Master of Science in Neuroscience

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

This programme description is valid for students admitted in the academic year 2016/2017.

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 signaling, 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 analyzing main outstanding issues in neurosciences, follow and analyze 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 analyze 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 analyze 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 programme 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
5. Human Movement Science, Medicine

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, 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. The language of instruction and examinations is English.

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
BI3010	Population Genetics	7.5 credits	Autumn
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 Department of 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):

Year 1		**Year 2**	
1st semester (autumn)	*2nd semester (spring)*	*3rd semester (autumn)*	*4th semester (spring)*
NEVR3001	NEVR3003	Thesis	
NEVR3002	NEVR3004		
Elective course	Experts in Teamwork		
Elective course	Elective course		

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.

Course Descriptions

Compulsory Courses

NEVR3001	**Basic Neuroscience**
Credits:	7.5
Period:	Autumn
Teaching methods:	Lectures and supervised project (essay based on literature search). The course is taught in the first half of the autumn semester with a final examination in October. The language of teaching and examination is English. This course has restricted admission. Students admitted to the MSc in Neuroscience are guaranteed a place. Other students must apply for a place by the given deadlines. Regular final examination is given in the autumn semester only. Students with legitimate leave of absence at the final examination and students who receive the grade F may take a re-sit examination in the spring semester. In the case of only a few candidates, the re-sit examination may be conducted as an oral examination. Timetable: https://timeplan.medisin.ntnu.no/timetable_show.php.
Recommended previous knowledge:	NEVR2010 (Introduction to Neuroscience) or equivalent background.
Compulsory activity:	Project (essay based on literature search)
Mode of assessment:	4-hour written examination. Letter grades (A-F)
Credit reduction:	NEVR3020: 7.5 credits
Host department:	Department of Neuroscience
Course coordinator:	Professor Linda White

NEVR3001 has restricted admission. Students admitted to the MSc in Neuroscience are guaranteed a seat. Other students must apply for a seat by the given deadlines.

General learning outcome

The student has an in-depth understanding of mechanisms related to neurotransmitter signaling and glial-neuronal interactions in health and disease

Specific learning outcomes

Knowledge

The student has knowledge about:

- the most common cell types in the nervous system, their individual components and relationships;
- molecular and cellular mechanisms underlying synaptic transmission and plasticity;
- membrane properties resulting in membrane potential, depolarization and hyperpolarization, action potential generation, membrane oscillations;
- cellular signaling cascades, receptor-second messenger systems, receptors in relation to the common transmitters, transmembrane transport, transporters and channels;
- the role of the various glial celltypes and glial-neuronal interaction, in particular glutamine-glutamate cycle

Skills

The student is capable of:

- applying the knowledge to normal signal transduction in neuronal networks;
- applying the knowledge to altered signal transduction as seen in some examples of diseased networks;
- finding relevant published information and writing about a theme within basic neuroscience in a scientific and coherent manner.

General competence

The student is capable of:

- formulating one relevant problem in cellular/molecular neuronal functioning;
- translating this problem in an adequate strategy to find relevant published information;
- summarize the obtained information into a coherent, scientifically acceptable answer to the question posed;
- write a short essay on the problem, possible answers or pragmatic ways to obtain an answer.

Learning outcomes for NEVR3001

After completing and passing the course NEVR3001 the student:	**Knowledge**	**Skill**	**General Competence**
has in-depth insight of basic brain structure and function from the molecular to the anatomical level	3	1	2
understands how molecular, biochemical, cellular and physiological aspects mutually contribute to neural systems	2	1	3
can search relevant sources of information to acquire literacy in basic neuroscience	1	1	1
can formulate a research question based on adequate insight into current knowledge	3	2	2
can report outcomes of research in a coherent oral and written report	1	1	1

1 = elementary; 2 = average; 3 = advanced

Academic content

The course will introduce the student to the study of cellular and molecular mechanisms relevant to functioning of the central nervous system, including mechanisms of synaptic plasticity. The course will also deal with signaling events in brain, receptors and transport systems for important neuroactive substances, and the function of the various cell types in brain. There will be a particular focus on excitatory and inhibitory signaling and its importance in normal functioning and diseases of the nervous system. The course involves writing an essay, usually under supervision, and based on a literature search of a topic. Topics for the essays are related to the content of the course. The project is evaluated as passed/failed. The student must pass the project assignment before (s)he can take the exam.

NEVR3002	**Sensory and Motor Neuroscience**
Credits:	7.5
Period:	Autumn
Teaching methods:	Lectures and supervised project (essay based on literature search). The course is taught in the second half of the autumn semester. The language of teaching and examination is English. Regular final examination is given in the autumn semester only. Students with legitimate leave of absence at the final examination and students who receive the grade F may take a re-sit examination in the spring semester. In case of only a few candidates, the re-sit examination may be conducted as an oral examination. Timetable is available at https://timeplan.medisin.ntnu.no/timetable_show.php
Recommended previous knowledge:	NEVR2010 (Introduction to Neuroscience) or equivalent background.
Compulsory activity:	Project (essay based on literature search)
Mode of assessment:	4-hour written examination Letter grades (A-F)
Credit reductions due to overlapping courses:	NEVR3020: 7.5 credits
Host department:	Department of Neuroscience
Course coordinator:	To be announced

General learning outcome

The student has an in-depth understanding of the overall organization of the vertebrate nervous system, including prevailing concepts on systems-level organization of the CNS.

Specific learning outcomes

Knowledge

The student has knowledge about:

- the definition of a primary cortical system, including thalamo-cortical and cortico-cortical hierarchical processing (feedforward, feedback and parallel transmission/processing pathways);
- sensory processing in the brain (somatosensory, visual, auditory, vestibular, olfactory, taste), including general anatomical and physiological principles, such as primary, secondary hierarchy , topographical organization (homunculus, tonotopy, retinotopy), and elementary processing as found in the visual system (hierarchical processing from edge detection and movement to complex scene recognition, color);
- the organization of the peripheral components of all sensory systems, including receptor types,peripheral-to-central pathways, topology;
- the motor system (primary cortical system including descending pathways, motor unit, basal ganglia, cerebellum);

- unconscious stimulus-response coupling in the brain, (spinal cord segmental reflexes, intersegmental reflexes, complex spinal cord brainstem reflexes, including the proprioceptive reflexus, vestibulo-oculomotor reflexes at the level of mesencephalon, cortex) corticobulbar and corticocerebellar integration;
- role/concept of the thalamus, basal forebrain, amygdala;
- main modulatory systems, cholinergic, histaminergic, dopaminergic, serotonergic and noradrenergic): anatomical location and organization, functional concepts;
- Comparative organization of sensory, motor and modulatory systems –evolutionary concepts.

Skills

The student is capable of:

- applying the knowledge to sensory-motor integration;
- integrating information from different systems into a high order integrative neuronal processing system within the domain of sensory-motor coupling;
- understanding of and conceptualizing different ways in biology to represent the outside world in the brain (multiple ways to solve the problem) in order to generate simple motor responses;
- finding relevant published information and writing about a theme within basic systems neuroscience in a scientific and coherent manner.

General competence

The student is capable of:

- formulating one relevant problem in systems neuroscience;
- translating this problem in an adequate strategy to find relevant published information;
- summarize the obtained information into a coherent, scientifically acceptable answer to the question posed;
- write a short essay on the problem, possible answers or pragmatic ways to obtain an answer.

Learning outcomes for NEVR3002

After completing and passing the course NEVR3002 the student :	**Knowledge**	**Skill**	**General Competence**
has in-depth insight of the basic concepts of the organization of sensory and motor systems	3	1	2
has insight of the basic structural and functional concepts of the major reflex pathways and modulatory systems in the central nervous	3	1	2
has knowledge about the organization of main subcortical integrative systems in the brain	2	1	2
can search and compare relevant sources of information to acquire literacy in basic neuroscience	2	2	2
can report outcomes of research in a coherent oral and written report	2	2	2

1 = elementary; 2 = average; 3 = advanced

Academic content

The course is divided into a sensory part and a motor part. The sensory part describes the signalling events of animal sensory systems, including detection and transduction of signal, as well as propagation, processing and coding of these signals in the peripheral- and the central nervous system. The motor part describes the signaling events of animal motor systems, including planning and execution of movement, as well as some important neurological diseases presented in the context of the mechanisms described.

The course involves writing an essay, usually under supervision, and based on a literature search of a topic. Topics for the essays are related to the content of the course. The project is evaluated as passed/failed. The student must pass the project assignment before (s)he can take the exam.

NEVR3003	**Behavioural and Cognitive Neuroscience**
Credits:	7.5
Period:	Spring
Teaching methods:	Lectures and supervised project (essay based on literature search). The course is taught in the first half of the spring semester (normally in February and March), with a final examination at the end of March. The language of teaching and examination is English. Regular final examination is given in the spring semester only. Students with legitimate leave of absence at the final examination and students who receive the grade F may take a re-sit examination in the autumn semester. If few candidates, the re-sit examination may be conducted as an oral examination. Timetable: https://timeplan.medisin.ntnu.no/timetable_show.php
Recommended previous knowledge:	NEVR2010 (Introduction to Neuroscience) or equivalent background.
Compulsory activity:	Project (essay based on literature search)
Mode of assessment:	4-hour written examination Letter grades (A-F)
Credit reductions due to overlapping courses:	NEVR3030: 7.5 credits
Host department:	Department of Neuroscience
Course coordinator:	Post Doctor Tora Bonnevie

NEVR3003 has restricted admission. Students admitted to the MSc in Neuroscience are guaranteed a seat. Other students must apply for a seat by the given deadlines.

General learning outcome

The student has an in-depth understanding of the neural foundation of behaviour and cognition.

Specific learning outcomes

Knowledge

The student has knowledge about:

- the neural mechanisms for behavior and cognition, covering topics such as reward processing and emotion, planning and behaviour, appetite, pair bonding, learning and memory, sleep, spatial processing, perception and language;
- the neuronal networks/substrates underlying these cognitive and behavioural processes;
- mainstream theoretical concepts on how alterations in these main neuronal networks underlie / cause main neurological and psychiatric clusters of disease;
- the potential relevance of main modulatory systems, cholinergic, histaminergic, dopaminergic, serotonergic and noradrenergic, for normal and abnormal cognitive functioning.

Skills

The student is capable of:

- applying the knowledge to formulate descriptions of cortical integrative processes that serve cognition and conscious behaviour;
- conceiving of and theorizing about the brain as comprised of multiple, mutually dependent functional networks that together generate appropriate adaptive behaviour;

- understanding how cortical and subcortical systems together contribute to complex cognitive behaviour.

General competence

The student is capable of:

- integrating knowledge about the brain into a coherent representation resulting in a consistent explanation of behaviour;
- selecting, evaluating, and integrating of published information on brain and behaviour into a coherent written or verbal account.

Learning outcomes for NEVR3003

After completing and passing the course the student :	**Knowledge**	**Skill**	**General Competence**
has in-depth insight of the basic concepts of the organization of higher order cortical systems	3	2	2
has insight of the basic structural and functional concepts of the major interactions between subcortical and cortical systems	2	2	2
is capable of describing certain cognitive behavioural processes in terms of contributions of and interactions between numerous brain systems	2	1	2
can acquire and evaluate published information relevant to our understanding of cognitive behavior	3	2	2
can report outcomes of research in a coherent oral and written report	3	2	2

1 = elementary; 2 = average; 3 = advanced

Academic content

The course provides a thorough introduction to the biological foundation of behaviour and cognition. It focuses on the neural mechanisms for behaviour and cognition, with particular emphasis on sleep, motivation, learning and memory, language, and emotions. The lectures will also address neurological and psychiatric symptoms and disorders, with emphasis on the underlying neural mechanisms.

The course involves writing an essay, usually under supervision, and based on a literature search of a topic. Topics for the essays are related to the content of the course. The project is evaluated as passed/failed. The student must pass the project assignment before (s)he can take the exam.

NEVR3004	**Neural Networks**
Credits:	7.5
Period:	Spring
Teaching methods:	Lectures and demonstrations. The course is taught in the second half of the spring semester. The language of teaching and examination is English. This course has restricted admission. Students admitted to the MSc in Neuroscience are guaranteed a seat. Other students must apply for a seat by the given deadlines. Compulsory assignment: An essay on a course related topic has to be handed in through it's learning. Further information on possible topics and requirements will be given at the onset of the course. The essay will be evaluated as pass/fail, and a score "pass" is required to be allowed to participate in the written examination. Regular final examination is given in the spring semester only. Students with legitimate leave of absence at the final examination and students who receive the grade F may take a re-sit examination in the autumn semester. In case of only a few candidates, the re-sit examination may be conducted as an oral examination. Timetable: https://timeplan.medisin.ntnu.no/timetable_show.php.
Recommended previous knowledge:	NEVR2010 (Introduction to Neuroscience) or equivalent background.
Compulsory activity:	An essay on a course related topic has to be handed in through it's learning. Further information on possible topics and requirements will be given at the onset of the course. The essay will be evaluated as pass/fail, and a score "pass" is required to be allowed to participate in the written examination.
Mode of assessment:	4-hour written examination. Letter grades (A-F)
Credit reductions due to overlapping courses:	NEVR3030: 7.5 credits
Host department:	Department of Neuroscience
Course coordinator:	Professor Yasser Rashtabadi Roudi

NEVR3004 has restricted admission. Students admitted to the MSc in Neuroscience are guaranteed a seat. Other students must apply for a seat by the given deadlines.

General learning outcome

The student has an understanding of neural network mechanisms of cognition and how these can be studied with and represented by realistic network models at an experimental and computational level.

Specific learning outcomes

Knowledge

The student has knowledge about:

- different classes of network models/modeling approaches currently used in neuroscience;
- different simulation programs/approaches;
- essential mathematical and theoretical concepts relevant to neural networks and theoretical modeling.

Skills

The student is capable of:

- writing simple codes for modeling;
- translating simple biological data sets on neuronal firing or network properties into a theoretical representation.

General competence

The student is capable of:

- critically appraise neural network descriptions and theoretical models of neural networks;
- understanding the difference between neuronal coding and network coding;
- writing a short essay, based on a critical appraisal and integration of a number of computational/theoretical modeling studies on specific neural or network properties.

Learning outcomes for NEVR3004

After completing and passing the course the student :	**Knowledge**	**Skill**	**General Competence**
has an understanding of neural network mechanisms of cognition	2	1	1
Can read and critically appraise publications dealing with modeling of neural network properties	1	2	2
has knowledge about the main types of models currently in use	2	na	na
can search and compare relevant sources of information to acquire literacy in basic neuroscience	3	2	2
Can critically appraise sources of information and contents of scientific publications and choose relevant information	2	2	2
can report outcomes of research in a coherent written report that meets requirements of a scholarly publication	3	2	3

1 = elementary; 2 = average; 3 = advanced

Academic content

Neuroinformatics and network models of brain functions are major topics. The course has a strong focus on models of memory in realistic cortical networks, using both experimental and theoretical (computational) approaches.

The course includes a project that involves writing an essay, usually under supervision and based on a literature search of a topic. The project is evaluated as passed/failed. The student must pass the project assignment before (s)he can take the exam.

NEVR3901 / FY3901	**Thesis in Neuroscience**
Credits:	60
Period:	2 semesters, though it is recommended to work gradually with the thesis during the entire study period.
Teaching methods:	Supervised project according to given guidelines. Practical information is available at www.ntnu.edu/dmf/studies/master
Entry requirements:	The student must be admitted to the Master of Science in Neuroscience. In order to be eligible to defend his/her master's thesis the student must have passed all exams, i.e. compulsory and elective courses worth 60 credits in total.
Mode of assessment:	Thesis and oral presentation/examination. The grade given on the thesis may be adjusted after the oral examination.
Host department:	Department of Neuroscience
Course coordinator:	Professor Clifford Kentros

The course code FY3901 is used only for student with a supervisor at the Department of Physics. All other students must use the course code NEVR3901.

General learning outcome

The student has mastered the principles of an independent problem-focussed experimental approach in neuroscience and can interpret experimental results in the context of critically appraised published information. The student has the skills and competences for continued scientific learning and education.

Specific learning outcomes

Knowledge

The student has advanced knowledge of:

- one subfield/discipline of neuroscience;
- relevant methodologies and techniques in neuroscience including both historical as well as more recent techniques;
- main resources to retrieve scientific information;
- general rules of reporting and publishing scientific reports;
- guidelines for oral presentation;
- best practice in scientific ethical behavior.

Skills

The student is capable of:

- performing a research project independently, but with supervision;
- recognizing, formulating and testing an hypothesis/research question;
- finding relevant methods and to applying those in order to experimentally address a scientific problem/question/hypothesis;
- adequate reporting of applied experimental approaches and obtained experimental results;
- adequate analysis of findings, including appropriate levels of statistics and integration with existing (published) information;
- retrieving and obtaining relevant published scientific information;
- communicating and defending own experimental results and their interpretations both orally and in the format of a master thesis;
- summarizing, documenting, reporting, and reflecting on own findings.

General competence

The student is competent to:

- evaluate ethical principles on animal and human research;
- search for relevant data on his/her own scientific question, and critically assess published data within the theoretical framework chosen for a particular project;
- carry out research independently and knows how to formulate and express results and interpretations of the research outcomes;
- participate in discussions, put forward his/her results both in a constellation of peers as well as for lay-people.

Learning outcomes for NEVR3901/FY3901

After successful defense of the thesis the student	**Knowledge**	**Skill**	**General competence**
has in depth insight one subfield of neuroscience.	3	1	2
can formulate a research question based on adequate insight into current knowledge	2	2	2
can apply and adopt experimental methods to gain new knowledge	2	2	3
can obtain, record and interpret experimental data	3	2	2
can retrieve and interpret published scientific data	3	2	2
is able to report outcomes of research and defend interpretations and conclusions in a coherent way both orally and in writing	3	3	2

1 = elementary; 2 = average; 3 = advanced

Elective courses

BEV3201	**Introduction to Signal Processing in Matlab**
Credits:	7.5
Period:	Spring
Teaching methods:	The course contains eight meetings of up to 5 hours which includes some lectures, but most practical exercises in Matlab. Students are expected to work on assigned tasks between the meetings and participate in all activities. The course is taught in English when required and all communications must be in English if international students are enrolled.
Entry requirements:	As for admission to the master's programmes in medicine, health and social sciences. The course is reserved for students enrolled at master's programmes in medicine, health and social sciences.
Recommended previous knowledge:	BEV3102, BEV3103, BEV3023, BEV3024, BEV3004
Compulsory activities:	Attendance to exercises (minimum 70 %)
Mode of assessment:	Oral examination Letter grades (A-F)
Credit reductions due to overlapping course:	BEV8003: 5 credits
Host department:	Department of Neuroscience
Course coordinator:	Post Doctor Espen Alexander Furst Ihlen

Learning outcomes

After completing the course, the student is able to

- explain important aspects of signal processing like data sampling, signal-to-noise ratio, data filtering and selection of time periods, and how these factors affect calculation of relevant signal characteristics;
- explain important aspects of data management in Matlab such as file names and folder structure;
- apply basic operations in Matlab such as importing and exporting data, data visualization, programming simple logical structures, indexing data vectors and matrices, and batch processing large data sets;
- create a Matlab script that can read the data, improve data quality, visualize results and compute relevant signal characteristics of various signals relevant in movement science • Interpret different signals (GPS, accelerometer, force, 3D motion, NIRS and electrophysiological data) on the basis of relevant theories;

- perform signal analysis using basic operations in Matlab;
- explain central concepts of signal processing;
- understand the importance of various aspects in signal analysis for data quality and further statistical analysis.

Academic content

The course will provide an introduction to signal analysis in Matlab. The course will include selected topics within signal processing like digital data sampling, signal-to-noise ratio, data filtering, selection of time periods, and calculation of relevant signal characteristics. The course will include introduction to basic operations in Matlab such as importing and exporting data, data visualization, programming of simple logical structures, use of functions, indexing of data vectors and matrices, and batch processing of larger data sets. The course will use exercises and examples from GPS, accelerometer, force, 3D motion, NIRS and electrophysiological data (EMG, EEG and / or EKG) to show the use and interpretation of signal analysis in movement science

BI3010	**Population Genetics**
Credits:	7.5
Period:	Autumn
Teaching methods:	Lectures: 30 hours Auditorium lectures with chapter-wise Powerpoint presentations uploaded to It's learning. Control questions (chapter-wise) uploaded to It's learning and treated in plenary sessions in auditory. Various software for genetic simulations and analysis is demonstrated in auditory and made available on It's learning. Lecturers may be available for answering questions sent by email.
Entry requirements:	Basic skills in biology, maths and statistical analysis. Basic skills in English.
Recommended previous knowledge:	The students need previous knowledge corresponding to BI1001, BI1004, BI1003 and BI2017. The students need basic knowledge in algebra, probability theory and statistics.
Mode of assessment:	4-hour written examination Letter grades (A-F)
Credit reductions due to overlapping courses:	MNKBI310 6.0 credits
Host department:	Department of Biology
Course coordinator:	Professor Jarle Mork

Learning outcomes

<u>Knowledge</u>

The candidate shall receive:

- insight in central themes of population genetics;
- knowledge of population genetics analytical tools.

<u>Skills</u>

The candidate shall know and understand:

- basic statistical analyses of genotypic distributions;
- estimates and statistical tests of genetic differences between populations;
- formulae for genetic equilibria between the four evolutionary forces;
- calculations of coancestry- and inbreeding coefficients from pedigree;
- methods for mapping of QTL (queantitative trait loci);
- estimating number of polymorphic loci affecting quantitative traits;
- estimating genetic response in specified selection experiments;
- genetic isolation and different types of speciation processes.

General competence

The candidate shall know and understand:

- general theory and analytical methods in qualitative and quantitative population genetics;
- implementing theory and methods for practical scientific purposes.

Academic content

The course gives an introduction to population genetics (qualitative and quantitative) and its analytical tools. Panmictic populations and genetic equilibium (Hardy-Weinberg). Genetically effective population size (Ne). Wahlund effect. Deviation from panmixia – genetic consequences. Change in gene frequencies due to the evolutionary forces mutation, genetic drift, gene flow, and selection. Measuring genetic differentiation between populations, speciation. Genetic processes in small populations (inbreeding, genetic drift). Molecular evolution and phylogenetics. Neutral and near-neutral theory, geneaology and coalescence. Different types of selection. Breeding genetics theory and methods. Epistasis and pleiotrophy. Evolutionary genetics.

BI3013	**Experimental Cell and Molecular Biology**
Credits:	7.5
Period:	Autumn
Teaching methods:	Laboratory course / demonstrations (40 hours, compulsory) Lectures (20 hours, compulsory)
Compulsory activities:	Laboratory course / demonstrations Approved report
Mode of assessment:	4-hour written examination Letter grades (A-F)
Credit reductions due to overlapping courses:	MNKBI313: 7.5 credits
Host department:	Department of Biology
Course coordinator:	Associate Professor Per Winge

BI3013 has restricted admission. Please contact the Department of Biology if you are interested.

Learning outcome

The aim of the course is to introduce basic methods in cell- and molecular biology. The course includes practical exercises in modern experimental techniques and instruments, and also training in literature search and the use of Internet. Selected analytical methods will be presented and tested. The course also includes analyses of problems and artefacts that generally occur in biological samples examined using chemical and biological analyses.

Academic content

On completion of the course students should be familiar with basic methods in cell- and molecular biology. Students should also be able to demonstrate knowledge of how to use modern experimental techniques and instruments.

BI3016	**Molecular Cell Biology**
Credits:	7.5
Period:	Autumn
Teaching methods:	Lectures (26 hours) and seminars (24 hours, mandatory)
Mode of assessment:	4-hour written examination
Credit reductions due to overlapping courses:	MNKBI316 7.5 credits
Host department:	Department of Biology
Course coordinator:	Associate Professor Per Winge

Learning outcome

On completion of the course students should have an understanding of cell biology mechanisms on a molecular level, and of the regulation of such mechanisms.

Academic content

Subjects covered include: Apoptose/necrose mechanisms; Kinases/phosphatases classification and regulation; Transcription factors, classification and regulation; Lipid mediators, regulation and function mechanisms; DNA repair mechanisms. Syllabus will mainly be based on research- and review articles.

BI3018	**Patenting and Commercialization of Biotech and Medtech Inventions**
Credits:	7.5
Period:	Spring
Teaching methods:	The course is held intensively during one week during the months March / April. Lectures and case-based work in groups are repeated for every theme in the course. Oral presentation of work in groups by students. Written assignments are to be submitted two/three weeks after completion of the intensive part of the course. These are performed in groups. Submission written project assignment.
Recommended previous knowledge:	Target group: Master's and PhD students, Tech Trans personnel, Biotech/Medtech staff
Required previous knowledge:	Bachelor's degree or equivalent.
Mode of assessment:	Report Letter grades (A-F)
Host department:	Department of Biology
Course coordinator:	Professor Berit Johansen

Learning outcome

Knowledge: The candidate shall have knowledge about:

- aspects involved in tranforming a research project to commersial product
- IP management;
- patenting; basics, process, national/international law, regulations, practising, similarities/differences;
- scientific versus commercial aspects on patenting strategy/IP evaluations;
- processes involved in transforming a research product to a clinical product;
- models for sale of IP, licensing versus sale;
- business development: IP, business plan, coworkers, financing.

Skills: The candidate can:

- identify and describe the different processes important for conservation of intellectual property of an invention and how to commercialize;
- identify and describe criteria and processes for sale of IP, including business development.

General competence: The candidate can:

- identify and explain principles in processes regulating protection and sale of IP.

Academic content

Topics that will be covered in the course include:

- Patenting: Principles, process, national/international laws, regulations and practice, similarities/differences between European and US patenting laws and practise.
- IPR strategies: Scientific/commercial aspects, how to develop an IP strategy to accelerate the innovation process and to safeguard IP investments, mastering freedom to operate in the Biotech/MedTech industry, Patent litigations, infringements and enforcements.
- Licensing: Models and negotiation strategies.
- Clinical testing: Design, implementation, analysis and presentation of clinical trials, adaptive clinical trial designs.
- Bio-tech/Med-tech business development: Strategy and organization when transferring a scientific idea into a commercial product/business, business plan development, product pipeline analysis, market analysis, market potential prediction, alliance structures and negotiation conditions, capital capture (pre-seed, seed, VC).

Target group: master's and PhD students, Tech Trans personnel, Biotech/Medtech staff, university academic staff.

BI3021	**Special Zoo Physiology**
Credits:	15
Period:	Both (autumn + spring)
Teaching methods:	Lectures and seminars: 72 hours (compulsory)
Required previous knowledge:	BI2020, BI2025 or similar
Compulsory activity:	Attendance at seminars
Mode of assessment:	Oral examination Letter grades (A-F)
Host department:	Department of Biology
Course coordinator:	Professor Claus Bech

Learning outcome

On completion of the course the students should be familiar with physiological processes and the relation between structure and function. Students should also have knowledge of basic equipment, techniques and methods in physiological science.

Academic content

The course provides an introduction to physiological processes and the relation between structure and function. Students will present current research literature in discussion groups, and write scientific reports. BI 3021 includes a methodical course that will familiarise the students with basic equipment, techniques and methods in zoological science. On completion of the methodical course students will also be familiar with scientific literature, literature sources and methods for handling of biological data.

FI3107	Biotechnology and Ethics
Credits:	7.5
Period:	Autumn
Teaching methods:	Lectures, plenary discussions, group work About the essay: The essay topic must be approved by the course instructors. The essay should be approx. 12 pages long in 12-point Times New Roman, 1.5-line spacing. The essay should be based on reading of the student's own choice (100-150 pages), in addition to 200 pages of obligatory readings. The essay should be argumentative. The essay can be written in either Norwegian or English. The essay should be submitted to the Department of Philosophy and Religious Studies (Dragvoll).
Compulsory activity:	Exercise, presentation. Compulsory attendance to lecture.
Mode of assessment:	Assignment. Letter grades (A-F)
Host department:	Department of Philosophy
Course coordinator:	To be announced

Learning outcomes

The students will acquire an overview of essential issues related to the development and application of modern biotechnology. They should be able to analyze these issues and to discuss and reflect on how to solve problems within this field, both orally and in writing.

Academic content

FI3107 reviews the ethical debate concerning both the research and application of modern biotechnology in a broad sense. Biotechnology is discussed in view of relevant ethical theories, worldviews, and central historical examples and lines of development. Relevant topics are debates concerning assisted reproduction, animal experimentation, organ donation, genetic improvement, the use of genetic information, selective abortion and euthanasia. Other issues of importance are precaution and risk assessment in relation to applications of biotechnology in agriculture and aquaculture.

KLH3100	Introduction to Medical Statistics
Credits:	7.5
Period:	Autumn
Teaching methods:	Lectures and exercises. Approved exercises from the same or previous semesters are required to sit for the exam. Approved compulsory activities are valid for three subsequent semesters after approval.
Required previous knowledge:	The course is primarily intended for students admitted to a 2-year master's programme at the Faculty of Medicine, NTNU. Other students may be accepted after an individual evaluation.
Compulsory activitiy:	Exercise assignments
Mode of assessment:	4-hour written examination Letter grades (A-F)
Credit reductions due to overlapping courses:	HLS3550: 7.5 credits KLH3004: 7.5 credits KLMED8004: 5.0 credits MNFSIB1: 7.5 credits PH3003: 7.5 credits ST3000: 7.5 credits ST3001: 7.5 credits
Host department:	Department of Public Health and General Practice
Course coordinator:	Associate Professor Turid Follestad

Learning outcome

After completing the course KLH3100, the student should be able to

- select appropriate summary statistics and graphical displays for describing data for continuous and categorical variables in an empirical data set;
- describe and apply statistical methods for comparing a mean value or a proportion in one sample to a reference value, and for comparing mean values or proportions in two independent or paired samples;
- describe and apply the methods of correlation and simple linear regression for identifying associations or relationships between two continuous variables, and methods for evaluating agreement in repeated measures for continuous and categorical data;
- select the appropriate statistical method for analyzing a specific research question, study design and data set;
- perform statistical analyses to an empirical data set by means of a statistical software package (SPSS);
- interpret and present the results from statistical analyses, and critically evaluate the validity of the results in light of the assumptions for the chosen method.

Academic content

- Introduction to the statistical software package SPSS.
- Descriptive statistic for continuous and categorical variables (measures of location and spread, frequency tables, graphical display), probability and probability distributions, estimation, hypothesis testing, one- and two-sample tests on mean values (Student T-test), non-parametric tests (Wilcoxon signed-rank test and Mann-Whitney U test), tests on differences in proportions (cross-table analysis; chi-square test and McNemar's test, Fisher's exact test), correlation and simple linear regression, methods for assessing agreement (Kappa coefficient, Bland-Altman plot).

MOL3001	**Medical Genetics**
Credits:	7.5
Period:	Spring
Teaching methods:	Lectures, student presentations, laboratory course and alternative methods of teaching. The lectures and the exam will be in English. If few candidates, alternative exam arrangements may be used. Timetable: https://timeplan.medisin.ntnu.no/timetable_show.php
Recommended previous knowledge:	Biochemistry and basic genetics
Compulsory activities:	Laboratory course
Mode of assessment:	4-hour written examination Letter grades (A-F)
Host department:	Department of Laboratory Medicine, Children's and Women's Health
Course coordinator:	Associate Professor Wenche Sjursen

Learning outcome

After completing the course MOL3001 the student is able to:

- describe central examples of monogenic, polygenic and chromosomal disorders;
- recognise patterns of mendelian inheritance of monogenic diseases, and explain genetic and biochemical mechanisms of some central monogenic disorders;
- describe and understand mechanisms underlying numerical and structural chromosomal aberrations and principles mediating chromosomal disease;
- describe what genetic counselling and risk assessment are;
- discuss bioethical issues in medical genetics;
- describe and understand central principles and examples of both sporadic and hereditary cancers;

- describe and understand principles for methods of genetic diagnosis, i.e. gene tests and cytogenetic methods;
- describe and understand principles and methods for gene mapping;
- calculate frequencies of genetic variants at individual and population based level.

Academic content
The course will give an overview of mechanisms for development of genetic diseases. Topics include different patterns of inheritance, like dominant, recessive, autosomal and sex linked inheritance. Genetic diseases will be classified in single-gene, chromosomal and multifactorial disorders. It will be discussed how identification of genes and variants in the genome, including gene mapping, make it possible to understand how variation can lead to disease.

MOL3005	**Immunology**
Credits:	7.5
Period:	Autumn
Teaching methods:	Lectures and colloquiums (not compulsory). The language of teaching is English. Timetable: https://timeplan.medisin.ntnu.no/timetable_show.php Information will be communicated on It's learning.
Recommended previous knowledge:	Basic knowledge within cell biology and biochemistry/molecular biology.
Mode of assessment:	4-hour written examination Letter grades (A-F)
Credit reductions due to overlapping courses:	BI2013: 7.5 credits MNKBI213: 7.5 credits
Host department:	Department of Laboratory Medicine, Children’s and Women’s Health
Course coordinator:	Researcher Ingvild Bjellmo Johnsen

Learning outcome

After completing the course MOL3005 the student is able to:

- demonstrate the basic knowledge of immunological processes at a cellular and molecular level;
- define central immunological principles and concepts;
- outline, compare and contrast the key mechanisms and cellular players of innate and adaptive immunity and how they relate;
- understand the principles of central (antibody-based) immunological methods to an extent that he/she can set up a theoretical experiment;
- elucidate the genetic basis for immunological diversity and the generation of adaptive immune responses;
- outline key events and cellular players in antigen presentation, and how the nature of the antigen will shape resulting effector responses;
- identify the main mechanisms of inflammation;
- understand the principles governing vaccination and the mechanisms of protection against disease;
- understand how immunodeficiencies related to disease;
- understand and explain the basis of allergy and allergic diseases.

Academic content

The immune system governs defense against pathogens and is of importance for development of autoimmune diseases, allergy and cancer. The course discusses basic immunology including cellular and molecular processes that represents the human immune system. Subjects to be presented include cells and organs of the immune system, antigen, immunoglobulins and antibody diversity, molecular mechanisms of innate and adaptive immunity, the complement system, antigen presentation, cell-

mediated effector responses, immunological techniques and select lecture on the immune system in health and disease.

MOL3010	**Animal Cell Culture**
Credits:	7.5
Period:	Autumn
Teaching methods:	Self-tuition. The language of the examination is English.
Recommended previous knowledge:	Basic knowledge in cell biology and biochemistry.
Mode of assessment:	Oral examination Letter grades (A-F)
Host department:	Department of Laboratory Medicine, Children's and Women's Health
Course coordinator:	Post Doctor Caroline Hild Hakvåg Pettersen

Learning outcome

After completing the course MOL3010 the student is able to:

- demonstrate knowledge of basic cell culture techniques;
- demonstrate knowledge of establishment of cell inlines and their maintenance;
- demonstrate knowledge on design and use the cell culture facilities;
- critically evaluate cell cultures constraints and possibilities as an in vitro model;
- discuss the advantages and limitations of primary cell culture compared to immortalized or transformed cell lines.

Academic content

The course will focus on practical aspects of cell culture, like design and layout of the laboratory, aseptic technique, cloning and selection of specific cell types, contamination, methods for measuring viability and cytotoxicity, cell culture environment (substrate, gas phase, medium) and the culturing of specific cell types.

MOL3014	**Nanomedicine I - Bioanalysis**
Credits:	7.5
Period:	Autumn
Teaching methods:	The syllabus of the course is defined by the learning objectives. The course is based on lectures given by experienced researchers within each theme. The course includes a compulsory project providing an in-depth review of the primary litterature, which will account for 25 % of the final grade. There might be simple lab exercises dependent on number of students enrolled. The language of instruction is English. Timetable: https://timeplan.medisin.ntnu.no/timetable_show.php
Recommended previous knowledge:	Basic skills in molecular biology, cell biology, chemistry, physics. Most suited for students who have completed courses in basic molecular and cell biology.
Mode of assessment:	4-hour written examination – 75 % of the final grade Exercise / Project – 25 % of the final grade Letter grades (A-F)
Host department:	Department of Cancer Research and Molecular Medicine
Course coordinator:	Professor Øyvind Halaas

Learning outcome

After completing the course MOL3014 the student is able to:

- understand how nanotechnology can be tailored and used for biomedical purposes;
- understand the problems and possibilities for analysis of proteins, nucleic acids and cells by micro fabricated devices and nanotechnological solutions;

- outline fabrication procedures and general considerations for microfluidics;
- understand how nano-relevant instruments such as focused ion beam scanning electron microscopes, atomic force microscopes and optical microscopes can be used in biomedicine;
- perform simple micro fabrication procedure;
- find, refer and consider relevant information.

Academic content

This course will cover fundamentals of bioanalysis and module integration for applications. In detail the course will contain:

- Advanced protein and DNA chemistry.
- Methods for quantification and identification of DNA/RNA and protein with focus on technical principles and emerging nanotechnologies.
- Use of imaging in nanoscale for biomedical research.
- Microfluidics.
- Principles for and contruction of lab-on-a-chip and biosensors.
- Nanoneuroscience.

This course is focused on technology rather than biology.

MOL3015	**Nanomedicine II - Therapy**
Credits:	7,5
Period:	Spring
Teaching methods:	The syllabus of the course is defined by the learning objectives. The course is based on lectures given by experienced researchers within each theme. The course includes a compulsory project providing an in-depth review of the primary litterature, which will account for 25 % of the final grade. The language of instruction is English. The lectures are held in the spring semester and start in early February. Timetable: https://timeplan.medisin.ntnu.no/timetable_show.php
Recommended previous knowledge:	Basic skills in molecular biology.
Mode of assessment:	4-hour written examination – 75 % of the final grade Exercise / Project – 25 % of the final grade Letter grades (A-F)
Host department:	Department of Cancer Research and Molecular Medicine
Course coordinator:	Professor Øyvind Halaas

Learning outcome

After completing the course MOL3015 the student is able to:

- understand how nanotechnological approaches can be used in biomedical therapies;
- understand biomaterials and interaction of biomaterials with cells, body fluids and tissues;
- understand basic stem cell biology and corresponding requirement for tissue engineering;
- understand the need, obstacles and solutions for polymeric, lipidous and solid nanosized drug delivery systems;
- understand the toxicological aspects of nanosized surfaces and particles;
- find, refer and evaluate available information.

Academic content

The course will introduce use of nanotechnology in therapy. In detail, the course will cover

- Clinical biomaterials, tissue regeneration, including stem cell technology, immunological limitations and encapsulation strategies.
- Methods and possibilities for drug discovery.
- Use and design of nanoparticles for gene therapy, drug delivery and drug targeting.

- Physiological, cellular and toxicological limitations for medical use of nanoparticles.
- Theranostics, the combined use of in vivo imaging/diagnostics and therapy.
- Ethical, legal and social aspects (ELSA) related to use of medical nanotechnology will be discussed.

A written report is included, where the student will choose a theme from the lectures, review the literature, describe current methods, consider and recommend use of emerging nanotechnologies in a therapeutic setting.

MOL3018	**Medical Toxicology**
Credits:	7.5
Period:	Spring
Teaching methods:	Lectures. The language of instruction and examination is English. The course is taught in the spring semester, and starts in late January or early February. Timetable: https://timeplan.medisin.ntnu.no/timetable_show.php
Recommended previous knowledge:	Passed examinations in BI1001 and BI1004, or TBT4100 and TBT4105 (or similar courses).
Required previous knowledge:	Basic knowledge of physiology, chemistry, biochemistry and mathematics.
Mode of assessment:	4-hour written examination Letter grades (A-F)
Credit reductions due to overlapping courses:	TOKS1010: 7.5 credits TOKS3010: 7.5 credits
Host department:	Department of Cancer Research and Molecular Medicine
Course coordinator:	Associate Professor Bent Håvard Hellum

Learning outcome

After completing the course MOL3018, the student is able to:

- describe and explain toxicological mechanisms;
- perform simple analysis of how some chemicals might be a possible health hazard upon exposure;
- explain how certain xenibiotics in the environment and work can have toxic effects on central organs and organ systems in humans;
- collect relevant background data regarding toxicologial problems.

Academic content

The course gives an introduction to general pharmacokinetic models. Liver, kidney, lung, the immuno- and nervous system will be discussed as target organs for chemical toxicity. Groups of toxic agents and substances of abuse will also be included. Major weight will be put on available methods for risk assessment of human expose to cancer and non-cancer agents.

MOL3020	**Virology**
Credits:	7.5
Period:	Spring
Teaching methods:	Lectures and alternative methods of teaching. Teaching and exam will be in English. If few candidates sign up alternative examination may be considered and used. Timetables for courses at the Faculty of Medicine are available at https://timeplan.medisin.ntnu.no/timetable_show.php
Recommended previous knowledge:	Knowledge in microbiology, cell biology, biochemistry, and molecular biology
Mode of assessment:	4-hour written examination Letter grades (A-F)
Host department:	Department of Laboratory Medicine, Children's and Womens Health
Course coordinator:	Professor Marit Walbye Anthonsen

Learning outcome

After completing the course MOL3020, the student is able to:

- demonstrate a general knowledge in molecular virology;
- describe elements of the viral life cycle;
- explain viral replication strategies;
- describe viral recognition mechanisms and immunological defense responses;
- discuss principles of virus pathogenesis;
- outline viral molecular epidemiology;
- explain vaccine strategies and mechanisms of antiviral drugs.

Academic content

The course will give an overview of medically important virus families, their replication strategies and mechanisms for development of viral infectious diseases.

Topics will include taxonomy, replication strategies, pathogenicity and transmission of viruses and, additionally, diagnosis, prevention and treatment of viral diseases. Antiviral immunity and viral immuno-evasion will also be covered. Common human viral infections will be the main focus of the course, and emphasis will be put on virus-host interactions as a key to understanding the diversity of viruses and viral diseases.

NEVR3040	**Private Study of Neuroscience I**
Credits:	7.5
Period:	Autumn / spring
Teaching methods:	Private study. The language of examination is English.
Entry requirement:	Admission to the Master of Science in Neuroscience.
Recommended previous knowledge:	Passed NEVR3001, NEVR3002, NEVR3003 and NEVR3004.
Mode of assessment:	Oral examination. Letter grades (A-F)
Credit reductions due to overlapping courses:	NEVR3050 7.5 credits
Host department:	Department of Neuroscience
Course coordinator:	Post Doctor Tora Bonnevie

Learning outcomes

After completing the course NEVR3040, the student

1. has detailed knowledge about a specific topic in neuroscience;
2. is capable of applying this knowledge to obtain an advanced functional understanding, ranging from underlying mechanisms to general principles;
3. can obtain relevant published information on that topic;

4. can critically assess and integrate published scientific information into a coherent and scientifically acceptable summary.

Academic content

The course consists of an individual curriculum associated with the master's thesis. The topic may, but does not have to be related to the thesis. The examination is normally held at the same day as the master's thesis examination, and with the same examiner.

NEVR3050	**Private Study of Neuroscience II**
Credits:	15
Period:	Autumn / spring
Teaching methods:	Private study, 2-3 semesters. The language of examination is English.
Entry requirements:	Admission to the Master of Science in Neuroscience.
Recommended previous knowledge:	Passed NEVR3001, NEVR3002, NEVR3003 and NEVR3004.
Mode of assessment:	Oral examination. Letter grades (A-F)
Credit reductions due to overlapping courses:	NEVR3040 7.5 credits
Host department:	Department of Neuroscience
Course coordinator:	Post Doctor Tora Bonnevie

Learning outcomes

After completing the course NEVR3050, the student:

1. has detailed knowledge about a specific topic in neuroscience;
2. is capable of applying this knowledge to obtain an advanced functional understanding, ranging from underlying mechanisms to general principles;
3. can obtain relevant published information on that topic;
4. can critically assess and integrate published scientific information into a coherent and scientifically acceptable summary.

Academic content

The course consists of an individual curriculum associated with the master's thesis. The topic may, but does not have to, be related to the thesis. The examination is normally held at the same day as the master's thesis examination, and with the same examiner.

NEVR8014	**Laboratory Animal Science for Researchers**
Credits:	7.5
Period:	Autumn
Teaching methods:	Lectures, study groups and individual assignments. The course consists of 35 hours of lectures (given in week 47), 24 hours of self-tuition (group work and individual home assignments) and 21 hours of practical training. The home assignment must be submitted and passed before written exam can take place. Students who have followed the theoretical lectures, passed the home assignement and passed the written exam will receive a FELASA dimploma. This diploma is valid together with a practiacal training document. The requirements are set by the Department of Agriculture (http://oslovet.veths.no/Oppl/nye.html#KatC). You must arrange the 3 days of practical training yourself. This is usually done in your own research group. The training must be supervised by a person with FELASA C or B competence. Then the practical training documentation must be signed and approved by the local competent person at your laboratory animal facility.
Recommended previous knowledge:	Biomedical education, courses in statistics, knowledge of literature search on the internet and in the library.
Required previous knowledge:	A 3-year education on university or college level is a prerequisite in order for the participant to use the title "FELASA category C, Researcher" when the compulsory activities (see the below) have been carried out. Enrolment in a PhD programme, master programme or at "forskerlinjen" in medicine at NTNU. PhD and "forskerlinje" students at the medical faculties at the universities in Bergen, Oslo and Tromsø are given access according to a mutual agreement between these institutions. Others are referred to the course MDV6003.
Compulsory activities:	Lectures (five days)
Mode of assessment:	4-hour written examination – 70 % of the final grade Report – 30 % of the final grade Passed/not passed
Host department:	Department of Cancer Research and Molecular Medicine
Course coordinator:	Clinic Veterinarian Siv Eggen

Learning outcome

After completing the course NEVR8014 the student:

- shall know the principles behind modern theory on animal experiments and welfare
- knows the legislature regulating the use of lab animals in Norway
- knows the potential health hazards related to animal experiments, and how to minimize these hazards
- understands the significance of the internal and external factors influencing a lab animal and which thereby may influence the outcome of the experiment
- knows roughly how to monitor the health of lab animals
- understands the most important principles for chosing methods for handling and treating lab animals
- understand the principles behind anaesthesia, analgesia and humane killing of lab animals
- understands the general principles for planning animal experiments, including quality control and know of the potential alternatives and supplements to animal experiments which exist
- is able to evaluate a published article on animal experiments with emphasis on how the animals are described and used and know of and be able to use guidelines for good reporting of animal experiments
- has insight into the most important factors which decide the running of a research department using lab animals and be able to do a simple evaluation of a department

- has an attitude towards the lab animals which reflect "the three R's" with focus on animal protection and animal welfare (Replace, Reduce, Refine).

Academic content

FELASA = Federation of Laboratory Animal Science Associations. We follow their minimum recommendations for education and training for researchers (FELASA C researcher). This means that you most likely can travel with your Diploma (FELASA C) to other European countries and work with Laboratory animals. But other countries might ask for additional training and have more stringent rules. The course will focus on the following topics: Legislation, Ethics and views in society; the course of events in animal experiments; biology of lab animals; the choice of species; genetical and environmental factors influencing animal experiments; health hazards; principles concerning the handling of animals, anesthesia, analgesia and humane killing of lab animals; evaluation and quality control of animal experiments; reporting; alternatives to animals experiments; literature search. The course is divided into two sections; a general section (3 days) and a selectable section (2 days) where the students can choose between traditional laboratory animals and fish/aquatic organisms. Course participants should select their specialization on the basis of the animals they will work with after the course. Traditional animals specialization: laboratory animals biology, health monitoring, anesthesia and euthanasia, ethology, genetics, transgenic animal models, handling techniques. Fish specialization: Legislation concerning fish, experimental conditions, stress, biorythms and acclimatization, pain and suffering, anesthesia, handling, surgical procedures and euthanasia, aggression and hierarchy formation, health monitoring and microbiological qualities, transgene fish.

PSY3110	**Learning, Behaviour and Environment**
Credits:	7.5
Period:	Autumn
Teaching methods:	Lectures and seminars
Recommended previous knowledge:	A bachelor’s degree or equivalent.
Mode of assessment:	4-hour written examination Letter grades (A-F)
Host department:	Department of Psychology
Course coordinator:	Associate Professor Kjellrun Tora Englund

This course is taught in Norwegian.

Learning outcomes

Knowledge: The student has a thorough knowledge of learning, skill development and learning processes in a lifetime perspective. The emphasis is on the reflecting on and the understanding of the interaction between behavior and environment.
Skills: The student can independently apply relevant psychological theories and empirical findings to analyze defined theoretical issues and empirical phenomena related to learning, skill development and the learning process.
General competence: The student has insight into and can communicate in writing the relevant field and illustrate subject issues.

Academic content

This course provides an overview of key developing psychological issues such as inheritance versus environment, dynamic systems theory and learning psychological issues such as learning processes, learning principles, social and cognitive processes in learning, biological processes in learning, abilities versus skills, flow and learning. In this course, importance will also be placed on understanding developmental and learning difficulties as well as gain an understanding of the processes that makes some people unable to perform at a high level. This course is also open for students from other disiplines than psychology. For students who do not have a bachelor’s degree in

Psychology, the course lecturer will recommend some background literature in addition to the curriculum.

PSY3111	**Individual Development, Genes, Neural System and Behaviour**
Credits:	7.5
Period:	Autumn
Teaching methods:	Lectures and seminars
Recommended previous knowledge:	A bachelor's degree or equivalent.
Mode of assessment:	4-hour written examination Letter grades (A-F)
Host department:	Department of Psychology
Course coordinator:	To be announced

This course is taught in Norwegian.

Learning outcomes

After completed course, the student possesses a principal understanding of the biological fundament linked to perception, behavior, and development. This consciousness builds on a thorough knowledge about selected issues in cognitive neuroscience.

Knowledge: The student have a basic knowledge about genetics and the origin/development of the nervous system, plus an in-depth understanding of the biological/cognitive aspects linked to specific topics including language, motor function, sensory systems, and mental disorders. Furthermore, the student possesses a general understanding of the plasticity characterizing the nervous system and a particular knowledge about neural principles underlying learning.
Skills: The student possesses a specific ability of analysing psychological phenomena from a biological/cognitive perspective. Besides, the student have a particular recognition of the plasticity characterizing the neural system.
General competence: The student possesses a general understanding of science as a subject funded on objective knowledge. Particularly, the student have a well-developed ability of analysing scientific theory in an independent and critical way.

Academic content

The course is a theoretical advanced course in cognitive and biological psychology with a focus on individual development. Factors such as genes, nervous system and behavior will be discussed, and the interaction between these factors and environment in relation to an individual's development. This course provides a review of the biological / cognitive basis of experience and behavior through to the entire range of human recognition, from attention, sensory, perception, action, language processes, problem solving, and thinking to learning and memory. This course provides students with knowledge of central concepts, themes, research problems and empirical research findings in social-cognitive, cognitive and biological psychology. This course is also open for students from other disiplines than psychology. For students who do not have a Bachelor degree in Psychology, the course lecturer will recommend some background literature in addition to the curriculum.

TBT4145	**Molecular Genetics**
Credits:	7.5
Period:	Autumn
Teaching methods:	Lectures, laboratory work (intensive lab course). The course will be given in English. If there is a re-sit examination, the examination form may be changed from written to oral.
Recommended previous knowledge:	Background in biochemistry basic and advanced course (TBT4102 and TBT4107). The course has limited attendance. Please register for attendance in accordance with general deadlines.
Compulsory activity:	Assignments
Mode of assessment:	4-hour written examination Letter grades (A-F)
Credit reductions due to overlapping courses:	SIK4045 7.5 SP
Host department:	Department of Biotechnology
Course coordinator:	Associate Professor Martin Frank Hohmann-Marriott

Restricted admission. Application deadline 1 June (StudentWeb).

Learning outcomes

To understand how the genetic information in prokaryotic and eukaryotic organisms is organized and realized, and to acquire basic knowledge about the methods used to study these topics. It will be important to understand a link between bioinformatics and laboratory-based experiments. The students should also obtain a basic understanding of how this knowledge can be used in applied biotechnology, and be able to suggest experimental solutions to common problems occurring in basic and applied molecular genetic research.

Academic content

The course aims at providing an introduction to the basic principles of the molecular genetics of prokaryotic and eukaryotic organisms. The main areas of recombinant DNA technology applications will also be covered. Examples of important topics that will be discussed are: gene organization in pro- and eukaryotes, regulation of transcription and translation, techniques in recombinant DNA technology, bioinformatics in gene and genome analyses, biotechnolgical applications of molecular genetics.

TFY4265	**Biophysical Micromethods**
Credits:	7.5
Period:	Autumn
Teaching methods:	Lectures and laboratory excercises. Teaching will be in English if students on international master programs are attending the course. When lectures and lecture material are in English, the exam may be given in English only. The re-sit examination (in August) may be changed from written to oral.
Recommended previous knowledge:	Background in Cell Biology. Basic Physics at the university level.
Compulsory activity:	Laboratory assignments and report
Mode of assessment:	Portfolio assessment is the basis for the grade in the course. The portfolio includes a 4-hour written exam (70 %) and exercises (30 %). The results for the parts are given in percent scores, while the entire portfolio is assigned a letter grade. A re-sit examination may be changed from written to oral.
Credit reductions due to overlapping courses:	FY8906 7.5 credits, FY8410 5.0 credits, SIF4071: 7.5 credits.
Host department:	Department of Physics
Course coordinator:	Associate professor Magnus Borstad Lilledahl

Learning outcomes

The student should have knowledge concerning the mechanism of molecular exitation and deexitation as well as understand the interaction between light and biological samples. The student should have knowledge about the central techniques within lightmicrosopy as well as practical knowledge concerning the operation of a selection of these techniques. This includes an understanding of the construction, mode of function as well as application area of the following microscopy techniques: - Bright field microscopy with different contrast techniques (Phasecontrast-, Differentiel interference-, Modulationcontrast-, Polarisation-, Darkfield-, Reflection interference contrast microscopy (RICM)). - Epiilluminationmicroscopy, including Fluorescencemicroscopy, Confocal laser sanning microskopy, Multiphotonmicroskopy. - Total internal reflection interference microskopy. - Stimulated emission depletion microscopy (STED). - Nearfield microscopy. The student should have knowledge concerning the design and moe of funtion of Flowcytometry. The student should have knowledge concerning the mode of function of the following detectors: The human eye, Photon multiplicator tubes (PMT), Photodiodes, Videocamera, CCD camera. The student should have knowledge concerning the construction, mode of function and application area of optical tweezers. This includes knowledge concerning the prosesses underlying the trapping of particles with light as well as an understanding of the determination of forces using optical tweezers. The student should have knowledge concerning the construction, mode of function and application area of atomic force microsscpy. This includes knowledge converning intermolecular forces, different imaging modes and dynamic force spectroscopy. The student should have knowledge concerning electronmicroscopy and its use for the study of biological samples. This includes knowledge concerning the interaction electrons – biological samples, electron optics, transmission electronmicroscopy (TEM), scanning elektronmicroscopy (SEM), scanning transmission electronmicroscopy (STEM) and preparation techniques for electronmicroscopy. The student should have knowledge concerning bionanophotonics and microarray technology (DNA and protein microarrays). The student should have skills concerning interpretation and presentation of scientific data obtained during the pratical work in the laboratory. The student should have skills concerning reading of research literature and both written and oral presentation of the content of this literature.

Academic content

The course gives an introduction into the mode of different types of instrumentation that is important for studies of biological macromolecules, cells and other soft materials. The course aims at providing an understanding of the mode of function of the components that the instrumentation consists of as

well as a theoretical and practical understanding of how to operate the instrument, including i.e. calibration procedures and maintenance. For each instrument the presentation of the components and the operation principles will be followed by examples of high quality resent research data obtained when using the instrumentation.

TFY4280	**Signal Processing**
Credits:	7.5
Period:	Spring
Teaching methods:	Lectures, calculation assignments, compulsory computer laboratory exercises (MATLAB). When lectures and lecture material are in English, the exam may be given in English only. Students are free to choose Norwegian or English for written assessments. The re-sit examination (in August) may be changed from written to oral.
Recommended previous knowledge:	Basic physics, mathematics and statistics
Compulsory activity:	Laboratory assignments
Mode of assessment:	4-hour written examination Letter grades (A-F)
Credit reductions due to overlapping courses:	SIF4076 7.5 SP
Host department:	Department of Physics
Course coordinator:	Professor Pawel Tadeusz Sikorski

Learning outcomes

The student is expected to:

1. obtain, through a combined theoretical and experimental approach to the subject, a fundamental understanding of signal processing and needed theoretical and mathematical background to describe signals and systems, experimental measurement signals and time series;
2. learn how to analyze various problems in signal processing using mathematical methods involving differential and integral calculus, as well as ICT-based/numerical methods by using Matlab.

Academic content

The course focuses on basic tools in analysis of analogue and digital signals and systems. Time and frequency domain description of signals. Use of Laplace, Fourier, and Z-transforms. Basic analogue and digital filter design, frequency response, data sampling. Excitation-response analysis of linear systems. Description and analysis of stochastic signals and measured signals with noise, correlations and energy spectrum analysis. Analysis of signals and systems using mathematical methods involving differential and integral calculus, as well as numerical methods using Matlab.

TFY4310	**Molecular Biophysics**
Credits:	7.5
Period:	Autumn
Teaching methods:	Lectures, problem solving and laboratory exercises. Portfolio assessment is the basis for the grade in the course. The portfolio includes a final written exam (80%), problem solving (10%) and lab exercises (10%). The results for the different parts are given in %-scores, while the entire portfolio is assigned a letter grade. For students that have completed the laboratory exercises in years where these have not been graded, the exam will have a weight of 90%. The exam may be given in English only. The re-sit examination (in August) may be changed from written to oral.
Recommended previous knowledge:	Knowledge in physics, mathematics and chemistry according to three years university studies in physics.
Compulsory activity:	Laboratory assignments
Mode of assessment:	4-hour written examination Letter grades (A-F)
Credit reductions due to overlapping courses:	SIF4090 7.5 SP
Host department:	Department of Physics
Course coordinator:	Associate Professor Rita de Sousa Dias

Learning outcomes

By the end of the course the student should be able to:

- describe the main types of intramolecular and intermolecular interactions and explain how these affect (i) the conformation and other dynamic properties of macromolecules, and (ii) the interactions between macromolecules and other solutes in aqueous solution;
- explain the theory behind the most important techniques used to study the physical, thermodynamic, hydrodynamic, spectroscopic and scattering properties of biological molecules and molecular assemblies, and enumerate the advantages and disadvantages of each one;
- predict and discuss the applicability of the studied techniques to a variety of biophysical systems;
- operate selected instrumental set-ups, interpret the obtained data, and summarize the results in written reports.

Academic content

The course focuses on the application of selected topics within physics to describe the molecular properties of biological molecules and biopolymer assemblies, and some of the most commonly used techniques for the determination of these properties.

TFY4320	**Physics of Medical Imaging**
Credits:	7.5
Period:	Spring
Teaching methods:	Lectures and mandatory laboratory assignments or demonstrations. Teaching will be in English if students on international master programs are attending the course. When lectures and lecture material are in English, the exam may be given in English only. Students are free to choose Norwegian or English for written assessments. The re-sit examination (in August) may be changed from written to oral.
Recommended previous knowledge:	Course TFY4225 Nuclear and Radiation Physics or equivalent is required.
Compulsory activity:	Laboratory assignments
Mode of assessment:	4-hour written examination Letter grades (A-F)
Credit reductions due to overlapping courses:	SIF4094 7.5 credits
Host department:	Department of Physics
Course coordinator:	Associate Professor Pål Erik Goa

Learning outcomes

The student acquires knowledge about physical priciples and methods used in medical diagnostics based on medical imaging. This includes being able to explain principles and implementations of computed tomography (CT) based on the use of nuclear medicine, roentgen X-rays, and magnetic resonance. The student can explain different forms of imaging by ultrasound, and how such imaging is principally different from CT-based imaging. The student acquires skills in evaluating performance parameters, application areas, as well as advantages and disadvantages of different modalities of medical imaging.

Academic content

Medical imaging modalities based on nuclear medicine (SPECT, PET), X-ray computed tomography (CT), ultrasound, and magnetic resonance imaging. Theory for image formation, image noise, image reconstruction and image processing. Quality assurance of medical imaging diagnostics.

TMA4255	**Applied Statistics**
Credits:	7.5
Period:	Spring
Teaching methods:	Lectures, exercises and works (projects). Portfolio assessment is the basis for the grade awarded in the course. This portfolio comprises a written final examination (80%) and works (projects) (20%). The results for the constituent parts are to be given in %-points, while the grade for the whole portfolio (course grade) is given by the letter grading system. Retake of examination may be given as an oral examination. The lectures may be given in English. If the course is taught in English, the exam may be given only in English. Students are free to choose Norwegian or English for written assessments.
Recommended previous knowledge:	ST0103 Statistics with Applications TMA4240 Statistics/TMA4245 Statistics, or equivalent
Compulsory activity:	Assignments
Mode of assessment:	Portfolio assessment is the basis for the grade awarded in the course. This portfolio comprises a written final examination 80% and selected parts of the exercises 20%. The results for the constituent parts are to be given in %-points, while the grade for the whole portfolio (course grade) is given by the letter grading system. Retake of examination may be given as an oral examination.
Credit reductions due to overlapping courses:	SIF5066, ST2202, ST2304, TMA4260: 7.5 credits TMA4267: 5 credits
Host department:	Department of Mathematical Sciences
Course coordinator:	Professor Bo Henry Lindqvist

Learning outcomes

1. Knowledge:
The student has a good basic understanding of the most popular statistical models and methods that are used in science and technology. This includes testing of hypotheses, linear regression, experimental design, analysis of variance, error propagation, process control, analysis of contingency tables and non-parametric methods.

2. Skills:
The student knows how to design an experiment to study a phenomenon of interest. Further, he or she knows how to collect informative data of high quality, and subsequently to analyse the collected data using statistical software. The student knows how to present the results from the statistical analyses to colleagues within his or her field of study, and how to use the results of the statistical analysis to draw conclusions about the phenomenon under study.

Academic content

Hypothesis testing. Simple and multiple linear regression. Model choice. Experimental design, including two-level factorial design. Error propagation formula. Analysis of variance. Process control. Contingency tables. Non-parametric methods. Use of statistical computer package.