 57 ec:

Obligatory MT courses:

Business & Society (5 ec) *
Organization Theory (5 ec) *
Innovation management (5 ec)
Strategy & Marketing (5 ec)
Finance & Accounting (5 ec)

* to be taken in the first masters' year

Elective MT courses from:

Science and entrepreneurship (3 EC)
Research strategy & Management (3 EC)
Industrial chemistry (3 EC)
Algemene managementvaardigheden (3 EC)

Electives in the MT programme should be chosen after consulting the MT-coordinator, the total master-programme should be approved by the examination committee. More information can be found in Chapter 3.

The MT-variant is coordinated by:

Prof.dr. B. Dankbaar (b.dankbaar@nsm.ru.nl)

Master track Management & Technology (MT)

General information

The Management & Technology (MT) master track is available as an option for students in all Master studies of the Faculty of Science of the Radboud University Nijmegen since September 2003. Science students can choose between the traditional research track, the education track, the communication track and the management & technology track. In the traditional research track, the curriculum consists basically of participation in (basic) research and supporting courses. Compared to the traditional research track, students in the other tracks spend less time in the laboratory. They follow courses devoted to the study of problems of education in science (the E-track), problems of science communication (the C-track), or problems of management and technology (the MT-track), and they also do (applied) research in these areas. These tracks take up approximately half of the study time available in the two-year Science Master. The Science Faculty of the Radboud University has decided that the E, C and MT tracks will be identical for all science students, regardless of the particular science field in which they are doing their Master. This means that the composition of the groups following these tracks is multidisciplinary.

Aim

The aim of the master track Management & Technology (MT) is to make students familiair with the language and perspectives of management studies with special emphasis on issues of innovation and technological change. Students become aware of the impact of social institutions, organizational forms and business strategies on the transformation of insights from science and technology into new products and services. They acquire practical experience working in the fields where science and management meet.

Admission:

see the admission criteria FNWI for the masters.

Year 4 (First Master year)

Semester 1: Business & Society (5 ec)

Deals with business organizations in relation to society (context, interactions), and includes an exercise in case presentation.

Semester 2: Organization Theory (5 ec)

Provides an introduction into theories and concepts of organizational structure, design and change and includes an exercise in organizational diagnosis.

Semester 2: Finance & Accounting (5 ec)
Provides and introduction in management accounting & control, financial accounting and finance.

Year 5 (Second Master year).

Semester 3: Innovation Management (5 ec)

Semester 3: Strategy & Marketing (5 ec)
The courses Innovation Management and Strategy & Marketing provide an in-depth treatment of issues related to the transformation of knowledge coming from science and technology into marketable products and services. The courses include further practical exercises preparing for the MT-research project. Admission to these courses is only granted after completion of the courses Business & Society and Organization Theory.

Semester 4: Research project MT (27 ec)
Admission after completion of the five obligatory MT-courses.

Optional courses
The total MT track also includes a minimum of 5 ec of optional courses, which can be followed at any time during the master. Optional courses of the MT-track include *Research Strategy & Management* (3 ec) and *Project Management* (3 ec) and courses given in the C-track (*Communication*). The choice is not limited to these courses; students can follow other pertinent courses subject to the consent of Prof. Dankbaar.

Cumulative structure

In the structure of the MT-master track, the courses Business & Society and Organization Theory provide basic knowledge about the 'outside world' of business organizations. Didactical methods include lectures, study of literature, assignments and presentations of case studies by students. The courses *Innovation Management* and *Strategy & Marketing* provide more in-depth knowledge, while the more elaborate practical exercises in these courses support the preparation of the MT-research project. The course on *Finance & Accounting* is not part of this overall cumulative structure, but it does provide essential knowledge for understanding decision making in companies.

3 Courses

3.1 Research Variant

Electives

The following section gives a *sample of elective courses* from Physics, Biology and Chemistry available to Master students in Natural Science. There are many more possibilities, be sure to check the other masterprospectuses (http://www.studiegids.science.ru.nl/2010/science).

Most research groups offer topical courses (Capita Selecta) alongside your internship. Other faculties and other universities also offer interesting courses that are not available in Nijmegen.

Master courses are often scheduled on demand. The usual procedure is to contact the lecturer or the group's secretariat to show your interest. If you encounter problems, contact your student counsellor.

Each student's programme, including electives and internships has to be approved by the Examination Board. A form can be downloaded at www.ru.nl/natuurwetenschappen.

Before starting an internship it requires approval as well. Failing to get approval may result in losing time!

Physics - elective courses

Brain and Behaviour 2

Course ID: **NM050B** *6 ec* second semester prof. dr. C.C.A.M. Gielen

Website
Blackboard

Teaching methods
- 28 hrs lecture

Prerequisites
Brain and Behaviour 1

Objectives
- The student is familiar with the main problems in the field of visual perception and motor control
- The student is familair with Information Theory (Mutual information and maximum log likelyhood estimator) to estimate information transfer
- The student can apply deterministic optional control (including Hamilton-Jacobi-Bellman equation and Pontryagin Maximum Principle)
- The student has the mathematical skills to develop advanced models to explain recent experimental data in a unified conceptual frame work

Contents
This course will present general principles of neuronal information processing. These principles are illustrated by discussing the functional characteristics of the visual system and motor system in man.

Subjects
- Control Theory
  - Conditions of stability of nonlinear systems
  - Conditions for stable control
  - Algorithms for optimal control
- Information Theory
  - Entropy; mutual information
  - Efficiency of information coding
  - Parameter estimation principles
- The visual system
  - Organisation of the visual system
  - Efficiency of visual information processing
- The motor system

- Organisation of the motor system
- Optimal control of the motor system
- Control of redundant manipulators

Literature
Necessary:
- Lecture notes (For sale at secretary's office of Biofysica room 0.20 M244, Geert Groteplein-Noord 21)

Examination
Written exam

Extra information
More information: www.mbfys.ru.nl/~stan/

Computational Neuroscience

Course ID: **NM047B** *6 ec* first semester prof. dr. H.J. Kappen
prof. dr. P.H.E. Tiesinga

Website
Blackboard

Teaching methods
- 30 hrs lecture
- 30 hrs problem session

Prerequisites
Inleiding Biofysica; neurophysics

Objectives
After successful completion of the course
- the student is able to calculate the response of a neuron or of a network of neurons to various inputs, both analytically and by computer simulations
- the student should be able to apply basic principles from Information Theory and Non-linear Systems analysis to quanitfy information processing by networks of neurons and to determine the attraction domain and stable states of a network of neurons.

Contents
The aim of this course is to give a theoretical description of the neuronal dynamics at the level of a single neuron and at the population level. The theoretical model will be used to explain the information processing and the storage and retrieval of information by populations of neurons.
The course consists of two parts. The first part is given by Kappen and consists of the following topics: Integrate and fire neurons, networks of binary neurons, synaptic plasticity, supervised and unsupervised learning, classical conditioning, reinforcement learning, control theory

This course deals with the mechanisms underlying the communication by and between cells in the central nervous system. It begins with the dynamics of changes in the configuration of proteins that are responsible for the transport of ions (sodium, potassium, chloride, etc.) through the outer cell membrane, and a biophysical model of the nerve cell is developed. Then, neuronal information processing and information storage within the CNS is treated, and how self organisation of the CNS can be understood from basic principles about development and learning.

Subjects
For part Kappen, see http://www.snn.ru.nl/~bertk/comp_neurosci/

For the part Gielen, see www.mbfys.ru.nl/~stan

Literature
Necessary:
- Reader with chapters from *Handbook of Biological Physics*, Vol.4: Neuro-Informatics and Neural Modeling. Editors: Gielen and Kappen, Elsevier, 2001 (For sale at secretary's office of Biofysica, room 020 M244, Geert Grooteplein-Noord 21)

Recommended:
- Theoretical Neuroscience, Computational and Mathematical Modeling of Neural Systems, by Dayan and Abbott, MIT Press, paperback version, (2005) is highly recommended.

Examination
Written exam

Extra information
The course relies on active student participation. The students will present most of the material.
The examination is based on these presentations, the regular and computer assignments, and on an essay that summarizes the recent developments on a particular neuroscience topic.

Electronic Structure of Materials

Course ID: **NM038B** *6 ec* second semester prof. dr. R.A. de Groot

Teaching methods
- 32 hrs lecture

Objectives
- To acquire basic knowledge and understanding of modern electronic structure methods
- To acquire basic knowledge and understanding of (crystallographic) group theory
- To perform electronic structure calculations on simple model systems independently
- To abstract physical properties and understanding from the calculations defined under 3

Contents
Tutorials involve the calculation of electron structure of:
- Simple metals
- Magnetic metals
- A semiconductor
- A relativistic material

all with the use of existing computer programs.

Subjects
- Reciprocal space, Brilliouin zones and group theory associated to electron structure calculations
- Basic sets, pro's and con's
- Density functional theory
- APW, ASW and LSW methods in some detail

Literature
- Lecture notes and references given during the lectures

Examination
Oral exam

Experimental Techniques

Course ID: **NM004B** *3 ec* first semester dr. S.A.J. Wiegers

Teaching methods
- 12 hrs lecture
- 12 hrs problem session

Prerequisites
- Bachelor Program Laboratory Courses

Objectives
- The student understands the experimental and physical background of achieving high vacuum, of operating lasers, achieving low temperaturs and using electronic lock-in signal techniques
- The student is able to translate a scientific question into an experimental design/realisation

Contents
Modern physics depends heavily on advanced experimental techniques. The technological fields of vacuum technology, laser technology, cryogenic technology and electronics are essential when translating a scientific question into an instrument including the collection and use of the observations. In this course, we want to stay close to the technology, pumps, lasers, coolers, lock-in amplifiers explaining their physical and practical operating principes. Next to making series of problem sets on the different topics, a self-chosen scientific problem and its experimental solution will be described and presented.

Literature
Heighly recommended:
J.H. Moore, C.C. Davis and M.A. Coplan, *Buiding Scientific Apparatus,* 4^{e} edition, Cambridge University Press, ISBN 978-0-52187858-6

Examination
- Take home experimental construction problem
- Oral presentation

Interaction of Light with Molecules and Materials

Course ID: **NM074B** *6 ec* second semester dr. A.V. Kimel

Teaching methods
- 16 hrs lecture
- 16 hrs problem session

Prerequisites
Inleiding Vaste Stof Fysica, Inleiding Atoom- en Molecuulfysica, Quantummechanica 1a,1b

Objectives
Bridging the gap between Bachelor Courses and Specialized Capita Courses, Broad Introduction to Optical Techniques in Research

Contents
We will present the quantum mechanical description of the interaction of light with quantum systems, introducing incoherent and coherent interactions and their non-intuitive consequences. Where abstract quantum systems are isotropic, solids and interfaces are not. The optical response of these systems requires vector and tensor descriptions. The course will explain why different solids (insulators, semiconductors, metals, super-conductors) have different optical responses. A special attention will be paid to non-linear optical processes, which allow changing the colour of light, ultrasensitive diagnostic of surfaces and interfaces. It will be shown that at the shortest most intense pulses, processes change. The special position of NMR (or MRI) will be explained.

Subjects
At the end of the course the student is expected to obtain knowledge on the following issues:
Interaction of Light with Matter
• Quantum treatment of atom-radiation interaction
• Two-level and few-level systems
• Rabi frequency
• Bloch vector, optical Bloch equations
• Principles of Coherent control
• Introduction to quantization of the optical field
• Excitation by intense laser fields (guest speaker)
Optics of Molecules and Atoms
• Linear optics (line shapes, the role of collisions)
• Non-linear optics in atoms and molecules (multi-photon excitation, (stimulated) Raman scattering, AC Stark shifts)
• Ultra fast spectroscopy
• Examples of coherent control
• The few level system, description of NMR/MRI
Optics of Materials
• Linear optics (approximations, dielectric permittivity, magneto-optical effects)
• Tensor representation of optical phenomena

• Nonlinear optics (approximations, optical rectification, second harmonic generation, photo-refraction, stimulated Raman scattering)
• Ultra-fast optics of solids (optical Bloch equation, semiconductor Bloch equations, ultra-fast transient processes in solids)
• Optics of dielectrics, semiconductors, metals and superconductors (approximations, specific spectral features and their correlation with transport properties)

Literature

- Lecture notes

Recommended:

- R. Loudon, *The Quantum Theory of Light* (Oxford University Press, USA, 2000).
- L. D. Landau, E. M. Lifshitz, *Electrodynamics of Continuous Media.* (Pergamon, Oxford, 1984).
- R. R. Birss, *Symmetry and Magnetism* (North-Holland,Amsterdam, 1966).
- Y. R. Shen, *The Principles of Nonlinear Optics* (John Wiley & Sons, 2003).

Examination

Open book oral examination

Materials Science

Course ID: **NM020B** *6 ec* second semester dr. P.R. Hageman

Teaching methods
- 30 hrs lecture
- 30 hrs problem session

Prerequisites
This course aims at master students physics, chemistry or natural sciences

Objectives
- The student has knowledge of the concepts and theory from material science as presented in the course
- The student can apply the presented concepts and theory in order to interpreted correctly scientific literature in the area of material science
- The student is capable to reduce the information from the scientific literature to the core problems
- The student is capable to solve these core problems using the presented theory and concepts or can present a different solution method

Contents
Understanding of the fundamental nature of materials during the last century has led to the development of materials science and engineering. Within this field traditionally the relation between the microscopic structure and macroscopic properties of bulk materials such as metals, semiconductors, ceramics and polymers is studied. Recent developments concentrate on the processing and performance of materials in the form of thin films, as these have become increasingly important in our daily life.
This material science course handles the relationship between material structure and the resulting mechanical, electrical, chemical, optical and magnetic properties of materials in general and thin films in particular. Enveloping this relation special emphasize is given to methods for thin film deposition (MOCVD, MBE, Sputtering) and their final performance. The processing -> structure -> properties -> performance interactions will be illustrated by the discussion of recently developed materials such as gallium-nitride and synthetic diamond coatings as well as specialized applications such as high efficiency solar cells and magnetic multi-layers.

Literature
Hand outs will be distributed during the course. No specific book is required.

Examination
The students write independently a paper about a subject dealing with materials science on basis of distributed scientific literature. In this paper the student has to apply the knowledge learned in the course.

Mechanical engineering; designing and manufacturing instruments

Course ID: **NM079B** *2 ec* 3 times a year dr. ing. S.M. Olsthoorn

Teaching methods
- 64 hours within two week period
- Instruction and practical training

Objectives
At the end the student will be able to:

- translate a theoretical idea into a experimental set-up
- interpret mechanical drawings and possibilities
- communicate on a technical level with mechanical engineers
- understand all possibilities of the mechanical workshops

Contents
This is an 8-day course in which the student is trained in learning to think as a mechanical engineer. The student learns how to start an experiment. What are the possibilities when designing and manufacturing a scientific set-up.
The student learns to read all details of technical drawings and an introduction to designing programs. After a theoretical introduction, the students will learn to make a simple mechanical drawing of an instrument or an experiment.
The student learns to work with mechanical tools. After a good introduction the student will work under supervision with all kinds of mechanical tools including a lathe and a milling machine.

Subjects
- The student learns the basics of mechanical engineering
- The student learns how to design an instrument or a simple experiment

Examination
During the course students have to manufacture a brench-screw.
At the end students have to deliver a good technical drawing (made in Autocad, Inventor, or by hand) including the necessary side- front- and top- views.

Extra information
This course is open for master students and for PhD students in Physics and Astronomy. (http://www.ru.nl/fnwi/technocentrum). The course will be offered three times per year and accepts three students per course. Students from other disciplines may be accepted dependent on the available capacity. After this course students have a good practical background in designing and manufacturing an instrument, however they have not yet the skills to work on their own in the mechanical workshop.
Registration: Dr. G. Swart, HG 01.832, email: g.swart@science.ru.nl

Nano Magnetism

Course ID: **NM044B** *6 ec* second semester dr. A.I. Kiriliouk

Teaching methods
- 28 hrs lecture

Prerequisites
Quantum mechanics; Introduction to Solid State Physics

Objectives
- The student has a knowledge about the basic magnetic interactions
- The student can apply the acquired knowledge to solve basic problems
- The student should be able to understand the recent discoveries in the area of magnetism
- The student is able to read and understand the articles in leading scientific journals

Contents
Magnetism is a phenomenon that has intrigued mankind since millennia and has found a large variety of applications ranging from the compass to hard disks. Modern preparation techniques have allowed the fabrication of magnetic structures with typical dimensions that are small compared to fundamental**length scales** such as exchange length, mean free paths or spin diffusion length, which have led to exciting new effects like giant magneto-resistance and spin injection. The importance of such phenomena has been recognized in the Nobel prize 2007.
This course will cover several topics of magnetism in **nanodimensions**, starting from basics. Special attention will be on the formation of the magnetic moments as well as on various aspects of magnetization dynamics. It will also include a review of experimental approaches.

Subjects
- quantum mechanics: spin-spin and spin-orbit interactions
- exchange and anisotropy
- magnetic order: ferro-, ferri, and antiferromagnets - dimension dependence
- superparamagnetism
- spin waves in nanoelements
- magnetization dynamics: domain wall, spin precession, spin heating, etc.
- magnetic quantum phenomena
- preparation and magnetic and structural characterization techniques
- magneto-optics as important tool for ultrafast dynamics studies
- utilization: are we going to have a magnetic computer?

Literature
Lecture notes are handed out at every lecture; blackboard will also be used for the lecture notes and extra material

As extra reading:

- S.V. Vonsovskii, *Magnetism,* John Wiley & Sons, New York, 1974
- S. Chikazumi, *Physics of Ferromagnetism,* Clarendon Press, Oxford, 1997
- D. Craik, *Magnetism: Principles and Applications,* John Wiley & Sons, New York, 1995
- D.C. Mattis, *The theory of magnetism,* Harper & Row, New York, 1965
- J. Stöhr and H.C. Siegmann, *Magnetism: from fundamentals to nanoscale dynamics*, Springer, 2006

Examination

Combination of a written short report, 15 minutes oral presentation on a selected subject, oral exam, and the work during the semester

Scanning Probe Microscopy

Course ID: **NM070C** *3 ec* first semester prof. dr. S.E. Speller
dr. B.L.M. Hendriksen

Teaching methods
- 30 hrs lecture

Prerequisites
Solid State Physics

Objectives

This course is an introduction to Scanning Probe Microcopy. It is recommended to students who are interested in nanoscopic phenomena and wish to gain insight in local probing and imaging methods used in nanoscience research. After successfully completing this course you
- understand how the physical and chemical properties of a material change when their size is reduced to the nanometer scale.
- understand the nano-scale physical and (bio)chemical interactions between the probe and a nanostructure on a surface.

- can recognize the instrument components of a scanning probe microscope and you understand their operation.
- are able to design experiments based on scanning probe microscopy, which target a given nano-scale question.
- have a general overview of applications of scanning probe microscopy in nanoscience research, you can read and comprehend scientific literature about scanning probe microscopy and you can actively participate in discussions on the topic.

Contents
This course is an introduction to:
• Scanning Tunneling Microscopy
• Atomic Force Microscopy
• Nano-Optical Microscopy
Scanning probe microscopes are widely used in nanoscience. A scanning probe microscope (SPM) can visualize atomic, molecular and nano-scale structures on solid surfaces by detecting atomic-scale interactions between a probe tip and the studied material. In this course we discuss the relevant probe-sample interactions (e.g. electron tunneling, nano-scale forces, near fields), we treat the electrical and mechanical components of the SPM instrumentation, we discuss the various operation modes of SPMs and provide a broad overview of applications of SPM in nanoscience. Examples from physics, chemistry and biology include: atom manipulation, electron confinement, nano-scale friction, magnetism, molecular-scale chemistry, protein unfolding.

Literature
On website during the course.

Examination
Oral presentation on a dedicated scanning probe microscopy mode. A support package is provided.

Solid State Physics

Course ID: **NM009B** *6 ec* first semester prof. dr. ir. J.C. Maan

Teaching methods
- 30 hrs lecture
- 30 hrs problem session

Prerequisites
Inleiding in de Vaste Stof Fysica and/or Structuur der Materie

Objectives
- The student will have an understanding of formal transport theory
- The student will have an understanding of mesoscopic phenomena
- The student will have an understanding of semiconductor and heterojunctions
- The student will have an understanding of superconductiviy
- The student will have an understanding of magnetism in solids
- The student will have an understanding of important quantum phenomena of solids in magnetic fields

Contents
This course assumes a working knowledge of key concepts and methods in solid state physics: the consequences of crystal symmetry, the notion of quasi-particles and the Fermi-particle character of the electrons, as obtained in a course like 'Inleiding Vaste Stof Fysica', and/or 'Structuur der Materie' and the student should have cursory understanding of energy bands and Fermi surfaces, and the consequences of band filling for metals, semiconductors and insulators.
The importance electron-electron interaction and the concept of quasiparticles to describe important phenomena like superconductivity and magnetism will be emphasized. Furthermore the effect of the discrete electron charge and wave character electron for small systems (mesoscopic physics) will be treated. The course aims at building a bridge bridge between the basis concept developed in the last fifty years to understand solid state physics and the new phenomena discovered in the last decades which are based upon this understanding.

The course material roughly covers chapters 8-13, 17 and 18 from Kittels book.

Subjects
- Formal transport theory in bulk and low dimensional (semiconductor) systems where mesoscopic phenomena play a role. Semiconductors and heterostructures will be treated

more thoroughly than in the introductory course
- Superconductivity which from a phenomenological point of view while also an introduction to the BCS theory is given
- Magnetism (paramagnetism, diamagnetism and ferromagnetism) both from an experimental as a theoretical point of view
- Important quantum effects in magnetic fields, like the Shubnikov-deHaas, deHaas van Alphen, Magnetic resonances, Quantum Hall effect and fractional quantum Hall effect will be presented

Literature
Necessary:
- Charles Kittel, *Introduction to Solid State Physics*, Wiley 2005, ISBN 0-471-680057-5, (8th edition or later)

Recommended:
- Luth and Ibach, *Solid State physics*, 2nd edition, Springer Verlag

Examination
Written exam and 1 point credits by joining the tutorial

Science & Literature (Philosophy 2)

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

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

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

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

Examination
Assignments, presentation, student paper

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

Philosophy 2 (for Physicists)

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

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

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

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

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

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

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

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

Literature
Papers will be distributed.

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

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

Biology - elective courses

Adaptatiefysiologie

Vakcode: **BB020B** *6 ec* vierde kwartaal prof. dr. G. Flik

Werkvormen
- 28 uur hoorcollege
- 27 uur practicum
- 42 uur werkcollege
- 63 uur zelfstudie

Vereiste voorkennis
Voorkennis en gedegen interesse van fysiologie van dieren is een pre, evenals basale histologie.

Leerdoelen
In deze cursus staan de structurele, fysiologische en gedragsadaptaties centraal die het dieren mogelijk maken om zich aan te passen aan dynamische veranderingen in hun omgeving.

Beschrijving
- Eerst wordt ingegaan op structuur en functie van het neuro-endocriene systeem, dat een belangrijke rol speelt bij adaptaties aan dynamische veranderingen in de omgeving van het dier: de hypothalamus-hypofyse-bijnier-as, die een essentiële rol speelt bij stressadaptatie. Vervolgens wordt een aantal thema's uit de adaptatiefysiologie behandeld: aanpassingen aan land en water, aan cyclische veranderingen (dagritmiek, jaarritmiek) en aan bedreigende veranderingen (stressoren). Deze thema's worden zoveel mogelijk geplaatst in een evolutionaire context, in het bijzonder de evolutie van de vertebraten.
- De betekenis van de stressfysiologie voor aquacultuur van vissen en aspecten van osmoregulatie in ongewervelden (i.h.b. crustacea) worden belicht in twee series gastcolleges door collega's uit Cadiz en Montpellier.
- Het practicum behelst vergelijkende histologie van de stress-as, simulatiepractica stressfysiologie en calciumhuishouding van vissen, analyse van een researchartikel, toepassing van moleculaire biologie in de fysiologie en een thema. In het themaonderdeel krijgen de studenten de opdracht om een onderwerp te bestuderen uit de adaptatiefysiologie, hierover een verslag te schrijven en een voordracht te presenteren aan het einde van de cursus. De cursus wordt afgesloten met een bijeenkomst op de afdeling waar de beste voordracht met een prijs wordt beloond op basis van een juryrapport.

Literatuur
- Leerboek: Eckert Animal Physiology, 5e druk, Randall et al. ; E 65
  of:
- Sherwood et al. Animal Physiology. From genes to organisms.
- Syllabus en practicumhandleiding

Tentaminering
Door een schriftelijk tentamen bestaande uit een tiental vragen (essay/open ending) die het

geheel der in colleges en practica behandelde stof beslaat (telt voor 60% mee), het maken van practicumverslagen en het houden van een voordracht (telt voor 40% mee).

Bijzonderheden

contact: mw. D. Maurits, d.maurits@science.ru.nl
De cursus wordt in genoemde periode verzorgd op do en vr.

Adaptation physiology

Course ID: **BM010C** *3 ec* September 27 - October 8, 2010 prof. dr. G. Flik
dr. P.H.M. Klaren

Teaching methods
- 26 hrs lecture
- 54 hrs individual study period

Prerequisites
Acquaintance with the content of the Bachelor courses 'Adaptation Phyiology' and 'Endocrinology' is highly recommended, but not a strict requirement.

Objectives
Increased insight in dedicated aspects of the broad field of adaptation physiology through interactive lectures on recent developments in this research field.

Contents
This series of lectures focuses on organismal physiology: regulatory mechanisms in the intact animal are addressed (Integrative Physiology). The central theme is how animals (including humans) have adapted to realise a dynamic interaction and to cope with continuously changing environmental conditions. Homeostatic and allostatic principles are discussed. Two internal systems are predominantly involved in this adaptation: the nervous system and the endocrine system. Together these systems control the activity of peripheral endocrine and non-endocrine targets, resulting in a functional adaptive response. In this regulation the hypothalamus and pituitary gland are pivotal as relays between the central nervous system and peripheral organs; in the hypothalamus signals from central and peripheral sensors are integrated with peripheral (endocrine) signals from e.g. the immune system and gastrointestinal tract. The intensive interaction of the immune system and the neuroendocrine system is illustrated with the stress response, based on ongoing recent research towards the neuroendocrine mechanisms at the basis of active and passive coping strategies in animal models.
The course's content is centered around the themes: Adaptation and Evolution, Temperature Adaptation, Allostasis and Allometry, Plasticity of Organ Systems, and Shore Lines and Estuaries. When appropriate, topics that received attention in recent papers and science sections of news papers can be addressed.

Literature
The lectures will be published as Powerpoint-handouts (without subtexts!) on BlackBoard.
Recommended: dedicated chapters in Eckert's Animal Physiology.

Examination
The written exam consists of a selection of open questions on different topics.

Extra information

contact: Mrs. D. Maurits (d.maurits@science.ru.nl)

Apoptosis

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

Teaching methods
- 20 hrs lecture

Prerequisites
Biochemistry and Molecular Biology II (BMB-II)

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

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

Literature
Hand-outs, distributed via blackboard

Examination
Written exam.

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

Molecular and cellular neurobiology

Course ID: **BM001C** *3 ec* April 18 - July 1, 2011 dr. B.G. Jenks
prof. dr. E.W. Roubos
prof. dr. G.J.M. Martens

Teaching methods
- 20 hrs lecture

Prerequisites
Bachelor level Cell Biology, Molecular Biology and Neurobiology

Objectives
The aim of this course is to give students an appreciation of current issues in Neurobiology, particularly molecular and cellular aspects and how these can impact on neurodgenerative diseases and behavior.

Contents
This course considers advanced topics of molecular and cellular aspects of neurobiology. Particular attention is given to where such mechanisms impact on behaviour. Among the topics covered in recent years are: Hypothalamic Control of Feeding; Oxytocin: a Multifunctional Behavioral Neuropeptide; The Neurobiology of Fear; Adult Neurogenesis; The Molecular and Cellular Mechanisms involved in Neurodegeneration; Genetic and Epigenetic Mechanisms underlying Neurodevelopmental Disorders. A selection of these, or similar topics will be presented in the course. Instructors for the course are: Bruce Jenks (10h of lectures), Gerard Martens (8h) and Eric Roubos (2h). The lectures are in English (Exam can be in English or Dutch).

Examination
Written exam

Gene expression, chromatin and disease

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

Teaching methods
- 24 hrs lecture

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

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

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

Literature
Literature: Lectures, PowerPoint print-outs

Examination
Written Essay

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

Cellular Imaging in Four Dimensions

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

Teaching methods

- 20 hrs lecture
- 60 hrs individual study period

Objectives

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

Contents

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

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

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

Examination

The final written exam includes both parts of the course.

Extra information

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

Capita selecta: Metabolism, transport and motility

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

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

Teaching methods

- 20 hrs lecture
- 60 hrs individual study period

Prerequisites

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

Objectives

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

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

Contents

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

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

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

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

Examination
written examination.

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

Endocrinologie

Vakcode: **BB048B** *6 ec* derde kwartaal dr. P.H.M. Klaren
prof. dr. G. Flik

Werkvormen
- 32 uur hoorcollege
- 12 uur practicum
- 8 uur werkcollege

Vereiste voorkennis
Er wordt een basiskennis van de moleculaire biologie, celbiologie en dierfysiologie verondersteld op grond van de eerstejaars cursussen.

Leerdoelen
De differentiatiecursus: 'Endocrinologie' is gepland in het begin van de tweede helft van de bachelors-fase en is bedoeld voor studenten Biologie met een zoölogische/fysiologische interesse en studenten Medische Biologie. De cursus Endocrinologie kenmerkt zich door een hoog aantal gastdocenten van buiten FNWI, en het intensieve gebruik van de digitale leeromgeving Blackboard. Studenten leggen een "mini-syllabus" aan en maken abstracts van hoorcolleges, waarmee wordt nagestreefd dat studenten, naast het vergaren van endocrinologische vakinhoudelijke informatie, zich ook algemene academische vaardigheden als integreren en ordenen van deze informatie eigen maken. De cursus omvat effectief vier weken met vijf werkdagen elk. 's Ochtends vinden hoorcolleges plaats (twee uur per ochtend), 's middags zijn practica (histologie, computersimulaties), zelfstudie en literatuurdiscussies. De literatuurdiscussies vinden plaats in kleine werkgroepjes waarin studenten kunnen oefenen in het lezen van review- of researchartikelen.

Beschrijving
De onderwerpen die in de cursus aan bod zullen komen hangen in belangrijke mate af van de deelnemende gastdocenten en hun wensen en expertise. Er wordt naar gestreefd om in elk geval aan de orde te laten komen:
- moderne endocrinologie (nieuwe concepten)
- histologie van endocriene klieren
- hypothalamus - hypofyse - bijnier as (humaan en vergelijkend)
- hormonen van de bijnier

- schildklier en schildklierhormonen
- endocriene pancreas
- (vrouwelijke) voortplantingsendocrinologie
- calcium-regulerende hormonen
- groei en groeihormoon
- hormonen van de digestietractus
- het immuunsysteem als endocrien systeem

Literatuur
De studiewijzer bevat researchartikelen voor besprekingen. PowerPoint-bestanden van de colleges worden, indien mogelijk, via BlackBoard beschikbaar gemaakt. De belangrijkste literatuur wordt echter gevormd door de persoonlijke mini-syllabus.

Tentaminering
Schriftelijk tentamen (waarbij het portfolio geraadpleegd mag worden) en uitvoering portfolio.

Bijzonderheden
Zelfstudie dient besteed te worden aan schrijven van abstracts direct na de colleges, het voorbereiden van de literatuurbesprekingen en het maken en up-to-date houden van de persoonelijke syllabus. Het bijhouden van het aangeboden studiemateriaal is een vereiste gezien het hoge tempo van deze cursus en de belangrijke plaats die zelfstudie in de cursus inneemt.
De cursus wordt in genoemde periode verzorgd op do en vr.

Ontwikkelingsfysiologie van met name het zenuwstelsel

Vakcode: **BB039B** *6 ec* cursus wordt niet verzorgd in 2010-2011 prof. dr. G.J.M. Martens
dr. S.M. Kolk

Werkvormen

- 14 uur hoorcollege
- 16 uur practicum
- 8 uur presentatie door studenten
- 5 uur responsie-college
- 40 uur werkcollege
- 85 uur zelfstudie

Vereiste voorkennis

Belangrijk: indien de basiskennis van de beschrijvende embryologie ontbreekt, dient men **vóór het begin van de cursus** contact op te nemen met de cursuscoördinator om na te gaan welke "bijspijkeropdrachten" via zelfstudie doorgenomen moeten worden.

Leerdoelen

De ontwikkeling van een bevruchte eicel tot een meercellig organisme is een prachtige triomf van de evolutie. Tijdens de embryonale ontwikkeling deelt de eicel tot miljoenen cellen die samen zeer complexe orgaansystemen samenstellen. De beschrijvende embryologie heeft ons in de vorige eeuw een overzicht gegeven van de vormveranderingen die een organisme doormaakt vanaf zijn ontstaan tot aan zijn volwassen toestand. In deze eeuw gaat de ontwikkelingsfysiologie een opwindende periode tegemoet omdat de moleculaire achtergronden van de ontwikkelingsprocessen steeds duidelijker worden. In deze cursus wordt ingegaan op de wisselwerkingen tussen de morfogenen die een rol spelen bij de opbouw van een meercellig organisme en wordt met name dieper ingegaan op de ontwikkeling van het zenuwstelsel.

Beschrijving

In het theoretisch gedeelte van deze cursus wordt dieper ingegaan op de moleculair-ontwikkelingsfysiologische regulatiemechanismen. Na een overzicht van de basisprincipes van inductie/responsie, differentiatie, celmigratie en morfogenese wordt aandacht besteed aan de mechanismen die de ontwikkeling van het zenuwstelsel reguleren. In het practisch gedeelte krijgt men aan de hand van laboratorium- en simulatie-experimenten een indruk van het onderzoek naar de mechanismen die ten grondslag liggen aan ontwikkelingsbiologische processen. Tevens worden computergestuurde simulatie-experimenten uitgevoerd, waarbij aandacht wordt besteed aan moderne methodieken die in het ontwikkelingsfysiologisch onderzoek worden gebruikt. De cursus wordt afgerond met de analyse van een (of twee) recent ontwikkelingsfysiologisch onderzoeksartikel dat verwerkt wordt tot een mondelinge presentatie en dat als basis dient voor het schrijven van een voorstel voor een onderzoeksproject.

Literatuur

97Syllabus incl. practicumhandleiding zal beschikbaar zijn via Blackboard
Leerboek: Scott F. Gilbert 'Developmental Biology' 2010, 9e druk, Sinauer Associates, Inc. **(verplicht)**
Loose leaf textbook, ISBN 978-0-87893-558-1, 74.95 dollar or Hard copy, ISBN 978-0-87893-384-6, 124.95 dollar

Tentaminering

Tussentijds schriftelijk tentamen (telt voor 60% mee) en het maken van verslagen, het houden van een presentatie en het maken van een onderzoeksvoorstel (telt voor 40% mee).

Het maximaal aantal studenten dat kan deelnemen is 40.

Bijzonderheden

contact: dr. S. Kolk, 3610565, s.kolk@ncmls.ru.nl
Deze cursus zal in het academiejaar 2010-2011 niet verzorgd worden.

Course on Laboratory Animal Science

Course ID: **BM024D** *3 ec* several times in 2010-2011 dr. ir. P.P.A.M. Leenaars

Website
http://www.umcn.nl/scientist/afdelingen/cdl/laboratory_animal_science_course

Teaching methods
Lectures, practical work, demonstrations, individual and group assignments. Several (external) guest lecturers will appear.

Prerequisites
The course is only open for students who have at least 500 study hours in basic biology. At least 200 study hours anatomy/zoology and 200 study hours animal physiology should be part of this 500 study hours in basic biology.
For MLW students this means:

- part of the first year biology course "Ontwikkeling en evolutie in de bouwplannen van dieren" (BP004B). For detailed information contact the coordinator of this course: dr. F. van Herp (f.vanherp@ncmls.ru.nl)
- one or both of the following courses from the bachelor biology:
"Endocrinologie" (BB048B) or "Adaptatiefysiologie" (BB020B)
- one or both of the following capita selecta from the master of biology
"Endocrinology" (BM048B) or "Adaptation Physiology" (BM010B)

Objectives
The course has the aim to gain knowledge and insight into the design of an animal experiment in a scientific and ethically justified manner, taken into account that alternatives (refinement, reduction, replacement) are not possible.

The program of the course on laboratory animal science comprises the requirements cited in article 9 of the Wet op de dierproeven (Experiments on Animals Act) and the (European) FELASA category C demands. The certificate of completion of the course together with an academic degree in biomedical science will lead to a legal recognition to design animal experiments in the Netherlands.

Contents
The objective of the course an laboratory animal science is to present basic facts and principles that are essential for the humane use and care of laboratory animals and for the quality of research.

The course will focus on:
the responsible and appropriate use of animals in scientific experiments in which alternatives

(refinement, reduction, replacement) play an essential role.

The student:
* will be able to make an ethical argumentation whether the use of laboratory animals in a specific experiment is acceptable (the benefits outweigh the expected adverse effects)

* has insight into the consequences of the animal experiment on the welfare/distress of the laboratory animal and how to effectively tackle this

* will form a critical attitude towards the use of animals in scientific research

* will be able to design an appropriate animal experiment which meets the legal requirements and scientific demands (statistics for example)

* has insight into the possibilities for alternative methods (reduction, refinement and replacement).

Literature
The core textbook in Dutch (less expensive than English copy):
Zutphen, L.F.M. van, V. Baumans & F.Ohl, 2009. Handboek Proefdierkunde. proefdieren, dierproeven, alternatieven en ethiek. Uitgeverij Elsevier gezondheidszorg, Maarssen. Vijfde druk. ISBN 9789035229815.
The core textbook in English:
Zutphen, L.F.M. van, Baumans, V. & Beynen, A.C. (eds.), 2001. Principles of Laboratory Animal Science: A contribution to the humane use and care of animals and the quality of experimental results. Elsevier Science Publishers, Amsterdam, 2nd (revised) edition. ISBN-13: 978-0444506122.

* A module guide will be available.

Examination
The examination is based on a written exam and the evaluation of the groupwork (design of an animal experiment; critical analysis of an article).

Extra information
The course is not an obligatory part of the study Biology.
The course on Laboratory Animal Science is organised by the Central Animal Laboratory (http://www.umcn.nl/cdl). The course is lectured in English.
The course is scheduled for:

- September 6th - 20th, 2010
- November 1th - November 15th, 2010
- January 10th - 24th, 2011
- March 7th - 21th, 2011

The application form can be found on:

http://www.umcn.nl/scientist/afdelingen/cdl/laboratory_animal_science_course
You can apply by emailing the application form to LAS@CDL.umcn.nl
Requests for further information may also be sent to LAS@CDL.umcn.nl.

Course Working with Radionuclides Level 5B

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

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

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

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

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

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

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

Subjects:
- radiation physics
- radiation risk and effects

- practical radiation safety
- legislation

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

Literature

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

Examination

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

Extra information

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

Bioethics for Lifescientists

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

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

Objectives
After finishing this course:

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

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

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

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

Literature
Texts will be made available via Blackboard.

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

preferably related to the topic of their Master thesis.

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

Extra information

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

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

Global Ethics and Sustainable Development

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

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

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

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

Literature
Will be distributed.

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

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

Principles of Systems Biology

Course ID: **BM041B** *3 ec* January 30 - April 15, 2011 prof. dr. L.M.C. Buydens

Teaching methods
14 x 2 hrs = 28 hrs lecture
14 x 4 hrs = 56 hrs individual study

Objectives
To obtain insight into the fundamental concepts and applications of systems biology at the theoretical and practical level, with emphasis on human metabolism. Lectures will be given by members of the Nijmegen Centre for Systems Biology and Bioenergetics (CSBB; www.csb-bioenergetics.nl) and invited external lecturers.

Contents
Biological systems like cells, tissues and organisms display a highly organized structure and function. The essence of systems biology has been described as: "The study of biological systems by systematically perturbing them (biologically, genetically, or chemically); monitoring the gene, protein, and informational pathway responses; integrating these data; and ultimately, formulating mathematical models that describe the structure of the system and its response to individual perturbations". In this sense, systems biology is a groundbreaking scientific approach that integrates recent developments in the fields of biochemistry, pharmacology, cell biology, cell physiology, computer science and systems engineering. Systems biology will be a vital tool in elucidating the many interacting factors that contribute to the cause of diseases. One of the most immediate impacts will be on the drug development process, bringing innovative drugs to the patient more quickly.
This course is intended to give advanced students a firm background understanding of the concepts used in systems biology. The biological focus will be on how systems biology approaches can help to understand human metabolism in health and disease. This directly relates to the recently established Nijmegen Centre for Systems Biology and Bioenergetics (CSBB), which aims to create large-scale metabolic flux models as well as dynamic models of single cells. These will be used to predict the consequences of disease-related disturbances of energy homeostasis with the aim to develop effective and safe pharmacological and nutritional interventions.

Subjects
1. Biological systems
- Metabolism
- Signal transduction

2. Model types
- Many particle models
- Kinetic models
- Dynamical systems
- Optimization and control theory
- Structural stoichometric models

- Deterministic kinetic and spatial models
- Stochastic dynamics

3. Modeling skills

- Model building
- Model reduction and combination
- Data collection and statistical analysis
- Parameter selection and optimization, model testing and selection
- Local sensitivity/control theory and global sensitivity/uncertainty analysis
- Optimal control

4. Special topics

- Spectral unmixing, machine learning and pattern recognition
- Drug discovery, nutraceuticals and adverse drug effects
- Mitochondrial medicine

Literature

"Systems Biology", Klipp et al., Wiley-VCH, 2009; price: ~ 60 Euro.

Examination

The final written exam includes essay questions, divided across the topics.

Endocrinology

Course ID: **BM032C** *3 ec* April 18 - July 1, 2011 prof. dr. G. Flik
dr. P.H.M. Klaren

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

Prerequisites
Acquaintance with the content of the Bachelor courses "Endocrinologie" and "Adaptatiefysiologie" is recommended, but not a strict requirement.

Objectives
The lectures are intended to increased the students' insight in current concepts and novel developments in the field of endocrinology.

Contents
This course focuses on selected topics in endocrinology. The scientific content of the caput course builds upon that of the Bachelor course "Endocrinology", but is far more advanced. Dedicated lectures address topics such as:
- The emergence of Endocrinology
- Evolution of ligand-receptor combinations
  - Ligand exploitation theory
  - Novel thyroid hormone metabolites and funtions
- Interactions between regulatory systems
  - Endocrines and the nervous system in the digestive tract
  - Endocrines and the immune system: chemokines and cytokines
- Complexity in endocrine signaling
  - The CRH/ACTH system
  - The melanocortin receptor family
- The power of comparative endocrinology
  - Stanniocalcins: from fish to human
  - PTHrP/PTH

Lecturers will present their comparative endocrinological views on the selected topics. Also, some lectures can be devoted to topics that receive public attention.

Literature
The PowerPoint-presentations of the lectures will be made available on Blackboard and/or a dedicated website.

Examination
The written exam will consist of a number of open questions on selected topics.

Extra information
Contact: Mrs. Daisy Maurits d.maurits@science.ru.nl

Chemistry - elective courses

Advanced crystallography

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

Teaching methods
- 30 hrs lecture
- 18 hrs problem session

Prerequisites
- FMM5
- Recommended: condensed matter

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

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

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

Examination
Written examination.

Advanced organic chemistry

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

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

Teaching methods

- 170 hrs problem session

Prerequisites

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

Objectives

After completing the course the student will be able

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

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

Contents

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

Literature

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

Examination

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

Application of metal-catalysis in natural product synthesis

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

Teaching methods
- 16 hrs lecture

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

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

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

Literature
Lecture notes and scientific papers.

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

Biocatalysis

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

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

Teaching methods
- 8 hrs lecture

Prerequisites
Structuur Biomoleculen, Organische chemie

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

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

Literature
Handouts of the lectures

Examination
Assignments (case studies)

Bioinformatics of protein structure

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

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

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

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

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

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

Examination
Written report.

Chemical Biology

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

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

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

Prerequisites
Synthesis of biomolecules

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

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

Literature
Handouts, scientific articles.

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

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

Extra information

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

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.

Computational drug discovery

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

Teaching methods
Two weeks of lectures and computer practicals.

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

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

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

Literature
Material is handed out during the course.

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

Industrial pharmaceutical chemistry

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

Teaching methods
- 32 hrs lecture
- 16 hrs problem session

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

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

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

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

Extra information

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

Instrumental analysis for molecular chemistry

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

Teaching methods
- 16 hrs problem session

Prerequisites
organische chemie 1
- magnetic resonance I (recommended)

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

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

Literature
Handouts and papers will be distributed during the course.

Examination
Written examination.

Magnetic resonance II

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

Teaching methods
- 50 hrs tutor session

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

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

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

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

Examination
Written examination, open book.

Magnetic resonance IIIa, Advanced biomolecular NMR

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

Teaching methods
- 30 hrs tutor session

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

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

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

Literature
Articles and reference books.

Examination
written examination, open book.

Magnetic resonance IIIb, Solid-state NMR

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

Teaching methods
- 30 hrs tutor session

Prerequisites
Magnetic Resonance I and Magnetic Resonance II

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

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

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

Examination
Written examination, open book.

Molecular Materials

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

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

Prerequisites
Organic chemistry 2

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

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

Literature
Handouts and scientific papers.

Examination
written examination, scientific report and presentations.

Pattern recognition for the natural sciences

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

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

Teaching methods
- 32 hrs computer course
- 20 hrs lecture

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

- Basic linear algebra

Objectives
The students should be able to

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

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

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

Examination
Written exam.

Polymer chemistry

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

Teaching methods
- 18 hrs lecture

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

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

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

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

Quantum dynamics

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

Website
www.theochem.ru.nl/quantumdynamics

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

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

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

In the theory will be applied in the computer lab.

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

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

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

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

Beroepsorientatie (in Dutch)

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

Teaching methods
- 26 hrs lecture
- 54 hrs student project

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

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

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

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

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

Extra information

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

3.2 C-variant

Science & Societal interaction

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

Website
www.ru.nl/sciencecommunication/

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

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

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

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

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

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

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

Literature
Literature will be made available on Blackboard

Examination
An assignment.

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

Risk Communication

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

Website
www.ru.nl/sciencecommunication/

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

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

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

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

Literature
Literature will be made available on Blackboard

Examination
assignment

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

Boundary-Work: The Tension between Diversity and Sustainability

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

Website
www.ru.nl/sciencecommunication/

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

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

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

Literature
Will be distributed.

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

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

Introduction Science Communication

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

Website
www.ru.nl/sciencecommunication

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

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

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

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

Literature
Literature will be made available on blackboard

Examination
Written exam, participation and presentation

Extra information
This course will be taught in Dutch.

Framing Knowledge

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

Website
www.ru.nl/sciencecommunication/

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

Prerequisites
The course 'risk communication' is recommended.

Objectives

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

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

Literature
Literature will be made available on Blackboard

Examination
An assignment.

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

Knowledge Society

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

Website
www.ru.nl/sciencecommunication/

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

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

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

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

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

Literature
Literature will be made available on Blackboard

Examination
written exam

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

Science & Media: strategies and trends

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

Website
www.ru.nl/sciencecommunication/

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

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

Objectives
- students will increase their abilities in media-oriented writing.
- students will increase their knowledge of strategical considerations and ethical codes involved in the process of transmitting information from the academic to the public arena.
- students will get acquainted with academic perspectives on (a) the current state of science reporting in the media, and (b) developments and trends in reporting about science and technology over the last few decades.
- students will get acquainted with different methodologies for (a) studying trends in science reporting and (b) studying public responses to media content.
- students will increase their abilities in research design.

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

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

Examination
Journalistic writing assignment & research design assignment

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

Visible Scientists

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

Website
www.ru.nl/sciencecommunication/

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

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

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

- find primary and secondary sources on scientists.

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

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

Literature
p.m.

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

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

Research project (Masterthesis) Mastertrack Science Communication

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

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

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

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

3.3 E-variant

Oriëntatiestage Educatie (in Dutch)

Vakcode: **FE0001B** *3 ec*

Werkvormen
- Stage in het voortgezet onderwijs 60 uur
- Voorbereiding, stageopdrachten en verslag 24 uur

Vereiste voorkennis
Vakinhoudelijke kennis op bachelorniveau

Leerdoelen
De Oriëntatiestage Educatie biedt studenten de mogelijkheid om zich tijdens de masterfase te oriënteren op de lerarenopleiding (de Educatieve variant of postmaster).

Beschrijving
Inhoud: De deelnemer aan de Oriëntatiestage Educatie wordt ondergedompeld in de praktijk van een eerstegraads leraar, waarbij de voorbereiding, het geven en de nazorg van lessen veel aandacht krijgen, maar ook andere taken van leraren in het zicht komen. Na de stage heeft de student een realistisch beeld van de taken van een leraar en is goed in staat om te bepalen of het voor hem of haar zinvol is om te kiezen voor de lerarenopleiding.
Planning: De scholen voor voortgezet onderwijs bieden twee periodes voor de oriëntatiestage aan, te weten van 1 oktober tot 1 december en van 1 februari tot 1 mei. Deze periodes zijn ruim genomen om de student en de school de gelegenheid te geven om de stage flexibel in te roosteren in de masterfase.
Begeleiding: De begeleiding vanuit de universiteit wordt verzorgd door een vakdidacticus van het Instituut voor Leraar en School (ILS). Deze instituutsdocent verzorgt een inleidende bijeenkomst, onderhoudt de contacten met de scholen, levert literatuur en opdrachten, en beoordeelt het verslag. De instituutsdocent komt alleen als daar aanleiding voor is naar de stageschool voor overleg ter plekke, al dan niet aangevuld met een lesobservatie. Een leraar van de stageschool begeleidt de student en geeft een schriftelijke beoordeling, waarin de vraag of de student geschikt is voor een loopbaan in het onderwijs centraal staat.

Literatuur
Ebbens, S. en S. Ettekoven. *Effectief leren. Basisboek.* Wolter-Noordhoff, 2e of latere druk. Deel 1, dat zijn de hoofdstukken 1 en 2. Het boek kan geleend worden bij het ILS.

Bijzonderheden
De schoolstage bestaat niet alleen uit meelopen en observeren, maar ook uit zelf lesgeven (4 tot 8 lesuren) en de (eigen) lessen nabespreken met de begeleidende docent. De Oriëntatiestage Educatie kan binnen twee weken gelopen worden (4 tot 5 dagen per week op school). De ervaring leert echter dat uitspreiden over langere periode (met dan 2 of 3 dagen per week op school) leidt tot een betere leerervaring. Het staat de student vrij om in overleg met de stageschool een eigen rooster te maken.
Stageplaatsen worden geregeld door het stagebureau van het ILS. Het gebruik van een OV-weekkaart kan nodig zijn.

Deze Oriëntatiestage Educatie is niet verplicht maar zeer aan te raden voor iedereen die de eerstegraads bevoegdheid tot leraar wil halen.

Neem voor verdere informatie contact op met het Secretariaat, Instituut voor Leraar en School, Erasmusplein 1, 6525 HT Nijmegen tel.024-3615573 of 3615572.

3.4 MT-variant

Master-thesis Management & Technology-track

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

Teaching methods

- 40 hrs personal study counseling

Prerequisites

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

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

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

Contents

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

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

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

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

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

Business & Society

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

Teaching methods
- 28 hrs lecture

Prerequisites
Master student FNWI

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

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

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

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

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

Finance & Accounting

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

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

Prerequisites
Master student FNWI

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

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

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

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

Literature

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

Examination

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

Innovation management

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

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

Teaching methods
- 32 hrs lecture

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

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

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

Literature
To be determined (See Black Board)

Examination
assignments and a written exam

Organization Theory

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

Teaching methods
- 30 hrs question session

Prerequisites
MT Course Business & Society

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

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

Literature
To be determined

Examination
Written examination and discussion of a business case

Strategy & Marketing

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

Teaching methods
- 30 hrs question session

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

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

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

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

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

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

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

Projectmanagement

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

Werkvormen

Opzet/werkvorm

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

Vereiste voorkennis

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

Leerdoelen

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

Inhoud

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

Beschrijving

Training is in Dutch.

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

Doelgroep.

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

Maximale groepsgrootte: inschrijving en plaatsing.

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

Tentaminering

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

Bijzonderheden

Toetsing en beoordeling

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

Cursusdata in studiejaar 2010-2011

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

4 Research

4.1 Multidisciplinary Research at the Faculty of Science

This chapter gives an overview of the multidisciplinary scientific research taking place at Radboud University. More and more interdisciplinary projects are carried by two or more research groups. Natural Science students can combine their Major and Minor internship into one interdisciplinary project shared by two research groups.

In this chapter a selection is made of research groups ('leerstoelgroepen', chairs) that are relevant for the Natural Science Master program. For an even more complete overview of all existing research groups we refer to the Prospectuses of Physics and Astronomy, Chemistry, and Biology that can be found at: http://www.studiegids.science.ru.nl/2010/science.

Most descriptions here are updated annually, but research projects change over time and new projects start. It is always best to go and talk with researchers in the department about their research and current possibilities.
Every researcher likes to talk about his work, do not hesitate to ask.

The large variety in subjects and experimental techniques makes it possible for every student to follow their interest. The traineeship can completely or partly take place outside the Faculty, for instance in industry or abroad.
Every internship should take place under ultimate supervision of a professor from the Faculty of Science.

During an internship, students get ample opportunity to participate in research. This can be on an individual basis by setting up and performing a short-term independent research under the supervision of a PhD-student or a senior staff member. In this case one can often lay the foundation of a possible PhD career. Another possibility is to do a bigger project with other students or in direct corporation with a PhD-student.
Concerning his/her more independently performed part in the research, the student is expected to write a graduate-report and to give a departmental colloquium.
Furthermore, in many cases, the student must write a thesis on a literature subject.

Note: Not all research projects in the selected departments are multidisciplinary and not all multidisciplinary research is suitable for the Natural Science Master program!
It could also be that multidisciplinary research is performed in a department that is not (yet) mentioned here. It is possible that such research could also be very suitable as a subject of a traineeship.

Internships should get approval BEFORE starting.
A form for planning and approval can be obtained from the study coordinator.

The two internships for the research variant must be taken in different groups and focus on different disciplines. This is the only way to get fully acquainted with concepts and methodology of different disciplines.

Relevant Research Institutes (See their respective websites)**:**

Institute for Molecules and Materials (IMM)
Institute for Water and Wetland research (IWWR)
Donders Institute for Brain, Cognition, and Behaviour
Institute for Molecular Life Science (NCMLS)
UMC St. Radboud

4.2 Analytical Chemistry (IMM)

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

Research:
Examples of current projects at the department:

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

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

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

- Molecular chemometrics: applying chemometrics to the analysis, optimisation and determination of molecular structure.

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

Mandatory course: Chemometrics I

4.3 Bio Organic Chemistry (IMM)

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

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

Description of research:
Research within the bio-organic chemistry group is positioned at the interface of three disciplines: organic chemistry, polymer chemistry and molecular biology. Inspired by concepts found in Nature, we develop biomimetic materials and processes by application of advanced synthetic techniques.
Within our group we use different methods to prepare smart polymers. We combine polymer chemistry with organic and peptide chemistry to connect biomolecules to synthetic polymers. These hybrid polymers are applied as antimicrobial coatings and are assembled into capsules, which find their application in the biomedical field.
Micro-reactors are synthetic devices which are much smaller than regular reaction vessels, such as round bottom flasks. The big advantages of micro-reactors are that reactions are much better controlled in a miniaturized environment, due to improved heat and mass transfer. Furthermore, only small amounts of reagents and catalysts are needed if you want to screen reaction conditions. Micro-reactors are becoming more and more important in the chemistry labs and therefore it is very interesting to get acquainted with this new type of technology.
Another area of research is peptide amphiphiles. By changing the hydrophobic-hydrophilic balance of a peptide its ability to fold and assemble will change drastically. This is then used to control both its functionality and/or structure. Via this approach we can make peptide fibres that can be perfectly aligned in magnetic fields. Switchable peptides can be used for

targeted drug delivery. Also peptides are combined with polymers which provide us with new designer materials with adjustable properties.
Proteins are functional biomolecules which are designed by nature to perform specifically dedicated tasks. Within our group we want to extend the natural function of proteins by introducing additional functionality. By combining molecular biology (protein engineering) tools with organic chemistry methods, we develop smart self assembling enzymes and virus capsids as novel nano-containers.
You can find more information on: http://www.ru.nl/bio-orgchem.

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

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

4.4 Biochemistry (NCMLS, UMC St. Radboud)

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

Research:

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

Description of research:

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

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

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

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

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

4.5 Bioinformatics (NCMLS)

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

Research:

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

Description of research:

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

Bacterial Genomics (Prof.dr. R.J. Siezen, e-mail: R.Siezen@cmbi.ru.nl)
Gram-positive bacteria play an important role in different aspects of food fermentation, ingredient production, food safety and health. In collaboration with NIZO food research (Ede) and the Top Institute Food and Nutrition (Wageningen), bioinformatics tools are being used to analyse and compare complete genomes of food-relevant gram-positive bacteria. Emphasis is put on the positive attributes of lactic acid bacteria (Lactococcus, Lactobacillus, Streptococcus) and the negative attributes of pathogenic and spoilage bacteria (Listeria, Bacillus cereus, Clostridium).

Comparative Genomics (Prof.dr. M. Huynen, e-mail: M.Huynen@cmbi.ru.nl)
The -omics era is characterized by tremendous amounts of data (genome sequences, single nucleotide polymorphisms, gene expression data, proteomics data, metabolite concentrations data), and by (relatively) little understanding of these data or of their value for biology. Within the computational genomics group we try to bridge the gap between experimental data and biological knowledge. We focus specifically on prediction of protein function, and protein-protein interactions such as observed in protein complexes or biochemical pathways.

In doing that we are not only interested in the functions of the proteins and their interactions in man, but also how these interactions have evolved.

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

Opportunities for students:

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

Master track bioinformatics

Students who are interested in bioinformatics can follow the bioinformatics track (B-track) in the MSc programme of Molecular Life Sciences. They will receive a Masters degree in Molecular Life Sciences with specialisation Bioinformatics.
Within the B-track both research projects (stages) have to have a bioinformatics research topic. One of the stages has to be followed at the CMBI, the other can be followed at other departments of FNWI and UMC. B-track students have to follow in total (BSc and MSc phase) 25 EC of bioinformatics classes. At least 16 EC of these courses needs to be at MSc level. There is a list of courses available which contains bioinformatics and bioinformatics-related (mainly statistics, data management and informatics) courses, both from the RU as well as from other universities. The student can also suggest courses for the B-track.
More information about the B-track can be found at www.cmbi.ru.nl/btrack or contact dr. C. van Gelder (C.vanGelder@cmbi.ru.nl).

4.6 Biomolecular Chemistry (IMM - NCMLS)

Head: Prof.dr. G.J.M. Pruijn

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

Research:

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

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

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

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

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

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

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

4.7 Biophysical Chemistry (IMM)

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

Description of research:

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

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

The main objective is to learn about biomolecular research, what it is and how it is done and at the same time learn the methods and techniques used in the field of Biophysical Chemistry. This is achieved by actively participating in one of the research projects at the department. Depending on your interest your own project can be more biologically oriented (e.g. expression and characterization of proteins or RNAs) or biophysically oriented (e.g. structural NMR) or even focused on methodology development (e.g. NMR methodology or developing computational methods for faster structure determination etc). Your research is usually under direct supervision of one of the PhD students or post-docs with regular discussion of progress to one of the principal investigators, who is ultimately responsible for the project. As a

member of the department you are expected to participate in all its activities, which includes drinking coffee or 'tea' and joining work meetings. There is an open collaborative atmosphere in the group so that anyone can be approached for help and there are technicians who can help with lab work or with the NMR.

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

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

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

4.8 Biophysics (DCN)

Head:	Prof.dr. C.C.A.M. Gielen
Scientific staff:	Prof.dr. H.J. Kappen, Prof.dr. A.J. van Opstal, Dr. H.H.L.M. Goossens (UMC), Dr. T.F. Oostendorp (UMC)
Secretariat:	Ms J. Fontaine, room GG 21.126.020, tel. 3614244, e-mail: neuroscience@donders.ru.nl
website:	http://www.ru.nl/mbphysics

The Biophysics group is funded both by the Faculty of Science and the University Medical Centre and collaborates with the Dept. of Biophysics of the University Medical Centre.

Research:

- Brain and behaviour
- Machine learning and artificial intelligence

Description of research:

Brain and behaviour
The research focuses on the neuronal information processing by the central nervous system, in particular on the sensory coding of visual, auditory and vestibular information and on sensori-motor transformations which map the sensory information into motor commands (eye, head, and arm movements) for appropriate action. The studies include an experimental and a theoretical approach. With regard to experiments the group collaborates with researchers in the Donders Center for Cognitive NeuroImaging (http://www.ru.nl/donders/),

which houses advanced equipment for measuring and imaging of neuronal activity, and with research groups in the University Medical Centre St. Radboud.

The topic of neuronal information processing is addressed from different perspectives:

- Experimental research based on system-theoretical approach. By presenting various complex stimuli and by measuring responses to those stimuli, we aim to elucidate and to characterize the functional properties and hierarchical structure of processes involved in perception and action.
- Electrophysiological studies recording neuronal activity in primates and humans.
- Characterization of source location of brain structures that contribute to neuronal activing using the bioelectricity of brain (electro-encephalography, EEG and magneto-encephalography MEG) in collaboration with the department of Neurology and researchers in the Donders Institute.
- Theoretical research modelling biological neurons and the information storage and retrieval by networks of neurons.

The theoretical research focuses on insight in information processing in neurobiological systems as well as on applications of knowledge using artificial neural networks. In the former, we develop models for complex biological neurons and investigate learning and communication between neurons, as well as the dynamics of self-organization and information storage by networks of neurons.

Machine learning and artificial intelligence
One day, we will have computers that can think and learn like humans. But this will be far in the future. Nevertheless, artificial intelligence research is producing useful methods that provide solutions in many branches of industry. At the department of Biophysics we develop novel machine learning methods and apply these methods to AI applications. In particular, methods that have a close resemblance to methods from statistical physics, such as mean field and Bethe approximations and Monte Carlo sampling, are developed by the group and are among the best methods world-wide. Applications are in the areas of medical expert systems, genetics, multi-agent control problems, and time-series forecasting. Soms of these applications are commercialized through spin-off companies or with industrial partners. Students that are interested to write their Master's thesis in this research direction are adviced to follow courses in statistical physics and the courses Introduction to Pattern Recognition, Machine Learning, and Computational Physics.

Opportunities for students:
The department of Biophysics offers several experimental and theoretical research projects for a Bachelor or Master project. Students are advised to contact the head of the Biophysics department or one of the staff members for more details.

4.9 Cell Biology (NCMLS)

Head: Prof.dr. B. Wieringa
Scientific staff: Dr. J.A.M. Fransen, Prof.dr. P. Friedl, Dr. K. Wolf, Dr. W. Hendriks, Dr. C.E.E.M. van der

	Zee, Dr. D.G. Wansink
Secretariat:	Mw M. Reawaruw, tel. 3614329, e-mail: m.reawaruw@ncmls.ru.nl
Website:	http://www.ncmls.nl/celbio/ http://www.umcn.nl/Research/Departments/celbiology/

Research:
Joint research of the Dept. of Cell Biology is aimed at understanding the pathobiological significance of

1. cellular energy and redox metabolism: Metabolic and allosteric effects of ATP and NAD(P)(H) on cell viability and growth,
2. coupling between energy and redox metabolism and actin-based cell shape dynamics and cell motility,
3. reversible protein phosphorylation reactions involved in the coupling between cell fate and growth regulation, actin cytoskeleton dynamics, and metabolic state,
4. the role of proteases and adhesion receptors in different types of cancer cell invasion, and
5. the mechanisms of cancer cell killing by cytotoxic T lymphocytes.

Study of these cellular reactions is important for a better understanding of health problems that are related to cancer cell growth and motility, neurodevelopment and neurodegeneration, immune defense, or diseases like myotonic dystrophy and mitochondrial myopathies.

Description of research:
Among the thousands of small compounds in mammalian cells, metabolites like ATP, PCr and NAD/NADH or NADP/NADPH have a special position in that they are utilized in the core pathways of energy and redox metabolism (glycolysis, PPP-pathway, TCA-cycle, OXPHOS) or directly as co-factors in the allosteric control of protein activity. Distinctly different processes like cell viability control and cell growth, formation of cell protrusions, development of podosomes and invadopodia by malignant cells, phagocytosis by macrophages, or the generation of lamellipodial/filopodial extensions in motile cells, and even cell cycle transition events, share the hallmark that they are under temporal and spatial control of ATP or NAD(P)(H)-based reactions. Without exception these processes are also determined by the coordination of actin polymerization behavior, force generation by myosin ATPases, and the local control of phosphorylation of proteins in upstream signaling pathways. Currently central in our interest is how the local distribution of ATP and NAD(P)(H), and activity of members of the protein tyrosine phosphatase (PTP) family or the ACG-kinase family member Myotonic Dystrophy Kinase (DMPK) determines fate of neurons, macrophages, and muscle cells. Other key topics are the diversity of tumor invasion and interaction with the tumor stroma; novel escape responses of tumor progression during targeted experimental therapy; the serial dynamics of T cell scanning across antigen-presenting cells during immune cell activation and effector function; and the regeneration of epithelial and interstitial tissue using tissue engineering. To visualize cell motility, cell-matrix interactions and dynamic cell patterning during cell differentiation, immune cell interactions and tumor invasion we use 2D and 3D extracellular matrix (ECM) based cell culture models and highly advanced imaging procedures with light, CSL or multiphoton microscopes to monitor cellular and molecular events in real time and simultaneously. As models, genetically

modified cells and transgenic mice are used. To validate in vitro findings, in vivo imaging of tumor and immune cell migration is performed by multiphoton microscopy.

Opportunities for students:
All MSc students with a chemical/biological, biological/physical or biomedical profile, with molecular biological and/or cell biological elements in their training program are invited to apply for traineeship opportunities. We assign an experienced supervisor to each individual student. Therefore, we have only a limited number of internship positions available at a given moment. For all further information we refer to http://www.ncmls.nl/celbio/ or http://www.umcn.nl/Research/Departments/cellbiology/.

4.10 Molecular Materials (IMM)

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

Research:

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

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

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

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

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

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

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

Opportunities for students:
The department is highly interdisciplinary in research. Cooperation with groups in Nijmegen and abroad entail a wide choice in research subjects for undergraduate students, from all subdivisions. We will tailor the internship to suit the needs of the student and will draft a specific educational plan for each individual. A whole host of techniques, ranging from chemical synthesis to single molecule experiments, scanning probe microscopy, electron microscopy etc. is employed in the research into new materials. Students interested in one of the projects should contact the secretary in advance.

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

4.11 Protein Biophysics (IMM)

Head:	Prof.dr. G. Vuister
Contact:	Prof.dr. G.W. Vuister, room NCMLS 0.25, tel. 3618940,

e-mail: g.vuister@science.ru.nl
website: http://proteins.dyndns.org/
Research:

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

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

1. Protein structure and function
* Regulation of Ca^{2+} transport.
Ca^{2+} ions are crucial in many cellular processes, including neuronal response, muscle contraction, enzyme activity, gene transcription, cell death, proliferation and differentiation. We study the regulatory mechanisms that govern Ca^{2+} fluxes across membranes from a structural- and biophysical perspective. In particular, we focus on the Na^{+}/Ca^{2+}-exchanger, a highly ubiquitous ion transporter that constitutes the dominant Ca^{2+} efflux mechanism in heart and sensory neurons and the TRPV5/6 Ca^{2+} channels involved in Ca^{2+} homeostasis.
* Assembly of active biomolecular complexes.
Protein interaction domains play essential roles in the transport, localization, assembly and functioning of multi-protein complexes. We study the structure function relationships of the five PDZ domains of the protein tyrosine phosphatase PTP-BL and the so-called PAH domains of the transcriptional co-repressor SIN3.

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

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

Opportunities for students:
The multidisciplinary nature of our research allows for many possibilities for your master research period. When you are interested in structure and functioning of biological

macromolecules, you can work both in the lab and use the biophysical techniques (NMR, ITC, SPR) as tools in your studies (project 1, suitable for Chemistry, Molecular Life Science and Natural Science). Those with an interest in biophysics can work on the development of biophysical techniques, in particular NMR spectroscopy (project 2, suitable for Chemistry and Natural Science). Finally, those with an interest in bioinformatics approaches, programming and computers can work on the tools for structure generation and analysis (project 3, suitable for Chemistry, Molecular Life Science and Natural Science).

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

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

4.12 Solid State Chemistry (IMM)

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

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

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

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

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

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

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

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

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

4.13 Solid State NMR (IMM)

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

Description of research:
Research goals: The overall aim of our group is to develop new solid-state NMR methods to study structure and dynamics of both crystalline and non-crystalline materials and to apply

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

Opportunities for students:
Within the research group there are always opportunities for students to participate in one of the research projects discussed above. The research has a strong multidisciplinary character; physical tools are used to study chemically or biologically relevant materials and processes. The work involves experiments, computer simulations and theory. Depending on the students' background it is possible to give more emphasis to either experiment or theory. Furthermore, one can decide to focus more on the chemical or physical aspects of the research.
Students are treated as full members of the research group and are expected to carry out their assigned research task with an important individual contribution. Personal initiative and creativity are therefore highly valued. Depending on the project the work is carried out under the direct supervision of a Ph.D. student, post.doc. or docent. There is an open atmosphere in the group where everyone is available to give support

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

4.14 Synthetic Organic Chemistry (IMM)

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

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

- Development of sensors for allergens and biomarkers (with prof. van Hest, prof. Zuilhof, WUR and Fraunhofer Institut, Duisburg)
- Conversion of biomass into high-end building blocks (with DSM)
- Application of enzymes in organic synthesis (with DSM, prof. Franssen, WUR and prof. Wever, UvA)
- Novel antimalarial compounds (with prof. Chibale, Kaapstad, Zuidafrika)
- RNA-targeting and toxicity studies of naturally occurring aminoglycosides (with Prof.

Russel, NCMLS, prof. Ennifar, Strasbourg)
- Synthesis and evaluation of pan-cholecystokinin (CCK) receptor binding ligands for radionuclide targeting of CCK-receptor positive tumors (with Prof. Boerman, Dr. Laverman, UMC St Radboud)
- Development of bioorthogonal ligation methods (with Prof. van Hest, prof. Boons, Athens, USA)
- Design and synthesis of germination stimulants (with Prof. Zwanenburg and Prof. Bouwmeester, WUR)

Description of research

The research focuses on the synthesis of enantiopure, multi-functionalized heterocyclic molecules, predominantly amino acid-based structures and carbohydrate derivatives. Emphasis lies on the development of new 'chemical tools', with particular focus on catalytic methods under sustainable and mild reaction conditions. This includes the following areas:
- Biocatalysis: use of enzymes as mild and environmentally benign catalysts for modification of organic molecules. Besides application of hydrolytic enzymes (lipases, amidases, nitrilases, sulfatases), enzymes that are capable of forming synthetically useful carbon-carbon bonds are investigated, such as hydroxynitrile lyases and aldolases. Synthetic challenges lie especially in the generation of enantiomerically pure compounds from racemic or non-chiral molecules. Furthermore, collaborations with molecular biology groups result in modified enzymes which are obtained via genetic engineering.
- Transition metal catalysis: transition metal-based catalyst systems (involving Pd, Ru, Cu, W, Ti) are applied in the functionalization and/or cyclization of highly functionalized molecules. For example, ring-closing metathesis is studied as a viable method for the synthesis of fluorinated building blocks, unnatural sugars, or conformationally constrained peptides. Pd-mediated processes are used for the synthesis of unnatural amino acids, and Cu-mediated reactions are explored to prepare triazole building blocks.
- Organocatalysis: in addition to bio- and metal-catalysts, also chiral amines (e.g. L-proline) can act as a catalyst to create enantiopure compounds. These types of reactions are being explored in a stereocontrolled approach to synthesize all possible stereoisomers of 1,3-aminoalcohols and diamines.

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

Opportunities for students:

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

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

4.15 Theoretical Chemistry (IMM)

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

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

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

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

Description of research:
Computation of intermolecular potentials:
With the aid of modem quantum chemical computer methods, such as 'symmetry adapted perturbation theory', 'coupled cluster theory', 'many body perturbation theory', etc., the van der Waals forces are calculated between two or more molecules.
They may be closed- or open-shelI molecules. The concept of the van der Waals force is very broad, it comprises: long range attraction, Born (steric) repulsion and hydrogen bonding. The aim of the work is a reliable analytic description of these forces as a function of the relative orientation and distance of the molecules. These so-calIed potential energy surfaces are used subsequently in project 2.

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

another under the influence of the collision. Cross sections are measured in very many laboratories in the world, including the Molecular and Laser Physics Lab in Nijmegen.

The theory of chemical reactions:
Computer methods exist, and are being improved; these are tools in the study of chemical reactions at the level of molecular quantum states. This means that the reactive collision is studied between two atoms and/or molecules that are in known, well-defined quantum states. The probabilities are computed that the reaction products appear in certain quantum states after the reaction is finished.
The time-dependent, as well as the time-independent, Schrödinger equation yields this probability. However, under certain circumstances 'semi-classical' methods (a mixture of quantum and classical mechanics) can be applied very fruitfully as well.
This project also contains the study of photodissociation: the 'reaction' of a molecule and a photon leading to the dissociation of the molecule. The photodissociation of molecules by sunlight is of crucial importance in atmospheric chemistry. In Amsterdam and in Nijmegen experiments are being performed on photodissociation reactions that are important for the atmosphere. In close cooperation with these groups the theoretical chemistry department works on the interpretation and explanation of the measured results.

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

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

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

4.16 Applied Materials Science (IMM)

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

- Solar cells
- Wide bandgap semiconductors

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

Description of research:

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

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

Opportunities for students:
The department offers many possibilities for students to conduct scientific research. Together with a supervisor the student defines a project assignment that he/she can conduct independently after a short introduction period. The research is completed with a colloquium

at the department and a final report (master thesis). Dependent on the result the project can lead to a publication in a scientific journal.

4.17 Condensed Matter Science and HFML (IMM)

Head: Prof. Dr Ir J.C. Maan
Scientific staff: Dr J.A.A.J. Perenboom, Dr P.C.M. Christianen, Dr S.A.J. Wiegers, Dr U. Zeitler, Dr H. Engelkamp, Dr A. McCollam, Ir. A. den Ouden, Dott. G. Pettinari
Secretariat: Ms H.E.M. Verhaegh-Peeters (hfmlsecr@science.ru.nl) room: HFML 02.15; tel. (36)52087;
Website: www.hfml.ru.nl/
Research:

- Connection with high magnetic fields
- Interdisciplinary research

Description of research:

Connection with high magnetic fields
In condensed matter physics the application of high magnetic fields is widespread. A (high) magnetic field changes the thermodynamic state of any system and a study of this change provides new and unique information. In some cases new states of matter (suppression superconductivity, quantum Hall effects, etc.) are discoverd.
In the area of the fundamental properties of matter the main emphasis is on nanostructures ranging from, those made from lithographically etched semiconductor to self-assembled supramolecular structures. Pioneering scientific discoveries are often done in the highest magnetic fields, which are available at HFML.

Interdisciplinary research
Magnetic fields also find applications in chemistry or biology related research. These applications comprise instrumental developments like high field Electron or Nuclear Magnetic Resonance (ESR and NMR) but also ordering of mesa molecular systems in high magnetic fields.
Finally there are also research activities in magnet technology.

Opportunities for students:
Many experiments can be done in the laboratory. Ranging from low temperature (mK) experiments, laser spectroscopy, far infrared spectroscopy, magnetostriction, magnetisation, susceptibility and transport experiments. Much research is performed in collaboration with other groups both within the university and other (European) research departments. This open and international character provides a broad orientation for the students. Research done at HFML provides an excellent training as experimental physicist, which is highly appreciated

on the labor market (both in academia as in industry).

4.18 Electronic Structure of Materials (IMM)

Head: Prof.Dr. R.A. de Groot
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Website www.ru.nl/esm
Research is related with:

- Anionogenic ferromagnets. Ultra relativistic Dirac compounds
- Half-metallic materials and spin-electronics
- Materials for hydrogen storage
- Electronic, optic and mechanical properties of organics and refractory superalloys
- Photovoltaics
- Electrocatalyses
- Materials and Solar-energy

Description:

The main goal is to understand and design the physical properties of various new materials, including artificial nanostructures, from ab initio calculations.

Modern quantum-mechanical computations within Density Functional Theory (DFT) and extensions like GW and Bethe-Salpeter schemes allow to investigate the electronic, magnetic, optical and mechanical properties of interesting materials.

Although the work is theoretical in nature, and mainly involves large scale computer work, we aim for a close collaboration with experimental groups.

Opportunities for students:
Several oppertunities exist for students to participate in the ongoing research of the group. A master student works on an identifiable subject. Subjects range from "theoretical" to quite applied. Usually his/her work results into a publication in an international journal. For qualified students industrial apprenticeships are possible.

4.19 Molecular and Laser Physics (IMM)

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

Website: http://www.ru.nl/mollaserphys/
Research:

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

Description:

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

In recent years quantum mechanical theory has been able to quantitatively describe a few of the simplest reactive and inelastic scattering processes. For the more complicated 'real-world' scattering systems laboratory work is essential. Experimental research on molecular scattering dynamics has blossomed worldwide in the last years due to new powerful laser- and molecular beam-based techniques, especially the velocity map imaging technique developed here in our group in Nijmegen.

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

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

despite it being the most important free radical in atmospheric chemistry. In collaboration with Prof. Ubachs of the Free University of Amsterdam we plan to chart out OH dissociation pathways for the ultraviolet to extreme ultraviolet (300-100 nm) spectrum.

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

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

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

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

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

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

4.20 Molecule and Biophysics (IMM)

Professor: Prof. Dr W.J. van der Zande
Scientific staff: Prof. Dr W.L. Meerts, Prof. Dr Marc J.J. Vrakking (FOM-Institute AMOLF)
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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.

4.21 Scanning Probe Microscopie (IMM)

Hoofd:	Mw Prof.dr. S. Speller
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Onderzoek

- Nano-proben
- Moleculaire electronica en mechanica
- Nano-chemie
- Bio-electronische relaties
- NanoLab Nijmegen

Scanning Probe Microscopie maakt het zichtbaar maken van objecten op de nanoschaal mogelijk. Onze interdisciplinaire onderzoeksgroep houdt zich bezig met de ontwikkeling van nieuwe methoden om systemen op de grensvlakken van de natuurkunde, scheikunde, en biologie, op de nanoschaal te bestuderen.

Beschrijving
In onze onderzoeksgroep Scanning Probe Microscopie zijn we geïnteresseerd in fenomenen die plaatvinden op zeer kleine schaal. Op de langere termijn is het doel om mechanismes en processen te ontrafelen die fysische, chemische en biologische structuren verbinden. Om dit doel te verwezenlijken worden geavanceerde scanning probe microscopie methoden ontwikkeld en toegepast. We vormen een interdisciplinair team van natuurkundigen, scheikundigen, natuurwetenschappers, biologen, en technici, en hebben samenwerkingen met onderzoeksgroepen uit het moleculair cluster, de theoretische groepen, en biochemiegroepen binnen het Instituut voor Moleculen en Materialen van de Faculteit der Natuurwetenschappen, Wiskunde en Informatica. Daarnaast werken we ook samen met een groot aantal internationale laboratoria, en met bedrijven.

Met behulp van Scanning Probe Microscopie (SPM) methoden kunnen op een unieke manier systemen en individuele nano-objecten op de nanoschaal zeer locaal bestudeerd en

gemanipuleerd worden. Het is ons doel om de toepasbaarheid en de selectiviteit van de SPM methoden te verhogen, door het ontwikkelen van nieuwe SPM varianten voor het bestuderen van complexe systemen in allerlei omgevingen. Dit omvat de functionalisering van nanoprobes, correlatieve nanoprobing, en het meten van locale tunnel- en ionenstromen in vloeistoffen en electrolyten. Met deze methoden zijn we in staat om heterogene systemen, (spin-) electronische en transporteigenschappen van nanostructuren, structuur-functie correlatie van materialen, en mechanismes van chemische reacties te onderzoeken.

Moleculaire electronica en mechanica

'Hoe geleiden moleculen electriciteit?' Dat is de centrale vraag van dit onderzoeksthema.Voor moleculaire electronica, organische electronica en electronentransport in biologische systemen is het van belang om de transportmechanismes van ladingsdragers in organische moleculen te begrijpen. Wij gebruiken Scanning Tunneling Microscopie (STM) en Atoomkracht Microscopie (AFM) om ladingstransport (electronen/gaten) door individuele moleculen en tussen moleculen in een assemblageste bestuderen, en daarbij wordt de nadruk gelegd op de relatie tussen het transport van de ladingsdragers en de moleculaire mechanica en de structuur van de moleculaire assemblages.

Nano-chemie

In de afgelopen decennia hebben SPM studies aan monolagen van moleculen in ultrahoog vacuum veel inzicht gegeven in chemische structuren en processen op de nanoschaal. Chemische processen in de industrie en in het laboratorium vinden echter plaats in veel realistischer omgevingen, meestal in een vloeistof en onder een gecontroleerde atmosfeer. Wij hebben een speciale vloeistof Scanning Tunneling Microscoop ontwikkeld waarin moleculaire lagen onder zulke praktische omstandigheden bestudeerd kunnen worden. In deze microscoop willen we met name dynamische processen onderzoeken, zoals het volgen van afzonderlijke stappen van een chemische reactie door moleculen te visualiseren terwijl ze met elkaar reageren. Op deze manier verwachten we op een unieke manier nieuwe informatie te verkrijgen over reactiemechanismes, omdat gegevens worden verkregen van individuele moleculen in plaats van miljoenen moleculen die tegelijkertijd reageren en waarvan het gedrag uitgemiddeld wordt. Het is ons doel om de het scala van apolaire oplosmiddelen dat we nu gebruiken uit te breiden naar electrolyten, en oml de microscopie te combineren met geavanceerde spectroscopische en optische technieken. Het sterk interdisciplinaire onderzoek wordt uitgevoerd in nauwe samenwerking met de chemiegroepen in het Moleculair Cluster.

Interactiekrachten van individuele biologische structuren

In de biologie zijn interacties tussen biomoleculen van essentieel belang. Voor het genezen van ziektes zoals HIV en Hepatitis, die veroorzaakt worden door virussen, is er natuurkundige kennis nodig van de specifieke interacties tussen eiwitten en nucleïnezuren. Omdat in de biologie de energie van processen dichtbij kT ligt, kunnen studies op het niveau van individuele moleculen veel nieuwe inzichten verschaffen. Er zijn AFM methoden ontwikkeld die bijzonder krachtig zijn in het ontrafelen van dergelijk biologische interacties. Individuele interacties kunnen worden blootgesteld aan organische reagentia of geneesmiddelen, en het effect van deze stoffen kan direct gemeten worden door middel van

krachtkarakteristieken. Ook op het niveau van virussen en levende cellen kan krachtspectroscopie op deze manier inzicht geven in interactiemechanismes.

Bio-electronische relaties

- Magnetiet nanokristallen en hun rol in magnetoreceptie.

Magnetoreceptie geeft dieren de mogelijkheid om te navigeren in het aardmagnetisch veld. Wij bestuderen nanokristallen van magnetiet in weefsels, met als doel is het ontrafelen van overdrachtsmechanismes van magnetoreceptie in vissen. De correlatie van Magnetische Kracht Microscopie-AFM, transmissie electronenmicroscopie, en het kleuren van epitheel gecorreleerd heeft ons onlangs de mogelijkheid gegeven om de verdeling van magnetische nanodeeltjes in cellen te bepalen. We bestuderen ook modelsystemen, zoals Ferrovloeistoffen, met behulp van Magnetische Kracht Microscopie.

- Visualisatie van ionenstromen in levende cellen

Cellen bruisen van activiteit en er vinden oneindig veel biochemische reacties en transportprocessen plaats. Typische voorbeelden hiervan zijn eiwitsynthese en -regulering, herstelprocessen, replicatie, moleculair transport en export, en de initiatie van processen zoals celdeling, -activering, en -differentiatie. Deze processen kunnen geactiveerd of beïnvloed worden door interne en externe stimuli, en worden vergezeld door substantiele fluctuaties van chemische stoffen. Wij onderzoeken locale veranderingen van ionenconcentraties in levende cellen met behulp van Scanning Iongeleiding Microscopie.

Mogelijkheden voor studenten

Voor studenten zijn er voldoende mogelijkheden om deel te nemen aan het onderzoek aan alle onderwerpen die hierboven besproken zijn. De begeleiding is doorgaans in handen van ervaren groepsleden, zoals promovendi, postdocs, of stafleden. Met name bestaan er uitstekende mogelijkheden tot het uitvoeren van interdisciplinaire stages.

4.22 Spectroscopy of Solids and Interfaces (IMM)

Head: Prof. Dr Th. Rasing
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room HG 01.074; tel. (36)53141
Website: www.ru.nl/imm/ssi
Research topics:

- Nanomagnetism
- (Sub)nanosized magnetic clusters
- Ultra fast carrier and spin dynamics, coherent control
- Nanophotonics
- Supramolecular structures
- Liquid crystals and polymers

- Applications

Mission: to understand the relation between properties and structure of condensed matter, in particular of nanoscopic, magnetic and molecular materials with a focus on phenomena occurring on ultra short time scales (femto seconds) and ultrasmall length scales (nanometers). In this regime quantum mechanical principles and surfaces and interfaces play a dominant role and may lead to surprising new results. For this research novel, advanced optical and scanning probe techniques are being developed and applied.

Description:

Nanomagnetism

This field of research includes magnetic surfaces and interfaces and electronic and magnetic properties of low dimensional objects such as nano-wires, ultra thin films and multilayers. This exciting area combines fundamental challenges with a high potential of practical applications like sensors (Nobelprize 2007) and datastorage. We use new Scanning Probe and Nonlinear Optical techniques that were partly pioneered in Nijmegen like Magnetization induced Second Harmonic Generation. New future developments are the combination of these approaches to allow the study of matter with the highest spatial (in-plane as well as out of plane) and temporal resolution.

(Sub)nanosized magnetic clusters

The goal is a comprehensive study of nanosized clusters of various oxides, both free and deposited on surfaces, that form the building blocks of new materials. Special attention is on the correlation between crystallographic structure, electronic states and magnetic properties. The combination of structural (infrared vibrational spectroscopy, SEM), electronic (UV ionization spectroscopy for free clusters, STM spectroscopy for clusters on a surface) and magnetic (Stern-Gerlach experiments for free clusters, magneto-optics and spin-polarized STM for the deposited ones) information will provide an unprecedented insight into the properties of these interesting strongly-correlated materials. Part of the research is done using the free electron laser FELIX at Rijnhuizen, while collaborations exist with various theoretical groups (including prof. M. Katsnelson).

Ultra fast carrier and spin dynamics, coherent control

The dynamics of electrons and holes in semiconductors and metals (in the presence of electric and magnetic fields) can be studied using ultrashort femto-second (fs) laser pulses. In this way electron-electron, electron-phonon and electron-magnon interactions can be probed directly, in contrast to standard transport experiments that only probe time - averaged quantities. For example, an intriguing question is: how fast can the magnetization of a magnetic system be changed (reversed)? This is an exciting area of fundamental research with far reaching practical consequences for opto-electronics, spintronics and magnetic recording. We have pioneered novel methods to create very fast controllable magnetic field pulses (Th. Gerrits, Nature **418** (2002) and A. Kimel et al, Nature **435** 2005) and have also demonstrated the possibility to observe and exploit the ultrafast spin dynamics in anti-ferromagnetically ordered materials (A. Kimel et al, Nature **429** (2004). A. Kimel et al Nature Physics ...)). We have recently demonstrated that magnetic domain can even be switches with a 40 fs optical pulse (D. Stanciu et al, Phys.Rev.Lett. (2007)) and discovered a

completely new linear reversal mode for the magnetic moment (K. Vahaplar et al Phys.Rev.Lett. 2009). This work profits from strong collaborations with many experimental as well as theoretical groups worldwide. Theoretical work is done in collaboration with Prof. Katsnelson.

We are further exploring complete coherent optical control of spins in magnetic media and in atoms to understand and exploit the interaction of photons, spins and angular momentum transfer (in collaboration with Prof. W. van der Zande).

Nanophotonics
The goal is to achieve the control of electronic and magnetic properties at femtosecond time scales with nanometer spatial resolution, where usual optical tools fail. Scattering-type near-field scanning-probe microscopy is being developed to achieve a resolution down to 10 nm. This, combined with femtosecond laser pulses, will allow the real-time observation of ultrafast nanometer-scale dynamics. On the other hand, plasmonic structures will be developed and used to concentrate electromagnetic optical waves in a sub-wavelength volume and achieve modification and amplification of opto-magnetic effects.

Supramolecular structures

In collaboration with the Organic Chemistry groups (Nolte, Rowan, van Hest) that are responsible for the synthesis of increasingly complex systems with tailor made properties, the physical properties of individual molecules and molecular aggregates are being studied with scanning probe and nonlinear optical techniques. This highly interdisciplinar field is a strongly growing research area with connections to biology.

Liquid crystals and polymers
These fascinating materials combine a large variety of interesting fundamental phenomena with a huge potential for application (LCD's: Liquid Crystal Displays and Biosensors). Topics of current research are light induced ordering, nano patterned surfaces, phase transitions and dynamics in very thin films. A new development is the exploration of the hierarchy of ordering in LC-cells (from the molecular nanoscale to the macroscopic scale of the LCD) for the application of LC cells as biosensors. This work is done in collaboration with Organic Chemistry (Nolte, Rowan, Kouwer), Philips and several European groups.

Applications
Many of the topics described above are at the interface between fundamental and applied research (a distinction that is often rather arbitrary). This is illustrated by the industrial collaboration with for example Philips, NXP, Seagate and others, often within European projects. Some of these applied research projects are monitored by an external advisory/user committee where researchers from industrial laboratories play an important role. This allows students to have contacts with industry and their approach to research at a quite early stage, which gives extra opportunities for students who desire a career in industry. There are also possibilities to do (part of) a research project in an industrial laboratory, both in the Netherlands and abroad.

Opportunities for students:
The research is mostly done by PhD students and postdocs in collaboration with undergraduate students. The senior scientists supervise the various PhD and undergraduate projects and are also involved in short time pilot projects, that if succesfully, will later be integrated in the research programme.
For students, there is ample opportunity to participate in the research of basically all the projects mentioned above. Our philosophy however is that the students should have their own, individual projects, that can but not necessarily have to be part of a larger project. Though not a necessary condition, the past experience shows that most of these student projects lead to one or more publications in international journals. There are also possibilities of joint projects (with other graduate or Phd students) and often the undergraduate projects may lead to a PhD project. Part of the research internship can be done abroad as part of the Socrates Programme (for example Leuven, Oxford, Marseille) or within one of the many collaborations (Japan, Germany, UK, France, USA, Sweden, Switzerland, Austria).

4.23 Theory of Condensed Matter (IMM)

Head: Prof.Dr. M.I. Katsnelson
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Research

- physical properties of solids
- physical properties of liquids
- essentially many-body properties

Description of research

The aim of condensed matter theory is an explanation of physical properties of solids and liquids on the base of fundamental physical principles. A broad class of phenomena, from strength, plasticity, friction, to magnetism, superconductivity, and superfluidity, can be explained in terms of laws of quantum mechanics. However, in practice it is an extremelly difficult problem, first of all, due to its essentially many-body character. The Theory of Condensed Matter group deals with this problem on different levels, such as model considerations of basic many-body effects for quantum and classical systems, realistic simulations of physical properties of specific materials, and phenomenological description of complicated phenomena such as equilibrium and nonequilibrium phase transitions.

Opportunities for students

The department of Theory of Condensed Matter offers several theoretical and/or computational research projects at the Bachelor and Master level. Students are advised to contact the head and members of the department to choose a project of mutual interest at the

right level. Master projects are in general related to one topic of current interest of the group and aim at reaching some original scientific result.

4.24 Aquatic Ecology & Environmental Biology

Head: prof.dr. J.G.M. Roelofs
Staff: dr. L.P.M. Lamers, dr. A.J. Smolders

Office: mw. J.Broekmans, 3652902, j.broekmans@science.ru.nl

The department investigates processes that determine the distribution and abundance of organisms in aquatic and semi-aquatic habitats with a focus on macrophytes and macrofauna. The department is part of the Institute for Water and Wetland Research (IWWR). Research takes place in riverine ecosystems, fens, bogs and poorly buffered surface waters.

Aquatic Ecology and Environmental Biology: plant species in poorly buffered surface waters, fens, bogs and riverine habitats.

- The impact of sulphate and nitrate load on the nutrient cycles in surface waters and nutrient poor ecosystems is studied in meso-cosm experiments. The role of micro-organisms in these cycles is explicitly taken into account
- Research into the possibilities for the restoration of floodplains, fens, bogs, seepage mires and pine forests degraded by eutrophication, dessication, and acidification. Re-establishment of severely threatened species from poorly buffered ecosystems is investigated in large field experiments and in chemostats in the lab.

4.25 Biological Psychology (Social Sciences)

Head: Prof.dr. Marcus Ullsperger

Staff: dr. Gilles van Luijtelaar, dr. Roland Maes, dr. Eric Maris, dr. Clementine van Rijn, dr. Marijtje Jongsma

Secretary: Saskia van Uum, B.02.14, tel: 024-3612544

Website: http://www.ru.nl/socialewetenschappen/nici/divisions/all_divisions/cognitive

On the Department of Biological Psychology (located in the Donders Istitute for Brain, Cognition and Behaviour), students in biology can participate in different research projects, among others:

Electrophysiological correlates of learning and memory processes (dr. R. Maes, tel 3615992, email: r.maes@donders.ru.nl)

Numerous human and animal conditioning research has generated a number of experimental procedures, each of which is linked to well-developed theories on learning and memory. These procedures include single-stimulus paradigms prompting elementary forms of (associative) learning, such as habituation and perceptual learning, and more complex, multi-stimulus paradigms. The latter include simple classical conditioning, latent inhibition, extinction, and discrimination learning. Even more complex paradigms concern occasion-setting procedures in which behavioral responding to target stimuli is modulated by the presence or absence of other stimuli.

The research is directed at the neuro-electrophysiological correlates of these diverse forms of learning in rats and humans and constitutes a valuable tool for establishing the neurobiological substrates and nature of cognitive processes involved in learning and memory, both within healthy organisms as well as in models of distinct pathologies (e.g. epilepsy, chronic pain, and aging).

Rats and humans are subjected to procedures known to prompt simple and/or complex forms of learning, while measuring local field evoked potentials on the skull (humans), or on the dura mater or in sub-cortical regions (rats).

Epilepsy and its modulation (dr. Gilles van Luijtelaar, tel 3615621, email: g.vanluijtelaar@donders.ru.nl)

The cortico-thalamic network: its role in modulation. The availability of a genetic rat model for absence epilepsy and recent discoveries of how specific parts of the cortex control spontaneous seizures allow the study of mechanisms involved in the control of these absence seizures. Moreover, it gives possibilities to study network interactions and plasticity in the cortico-thalamo-cortical network.

A closed loop system for prevention of limbic seizures. Seizure control by drugs is poor in many epilepsy patients. Brain surgery is only an option for a limited number of patients. Research is aimed to develop various deep brain stimulation techniques and protocols in rats with temporal lobe epilepsy in order to treat them. Some deep brain stimulation techniques will induce plasticity; other techniques are aimed to block an ongoing seizure. Next, we will develop an early seizure detection technique, and, finally, a closed loop system that allows stimulating the rat brain after the onset of a seizure has been detected.

Opportunities for students

It is recommended that an interested student contacts dr. van Luijtelaar minimally four months before the actual start of the experiments. Students (biological-physical profile) can participate in ongoing human or animal research; however, in the latter case permission from the Animal Welfare officer must be obtained. The work placement offers the opportunity to acquire and combine knowledge from the field of electrophysiology and behavior (e.g. learning psychology, epilepsy and behavior, drugs and behavior) including a number of laboratory techniques that are indispensable for those who are seeking a career in neuroscience. The student will acquire theoretical knowledge on recent developments within the field of animal and human learning psychology, sensory perception (e.g. pain in volunteers and in patients), brain networks, specifically in the sub-domain of interest, and will experience in a) working with laboratory animals (rats), if the work placement concerns animal research, b) will be trained in using electrophysiological equipment, stimulators and other equipment used to present learning tasks (including programming), c) will learn to interpret EEG, learn to use programs for behaviour recording and analyses, d) will learn to perform data analysis, including statistics, e) and to report experimental data.

4.26 Cellular Animal Physiology

Head: Prof. dr. E.W. Roubos

Staff: Dr B.G. Jenks, 3653335 and dr W.J.J.M. Scheenen, 3652036

Secretariat: G. Hulzebos, 3652702, g.hulzebos@science.ru.nl

We perform fundamental and applied research on adaptation and cognitive processes, with particular emphasis on intercellular and intracellular communication in the brain and pituitary gland. In this endeavor we take a multidisciplinary approach involving morphological, molecular, biochemical and electrophysiological methods.

The traditional core of our research has been the analysis of neuroendocrine integration using an amphibian model, background adaptation in the South African clawed toad, *Xenopus laevis*. Amphibians have the remarkable ability to change their skin color in response to the color of background. In animals on a white background the pigment in dermal melanophores is concentrated in a perinucular position and consequently the animal appears white. In animals on black background there is a release of the peptide a-melanophore stimulating hormone (a-MSH) from the pars intermedia of the pituitary gland. a-MSH stimulates the dispersion of the pigment in the dermal melanophores and consequently the animals skin darkens. We use this eye-brain-melanotrope system to study mechanisms of signal transfer.

Current studies are focused on the role of Brain-Derived Neurotrophic factor (BDNF) in synaptic plasticity, the role of CRF, urocortin and their receptors in stress adaptation, neuropeptides in volume transmission via the cerebral liquor and characterization of integrative function of the melanotrope cell at the level of neurotransmitters, receptors, ion channels, second messengers and calcium sensing. In recent years our reseach has expanded to mammalians, namely the rat and mouse. In mammals a large body of evidence has

emerged linking chronic stress with increased vulnerability for depression and anxiety disorders. As corticotropin-releasing factor (CRF) is hypersecreted under these psychological conditions, we study underlying brain mechanisms possibly causing these disorders. Urocortin (Ucn), a recently discovered member of the CRF peptide family may play a role in the pathophysiology of stress-induced disorders.

Our results support the hypothesis that CRF and Ucn neuronal systems work in concert in response to acute challenges, but are inversely regulated in their activities during chronic hyperactivity of the hypothalamo-pituitary-adrenal axis.

4.27 Microbiology

Head: Prof.dr.ir. M.S.M. Jetten

Staff: dr. J.T.M. Keltjens, dr. H.J.M. Op den Camp, dr. L.A. van Niftrik, dr. B.K. Kartal

Office: mw. M. Uijt de Haag, 3652940, mailto:mariauyt@science.ru.nl

Contact for interships: dr. H.J.M. Op den Camp (h.opdencamp@science.ru.nl, tel. 52657)

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

Research aim: Ecophysiological microbiology is aimed at the diversity and activity of microorganisms in their natural environment, on their mutual interactions and on their survival strategies. The research is focused on the microbial ecology of freshwater systems and in particular on the microbial processes at the very dynamic oxic/anoxic interface between the sediment and the water column. Besides ecological aspects, also the biochemistry, molecular biology and ecophysiology of relevant trophic groups of bacteria involved in the carbon, nitrogen and sulfur cycles are studied.

Description of research: A major research topic is the microbial nitrogen cycle and more specific, the chemolithoautotrophic bacteria active in this cycle: in the first place anaerobic ammonium oxidizers (anammox), but also aerobic ammonium oxidizers and aerobic nitrite oxidizers. The microbiological research of anammox, in which ammonium and nitrite are converted to nitrogen gas with hydrazine as an intermediate, is leading in the world. More generally, we investigate the interactions of the above-mentioned three groups of autotrophs at the oxic/anoxic interface, and their application in wastewater treatment.

Volatile sulfur compounds are very malodorous and toxic, and are also produced in a number of industrial processes. Further, they have a major impact on global warming and acid precipitation processes. Research is focused on the bacterial production and degradation of volatile organic sulfur compounds. Studies of the degradation are coupled to the application of promising bacterial isolates in treatment of polluted air.

Methane oxidizing bacteria (methanotrophs) utilize methane as their sole source of carbon and energy. Methanotrophs play an important role in the oxidation of methane in natural

environments (wetlands, freshwater systems). This research is conducted in close cooperation with the Department of Aquatic Ecology and Environmental Biology and focuses on the function, identity and ecophysiology of both aerobic and anaerobic methanotrophic bacteria in wetland ecosystems.
The experimental approach is polyphasic, including ecophysiology, molecular ecology, biochemistry, cell biology and environmental genomics. We are interested in how biochemistry/cell biology determine the ecological niche differentiation of the bacteria and which environmental factors determine the qualitative and quantitative output of the respective elemental cycle to the atmosphere.
Techniques used include enrichment and continuous culture of relevant bacteria in laboratory bioreactors, fluorescence in situ hybridization (FISH), PCR amplification, DNA sequence analysis, denaturing gradient gel electrophoresis (DGGE), 2D-gel electrophoresis, MALDI-TOF mass spectrometry, bioinformatics, stable isotope probing, gas chromatography, HPLC analysis and a variety of protein purification methods.

Opportunities for students: In all of the aforementioned research topics several projects are available for Biology students. As a result of the on-going research, projects are constantly be reformulated. The student is supervised by a Ph.D. student, post-doc or staff member. Especially in the first part of the training guidance will be intense: regularly with the supervisor, weekly sessions with other members of the research group. In this period the student will be introduced to literature, and techniques relevant for his/her topic. In the second part of the training the student will show him(her)self more initiative in planning, designing and performance of experiments. At the end of the experimental period a report has to be written and the work is presented in a seminar. In addition, a literature thesis has to be written on a subject not related to the own research. The theoretical examination consists of capita selecta of modern microbiology; the student will be consulted with respect to the choice of the material.

Requirements:
To start with the internship "microbiology", one of the specialized microbiology courses (Physiological Microbiology and Ecological Microbiology) is recommended. As an introduction to the training the research practical 'Microbiology' (BSc level, contact person: dr. H.J.M. Op den Camp) is very useful.

4.28 Molecular Animal Physiology

Head: Prof.dr G.J.M. Martens, mailto:g.martens@ncmls.ru.nl

Scientific staff: Dr F. van Herp

Office: dhr. B. Portier, 3610565/10564, b.portier@ncmls.ru.nl

Website: https://rumba.science.ru.nl/text/edit/15441/www.ru.nl/molanphys/

The Department of Molecular Animal Physiology is part of the Donders Centre for Neuroscience and housed in the Nijmegen Centre for Molecular Life Sciences (NCMLS). Examples of our current research activities and possibilities for student projects are:

A. The molecular basis of psychiatric disorders: effects of (epi)genetic and environmental (early-life stress) factors on brain development

Early pre- or postnatal stress together with genetic background may play an important role in the development of psychiatric disorders such as schizophrenia. To study gene x environment interactions, we examine a rat model, the so-called APO-SUS and APO-UNSUS rat lines; APO-SUS rats display deficits observed in schizophrenia. We explore differences in the (epi)genetic make-up and brain mRNA/protein expression profiles between the APO-SUS and -UNSUS rats. We try to link the (epi)genetic and expression differences to molecular pathways responsible for the behavioural phenotypes. Furthermore, we study genetic variations in genomic DNAs from schizophrenic patients to obtain insight into susceptibility pathways for psychosis. Our research may lead to a better understanding of the highly complex mechanisms underlying schizophrenia and related complex neurodevelopmental disorders.

B. The molecular regulatory mechanisms in the regulated secretory pathway of neuroendocrine cells

We explore the physiological roles of a number of proteins of unknown function, including proteins of the secretory pathway. The studies include the generation and analysis of transgenic *Xenopus* with intermediate pituitary (neuroendocrine) cell-specific transgene expression. In addition, we apply biochemical +/- approaches (differential display proteomics) to identify novel neuroendocrine proteins.

C. Linking behavioral somatosensory learning in rats with gene expression profiles (in collaboration with Dr. Peter De Weerd, University of Maastricht)

We are interested in characterizing gene expression during the acquisition of skills. We use the whisker system in the rat as a model system because it permits the controlled delivery of stimuli in somatosensory cortex (barrel cortex). This research fits in a larger program where links are sought between gene expression, molecular pathways and cognitive processes, for both rats and primates, with the ultimate goal of influencing learning through anti-sense or other techniques.

Techniques used include gene transfer approaches (such as microinjection of DNA to generate transgenic *Xenopus* frogs), (2-D) protein separation, proteomics, mass spectrometry, (real-time quantitative/arbitrarily primed)-PCR, microarray analysis (mRNA expression profiling), mutagenesis, SNP/CNV genomic analysis, cell culture, electron/fluorescence microscopy, (live) imaging, and behavioral tests (operant conditioning, psychophysics, staircase threshold measurements).

There are no strict requirements; inclusion of the Differentiation courses Cell Biology, Molecular Biology, Neurobiology and Developmental Physiology in your training schedule is however advised for this internship.

4.29 Organismal Animal Physiology

Head: prof.dr. G. Flik

Staff: dr. P.H.M. Klaren

Contact: mw. D. Maurits, 3653242, D.Maurits@science.ru.nl

The department's research program focuses on the regulation of stress-adaptation, in particular on the role of communication between neuro-endocrine systems (hypothalamus-pituitary gland-adrenals axis, hypothalamus-pituitary gland-thyroid gland axis) and the immune system. Stress requires careful regulation of energy expenditure and therefore stress regulatory systems receive priority over systems regulating reproduction, immunity, growth and feeding: stressed animals tend to show poor growth, not to eat or reproduce, and get sick. Stressors, such as high population or stock densities (crowding) and temperature changes, affect growth negatively and result in an increased susceptibility for diseases, the latter due to suppression of the immune system. Several hormones from the pituitary, thyroid gland and adrenal (e.g. prolactin, growth hormone, ACTH, MSH, endorphines, thyroid hormones and cortisol) are involved in the adaptation to these stressors, resulting in a (partial or complete) recovery from the stressful conditions. A remarkable role is played by leptin, a hormone related to energy regulation via control over fat stores; fish can experience starvation under many natural conditions and leptin's role in energy regulation may be fundamentally different in ectotherms like fishes, compared to endothermic mammals.

The physiology of stress-adaptation is studied in fish (adults, as well as stages in early development), in particular the structure and function of systems involved in adaptation (brain, pituitary, gills, gastro-intestinal tract, adrenals, immune system, etc.) at the molecular, cellular, organ and organism level. Techniques from physiology, biochemistry and molecular-biology are employed, as are a wide range of imaging techniques: light- and electron-microscopy, confocal laser scanning microscopy and functional MRI. Immunocytochemistry and in-situ hybdridisation are important applications in our imaging program.

Within the Institute for Water and Wetland Research we collaborate with the departments of Animal Ecophysiology (stress in reef fish), Microbiology (probiotics and feeding) and Botany (vegetarian feed in fish aquaculture). Other research groups we collaborate with are the departments of Cell Biology and Immunology, and Aquaculture and Fisheries at Wageningen University, groups in Belgium (Antwerp (fMRI), Leuven) and Canada, and (in the context of EU collaborations) Norway, Portugal, Spain, France and Greece. In collaboration with IMARES (IJmuiden/Yerseke) we run a program on pain and welfare in fish.

Furthermore, a line of research on bone physiology in fish is supported by a SMARTMIX grant of the ministeries of Economics and Education; in this research zebrafish and carp are

used as model fish to study osteogenesis in dermal scales as a tool to develop medication against osteoporosis. A close collaboration with the consortium partners in Leiden, Amsterdam and Utrecht as well as with the department of Dentistry at the RU is ongoing.

Beyond studies at the RU, master's students are welcome to spend some time abroad; in those cases part of the internship is fulfilled in Nijmegen in preparation for the stay abroad.

4.30 Plant Cell Biology

Head of the department: Prof. dr. C. Mariani

Staff: Dr. I. Rieu
Secretariat: Else Schaberg, HG 2.309, 024-3652777, e.schaberg@science.ru.nl
Website: http://www.ru.nl/pcb/

At the department of Plant Cell Biology (PCB) we aim to understand how plants adapt to stress. Plants continuously have to cope with stress, e.g. as caused by changing or unfavourable environmental conditions, by resource deficiencies or by biotic agents such as pathogens or herbivores. In our research we try to discover the genetic, molecular and physiological processes that underlie the adaptation to various stresses and thus confer tolerance. We closely collaborate with other members of the Institute of Water and Wetland Research at the RU, research groups from the national graduate school Experimental Plant Sciences, a number of foreign research groups and several plant biotech companies. You can find a detailed description of our research projects under Research. Furthermore we are involved in teaching at the BSc, MSc and PhD level, as you may read under Courses and Student Projects.

Research themes:

Heat stress adaptation
Exposure of plants to high temperatures imposes constrains on growth and can markedly affect development and reproductive success. Major physiological effects are male sterility and abnormalities in fruit development. This is a considerable problem in fruit production in many parts of the world: E.g. tomato plants grown around the Mediterranean frequently suffer from high temperature stress, resulting in reduced fruit set and suboptimal fruit quality. In this research line we aim to discover how plants adapt to high temperatures and what determines the level of heat stress tolerance, looking at genetic determinants and epigenetic and transcriptomic responses.

Hypoxia signalling
Oxygen is a necessity for most forms of life. To be able to avoid the potentially life-threatening situation that arises upon reduced oxygen levels (hypoxia) most organisms have systems in place to measure intra-cellular oxygen availability. Although plants frequently encounter hypoxic conditions, so far there is very limited knowledge on the primary hypoxia signalling pathway in these organisms. In this line of research we aim to unravel how plants

sense the oxygen availability and modify gene expression in response by using state-of-the-art methods available for the model plant Arabidopsis thaliana.

Water stress tolerance in Solanum dulcamara
Solanum dulcamara (Bittersweet) has an exceptionally wide habitat range with regard to water availability, thriving both in the dry sand dunes along the coast and in wet areas, such as river flood plains. In the B'sweet initiative, a collaboration between several research groups of the IWWR, we study this phenomenon from the molecular up to the ecological level. In particular, our group is interested in deciphering the signalling pathway by which flooding induces adventitious root outgrowth, focusing on the role of hormones and early responsive genes.

Pathogen resistance genes in Solanum
Species of the genus Solanum comprise wild plants but also many cultivated species such as tomato and potato. Wild Solanum species frequently show resistances to biotic and a-biotic stress factors that can be useful for crop improvement. For example, Solanum dulcamara (Bittersweet) shows clear resistance to Phytophthora infestans, the cause of late blight disease. We have previously made an extensive collection of various bittersweet ecotypes and we are using them to identify and clone new resistance genes (R-genes) against this pathogen. Similarly, an extensive collection of other Solanum species from Indonesia is used to map the R-gene against the bacterium Ralstonia solanacearum, the cause of brown rot in potato.

Information for students

Student projects (internships) are available for Biology, Molecular Life Science and Natural Science students in all of our research projects. This means students can get acquainted with a range of scientific approaches, including genetics, molecular biology, cell biology, plant physiology and bioinformatics. If you are interested, please feel free to visit our department and talk to the researchers. An appointment can be made with Dr. Ivo Rieu (i.rieu@science.ru.nl or +31 (0)24 3652777/61). We can also accommodate students from the HLO and students from abroad.

4.31 Cell & Applied Biology

Head: prof.dr. E.J.J. van Zoelen (contact person)
Staff: Dr. A.P.R Theuvenet, Dr. J.E.M. van Leeuwen, Prof.dr. W. Olijve, Dr. K.J. Dechering

Secretary: mw. J. Rullmann-Freriks, HG02.204, 3652701, j.rullmann-freriks@science.ru.nl

Website: http://www.celbi.science.ru.nl/ (also for more information on traineeships)

Research in the department focusses on the role of polypeptide growth factors in the control of proliferation and differentiation of normal cells, stem cells and tumor cells. Use is made particularly of cells grown in tissue culture, using a combination of cell biological, molecular

biological, biochemical, biophysical and bioinformatical approaches. There are three lines of research in the department:

1. **Lineage-specific differentiation of human mesenchymal stem cells (MSCs):** MSCs from bone marrow are able to differentiate in vitro into bone, cartilage or adipose (fat) cells. Using genome-wide expression analysis by microarray techniques we are studying the gene expression profiles of MSCs during growth factor-induced lineage-specific differentiation. The role of regulatory genes (generally nuclear transcription factors) is being studied by lentiviral overexpression and shRNA-mediated repression. These studies are important for regenerative medicine in patients with osteoporosis or arthritis.
2. **Intracellular targeting of ErbB receptors**: After ligand binding ErbB receptors are internalized and degraded in lysosomes. Impairment of this process can result in enhanced mitogenic activity and cancer. In our studies, emphasis is placed on the role of E3 ligases and deubiquitinating enzymes, which control the ubiquitination and intracellular sorting of the internalized ErbB receptors.
3. **Allele-specific PDGFRA expression in human glioma cells**: PDGFRA plays an important role in neural development. We have detected multiple polymorphisms in the PDGFRA promoter region, based on which strong (H2a) and weak (H1) haplotypes can be identified. We have shown that the H1 allele predisposes to neural tube defects but protects against glioma brain tumors. Current studies focus on the haplotype-specific expression regulation of PDGFRA in cultured glioma stem cells.

Recommended for traineeships: 2nd year course Animal Cell Biology and 3rd year course Medical Biotechnology

5 Organisation

5.1 Coordination, Information and Advice

General

Coordination of the Master Natural Science

Natural Science is one of three Masters offered by the Institute for Molecular Sciences. Director of the Institute is prof. dr. F.P.J.T. Rutjes.
The master Natural Science is coordinated by **Prof. dr. A.J. van Opstal**. He is chairman of the Steering board of the programme and responsible for the educational policy. Daily coordination is performed by **Dr. L.J.J. Laarhoven**. He is the main source of information for students, mediates in contacts with lecturers, and informs students about courses, schedules, planning, etc.

Coordinator:	Prof. dr. A.J. van Opstal (John)
room:	Medical and Biophysics, Geert Grooteplein-Noord 21, k 1.08
tel::	(024) 36 14251
e-mail:	J.vanopstal@science.ru.nl

Coordinator:	Dr. L.J.J. Laarhoven (Luc-Jan)
room:	HG01.061
tel:	(024) 36 53434
e-mail:	L.Laarhoven@science.ru.nl

Secretariat Molecular Sciences: Ms. Ine Meijer and ms Ingrid Nijland
room: HG01.060
tel: (024) 36 53429
e-mail: secromw@science.ru.nl
e-mail: i.nijland@science.ru.nl

Information about schedules etc. can also be obtained from:
Ms. Wilma Philipse
room: HG01.059
tel: (024) 36 53173
e-mail: W.Philipse@science.ru.nl

Announcements
Announcements about courses, changes in schedules, etc., etc. are made mainly by email.
It is important to check your email on a regular basis.

Also **Blackboard** will play an important role in spreading information about courses by the teachers themselves. Make sure to be enrolled in courses (via KISS). (See next section).

Student advisor
Dr. Laarhoven functions as a student advisor. He keeps an eye on results and can offer advice about courses and tracks and whenever problems arise.
The members of the Steering Board offer discipline-related advice. Do not hesitate to contact them:

Dr. A.J. van Opstal	tel. (024) 36 14251	Medische en Biofysica, Geert Grooteplein-Noord 21, k 1.08	(physics)
Dr. W.J.J.M. Scheenen	tel. (024) 36 52036	HG 02.010	(biology)
Prof.dr. S.S. Wijmenga	tel. (024) 36 53384	HG 03.345	(chemistry)

Lecture and examination schedules
Schedules with chemistry, physics or biology courses are available before the start of each semester and can be found online at www.ru.nl/rooster. There is no separate schedule for Master students natural science.
Some Masters courses are scheduled on-demand (contact the teacher, or the secretariats of Biology, Physics or Chemistry). Electives from bachelor curricula can be found in the appropriate schedules and on KISS.
You can again contact the various secretariats, or ask for advise with the study coordinator.

Tentamens (written examinations) can be found in KISS. You need to register in KISS. For some Master's courses also oral examinations may be scheduled. For these you have to contact the teacher and register a 'testimonium' at the students administration.

You have to register for tentamens at least 7 days before the tentamen. See the appropriate section elsewhere in this prospectus.

Examination board
All Master's programmes must be approved by the examination board. Also requests for extra resits for an exam (4th try) must be directed to the examination board.

Students administration/examenbureau B-faculteiten (FSA)
The students administration can be found in room
HG00.134 ; tel. 36 53392 / 36 52247
Opening hours: Monday to Thursday 13.00 - 16.00 h, Friday 9.00 - 12.00 h

Committees and Board

Examination Board
Decides on admission, approval of exams, extra resits, extraordinary study-tracks, etc. Requests must be directed in writing to the chairman (possible via the secretary).

Chairman:	Secretary:
Dr. G.W. Vuister	Dr. L.J.J. Laarhoven
Room NCMLS 0.25	Room HG 01.061

email: G.Vuister@nmr.ru.nl email: L.Laarhoven@science.ru.nl
Composition on July 1, 2008:

Dr. G.W. Vuister (Chairman)
Dr. L.J.J. Laarhoven (Secretary)
Dr. P.C.M. Christianen
Prof.dr. C.C.A.M. Gielen
Drs. W.J.J. Gielen
Dr. J.T.M. Keltjens
Dr. C. Logie

Programme Committee
Eight members (4 teachers and 4 students) monitor the curriculum and the quality of teaching, approves the examination regulation and advises the Programme Coordinator. In the Natural Science Programme Committee at least one teacher from each of the disciplines is present.

Composition on 1 September 2007:

Dr. H.L.M. Meekes (chairman)
Dr. L.J.J. Laarhoven (Secretary)
Dr. J.L. Peters (Biology)
Prof. Dr. H.J. Kappen (Physics)
Prof. dr. A.E. Rowan (Chemistry)
R. van Bruggen (student, 4th year)
J. Deurloo (student, 3rd year)
O. Rusche (student, 3rd year)
C. Dammeier (student, 2nd year)

Email: olc-nw@student.science.ru.nl.

Steering Board
Because of the broadness of the Natural Science programme a steering board assists the programme coordinator.
Its members represent the three disciplines:

Prof. dr. A.J. van Opstal (Physics - programme coordinator and chairman)
Prof. dr. S. Wijmenga (Chemistry)
Dr. W.J.J.M. Scheenen (Biology)
Dr. L.J.J. Laarhoven - Secretary

Board of the Educational Institute Molecular Sciences

Director:
prof.dr. F. Rutjes (Floris)
tel.: 3653202
e-mail: f.rutjes@science.ru.nl

Room HG 03.024

Board:
Dr. R de Gelder (Programme Coordinator Chemistry)
Prof. dr. G. Martens (Programme Coordinator Moleculaire Levenswetenschappen)
Prof. dr. A.J. van Opstal (Programme Coordinator Natuurwetenschappen)
Secretary: Dr. L.J.J. Laarhoven

Advisory Board/Cluster Committee

The advisory board meets four times per year and consists of the programme coordinators, the student coordinators, three lectureres and three students.
secretary: dr. L. Laarhoven (Luc-Jan), e-mail: l.laarhoven@science.ru.nl

Coordinator international affairs for Molecular Sciences
dr. L. Laarhoven (Luc-Jan)
room HG01.061
tel.: 3653434
e-mail: l.laarhoven@science.ru.nl

Advisory board for the institute
dr.mr. J.H.A.A. Uitzetter (Senior legal advisor, Ministry of Economic Affairs, Directorate-general for Entrepreneurship and Innovation)
prof. dr. Pedro Hermkens (MSD, Medicinal Chemistry, Oss; also professor of Industrial Pharmaceutical Chemistry, Radboud University)
prof.dr. Edwin Cuppen (professor of human genetics and genome biology, Netherlands Institute for Developmental Biology, Hubrecht Laboratory, Utrecht)
dr. Wim-Jan Koot (Business Development, UMC, St. Radboud, Nijmegen
dr. Johan van de Ven (Consultant)

Blackboard

Radboud University embraces the computer programme 'Blackboard', which creates a digital study and communication environment between teacher and student.
Every course has a spot on Blackboard where the teacher can place assignments, announcements, or extra information. More and more lecturer use Blackboard, so this will become an important medium.

Students have to enrol the courses they wish to attend or follow via KISS. At the start of each course, the lecturer will 'open' his or her blackboard-site and all students who enrolled via KISS automatically have access to this site.

Enroling courses in KISS should be possible at all times, even when the course has already started.
However, enrolling into a course needs to be done 4 weeks in advance via KISS.

Facilities

Libraries

The Faculty Library can easily be found in the new Huygens building. It houses the main part of the science collection and offers room for students to quietly study.

Every student also has access to the **University Library**, Erasmuslaan 36. Your university Collegekaart allows you to borrow books. Most of these are stored in a back-office. For details and opening hours, see the Vademecum.

Computerfacilities

Every student receives a personal login an email address. These can be used to work on the computers at the Faculty and are needed to register for examinations. The Huygens building houses a number of terminal-rooms that can be used by students, but may also be reserved for teaching. The builiding is equipped with a wireless network for laptops.

Selfstudy

In the Faculty library ample space for individual stuyding is available.

Studymaterial

Most books can be purchased via the students-association Leonardo. Readers are sold by the lecturer or the secretariat, or at the Campusshop in Thomas van Acquinostraat.

Copying

To use the copymachines in the building a copycard is required. This can be purchased at the Library.

Service for students affairs

Is located at Comeniuslaan 4-6 and offers a number of services. For details and opening hours, please see the Vademecum or www.ru.nl/studenten:

Balie Studentenzaken and Central Students Administration

Registring as a student, study-information, student-counsellors, psychologists, courses in student management.
These services can be very helpfull.

Comeniuslaan 4 and 6, Nijmegen
tel: (024)-3612345
email: balie@dsz.ru.nl (to make an appointment)

Studie Loopbaan Advies Groep

Offers an Infotheek that can be helfull with

- choice of study or profession
- training in jobapplication
- studying abroad

Faculty Students Administration
All results and administrative data are kept at the Faculty. Registring for interim exams and, e.g., change of address should be done electronically via KISS.
Applying for exams (propedeuse, Bachelor, Master) must be done in person, with your students card (Collegekaart) and, if applicable, foreign diploma's, at the Faculty Students Administration.
Dates and deadlines of the exams can be found in this prospectus.

Studentenadministratie/examenbureau B-faculteiten (FSA)
Huygensgebouw room HG 00.134
tel. 3653392 / 3652247

Hours:
Mo - Thur 13.00 - 16.00 h
Friday 9.00 - 12.00 h

Leonardo da Vinci
Students club Leonardo da Vinci offers seminars, books and social events to Natural science students.
The bar is located in the 'south cantina'.
Leonardo@science.ru.nl - www.ru.nl/leonardo

Information Channels at this university:

- Website R.U. Nijmegen: www.ru.nl
- Infotheek Dienst Studentenzaken
- email and blackboard
- VOX Magazine Radboud Universiteit Nijmegen

Preparing to find a job

Every year the 'BBB' organizes a job-market where companies present themselves to students.
See http://www.bbb.science.ru.nl.
In connection to this day there are also possibilities to to have an appointment with recruiters and to participate in several workshops.
Stichting BBB-CarrièreBeurs, PO-box 9010, 6500 GL Nijmegen; tel. (024) 3652388, e-mail: bbb@science.ru.nl

The central students facility at Comeniuslaan 4-6 offers courses in presentation and has facilities for job-orientation.

5.2 Final Qualifications Master Natural Science

The degree courses in Natural Science (Bachelor's and Master's) aim to educate and train

students in the Natural Sciences, *i.e.* Chemistry, Physics and Biology, and the links between these disciplines, so that they are able to:
1) Work in interdisciplinary fundamental or applied research within the physical-chemical, chemical-biological or biological-physical fields
2) Work as "academic professionals" within management, communication or education.

Students should attain equal levels of knowledge, skills and academic attitude as their mono-disciplinary peers.
The objectives and final qualifications of the Natural Science program were set up by scientists involved in international, multi-disciplinary research in Physics, Chemistry and Biology, and correspond to the requirements made by scientists in mono-disciplinary and multi-disciplinary research.

Competences of the Master's Program
Master's graduates are expected to have the following supplemental skills to complement their Bachelor's competences:

1. specialized insight in at least one interdisciplinary field of natural sciences (i.e. one of the related fields, chemistry/biology, biology/natural sciences and natural sciences/chemistry)
2. sufficient knowledge in this specialized field to carry out scientific research under supervision
3. the ability to read scientific articles about their chosen specializations comprehensively, to master newly acquired knowledge within those fields of specialization and to integrate it into existing knowledge
4. the ability to formulate new definitions of questions and hypotheses within their chosen specializations and to select the correct paths and research methods for resolving these questions
5. the ability to follow general scientific developments within the chosen interface of natural sciences
6. the ability to adapt at a specialist level of another sub-specialization within the chosen interface of natural sciences
7. the ability, under supervision, to set up experimental or theoretical research, to treat systematically and critically interpret the research results and to formulate conclusions
8. the ability to present research results, both orally with clear delivery and, in written form, in a scientific article for professional colleagues and for a non-specific, expert audience
9. the ability to communicate about scientific knowledge at specialist level with professional colleagues working in the same discipline
10. sufficient knowledge of and insight in the societal significance of the natural sciences to be able to reflect on social problems based on the knowledge gained from the natural sciences

Graduate Master's students who have taken the **Research variant**, as a supplement to competences 1 to 10, are expected:

11. to have sufficient knowledge and skills to be able to conduct scientific research independently within at least one inter-disciplinary field of natural sciences
12.to be capable of critically analyzing the results obtained from research and, on this basis, explore new avenues of research.

Graduate Master's students who have taken the **Communication variant**, as a supplement to competences 1 to 10, are expected:

11. to have knowledge and skills derived from communication studies
12. to be capable of designing, conducting, delegating and supervising communication research, independently and methodically
13. to contribute to the analysis and approach to problems that occur in the interaction between science, technology and society
14. to have an overview of the interaction and communication processes that occur in social discourse
15. to be able to work effectively in a policy team with a broad composition (interaction between science, technology and society) and be open for other types of knowledge (intuitive and practical experience).

Graduate Master's students who have taken the **Education variant**, as a supplement to competences 1 to 10, are expected to be able to fulfill the following six instructor roles:

11. the classroom instructor
12. the expert
13. the educationalist
14. the reflective professional
15. the instructor outside the classroom
16. the developer and researcher.

Graduate Master's students who have taken the **Business and Management variant**, as a supplement to competences 1 to 10, are expected:

11. to be familiar with the language of management, in addition to the language of their own natural-science specialization
12.to be capable of conducting research independently with regard to problems that occur at the interface of technology, organization and society
13. to be capable of contributing to the solution of management problems
14. to be capable of effectively cooperating and communicating in a multidisciplinary team.

5.3 Regulation of interim exams

Participation in interim exams (tentamens) is strictly regulated through the 'tentamenregeling' which can be found in the Education and Examination Regulation, OER.

Students are allowed three opportunities to pass an interim exam and are required to register for each tentamen (or other part of the final exam, such as practica). This is possible up to 7 days before the tentamen using KISS.
Unregistring is likewise possible through KISS up to 7 days before the test. After that it has to be done in writing (email) with the responsible teacher.

Registered students that do not show at the tentamen, lose one opportunity.

After two opportunities have been unsuccesfull, the student has to ask the examination board for additional tasks in order to be allowed a third try. Usually this will be a requirement to follow lectures again or to hand in additional excercises.

5.4 Exams

Regulations for exams

All regulations for exams and the study programme are laid down in the 'Onderwijs en Examenregeling Master' (OER). This is available on the site of Natural Science and the faculty website:
www.ru.nl/natuurwetenschappen, www.ru.nl/fnwi.

The OER states for instance the exact educational programme for each cohort of students, regulations for tentamens and practica, and language criteria. Other exam-regulations, such as compensation and judicia are specified by the examination board and can be found elsewhere in this prospectus.

Appeal

If you disagree with the grade of an exam, or find yourself dishonestly treated, it is best to first contact the lecturer and/or the student advisor and see if things can be worked out. Also the examination board can be asked to rule or advise.
Ultimately, if matters cannot be agreed upon, it is possible to ask for a ruling of the Board of Appeal.

Such an appeal must be directed in writing to the Board, within four weeks after the disputed decision was made. The student deans (Decanen) at Comeniuslaan can assist in such a procedure.

College van Beroep voor de Examens
Comeniuslaan 4
Postbus 9102
6500 HC Nijmegen
tel. (024) 3612270

See also www.ru.nl/studenten/

Masters Exam

The Exam comprises a number of interim exams (tentamen, practica, internship) with a total of at least 120 ec.
The composition of the exam requires approval of the examination board. Make sure you get this well in advance.
The exam is passed if all components were graded 6 or higher

Dates for Bachelor/Master/Doctoral Exams in 2010-2011

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

It is possible to register for an exam if all results of interim exams are registered.
After passing the exam you will receive a notification with which you can apply for your diploma at the central students administration (Comeniuslaan 4).
Every month diploma'a are presented in a ceremony.

Exception for August 31:
For the August 31 exam it is possible to register without all results being registered in KISS. This has to done before May 31st. The last results need to be registered by August 31.

To register for an exam you need to present:

- a valid Students card (collegekaart), both parts
- the approval of the examination board for your study programme
- A valid passport or ID-card. Drivers license is not sufficient
- students with a propedeuse/bachelor not from Radboud University: Your last diploma

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

When the exam is passed and approved by the examination board the Diploma will be made at the central administration (Comeniuslaan)
The graduation ceremony takes the following format:

1. The chaiman of the examination board introduces the ceremony
2. Each candidate gives a short presentation of his/her graduation work and receives the Diploma from his/her graduation professor
3. The ceremony is celebrated over drinks at the Faculty or at the Aula

If necessary it is possible to receive your diploma earlier than the official cermonies. Please contact the students coordinator in that case.

5.5 Regulation for internships

Learning outcomes:
After completing an internship a student should be able to:

- locate and use relevant literature to solve a scientific problem
- be acquainted with multidisciplinary scientific research
- be able to set up a scientific experiment
- obtain, interpret and use the results of such an experiment
- communicate about his/her research written and in a presentation
- participate in a topical scientific discussion

In order to achieve these goals, the following aspects should be taken care of:

1. **Knowledge:** Before starting an internship the research practica (doctoral student), or bachelorstage (master student) should be fulfilled. If a subject is chosen that is outside the scope of the students bachelor specialisation, certain courses may be required by the research department chosen for the internship.
2. **Approval:** Each research internship should be approved for multidisciplinarity by two members of the Steering Board of Natural Science. For this, an **internship-form** must be filled out by the student together with, and signed by the aspired supervisor. The form should state the content and goal of the internship, the daily supervisor, the intended duration and, if needed, the required specialisation courses. **It must clearly describe the multidisciplinary aspects of the internship.**
3. **External:** External internships are supervised by a professor at one of the research departments of the faculty of science.
4. **Guidance:** each internship is performed under responsibility of a member of the scientic staff of the faculty of science. Daily guidance can be given by a knowledgable researcher at the department. These should be stated on the form mentioned above.
5. **Report:** An internship is always concluded by a written report and usually by an oral presentation. A (digital) copy of the report should be handed to the study-coordinator of Natural Science. This is for external reviewing purposes by the educational inspection.
6. **Conflicts:** In case a conflict arises between student and research supervisor the members of the stuurgroep (see colofon) can mediate. Ultimately any decision can be formally put before the 'college van decanen'. For this see the vademecum.

Two internships
A Master in Natural Science should be at home in two disciplines. Therefore it is required to perform two internships in two different research groups of different disciplines. That is the only way to become truly acquainted with the concepts and methodology of both fields of science.
It can be possible to do a combined intership at two departments that cooperate on an interdisciplinary subject. Further information on possibilities and requirements are available from the study-coordinator.

Requirements:
Different research groups, different disciplines work in different ways and may have different approaches toward internships. In any internship practical work, a written report and a

presentation are required. As a theoretical part some groups offer the possibility to write a literature thesis, other groups have caput courses and monthly tests or require external courses to be followed.

The requirements for an internship should be agreed upon before starting and be written down on the internship-agreement that is available via www.ru.nl/natuurwetenschappen.

Research reports and theses:
The student needs to produce a number of copies of research reports and theses.
The secretariat of Natural Science requires one (digital) copy for the examination board.

Marks:
The supervisor and, if applicable, the leader of the research department will mark the internship and the report. In a mutual desicion with the student the duration of the internship and amount of ec's is agreed upon.
In cases of disagreement the study coordinator, or the students-advisor may mediate.
Ultimately there is the appeal procedure described in the vademecum and elsewhere in the study guide.

5.6 Academic Calendar

From August 30, 2010, until August 31, 2011

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

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

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

6 Examination regulations

6.1 Examination regulation Master of Natural Science(OER)

The Examination Regulation (OER) of the Masters programme in Natural Sciences will be available on the Faculty of Science website.

6.2 Regels en richtlijnen van de examencommissie

Regels en richtlijnen van de examencommissie Natuurwetenschappen
Artikel 1 - toepassingsgebied
Deze regels en richtlijnen zijn van toepassing op de tentamens en examens in de bachelor en master opleiding natuurwetenschappen 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 docenten betrokken bij het onderwijs van de opleiding Natuurwetenschappen. Zij worden benoemd door het faculteitsbestuur NWI. Zorg wordt gedragen voor een evenwichtige verdeling van docenten over de disciplines die betrokken zijn bij de opleiding.

Artikel 4 - dagelijkse gang van zaken examencommissie
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 - aanmelding tentamen
1. Conform de facultaire richtlijn mogen studenten maximaal 3 keer aan een tentamen deelnemen. Een volgende deelname kan slechts plaatsvinden na toestemming van de examencommissie.
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.

3. Deelneming aan een schriftelijk tentamen kan pas plaatsvinden na deugdelijke en tijdige aanmelding bij de facultaire studentenadministratie.

Artikel 6 - cijfers
De cijfers die voor de beoordeling van de tentamens gebruikt mogen worden zijn uitsluitend: 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;
of indien geen cijfer wordt gegeven: Voldaan. Cijfers 6,0 of hoger zijn 'voldoende'.

Artikel 7 - 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 de hoogst behaalde beoordeling in beschouwing.
4. Men is dan en alleen dan geslaagd voor het propedeutisch examen natuurwetenschappen indien:

a. alle onderdelen van het examen met een voldoende (minimaal cijfer 6,0) zijn beoordeeld of
b. alle onderdelen op één na voldoende. Die ene onvoldoende is een 5,0, en wordt gecompenseerd met minimaal een 7,0 voor een van de andere onderdelen.

5. Men is dan en alleen dan geslaagd voor het bachelor examen natuurwetenschappen indien de propedeuse natuurwetenschappen is behaald en alle onderdelen van de post-propedeuse met een voldoende (minimaal cijfer 6,0) zijn beoordeeld;

6. Men is dan en alleen dan geslaagd voor het master examen natuurwetenschappen als alle onderdelen van het master-examen met een voldoende (minimaal cijfer 6,0) zijn beoordeeld.
7. In bijzondere gevallen kan de examencommissie afwijken van het hiervoor bepaalde.

Artikel 8 - judiciumregeling
Aan de examens kan door de examencommissie een judicium worden toegekend.
Daarbij worden in aanmerking genomen respectievelijk de onderdelen van de propedeuse, van de postpropedeuse (bachelorjaar 2 en 3) en van het masterprogramma.

Voor het propedeutisch examen en het bachelor-examen luidt het judicium:

- bij een gemiddelde van 7,5 tot 8,0: bene meritum;
- bij een gemiddelde gelijk of hoger dan 8,0: 'cum laude'.
- Wanneer in de lijst een 5 staat, wordt het judicium 1 graad verlaagd.

Voor het master-examen luidt het judicium:

- bij een gemiddelde van 7,5 tot 8,0: 'bene meritum';
- bij een gemiddelde gelijk of hoger dan 8,0, waarbij het gemiddelde van de uitgevoerde stages tenminste 8,5 is: 'cum laude'.
- Wanneer in de lijst een 5 staat, wordt het judicium 1 graad verlaagd.

Artikel 9 - toelating tot afleggen van tentamens van het bachelor examen natuurwetenschappen
1. De toelating tot het afleggen van post-propedeuse tentamens van het bachelorexamen natuurwetenschappen wordt een student verleend

a. indien het propedeutisch examen natuurwetenschappen met goed gevolg is afgelegd;
b. danwel vrijstelling is verkregen van het afleggen van het propedeutisch examen natuurwetenachappen;
c. danwel tenminste 45 ec van de propedeuse voldoende (cijfer 6,0 of hoger) is afgelegd. De bachelorstage kan niet worden begonnen voordat de propedeuse en tenminste 60 ec van de postpropedeutische onderdelen zijn behaald.

2. In alle overige gevallen wordt de student geen toelating tot het afleggen van onderdelen van het bachelorexamen natuurwetenschappen verleend.
3. In bijzondere gevallen kan de examencommissie afwijken van het bepaalde in het voorgaande lid.

Artikel 10 - vrijstellingsverzoek
1. Een verzoek om vrijstelling van een tentamen of examen wordt schriftelijk en 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 - overige verzoeken
Verzoeken tot goedkeuring van een studieprogramma of opname van een enkel vak daarin, alsmede verzoeken om na drie pogingen deel te nemen aan een tentamen, worden schriftelijk aan de examencommissie gericht.
De examencommissie neemt indien mogelijk eens per maand beslissingen over de liggende verzoeken. De beslissingen worden per omgaande meegedeeld aan de indiener.
Studenten krijgen in de regel na drie pogingen nog één extra tentamenkans. In overleg met de docent kunnen daarbij nadere eisen worden gesteld.

Artikel 12 - orde tijdens een tentamen
1. De examinator van een examenonderdeel zorgt dat t.b.v. de schriftelijke examinering surveillanten worden aangewezen die erop toezien dat het tentamen in goede orde verloopt.
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.

Artikel 13 - 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 danwel redelijk vermoeden 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 14 - 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 15 - onvoorzien

In gevallen waarin deze 'regels en richtlijnen van de examencommissie natuurwetenschappen' niet voorzien danwel twijfel bestaat over de interpretatie ervan, beslist de examencommissie natuurwetenschappen.

Artikel 16 - inwerkingtreding

Deze regels en richtlijnen treden in werking op 31 augustus 2009

List of courses