Master of Science in Neuroscience

This programme description is valid for students admitted in the academic year 2017/2018. It was approved by the Faculty of Medicine and Health Sciences on 7 March 2017.

Facts about the Programme of Study

Programme code: MSNEUR
Webpage: www.ntnu.edu/studies/msneur

Title of the degree: Master of Science in Neuroscience
ECTS credits: 120
Duration: Two years (four semesters)

Host Faculty: Faculty of Medicine and Health Sciences
Host Department: Kavli Institute for Systems Neuroscience

Introduction

The MSc in Neuroscience provides an in-depth study of brain structure and -function, reaching from the molecular to systems level. A central aim for students is to understand how neural systems may contribute to sensory experiences, thoughts, emotions and behaviour, and learn to adopt experimental methods to gain new knowledge in the field.

The MSc in Neuroscience is an interdisciplinary collaboration between five faculties at NTNU.

The MSc is coordinated by the Programme Council of Neuroscience, with representatives from the students and the participating faculties. It is administered by the Department of Neuroscience at the Faculty of Medicine.

The degree awarded to students completing the programme will be *Master of Science in Neuroscience*. Completion of the master's degree is a qualification for studies at the PhD level.

Learning Outcome

General learning outcome

A solid knowledge about neuroscience, good experimental and theoretical skills, and competence to obtain and critically appraise own and already published experimental and theoretical data and to pursue a career in neuroscience.

Specific learning outcome

Knowledge

- The student has advanced knowledge of the research field of neuroscience including its subareas (Molecular and Cellular neuroscience, Systems Neuroscience (including comparative neuroscience), Computational Neuroscience and Cognitive Neuroscience) and disciplines (Anatomy, Physiology, Biochemistry, in vivo and in vitro Imaging techniques at cellular and network level, Neurogenetics, Neurophysics).
- The student has knowledge of relevant methodologies and techniques in neuroscience including both historical as well as more recent techniques.

- The student has knowledge about:
    - Sensory systems (somatosensory, visual, auditory, olfactory and taste, vestibular, pain, visual streams, barrel cortex, topographic organization, homunculus)
    - Motor systems (prim motor system, basal ganglia, cerebellum)
    - Association cortex (definitions and different levels such as prefrontal, parietal, temporal cortex, etc.)
    - Monosynaptic and complex reflex networks at spinal cord and brainstem levels.
- The student has specialized knowledge in at least one of the above mentioned disciplines.
- The student has knowledge about the main current theoretical concepts in Neuroscience, and can apply this to his/her own research: Chemical and electrical signalling, cellular integration, regulation of neuronal activity, excitatory and inhibitory transmission and the related cellular mechanisms (transmitter synthesis, packaging, release, receptor binding, location and regulation of receptor expression). Theorems include cortical networks, hierarchical processing, feedforward and feedback connectivity. Primary and higher order (association) cortex, oscillations and their functions, concepts of neuronal networks. Role of thalamocortical and cortico-basal ganglia networks, default networks, (monoaminergic/subcortical) modulation, and computational models including connectionists models (small world networks, spin glass models) and oscillatory models.
- The student has knowledge about mainstream concepts of Neurophilosophy and ethics. The student is aware of and has knowledge of the relevant historical perspectives in Neuroscience, its traditions and the position in the society. Is aware of debates in the field on Neurophilosophy, theory of mind and discussions on consciousness.

Skills

- The student is capable of analysing main outstanding issues in neurosciences, follow and analyse ongoing debates in the field, with special knowledge in at least one domain.
- The student knows how to find relevant methods and how to apply those to his/her project/question of interest.
- The student has competence to analyse experimental data, put them in a context of relevant available (published) data in neuroscience and directly adjacent fields such as psychology, and the ethical and societal issues related to neuroscience research and is able to communicate experimental results both orally and in a number of specific written formats.
- The student can analyse existing theories, methods and assumptions within the field of neuroscience.
- The student can recognize and validate problems; formulate and test hypotheses.
- The student can evaluate and formulate a theoretical concept. Evaluation includes originality, independence and applicability.
- The student can, with supervision, perform a research project independently, including the formulation of the research question based on good general insight in the field, experimental design and implementation, results analyses and reporting.
- The student is capable of adequate analysis of findings, including appropriate levels of statistics and integration with existing (published) information.
- The student can summarize, document, report, and reflect on own findings.

General competence

- The student knows how to analyse relevant general issues in neuroscience including field specific theorems and ethical issues, including how to decide on animal and human research, general insight in ways to diminish research that causes suffering to humans and animals and knows how to evaluate and weight the outcome to the inflicted suffering.
- The student is capable to apply his/her knowledge and capabilities to analyse and carry out complex experiments in neuroscience in not-familiar domains.
- The student has proven capability to apply his/her knowledge to new domains within neuroscience; has skills and knowledge to search for relevant data on his/her own scientific question, and can critically assess published data within the theoretical framework chosen for a particular project.

- The student can carry out research independently and knows how to formulate and express results and interpretations of the research outcomes.
- The student knows how to participate in discussions, put forward his/her results both in a constellation of peers as well as for lay-people.
- The student has proven capabilities to contribute to the generation of new idea/concepts/technical approaches to experimental research questions.
- The student can summarize, document, report, and reflect on own findings.

Learning outcome for Master of Science in Neuroscience

After completion of the program the student	**Knowledge**	**Skill**	**General competence**
has in depth insight in basic brain structure and function reaching from the molecular to systems level.	3	1	3
understands how neural systems contribute to sensory experiences, thoughts, emotions, behaviour	2	2	3
can apply and adopt experimental methods to gain new knowledge	2	3	2
can formulate a research question based on adequate insight into current knowledge	3	3	2
is able to report outcomes of research in a coherent oral and written report	3	2	2

1 = elementary; 2 = average; 3 = advanced

Target Groups and Admission Requirements

The MSc in Neuroscience is suitable for students motivated towards research in Neuroscience in particular or the natural sciences in general. *Some previous basic knowledge of Neuroscience and/or Cell and Molecular Biology is highly recommended.*

Admission to the MSc in Neuroscience requires a bachelor's degree (or an equivalent 3-year higher education) in one of the following disciplines:

1. Neuroscience
2. Biology, Biotechnology, Biomedical Science
3. Chemistry, Mathematics, Physics
4. Psychology

Other relevant disciplines, combined with or including course work in Biology, Chemistry, Mathematics/Statistics, Neuroscience and/or Physics, may be accepted after an individual evaluation of the applicant's qualifications.

Applicants are encouraged to include the NTNU-based course NEVR2010 – *Introduction to Neuroscience* as a part of their bachelor's degree. Students who do not have NEVR2010 (or an equivalent background in Neuroscience) when admitted, may be required to follow the NEVR2010 lectures during their first semester of the master's programme.

International applicants need to submit proof of English proficiency (TOEFL, IELTS, APIEL or University of Cambridge test). More details about the language requirements are available at www.ntnu.edu/studies/langcourses/languagerequirements

Applicants who are not citizens of the European Union (EU) or the European Economic Area (EEA) need to provide a financial guarantee to get a residence permit in Norway.

Teaching Methods and Learning Activities

The MSc in Neuroscience is a two-year, full-time programme. The teaching includes lectures, team-based learning, laboratory demonstrations, and supervised project work. The language of instruction and examination is English.

The master's programme has small classes, which stimulates a good study environment. The students contribute to the interdisciplinary environment with their different educational and ethnical backgrounds. Master's thesis projects are offered in multidisciplinary research teams such that students are exposed to and encouraged to participate in collaborative projects.

Students will get access to high-tech laboratory environments, and modern reading and lecture rooms, computer labs and library facilities at Øya campus in Trondheim. NTNU shares this campus with St. Olav's University Hospital.

Soma is an academic and social organization for master's students at the Faculty of Medicine. Soma runs a buddy programme at the start of the semester, and various events through the academic year.

Compulsory HSE Training

All master's students must participate in compulsory Health, Safety and Environment (HSE) training. This includes a HSE lecture and a fire protection course, both held in the first two weeks of the semester. When these activities have been completed, the student must pass an electronic test. This is to be done by 1 September 2016. If the student fails to do so, the access card to the campus/hospital buildings will be withdrawn.

Programme Structure

The master program is made up of the following three components:

- Master's thesis (60 credits)
- Compulsory courses (37.5 credits)
- Elective courses (22.5 credits)

Master's Thesis

NEVR3901*	Thesis in Neuroscience	60 credits

* The course code FY3901 is used by students with a supervisor at the Department of Physics.

Compulsory Courses

NEVR3001	Basic Neuroscience	7.5 credits	Autumn
NEVR3002	Sensory and Motor Neuroscience	7.5 credits	Autumn
NEVR3003	Behavioural and Cognitive Neuroscience	7.5 credits	Spring
NEVR3004	Neural Networks	7.5 credits	Spring
Various	Experts in Teamwork	7.5 credits	Spring

Elective Courses

A selection of suggested elective courses is presented below. Other courses at NTNU or other universities can be approved by the Programme Council on request.

Some of the courses have entry requirements and/or restricted admission. Be sure to check this before you register for a course.

Courses with a course code in the 8000-series are at PhD level, but are open for qualified and motivated master's degree students.

The elective courses should normally be at master's degree level (3000-series or higher). However, if the student lacks appropriate background in areas relevant for the master's thesis, undergraduate courses in biology, chemistry, informatics, mathematics, medicine, physics, psychology or statistics may be accepted as well.

BEV3201	Introduction to Signal Processing in Matlab	7.5 credits	Spring
BI3013	Experimental Cell and Molecular Biology	7.5 credits	Autumn
BI3016	Molecular Cell Biology	7.5 credits	Autumn
BI3018	Patenting and Commercialization of Biotech and Medtech Inventions	7.5 credits	Spring
BI3021	Special Zoo Physiology	15 credits	Both
FI3107	Biotechnology and Ethics	7.5 credits	Autumn
KLH3100	Introduction to Medical Statistics	7.5 credits	Autumn
MOL3001	Medical Genetics	7.5 credits	Spring
MOL3005	Immunology	7.5 credits	Autumn
MOL3010	Animal Cell Culture	7.5 credits	Autumn
MOL3014	Nanomedicine I – Bioanalysis	7.5 credits	Autumn
MOL3015	Nanomedicine II – Therapy	7.5 credits	Spring
MOL3018	Medical Toxicology	7.5 credits	Spring
MOL3020	Virology	7.5 credits	Spring
NEVR3040	Private Study of Neuroscience I	7.5 credits	Both
NEVR3050	Private Study of Neuroscience II	15 credits	Both
NEVR8014	Laboratory Animal Science for Researchers	7.5 credits	Autumn
PSY3110	Learning, Behaviour and Environment	7.5 credits	Autumn
PSY3111	Individual Development, Genes, Neural System and Behaviour	7.5 credits	Autumn
TBT4145	Molecular Genetics	7.5 credits	Autumn
TFY4265	Biophysical Micromethods	7.5 credits	Autumn
TFY4280	Signal Processing	7.5 credits	Spring
TFY4310	Molecular Biophysics	7.5 credits	Autumn
TFY4320	Physics of Medical Imaging	7.5 credits	Spring
TMA4255	Applied Statistics	7.5 credits	Spring

Progression

NEVR3001 and NEVR3002 should be taken during the first semester. NEVR3001 is taught in the first half of the semester, and the final written examination is held in October. NEVR3002 is taught in the second half of the semester and the final written examination is held in December.

NEVR3003 and NEVR3004 should be taken during the second semester. NEVR3003 is taught in the first half of the semester, and the final written examination is held in March. NEVR3004 is taught in the second half of the semester and the final written examination is held in May or June.

The modular course *Information Literacy* is embedded in the four compulsory courses NEVR3001, NEVR3002, NEVR3003 and NEVR3004.

The course *Experts in Teamwork* (EiT) is compulsory for all master's degree students at NTNU, and is taught intensively in the weeks 2, 3 and 4 in the second semester. Read more about EiT here: www.ntnu.edu/eit

The elective courses are to be taken when convenient for the work with the master's thesis. In the second semester, the student must choose a topic for the thesis. A contract for the master's thesis including a project description is drawn up by the student and his/her supervisor and submitted to the Kavli Institute for Systems Neuroscience within 15 March. Due to the nature of experimental projects in Neuroscience, it is recommended to work continuously with the master's thesis during the two years of the programme.

Model of the MSc in Neuroscience (example):

<table>
<tr><th colspan="2">Year 1</th><th colspan="2">Year 2</th></tr>
<tr><td>1st semester (autumn)</td><td>2nd semester (spring)</td><td>3rd semester (autumn)</td><td>4th semester (spring)</td></tr>
<tr><td>NEVR3001</td><td>NEVR3003</td><td colspan="2" rowspan="4">Thesis</td></tr>
<tr><td>NEVR3002</td><td>NEVR3004</td></tr>
<tr><td>Elective course</td><td>Experts in Teamwork</td></tr>
<tr><td>Elective course</td><td>Elective course</td></tr>
</table>

Please note that this is only a suggestion. As mentioned above, the student can choose to start with the thesis already in the first year and postpone one or more of the elective courses to the second year.

The student must have passed all examinations in compulsory and elective courses before the thesis can be submitted.

Innovation and Entrepreneurship

The interdisciplinary profile of the MSc in Neuroscience contributes to an environment where innovation has the potential to develop and benefit society as a whole. With a strong basis in research, as well as students and faculty bringing in different backgrounds and perspectives to the field, the programme is an untapped resource regarding entrepreneurship.

Course Descriptions

The course descriptions are available at www.ntnu.edu/studies/courses