MASTER TRACK
NEUROSCIENCE

FACULTY OF SCIENCE (FNWI)

RADBOUD UNIVERSITY NIJMEGEN
CONTENTS

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1. The Donders Institute for Brain, Cognition, and Behaviour

The Donders Institute for Brain, Cognition and Behaviour is the largest interfacultary research institute at the Radboud University, with over 200 fte research staff. Founded on September 1, 2008, it brought together, under one organisational umbrella, all Neuroscience research at the RUN. For more detailed information about the Donders Institute, its latest activities, and its four major research themes, please see http://www.ru.nl/donders

The Donders Institute operates at the forefront of Neuroscience research with worldwide-acknowledged experts in the fields of Cognitive Neuroscience and Neuroimaging, Systems Neuroscience, Translational and Clinical Neuroscience, Neurophysiology, and Computational Neuroscience.

Neuroscience is a prime example of an interdisciplinatory research field, in which scientists from backgrounds as diverse as biology, physics, mathematics, chemistry, computer science and informatics, psychology and the clinical sciences (neurology, psychiatry) all work together to unravel the mysteries of the brain in health and disease.

![Diagram of the Donders Institute with its three centres: DCN, DCCN, and DCC. The Max Planck Institute (psycholinguistics) and the Centre for Language Studies are affiliated institutes.]

Research at the DI is performed at three research centres on the University Campus. It includes three faculties (Science, Medicine, and the Humanities) and the Donders Neuroimaging facility. Research at the DI is organised along four major themes:

1. Language and Communication
2. Perception, Action, and Control
3. Plasticity and Memory
4. Brain Networks and Neuronal Communication
2. **Master Track Neuroscience at FNWI**

The scheme in Figure 2 illustrates the top-down and bottom-up relations of the Neuroscience master track at FNWI with the Donders Institute, and with the different Education Institutes (WiNST, Informatics, Medical Biology, Molecular Life Sciences, and Chemistry).

The Donders Centre for Neuroscience (DCN) consists of four research departments at FNWI (see section 8), which together will offer a multitude of Neuroscience specialisations, ranging from theoretical, computational neuroscience, and neurophysics, on one end of the spectrum, to neurophysiology, molecular neuroscience, and translational neuroscience on the other end. Each specialisation contains a series of courses that will appeal to students from a wide range of different backgrounds in the natural sciences. Top researchers at the four participating departments contribute advanced courses to each specialisation.

As tentative examples, described in more detail in sections 4 and 5, two such specialisations are highlighted here: Neurophysics and Neurobiology.

<table>
<thead>
<tr>
<th>Neurophysicists</th>
<th>Study the neurophysical mechanisms of the brain, and focus on topics from biophysics, computational neuroscience, psychophysics, theoretical neuroscience, machine learning, artificial intelligence, and robotics. It is primarily directed at students with a bachelor in physics, mathematics, informatics, or science (biophysics).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neurobiologists</td>
<td>Investigate the neurobiological mechanisms of the brain at molecular, biochemical, cellular, physiological and network levels. The programme will appeal to students with a bachelor in medical biology, molecular life sciences, science (biochemistry and physical chemistry), and chemistry.</td>
</tr>
</tbody>
</table>
3. Obligatory courses Track Neuroscience

The departments of the DCN institute at FNWI offer a single Master Track Neuroscience for all students from the majority of science-related disciplines (see figure 2). Within the master track Neuroscience, students can tailor their individual preferences (theoretical, experimental, molecular, clinical, etc.) to a high degree, by selecting from a wide variety of courses. However, all students embarking on the Neuroscience track share a 15 ec common programme (in the first year of their master curriculum) that consists of the following courses:

Obligatory courses for all Neuroscience master track students (see Section 8)

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behavioural and Systems Neuroscience</td>
<td>6 ec, Q1</td>
</tr>
<tr>
<td>Methods in Neuroscience</td>
<td>3 ec, Q2</td>
</tr>
<tr>
<td>Systematic Neuroscience Reviews</td>
<td>6 ec, Q3+Q4</td>
</tr>
</tbody>
</table>

Students have considerable freedom in defining the contents of their Neuroscience Track through a dedicated selection of neuroscience courses. Sections 4 and 5 describe two possible examples of such tracks that correspond to two major Neuroscience subfields at the DCN institute: Neurophysics (primarily implemented by the Biophysics and Neuroinformatics depts) and Neurobiology (primarily corresponding to the Neurophysiology and Molecular Animal Physiology depts).

Diploma. Students who follow the Neuroscience Master Track will ultimately obtain their master’s degree in Physics, Mathematics, Informatics, Medical Biology, Science, Molecular Life Science, or Chemistry (see Figure 2).

It should be noted that each educational institute has set additional requirements in terms of their discipline-specific obligatory courses.

For example, to obtain the master’s degree in Physics, students (regardless their selected track) should also pass the following courses (7 ec):

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrodynamics 1</td>
<td>3 ec</td>
</tr>
<tr>
<td>Professional preparation</td>
<td>1 ec †</td>
</tr>
<tr>
<td>Philosophy</td>
<td>3 ec</td>
</tr>
</tbody>
</table>

To obtain the master’s degree in Medical Biology, students are required to take the following courses (9 ec):

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trends in Medical Biosciences 1</td>
<td>3 ec</td>
</tr>
<tr>
<td>Trends in Medical Biosciences 2</td>
<td>3 ec</td>
</tr>
<tr>
<td>Molecular and Cellular Neurobiology</td>
<td>3 ec</td>
</tr>
</tbody>
</table>

As described in section 6, it is in principle possible for the best and highly motivated students to also enroll in the CNS research master, and obtain their second degree in Cognitive Neuroscience (double master) through an extended curriculum of 180 ec.

† The Professional Preparation course for physicists combines with the Neurophysics Seminars (see Section 4) to a full 3 ec course (total of 24 ec obligatory courses).
4. **Neurophysics**

Bachelor students from the following science disciplines (obtained at the RU, or elsewhere) may enroll in the Neurophysics specialisation:

- Physics
- Mathematics
- Science (biophysics)
- Informatics

Students should preferably have passed Neuroscience-related courses in their bachelor programme, e.g. through the Neuroscience Minor at WiNST (boldface: highly recommended courses) (see the Bachelor study guides Physics, Mathematics and Science, for more information):

**Inleiding Neuroscience (3 ec, propedeuse)**

**Neurofysica 1** (3 ec, 2nd year, Q3),
**Neurofysica 2** (3 ec, 2nd year, Q4),
**Psychofysica 1** (3 ec, 2nd year, Q3),

**Inleiding Machine Learning** (3 ec, 3rd year, Q1),
**Applied Nonlinear Dynamics and Chaos** (3 ec, 3rd year, Q4),

Students who wish to enrol in the Neurophysics specialisation, but have not completed the three recommended bachelor courses, or equivalent courses, can incorporate up to two of the missing courses in the first year of their free elective programme of 18 ects. As these courses are programmed in the second semester students will have to acquire these courses through self-study, for which a weekly feedback and response hour with the responsible lecturer can be organized.

**Entry level to the neurophysics specialisation: Neurophysics 1 and 2**

Text book by Thomas P. Trappenberg
“Fundamentals of Computational Neuroscience”
2nd Ed. 2010

Recommended general neurobiological background:
Text book by Dale Purves et al.
“Neuroscience” (5th edition, 2012)

**A. Obligatory Courses (total 42 ects)** (including the 15 ec obligatory Neuroscience Track courses + 7 ec physics-specific courses; see Section 3)

**A1. For all neurophysics students:**
Computational Neuroscience (6 ec, Q1-2)
Neurophysics Seminar (2 ec, Q1-4)\(^1\)

**A2.1 For computational/theoretical neurophysics students**
Machine Learning (6 ec, Q1-2)
Quantitative Brain Networks (6 ec, Q3-4)

**A2.2 For experimental neurophysics students**
Psychophysics 2 (6 ec, Q3-4)
Quantitative Brain Networks (6 ec, Q3-4)
B. Free elective courses.
Neurophysics students can further select up to 18 ec from the following courses:\(^2\)

At FNWI:

- Advanced Computational Neuroscience (3 ec, Q4)
- Advanced Quantitative Brain Networks (3 ec, Q2)
- Auditory Perception and Technology (3 ec, Q2, per 2014)
- Optimising Cognitive Functioning (3 ec, Q2, per 2014)
- Current Advances in Neuroscience Techniques (6 ec, Q3-4, per 2014)

- Spin Glasses and Neural Networks (6 ec)
- Computational Physics (6 ec, Q3-4)
- Numerical Methods (3 ec, Q3)
- Data Analysis (3 ec, Q4)

(See the study guide for more detailed information: [http://www.studiegids.science.ru.nl/2012/science/prospectus/physics_master/content/s/info/32769/](http://www.studiegids.science.ru.nl/2012/science/prospectus/physics_master/content/s/info/32769/))

Elective courses from the Research Master Cognitive Neuroscience\(^3\):

- Perception (6 ec: Visual Perception, Q2-3)
- Motor Control (6 ec, Q1-2)
- Neuroanatomy (3 ec, crashcourse 3 days Sept.)
- Cognitive Control (6 ec, Q3-4)
- Neuroimaging 1 (6 ec, Q1-2)
- Neuroimaging 2: Electrophysiology (6 ec; Q3-4)
- Neuroimaging 2: Haemodynamics (6 ec; Q3-4)

See the study guide for more detailed information: [http://www.ru.nl/master/cns/students/course_descriptions/](http://www.ru.nl/master/cns/students/course_descriptions/)

Elective courses from the Biology bachelor curriculum\(^4\):

- Neurobiology (6 ec; Q4),
- Neuroscience: van basis tot kliniek (6 ec; Q1)
- Neurobiophysics (6 ec; Q2)
- Neurophysiology of Cognition and Behaviour (6 ec, Q1)
- Neurodevelopment (6 ec; Q2)
- Cognitive Neuroimaging (6 ec; Q3)

Elective courses from the Physics bachelor Neuroscience minor (see above).

C. Master thesis project: 60 ects.\(^5\)

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\(^{2}\) This list includes the obligatory courses from A2.1 and A2.2.
Free electives (not FNWI-related) require approval from the Exam Committee.

\(^{3}\) Approval from the Course Coordinator CNS is required.

\(^{4}\) Approval from the Exam Committee is required.

\(^{5}\) Within the Master thesis, an additional industrial project (or comparable) can be included.
# Example table of Courses Track Neuroscience for Physics students

<table>
<thead>
<tr>
<th>Quarter</th>
<th>Obligatory</th>
<th>Electives PI groups</th>
<th>Free electives (selection)</th>
<th>From the Bachelor Minor</th>
</tr>
</thead>
</table>
| **Q1**  | - Electrodynamics 1 (3 ec)  
- Behavioural & Systems Neuroscience (6 ec)  
- Computational Neuroscience ()  
- Neurophysics seminar ()  
- Self study Introduction Neuroscience (2 wkn)*  
- Machine Learning ()  
- Motor Control () (cns)**  
- Neuroimaging 1 () (cns) | - Auditory Perception & Technology (3 ec)  
- Optimising Cognitive Function (3 ec; SMI*** )  
- Adv. Quant. Brain Networks (3 ec)  
- Motor Control (6 ec; cns)  
- Neuroimaging 1 (6 ec; cns)  
- Perception () cns  
- Inleiding Machine Learning (3 ec) |  |  |
| **Q2**  | - Methods in Neuroscience (3 ec)  
- Computational Neuroscience (6 ec)  
- Neurophysics seminar ()  | - Machine Learning (6 ec)  
|  |  | - Machine Learning (6 ec)  
|  |  | - Auditory Perception & Technology (3 ec)  
|  |  | - Optimising Cognitive Function (3 ec; SMI*** )  
|  |  | - Adv. Quant. Brain Networks (3 ec)  
|  |  | - Motor Control (6 ec; cns)  
|  |  | - Neuroimaging 1 (6 ec; cns)  
|  |  | - Perception (6 ec; cns)  
|  |  | - Inleiding Machine Learning (3 ec) |  |  |
| **Q3**  | - Professional preparation (1 ec)  
- Philosophy on Modern Physics (3 ec)  
- Systematic Reviews in Neuroscience ()  
- Neurophysics seminar ()  
- Quantitative Brain Networks ()  
- Psychophysics 2 ()  
- Cognitive Control () cns  
- Perception (6 ec; cns) |  |  |  |
| **Q4**  | - Systematic Reviews in Neuroscience (6 ec)  
- Neurophysics seminar (2 ec)  
- Quantitative Brain Networks (6 ec)  
- Psychophysics 2 (6 ec)  
- Adv. Comp. Neurosci. (3 ec)  
- Cognitive Control (6 ec, cns) |  |  |  |

* "Self study Introduction Neuroscience" in the first two weeks of the Master Track prepares students without any background in neurobiology for the obligatory course Behavioural and Systems Neuroscience, which starts in the third week of the first quarter (see section 7). Web-teach activities; Text: Dale Purves: "Neuroscience", 5th Ed, Chapters 11-14 & 16-20.

** Enrollment in Courses at the Cognitive Neuroscience Research Master (cns) needs written permission from the Study Coordinator at CNS.


Course () means that it runs over two quarters (a 6 ec course; i.e., 3 ec/quarter).
5. Neurobiology

Bachelor students from the following disciplines can enroll in the Neurobiology specialisation of the Neuroscience master:
- Biology with a minor in medical biology, neurobiology or medicine
- Medical Biology
- Molecular Life Sciences
- Science (biochemistry and physical chemistry)
- Any comparable study from our sister universities in the Netherlands
- A relevant study in neurobiology from the Dutch higher education studies (HBO diploma) in combination with the premaster programme Medical Biology of the RU Nijmegen
- A comparable study in Biology from universities outside The Netherlands

To enroll in the Neurobiology programme students should preferably have passed several Neuroscience courses in their bachelor programme, e.g. through the Neurobiology Minor (boldface: highly recommended):

Hersen en gedrag, sensorimotoriek (6 ec, 2nd year),
Neurobiology (6 ec, 2nd year),
Neuroscience (6 ec, 3rd year),
Neurofysiologie van cognitie en gedrag (6 ec, 3rd year),
Neurobiofysica 1 (6 ec, 3rd year),
Neurodevelopment (6 ec, 3rd year),
Cognitive Neuroimaging (6 ec, 3rd year)

Master Courses

Obligatory
For all Master track students Neuroscience (15 ec, see section 3)
- Systems and Behavioural Neuroscience (6 ec)
- Methods in Neuroscience (3 ec)
- Systematic Reviews in Neuroscience (6 ec)

Medical Biology- and neurobiology specific courses:
- Trends in Medical Biosciences 1 (3 ec)
- Trends in Medical Biosciences 2 (3 ec)
- Molecular and Cellular Neurobiology (3 ec)

Electives
Students have to choose 6 of the following courses (all 3 ec, unless stated otherwise in the study guide):
- Adaptation physiology
- Apoptosis
- Cellular imaging in four dimensions
- Computational drug discovery
- Endocrinology
- Human genetics
- Laboratory animal science and alternatives
- Metabolism, transport and motility
- Molecular and translational oncology
- Molecular aspects of host defence, tissue destruction and repair
- Oncology
- Principles of systems biology
Working with radionuclides (level 5B) (2 ec)

Elective courses can also be drawn from the M.Sc. studies “Cognitive Neuroscience” and “Molecular Mechanisms of Disease”.

An up to date list of available courses, plus course descriptions can be found in the study guide.

**Master theses and internships**

Students must follow two internships, each with a minimum of 36 ec. At least one of these internships must be under supervision of a (assistant/associate) professor at a department of the Donders Institute, and approved by the exam committee of Medical Biology, or Molecular Sciences (an up to date overview can be found in the study guide). Each internship is accompanied by a thesis and an oral presentation of the obtained results.

Two literature theses of 6 ec each on a relevant topic within the Neurobiology are required. Alternatively, and only after approval by the exam committee, students can write one thesis of 12 ec, that for example can be published as a review article.

**6. Double Master degree**

As described in section 3, students of the FNWI track Neuroscience obtain a diploma in Physics, Mathematics, Medical Biology, Science, or Informatics. However, it is possible for the best students to obtain a *double master degree* (e.g. Physics & CNS) by including an additional 60 ec of courses from the Cognitive Neuroscience Research master programme in their curriculum (i.e., a total of 180 ec, 3 years, including the internship).

Because of the large variety of potential backgrounds and preferences of students, there is no preset double-master curriculum with a fixed list of courses. Therefore, students who wish to embark on a double-master curriculum should indicate this as early as possible in their FNWI master track, so that a full programme can be defined and submitted for approval by the Exam Committees of both master programmes. Close coordination between the student and the program coordinators of the Neuroscience Track at FNWI and at the Cognitive Neuroscience research master will be essential.

Note that normal tuition fees and rules will apply for the duration of the double master, as long as students remain registered at the Radboud University.
7. Descriptions of the 15 ec obligatory courses Neuroscience Track

Systems Neuroscience

Teaching methods
- 14 hours lecture
- 8 hours student presentation
- 6 hours question session

Pre-requisites
Basic knowledge in Neuroscience and Behaviour, at the level of basic Neuroscience textbooks (e.g. Neuroscience by Purves) is required. It is therefore recommended that you have attended one or more of the following Bachelor courses in the Biological Sciences Bachelor programme, or other basic Neuroscience courses: ‘Hersen en Gedrag’, ‘Neurobiophysica’, ‘Neuroscience’, ‘Neurobiologie’, ‘Neurofysiologie van Cognitie en Gedrag’, etc.

Objectives
- Student can critically read and discuss primary scientific literature
- Student can formulate critical questions about primary scientific literature
- Student understands and can explain concepts in the field of ‘systems neuroscience’
- Student understands the concepts circular analysis, ‘double dipping’, image selection criteria and can apply these concepts on primary scientific literature in the neurosciences
- Student can shortly describe the essential findings after a presentation by a top-centric in systems neuroscience and can summarize the talk in a short essay
- Student can present recent findings from primary literature in a presentation for fellow students
- Student can ask critical questions during presentations of fellow students or lecturers

Contents
Comprehensive series of introductory lectures on systems neuroscience that go beyond basic (bachelor) knowledge. One introductory lecture will be on “double dipping in Systems Neuroscience”. Students will be asked to read background (primary) literature and write a short essay. Emphasis will be on multi-disciplinary approaches and biomedical relevance. Topics can vary, examples:
- Perceptual processing
- Multimodal approaches
- Modelling in Systems Neuroscience
- Advanced techniques in Systems Neuroscience
- fMRI and its neural basis
- Object localization by touch
- Parkinson’s Disease
- Entrepreneurship in System Neurosciences

Subjects
Comprehensive series of introductory lectures on systems neuroscience that go beyond basic (bachelor) knowledge. One introductory lecture will be on “double dipping in Systems Neuroscience”. Students will be asked to read background (primary) literature and write a short essay. Emphasis will be on multi-disciplinary approaches and biomedical relevance. Topics can vary, examples:
- Perceptual processing
- Multimodal approaches
- Modelling in Systems Neuroscience
- fMRI and its neural basis
- Advanced techniques in Systems Neuroscience
- Object localization by touch
- Parkinson’s Disease
- Entrepreneurship in System Neurosciences

Examination
Examination and grading
- 50% Topic Lectures; quality of questions and answers
- 50% Assignment; Circular Analysis
- 25% Abstract lecture
- 25% Presentation + discussion participation during the whole course

Literature
Literature hand-outs are distributed during the lecture. Basic reference book is recommended (Purves or Kandel).

Extra information
Contact: Prof. Dr. Richard van Wezel, rvanwezel@donders.ru.nl

Note that experience in previous years has learned that this course is time-consuming for the students, and cannot be attended simultaneously with other courses or other obligations.
Master Track Neuroscience  
Faculty of Science  
Radboud University Nijmegen  
16-08-2014

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Type</th>
<th>Description</th>
<th>Location(s)</th>
</tr>
</thead>
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<td>Mon 15 Sep</td>
<td>10:30 - 12:30</td>
<td>Hoorncollege</td>
<td>NWI-BM044B Systems Neuroscience</td>
<td>HG00.310</td>
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<td>Tue 16 Sep</td>
<td>10:30 - 12:30</td>
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<td>10:30 - 12:30</td>
<td>Hoorncollege</td>
<td>NWI-BM044B Systems Neuroscience</td>
<td>HG01.028</td>
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<td>NWI-BM044B Systems Neuroscience</td>
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<td>Tue 23 Sep</td>
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<td>Wed 24 Sep</td>
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<td>Fri 26 Sep</td>
<td>08:30 - 12:30</td>
<td>Tentamen</td>
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<td></td>
<td>13:30 - 17:30</td>
<td>Tentamen</td>
<td>NWI-BM044B Systems Neuroscience</td>
<td>LN 3</td>
</tr>
</tbody>
</table>


**Behavioral Neuroscience**

**Teaching Methods**
- 4 hours computer course
- 14 hours lecture

**Pre-requisites**
For this course a B.Sc. programme in medical biology or neurobiology is required.

**Objectives**
- The student has a deep understanding of behavioral studies and the read-out of their parameters
- The student can formulate a successful design for a behavioral neuroscience study within the topics covered
- The student can analyze and discuss recent literature within the field of behavioral neuroscience

**Contents**
Behavioral neuroscience unravels the functioning of the brain in relation to the subjects behavior. It is a broad research field that covers both animal and human studies and ranges biological to pathophysiological situations. All behavior, irrespective of its function can be characterized in three stages, or phases: (i) sensation of an external stimulus, (ii) perception of the stimulus and (iii) action towards a behavioral outcome following the initial input. During this course we will cover these three phases using both animal and human experimental paradigms. Apart from background lectures students will study recent research articles. Journal club discussions of these articles will focus on experimental design: Can all conclusions be justified following the experimental design?

**Subjects**
1. Overview of the most important experiments in behavioral neuroscience
2. Sensation of external stimuli
3. Perception
4. Action towards behavioral outcome
5. Spatial cognition
6. Memory encoding and consolidation

**Examination**
Final mark will be determined on an exam of the materials discussed during the course.

**Literature**
Recent literature will be provided at the start of the course.

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**Course ID**
NWI-BM053B

**Credits**
3

**Scheduled**
First quarter

**Show schedule**
SVS / PersoonlijkRooster

**Lecturers**
- prof. dr. R.J.A. van Woerden
- prof. dr. T. Ceulemans
- dr. F.P. Bettanassis

**Included in**
- Bachelor Moleculaire Levenswetenschappen
- Bachelor Science
- Clinical Biology
- Functional Genomics
- Neuroscience
Methods in Neuroscience

Teaching methods
- 16 hours computer course
- 16 hours lecture
- 8 hours question session

Pre-requisites
Neurophysica 1 (WNS1, Science), or Neurobiotechnics (Bi), or equivalent Systems Neuroscience (Master), Behavioural Neuroscience (Master)

Objectives
1. Students can describe and compare different high-resolution neurophysiological techniques, and understand the strengths and limitations of the different techniques.
2. Students can motivate why a particular technique will be preferred for a given research question.
3. Students can interpret neural responses to sensory stimuli and behavioural responses obtained with the different techniques.
4. Students understand the physical-chemical principles of electrophysiological recordings, of two-photon neuroimaging, and of optogenetics.

Contents
The course provides conceptual, methodological, and practical insights into the major high-resolution neurophysiological techniques that are used to probe and manipulate the function of local neural circuits in vivo and in vitro preparations, such as single-unit recordings, microstimulation, and local inactivation (Van Ooststj), patch clamping, multi-electrode recording arrays (MEA's) and multi-unit data analysis (Datatigla), two-photon microscopy (Van Wezel), and optogenetics (Tiesinga).

Each method is explained in a 2 hr lecture, and illustrated by a key research paper (to be further discussed by the students in the response hour), and a two-hour computer practicum, in which experimental results obtained with the method are analysed and interpreted by the students as assignments (and a written report).

Subjects

Topics
2. Analysis of single-unit spike trains from the visual, somatomotor, and auditory systems.
   - Spike-sorting algorithms, reverse correlation, extraction of receptive fields, sensorimotor encoding.
5. Optogenetics.

Examination
Written exam (70%) and brief essays on results computer practicals (30%)

Literature
A syllabus and a selection of modern research papers will be disseminated through Blackboard.

Extra information
This course is obligatory for all students enrolled in the FNWI Neuroscience Master Track. It is also open as an elective course for students from the Cognitive Neuroscience Research Master (track 4: Brain Networks and Neural Communication, and track 2: Perception, Action, and Control).

<table>
<thead>
<tr>
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<td>NWI-NM103B Methods in Neuroscience</td>
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<td>Tue 2 Dec</td>
<td>08:30 - 10:30</td>
<td>Hoorncollege</td>
<td>NWI-NM103B Methods in Neuroscience</td>
<td>HG01.029</td>
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<tr>
<td>Thu 4 Dec</td>
<td>10:30 - 12:30</td>
<td>Hoorncollege</td>
<td>NWI-NM103B Methods in Neuroscience</td>
<td>HG00.071</td>
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<tr>
<td>Tue 9 Dec</td>
<td>08:30 - 10:30</td>
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Systematic Reviews in Neuroscience

Teaching methods
- 10 hours guided individual project work
- 10 hours student presentation

Pre-requisites
- Systems Neuroscience (master), Behavioural Neuroscience (master) and Methods in Neuroscience (master)

Objectives
The student will learn to generate scientific articles in an abridged form and in their own words. In doing so, they will:
- present a neuroscience subject in a structured and logical fashion in the form of a thesis, based on a selection of relevant peer-reviewed research papers from scientific journals
- learn to work with various literature search systems

Contents
A specialized subject pertaining to the field of Neuroscience that is readable and comprehensible for your peers. If so desired, for example if you graduate in the Communication, Education, or Science-Innovation tracks, the targeted audience of your thesis may adjusted accordingly. It is also possible to select your own topic. Please, ensure beforehand that your supervisor agrees with the topic.

Procedure
The student first discusses her/his topic of interest with a selected supervisor. The subject is to be worked out in more detail on the basis of a number of relevant research articles, using various literature systems. It is important that you formulate, outline, and then discuss a problem in depth in your thesis. Note that the thesis is not meant to serve as a summary of results. Instead, particular attention should be made to describe and present the topic according to a logical structure, give clear argumentation about obtained results, methods and remaining problems, and provide a scientific and academic analysis and synthesis of the topic. These aspects will all be used in the grading of the thesis work.

Subjects
Each thesis is written in English and must comprise the following:
- title page (title, name of the author, place and date)
- a brief summary (max. 350 words)
- an introduction in which a problem is formulated (max. 700 words)
- a section in which the burden of proof, the articles used, are examined
- a discussion with critical comments with respect to the articles that are used and conclusions concerning the problem as formulated
- a reading list.

Examination
Thesis report.

Literature
To be discussed with the supervisor.

Extra information
The Academic Writing Centre Nijmegen (in Dutch: ASN) offers every student or teacher support based on one's individual needs concerning the execution or supervision of academic writing tasks. This support may vary from coaching with respect to various writing assignments to workshops in writing skills to assistance in softening the student's writing didactics. The services of the ASN are easily accessible, free of charge and intended for anyone associated with the university so as to contribute to developing a high-quality academic writing culture. Visit www.ru.nl/asn for more information.
8. Contact Information

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9. DCN research departments at FNWI

**Department of Biophysics**  
HG00.800  
Staff: prof. dr. AJ van Opstal (head), prof. dr. HJ Kappen, prof. dr. RJA van Wezel, prof. dr. R van Ee, dr. W Wiegerinck, prof dr. P Fries, prof dr D Norris

Experimental research of the department focuses on the neural basis of sensorimotor behavior, through psychophysical studies of the auditory system (directional hearing, and sound processing in the brain), the visual system (binocular vision, visual motion processing, decision making), balance control (rotational and translational accelerations of the body), and the eye-head motor systems.

We build testable models (using techniques from computational neuroscience, statistical inference and optimal control) to explain our findings.

Our auditory research also collaborates with the ear-nose-throat department of the University Medical Centre. We test patients with cochlear implants, or with different types of hearing aids in our setups to assess (and help to improve) directional hearing capabilities, and auditory processing with the devices.

Theoretical research of the department focuses on the computational principles that underlie intelligent behavior in natural systems, and in building artificial intelligence. Intelligent behavior is adaptive and changes on the basis of past experience (i.e., data). It thus integrates sensory data with prior knowledge, and it must be robust to noise. We develop theoretical insights and models to address these problems, which are highly relevant for neuroscience, as well as for a wide range of technical and societal applications.

The group uses and develops techniques from Machine Learning and Optimal Control theory. Bayesian methods also have considerable potential for immediate applications in areas outside science, such as medical diagnosis, and forensics (e.g., DNA profiling). The SNN group builds such applications with her spin-off company Smart Research.

**Department of Neuroinformatics**  
HG00.800  
Staff: Prof. dr. PH Tiesinga (head), Prof. dr. O Jensen, Prof. dr. S Fisher, dr. F Battaglia, dr. R Memmesheimer, dr. A. Ashrafi, dr C Döller

The overall goal of the theoretical research within the department is to understand how neurons encode information and to understand the mechanisms by which this information is processed and modulated. To achieve these goals, we use techniques from physics and mathematics to build network models, ranging in size from single neurons to millions of neurons, and with the models for individual neurons ranging from the extremely simple to highly complicated biophysical models with thousands of degrees of freedom. Our focus is on models of hippocampus, visual cortex, barrel cortex and prefrontal cortex, and we investigate different coding schemes the brain might use. These theoretical and computational models and analyses have lead to a deeper understanding of the role of oscillations in stimulus selection, communication between different brain areas, information transmission, memory and decision making. Neuroinformatics is also concerned with making it easier to share data between different neuroscience groups and integrate it in large, publically accessible databases for this we participate in the 1 billion euro Human Brain Project.

The experimental research at the molecular level aims to translating genetic findings to an understanding of their biological consequences in order to delineate the role of genes in the nervous system.
small regulatory microRNAs as markers and mediators of a subset of neurodevelopmental disorders. Toward this end, we utilize in vitro models of synaptic activity, as well as rodent models of neurological disorders, to assess the function of microRNA regulation in neuronal growth, differentiation and synaptic plasticity. At the systems level, we use a range of cutting edge experimental tools to collect large samples (tens to hundreds of simultaneously recorded neurons) of neural activity. We aim to determine how information encoded in neural activity, how it is stored in memory, and how different brain areas interact to exchange information. We look at these questions in the context of complex behavioral situations, including decision making and social interactions, using transgenic mouse models and optogenetics. In addition, we develop innovative analysis methods for time-frequency analysis and methods to determine the information content of neural activity.

**Department of Neurophysiology**  
HG02.200  
Staff: prof. dr. T. Celikel (head), Dr. W. Scheenen, Dr. B. Englitz, Dr. A. Aschrafi

Sensation doesn't make sense except in reference to an embodied self. The brain therefore processes information from the environment through sensory organs in reference to their internal representations. These neural representations of the sensory world are continuously modified: Prof. Tansu Celikel and his team of Neurophysiology work towards a system level description of the neural circuits that process sensory information, and their plasticity to determine how adaptive changes in neural representations are translated into cognition and action. Our research topics include, but not limited to, control of synaptic transmission and neural growth, structural and functional organisation of neural circuits, quantitative analysis and targeted control of brain plasticity, molecular control of network function, analytical study neural information processing, in silico (hardware and software) network models, close-loop neural control in robotic and virtual environments, neurotechnology: novel method development.

**Department of Molecular Animal Physiology**  
NCMLS rte 282  
Staff: prof. dr. G. Martens (head), Dr. S. Kolk

The research interests of Prof. Gerard Marten's group of Molecular Animal Physiology centres include neurobiology/neuroendocrinology, and cell and developmental biology, with a specific focus on the molecular mechanisms underlying the functioning of neuronal and neuroendocrine cells. Major current projects include functional studies (on proteins involved in cargo transport and acidification of the secretory pathway, and in neuronal development - axon outgrowth, synaptic plasticity - and neurodegeneration) and also concern the epigenetic basis of psychiatric disorders (changes in DNA methylation patterns). For the functional studies, stable Xenopus transgenesis with intermediate pituitary and retinal ganglion cell-specific transgene expression is used.