2-year SDC *Masters degree in Neuroscience and Neuroimaging* (Life Science)

Introduction
The proposed interdisciplinary Master study in Neuroscience and Neuroimaging is the first of its kind in Denmark and combines subjects from the Technical, Natural, and Life Sciences with the aim of producing graduates with state-of-the-art theoretical, technical, and clinical knowledge within neuroscience and neuroimaging. In particular, the broad approach to the field of neuroimaging, including the theory and engineering aspects underlying all cutting-edge image modalities is not offered as a master education anywhere else in Europe, The neuroimaging field is developing rapidly and it is, therefore, essential to train students in cutting-edge imaging techniques and theory in combination with a thorough insight in their use in neuroscience. This will fill a growing need for researchers and candidates in academic and industrial development. This expertise is in high demand in research that increasingly depends on interdisciplinary understanding and collaboration. By uniting the expertise of Danish neuroscientist within basic, molecular, and clinical neuroscience and PET/MR based neuroimaging with Chinese scientists trained in MEG and in the design of PET/MRI hardware, the study program offers a unique educational environment not seen anywhere in the world. In addition, the study program includes courses in basic neuroscience from the molecular level to the clinical setting describing the different neurological diseases, the treatment of these as well as the study of these including animal models used in neuroscience and neuroimaging research.

Perspectives for SDC *Masters in Neuroscience*
As the Masters study in Neuroscience is unique in Denmark and the combination of courses in neuroscience and Neuroimaging Hardware Design is not offered anywhere else, the graduates should be attractive to a number of neuroscience related fields. This includes PhD schools at the different universities focused on the study of neuroscience and neuroimaging e.g. the GP8: Neuroscience Graduate Programme at the Graduate School of Health Sciences, Aarhus University, the Neuroscience Graduate Programme at Copenhagen Graduate School of Health Sciences, University of Copenhagen, and the Copenhagen Image and Signal Processing Graduate School, Technical University of Denmark. In addition, the graduates extensive knowledge in brain imaging theory and techniques make them ideal candidates for the radiological and nuclear medicine departments at the hospitals that offers brain scanning as part of their diagnostic repertoire. Furthermore, the interdisciplinary master study prepares the graduates for employment at pharmaceutical and medicotechnical industrial companies with focus on neuroscience and neuroimaging research and development. The inclusion of courses in cutting edge imaging techniques as well as hardware design first of all produces unique graduates not educated anywhere else in the world but secondly, and most importantly, produces graduates that will be in high demand from companies specialized in the development and construction of brain scanners used in diagnostic imaging and in research.

Admission requirements for entering the Masters degree programme
Students with a Bachelor degree from a suitable major can enter the Masters degree programme. Two different groups of BSc degrees can grant admission to the Masters degree programme depending on the skills of the student:

I. Group 1; Passed mathematical subjects in basic calculus, linear algebra, vectors, matrices, complex numbers, and Fourier analysis as well as knowledge in digital signal processing and analysis. Eligible degrees include technical BSc degrees e.g. Electro-, Healthcare Technology-, Biomedical-, and Medicine and Technology Engineering as well as some natural science BSc degress e.g. Physics, Nanoscience, Medical chemistry or equivalent.

II. Group 2: Passed general physiology. Eligible BSc degrees include: Medicine and Pharmacology as well as some natural science BSc degrees e.g. Molecular Biology, Biochemistry and Molecular Biology, Biomedicine, Molecular Medicine, Molecular Biomedicine or equivalent.

General English language requirements ('English B level') According to the Danish Ministry of Science's Order no 181 of 23 February 2010 on Admission to Danish Universities, all applicants with non-Danish examinations to Master's programmes taught in English must document English language qualifications comparable to an 'English B level' in the Danish upper secondary school ('gymnasium').

Academic competences and qualifications

During this interdisciplinary master study, the graduates will obtain state-of-the-art competences and qualifications in imaging modalities as well as in neuroscience and will, thus, be well suited for positions in the medical imaging industry and related technical support organizations. Furthermore, the graduates will be qualified to enter neuroscience and/or neuroimaging graduate schools at higher educational institutions.
The graduates will master the theory behind different imaging modalities including ultra sound, X-ray/CT, fMRI, PET, and MEG/EEG as well as advanced and practical uses of these modalities. In relation to these competences, the graduates will be able to independently plan, perform, and analyze neuroimaging studies as well as conduct method development, optimization, and implementation. Therefore, the graduates should be able to participate in interdisciplinary research groups as the neuroscience and neuroimaging expert as well as in radiological and nuclear medical departments at hospitals. In addition, the graduates will be educated in hardware design, thus, qualifying the graduates for employment by companies or at institutions that develops scanner equipment. Based on the extensive knowledge of imaging modalities, the graduates will also be competent in the process of selection and purchase of advanced imaging equipment as well as in the clinical testing of novel imaging equipment.
The extensive knowledge in imaging modalities will be coupled with an expertise in neurological issues from molecular and cellular neuroscience and functional neuroanatomy to an understanding of neurological diseases and the use of model systems in neuroscience research. Thus, the graduates will master molecular, cellular and systemic components of the nervous system coupled with a profound knowledge of different neurological diseases, their clinical symptoms, underlying anatomical, physiological and molecular elements, as well as the current treatment of these diseases.
The graduates should also obtain skills in systematic and critical review of original literature and thereby be able to obtain a detailed overview about different research topics. Finally, the graduates should master communication to convey scientific issues and questions to the public and the scientific community.

In the table below is an outline of the relationship between the New Danish qualifications framework for higher education and the competence profile of the master education.

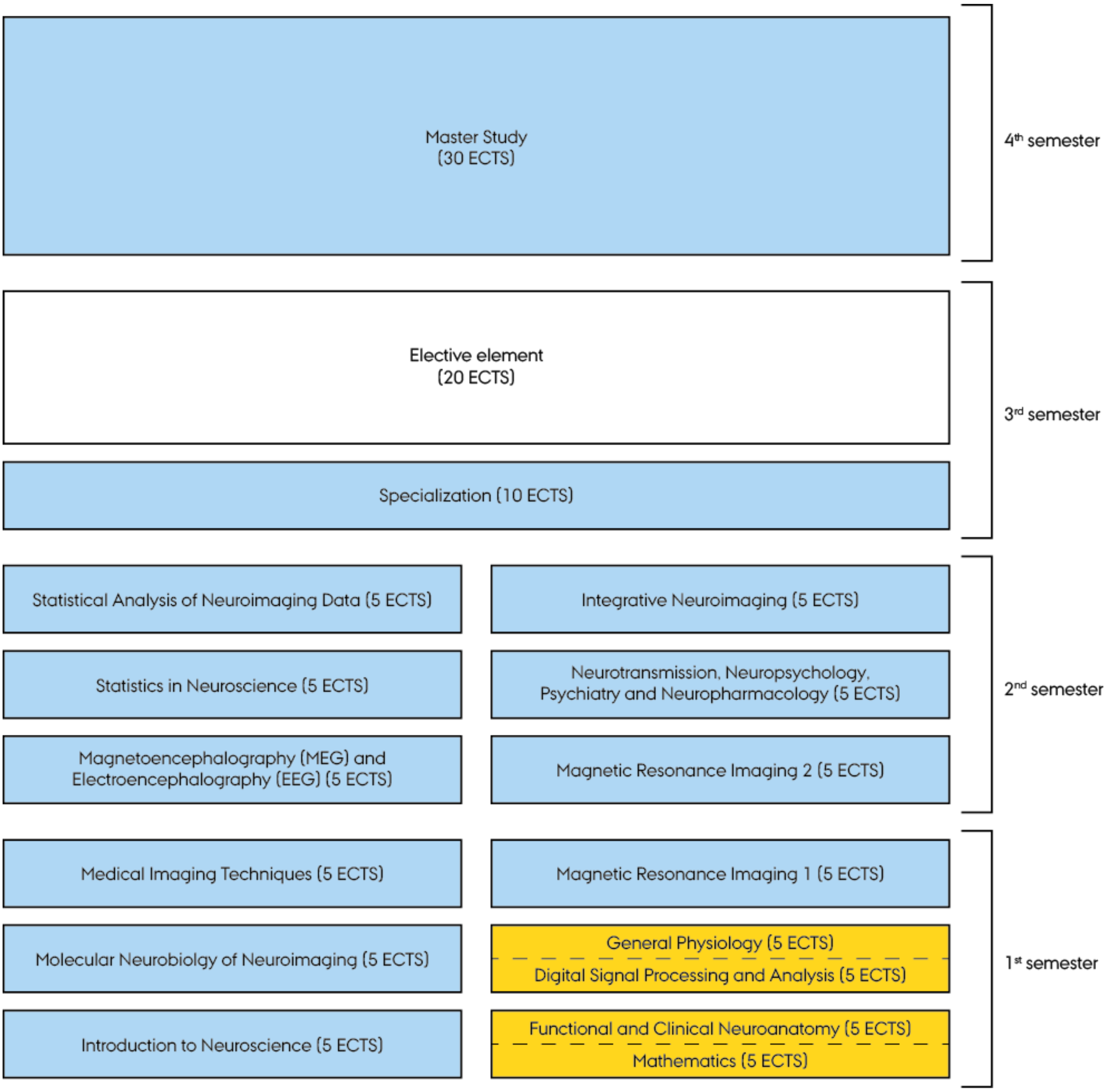
Master in Neuroscience and Neuroimaging		
Requirements for level as indicated by New Danish qualifications framework for higher education)		The competence profile / learning objectives of the education that fulfills the requirements

Knowledge	Should have knowledge that in some fields is based on the highest international research within one or more disciplines
	Must scientifically be able to understand and reflect on the knowledge of the discipline(s) and identify scientific issues.
		The graduates will have
		• Research based knowledge in
		  • Neuroanatomy and general physiology
		  • Mathematics and statistics related to the field
		  • Digital signal processing and analysis
		  • Molecular Neurobiology
		  • The different imaging modalities: ultra sound, MR, PET, SPECT, MEG, and EEG
		  • Diseases of the nervous system
		• An in-depth understanding of the knowledge in the above topics that enables the graduate to scientifically reflect on this knowledge to identify scientific problems within neuroscience and/or neuroimaging

Skills	Should master the scientific methods and tools of the discipline(s) as well as the general skills that are	The graduates will • Master technological skills

	connected to employment within the discipline(s). Must be able to evaluate and choose among the scientific theories, methods, tools and general skills of the discipline(s) and a on a scientific basis develop new analysis and solution models. Must be able to disseminate research-based knowledge and discuss professional and scientific topics with both peers and non-specialists.	within the topics of the education to perform scientific research, individually or as part of an interdisciplinary research collaboration • Be able to select the best scientific/technological approach to a given research problem based on the acquired theoretical, technical and practical skills from the courses of the education • Be able to develop, optimize, and implement new analysis and solution tools in neuroscience and neuroimaging alone or in collaboration with clinicians and/or researchers • Be able to communicate scientific achievements and professional topics to layman as well as the scientific community
Competencies	Must be able to manage work and development situations that are complex, unpredictable and require new approaches. Should be able to, independently, initiate and implement academically and interdisciplinary cooperation and to assume professional responsibility. Need to independently take responsibility for one's own professional development and specialization.	The graduates will be able to • Play a central role in the establishment of professional collaborations both interdisciplinary and within the disciplines of the education through the interdisciplinary approach combining topics form the technical, natural, and health sciences • Collaborate to develop and/or implement novel techniques and/or medicotechnical equipment • Educate health professionals in the use and operation of advanced neuroimaging equipment • Cope with complex and/or unpredictable scientific obstacles through the use of known methods in a novel setting or by developing new approaches • Keep updated within the neuroscience and neuroimaging field as well as within the chosen scientific specialization

Overview of SDC Master in Neuroscience and Neuroimaging



The layout of the study is two courses run in parallel for 4 weeks provisionally divided into a morning session with one subject and an afternoon session with the other subject. Exams will be conducted in the week after the 4-week course. Each session could contain lectures and/or theoretical exercises, which could be composed of reviews of original literature, student presentations, multiple-choice tests, essay questions, computer-assisted exercises (e.g. MATLAB) etc.

The constituting courses are marked in blue while the Elective Element (20 ECTS) is white. The yellow courses highlights the different courses for the two admission groups.

In the first teaching modules, the two different admission groups follows different courses based on their BSc degree (modules marked in yellow). Both groups have to follow the Introduction to Neuroscience and Molecular Neurobiology of Neuroimaging courses. Group 1 follows the courses in Functional and Clinical Neuroanatomy (5 ECTS) and General Physiology (5 ECTS) as outlined in the study plan above, while Group 2 will follow the Mathematics (5 ECTS) and Digital Signal Processing and Analysis (5 ECTS) courses.

At the end of the 2nd semester the students will select their 3rd semester Specialization (10 ECTS) and choose between advanced molecular neuroscience and advanced neuroimaging. For the advanced molecular neuroscience specialization, the students will follow Animal models in Neuroscience (5 ECTS) and Advanced Molecular and Systems Neurobiology (5 ECTS), while students choosing the advanced neuroimaging specialization will attend the courses in Magnetic Resonance Imaging 3 (5 ECTS) and Neuroimaging Hardware Design (5 ECTS).

Introduction to Neuroscience (5 ECTS) – IN

Course parameters:
- 1st semester

Course organizers:
Professor Kimmo Jensen, MD, PhD. Department of Physiology and Biophysics, AU

Summary
The course introduces the students to key concepts in neuroscience and neuroimaging starting by describing molecular and cellular components of the central nervous system (CNS), their development and organization. Furthermore, an introduction to the different signaling pathways, electrical and receptor-neurotransmitter mediated signaling between neurons and other cells in the CNS will be given including a presentation of different neurological disease attributed to the dysfunction of the different signaling systems. Finally, synaptic plasticity will be discussed in relation to learning and memory.

Learning objectives (Listed as in New Danish qualifications framework for higher education)	
Knowledge	During the course the student will gain: • Knowledge regarding the basic structural and functional properties of cells and networks in the central nervous system • Basic insights in the chemical and electrical signaling of neurons and glial cells, both in the developing, mature, and diseased nervous system
Skills	The students is expected to: • Demonstrate skills at a basic level related to the understanding of the general principles of the structure and function of cells in the central nervous system • Be able to point to suitable methodologies utilized to investigate properties of neurons and glial cells, including their interactions • Display skills with respect to actions of pharmacological substances and other treatments of the nervous system at an introductory level
Competencies	At the end of the course the student will: • Be able to formulate short lectures on the basic structure and function of the central nervous system • Have a sound knowledge foundation and a basic critical approach to scientific understanding in order to study more advanced topics within neuroscience and neuroimaging

Student requirements

Teaching materials
Book: Neuroscience by Dale Purves, Sinauer Associates

Teaching form
Mainly lectures, in addition to some theoretical/practical exercises

Examination form
Written examination. 7-step grading scale. Internal censor

General Physiology (5 ECTS) – GP

Course parameters
- 1st semester

Course organizers:
Professor Tobias Wang, PhD, Department of Biological Sciences, AU

Summary
The course is a comprehensive introduction to the function of, and interactions between, the different organ systems within animals. Emphasis will be placed on the general mechanisms of physiological functions, where the course will take a comparative approach to highlight the basic principles of functions that are shared amongst all living animals. Accordingly, the course will include basic physiological function of many animals used for neurophysiological research (*e.g. Aplysia*, zebrafish and *Xenopus*), where evolutionary similarities and differences will be highlighted. There will also be an emphasis on regulation of physiological functions and hierarchies of physiological regulation will be discussed.

Learning objectives (Listed as in New Danish qualifications framework for higher education)	
Knowledge	At the end of the course, the student: • Will have knowledge about the Fick equation, the concept of clearance and the lung gas exchange equation • Be able to use these mathematical formulas to make qualitative predictions about physiological responses.
Skills	The student will be able to: • Demonstrate understanding of the principles of various physiological measurements • Understand strengths and weaknesses of studying physiological processes at various levels of biological organization • Identify relevant techniques to solve a given physiological problem
Competencies	The course will provide the student with the ability to: • Work independently as well as in teams, in relation to trans-disciplinary scientific projects using a variety of physiological methods • Critically review own and general knowledge and understanding of physiological functions, and indicate avenues for further improvements

Student requirements

Teaching materials
Book: Animal Physiology, 2nd edition by Richard W. Hill, Gordon A. Wyse and Margaret Anderson, Sinauer Associates A few selected review articles

Teaching form
Time is divided equally between lectures and theoretical/practical exercises

Examination form
Written examination. Passed/not passed. Internal censor

Mathematics (5 ECTS) – MAT

Course parameters
- 1st semester

Course organizers:
Associate Professor Kim Mouridsen, MSc, PhD. CFIN, AU

Summary
This course introduces topics in linear algebra and calculus, which will be employed in the master courses. We begin with a review of vector and matrix algebra and continue with orthogonality and eigen-decompositions. We review basic integration and differentiation techniques and introduce ordinary differential equations and constrained optimization. The course also covers trigonometry, complex numbers and Fourier analysis.

Learning objectives (Listed as in New Danish qualifications framework for higher education)	
Knowledge	At the end of the course the students will be able to: • Scientifically understand and reflect on knowledge of vector and matrix algebra, trigonometry, complex numbers, Fourier analysis and ordinary differential equations
Skills	During the course the student will have obtained expertise in order to: • Independently solve typical problems in linear algebra, trigonometry, complex- and Fourier analysis • Identify relevant mathematical techniques necessary to solve particular problems • Provide concise description of solution strategy
Competencies	

Student requirements
Knowledge and some practical experience with vector- and matrix algebra, derivatives and integrals

Teaching materials
Book: Engineering Mathematics by Croft, Davison, Hargreaves, Prentice Hall

Teaching form
Time is divided equally between lectures and theoretical/practical exercises

Examination form
Written examination. Passed/not passed. Internal censor

Digital Signal Processing and Analysis (5 ECTS) – DSPA

Course parameters
- 1st semester

Course organizers:
Associate Professor Henrik Karstoft, M.Sc. PhD. Aarhus School of Engineering, AU/IHA.

Summary
This course covers basic topics from Digital Signal Processing and Analysis. The first part of the course will introduce basic tools in Signal Processing, e.g. discrete time signals, Shannons Sampling Theorem, convolution and FIR, IIR filters and spectra. In the second part of the course, basic tools from Stochastic Signal Processing will be introduced, including autocorrelation and Power Spectrum Density.

Learning objectives (Listed as in New Danish qualifications framework for higher education)	
Knowledge	The participants must at the end of the course be able to: • Compare and relate deterministic and stochastic discrete signals • Calculate and interpret the autocorrelation functions of a random signal • Calculate and interpret the power spectral density of a random signal
Skills	The participants must at the end of the course be able to: • Explain and describe basic concepts for discrete-time signals e.g. sampling and quantization • Explain and apply Shannons sampling theorem • Explain and apply the Discrete Fourier transform • Explain and design linear discrete-time systems in the time-domain and in the frequency-domain • Explain the structure of simple FIR and IIR filters
Competencies	

Student requirements
A basic course in linear algebra and calculus i.e. the course in Mathematics in the Neuroscience and Neuroimaging master program.

Teaching materials
Book: Biosignal and Biomedical Image Processing, “John L. Semmlow”, Marcel Dekker, Inc. 2004 Lecture notes

Teaching form
Lectures, theoretical exercises and practical demonstrations.

Examination form
Written examination. 2 hours. 7-step grading scale. Internal censor

Molecular Neurobiology of Neuroimaging (5 ECTS) – MNN

Course parameters
- 1st semester

Course organizers:
Professor Olaf Paulson, DMSc. Neurobiology Research Unit, Copenhagen University Hospitals, Rigshospitalet; Danish Research Center in Magnetic Resonance (DRCMR), Copenhagen University Hospitals, Hvidovre

Summary
The molecular background of neurological mechanisms will be described from genes to proteins. The course will also describe the molecular foundation of the different intercellular signaling pathways as well as intracellular signaling cascades. The mechanisms underlying synaptic transmission will be described as well as the molecular basis of different neurological diseases. The course thus gives an overview of molecular neurobiological aspects of fundamental relevance for the understanding of the background for what can be visualized with brain imaging methods. Specifically, the basis for our understanding of the biology linked to the use of PET radio ligands, of MRS, of optical imaging, of two-photon imaging, and of hyperpolarized MR-substances. The course also describes molecular aspects of the coupling between function, flow, and metabolism.

Learning objectives (Listed as in New Danish qualifications framework for higher education)	
Knowledge	At the end of the course the student will obtain knowledge about and understanding of neurobiology related to biochemistry and cellular biology. This includes: • Biochemical aspects related to pyruvate and lactate, amino acids, n-acetyl aspartate, proteins, e.g. amyloid, tau, translocator proteins, and enzymatic activity • Cellular aspects related to synapse, neurotransmitter, receptor, and transporter; receptor agonist versus antagonists • Main receptor systems: GABA, glutamate, dopamine, serotonin, acetylcholine, adenosine • Second messenger systems: Calcium, phosphodiesterases, arachidonic acid • Glucose and neurovascular coupling • Clinically relevant aspects, e.g., Alzheimer's disease, multiple sclerosis
Skills	At the end of the course the student will master and understand the molecular background of these imaging techniques: • Molecular cell type imaging including *in vivo* fluorescence imaging in animals • Dual photon imaging • Positron emission tomography (PET). This is a main topic in another session • Magnetic resonance spectroscopy (MRS). This is a main topic in another session Based on these skills the student will be able to chose the most suitable method for a given topic
Competencies	• The primary aim of this course is to provide a background at a high scientific level allowing the students to understand and reflect on the basic biological mechanisms and their interactions in molecular brain imaging research

Student requirements
Knowledge in biochemistry and cellular biology

Teaching materials
Book: Principles of Neural Science by Eric R. Kandel et al, Mc Graw Hill Review articles related to the single topics and slides from lectures

Teaching form
Lectures and study groups

Examination form
Oral examination. 7-step grading scale. External censor

Functional and Clinical Neuroanatomy (5 ECTS) - FCN

Course parameters

- 1st semester

Course organizers:

Associate Professor Carsten Bjarkam, PhD. Department of Anatomy, AU

Summary
FCN gives an elementary overview of the structure and function of nervous system, with special emphasis on functional systems responsible for sensorymotor, autonomous, and cognitive function and their importance for major brain diseases within the fields of neurology, neurosurgery and psychiatry. In addition, the fundamental principles of diagnostics and treatment of major brain diseases will be discussed. The course will enable the participants to understand the nervous system and its major diseases at a level corresponding to the MD-bachelor degree. It will thus form a relevant background for candidate degrees within medicine, biology and science focused on brain function.

Learning objectives (Listed as in New Danish qualifications framework for higher education)	
Knowledge	The participants will obtain knowledge and understanding of human neuroanatomy based on, postmortem studies, comparative studies, histology, and recent brain imaging techniques such as CT, MRI, PET, & MEG
Skills	The participants will be able to: • Use and understand neuroanatomical nomenclature • Identify neuroanatomical structures on postmortem tissue, brain images and histological specimens • Identify neural structures of importance for major brain diseases • Understand the rationale between the neurological examination and a given clinical diagnosis
Competencies	The course will provide the participants with competencies to: • Navigate within the human nervous system • Acquire knowledge through anatomical and clinical literature to describe a scientific research topic • Handle self-generated neuroanatomical data and formulate these to the scientific community

Student requirements

Teaching materials
Book: The Human Brain, 6th Edition, By John Nolte, ISSBN 978-0-323-04131-7, Mosby 2009 Brain specimens from human, pig, rat and mouse Videos with clinical cases 3D-interactive material (brain navigator)

Teaching form
• 30 lectures of 50 min each covering the human functional and clinical neuroanatomy as outlined in the textbook • 6 x 50 min based on work with brain specimens • 6 x 50 min based on clinical work (cases, examination technique, video) • 7 x 50 min based on work with 3D-interactive material and web-resources

Examination form
The examination will be divided in two both will be written and without any books or electronic aids. 1. A spot test where the participants will have to identify depicted nervous system structures on brain specimens, images and brain scans. There will be 20 items to identify and the participants will have 1 minute per item 2. Two hours essay test. Testing the knowledge of the participants on the structural, functional and clinical aspects of a

given brain system such as the basal ganglia, the somatosensory system etc. Written examination. 7-step grading scale. Internal censor

Medical Imaging Techniques (5 ECTS) – MIT

Course parameters

- 1st semester

Course organizers:
Professor Hans Nygaard, DMSc. Institute of Clinical Medicine, AU.

Summary
MIT is a fundamental introductory course teaching the student the theoretical background, the utilization, and the limitations of the most used diagnostics imaging techniques such as different types of ultrasound scanning, X-ray, CT, PET, and SPECT. Furthermore, the course will give an introduction to the predominant methods used for medical imaging processing and analysis.

Learning objectives (Listed as in New Danish qualifications framework for higher education)	
Knowledge	At the end of the course the student will: • Have obtained knowledge about X-ray physics and detectors, computer tomography, nuclear medical imaging techniques, Single Photon Emission Computed Tomography (SPECT), Positron Emission Tomography (PET), diagnostic ultrasound, A-mode and B-mode ultrasound, Doppler ultrasound • Have obtained basic knowledge about image transformations, morphological operations, image reconstruction, image segmentation, and registration • Understand advantages, disadvantages and specifications of different imaging techniques • Be able to reflect scientifically on future developments in medical imaging
Skills	The student will be able to: • Identify relevant medical neuroimaging techniques to solve particular problems in neuroscience research • Identify new clinical applications of existing imaging techniques • Concisely accord for solutions and analysis results necessary for publication in scientific journals
Competencies	This course enables the student to: • Participate in research and development of new techniques and applications for neuroimaging • Participate in clinical evaluation of new techniques and applications for neuroimaging • Teach theory and practical use of different medical imaging techniques

Student requirements
Knowledge and competences within mathematics equivalent to the Mathematics course in the Master's program

Teaching materials
Book: Introduction to Medical Imaging Physics, Engineering and Clinical Applications by Nadine Barrie Smith and Andrew Webb. Cambridge University Press

Teaching form
Lectures, practical exercises and clinical demonstrations

Examination form
Written examination. 7-step grading scale. Internal censor

Magnetic Resonance Imaging 1 (5 ECTS) – MRI1

Course parameters
- 1st semester

Course organizers:
Associate Professor Peter Vestergaard-Poulsen, MSc., PhD, Institute of Experimental Clinical Research and CFIN, AU

Summary
MRI1 will cover the basic principles of magnetic resonance (MR) imaging techniques. This includes spin dynamics in a magnetic field, interaction of magnetization by radiofrequency pulses, principles of MR imaging by the use of magnetic field gradients, relaxation of magnetization and contrast in images. The most important applications of MR will be introduced. These include angiography and blood flow measurement, perfusion and diffusion assessment and functional MRI. Besides, examples of the clinical use of MR imaging will be shown.

Learning objectives (Listed as in New Danish qualifications framework for higher education)	
Knowledge	During the course the student will understand the principles of: • Magnetic dipole moments in a magnetic field • Image formation • Obtaining contrast in MR images • Using MRI for various physiological measurements • Clinical MRI
Skills	At the end of the course the student will: • Possess overall knowledge of the clinical use of MRI • Understand which kind of research problems MR can be used for • Understand the limitations of MR
Competencies	This course equips the student with knowledge and skills so the student actively can: • Participate in research projects using MRI • Participate in evaluation of MR scanners for equipment purchasing

Student requirements
Knowledge and competences within mathematics equivalent to the Mathematics course in the Master's program

Teaching materials
Book: MRI: Basic Principles and Applications by Mark A. Brown, Richard C. Semelka Lectures notes

Teaching form
Lectures, theoretical exercises and practical demonstrations

Examination form
Written examination. 7-step grading scale. Internal censor

Magnetoencephalography (MEG) and Electroencephalography (EEG) (5 ECTS) – MEEG
Course name: Mathematics

Course parameters
- 2^{nd} semester

Course organizers:
Professor Leif Østergaard, DMSc, CFIN, AU

Summary
The synaptic signaling of the brain generates currents that in turn lead to electric and magnetic fields. These fields can, under certain circumstances, be recorded non-invasively on the surface of the human head. The course describes the fundamentals of electroencephalography (EEG) and magnetoencephalography (MEG), as well as the similarities and differences between the techniques. Hardware for both EEG and MEG is discussed, in particular the use of Superconducting Quantum Interference Devices (SQUIDs) to measure the minute magnetic field fluctuations caused by brain activity. Experimental design and data analysis will first be discussed in terms of event-related potentials and -fields (ERP, ERF). The fact that neither EEG or MEG produce "images" of the brain is highlighted, and the graduates will be trained to understand why the problem of localization of EEG/MEG sources is a so-called ill-posed problem. Potential solutions to this problem are introduced and discussed in relation to each other. The combination of MEG and EEG with other neuroimaging techniques will be included as well as practical examples of studies of sensory processing and cognitive tasks. The use of EEG/MEG in clinical settings is briefly reviewed.

Learning objectives (Listed as in New Danish qualifications framework for higher education)	

Knowledge	This course provides the student with:
	• An understanding of the principles of
	  • Bioamplifier design and use in the context of EEG/MEG
	  • SQUID fundamentals and practical application
	  • EEG/MEG signal generation and interpretation in the context of neuronal sources
	  • Modeling strategies for EEG/MEG data for obtaining source estimates
	• Practical solutions to the ill-posed source localization problem
	• The ability to choose among localizing and non-localizing analysis strategies on the basis of reflections on the scientific problem/question at hand

Skills	At the end of the course the student will be able to: • Understand Good Practices of data collection, and apply data pre- and post-processing to obtain artifact-free records of neuronal activity • Choose a localizing or non-localizing analysis strategy, and in the case of the former, identify the relevant a priori constraints to place on the inverse problem solutions • Understand the interpretability of the results from various data analysis strategies • Express results in both rigorous state-of-the-art terms, as well as to a more general neuroscientific audience (especially those with imaging-only background)
Competencies	The course will equip the student with the ability to: • Know where to look for (open source) research packages for the analysis of EEG/MEG data, and how to apply them to real data • Independently develop analysis strategies and apply combinations of methodologies to solve research-based problems • Disseminate published works on the basis of the applied methods

Student requirements
Knowledge and competences within mathematics equivalent to the Mathematics course in the Master's program and passed Introduction to Neuroscience

Teaching materials
Book: MEG. An Introduction to Methods by Hansen, Kringelbach, and Salmelin, Oxford University Press Book: EEG. An Introduction to the Event-Related Potential Technique by Luck, The MIT Press Review article (handout): M. Hämäläinen, R. Hari, R. Ilmoniemi, J. Knuutila, and O. V. Lounasmaa, "Magnetoencephalography

- theory, instrumentation, and applications to noninvasive studies of the working human brain," Reviews of Modern Physics, vol. 65, pp. 413-497, 1993. Review article (handout): S. Baillet, J. C. Mosher, and R. M. Leahy, "Electromagnetic Brain Mapping," IEEE Signal Processing Magazine, vol. 18(6), pp. 14 - 30, 2001.

Teaching form
Mostly lectures, some hands-on data viewing and analysis

Examination form
Written home-exam. 7-step grading scale. External censor

Magnetic Resonance Imaging 2 (5 ECTS) – MRI2

Course parameters
- 2nd semester

Course organizers:
Associate Professor Peter Vestergaard-Poulsen, MSc. PhD, Institute of Experimental Clinical Research and CFIN, AU

Summary
The course teaches the physical principles of basic and advanced MR spectroscopy and imaging techniques using classical and quantum mechanical descriptions. In addition, the students will be trained in magnetic properties of tissue, liquids, and contrast agents as well as in advanced radio frequency theory, ultra fast imaging, parallel imaging, and other advanced technical aspects of MR imaging.

Learning objectives (Listed as in New Danish qualifications framework for higher education)	
Knowledge	By the end of the course the student will be able to understand the principles of: • Nuclear spin, described classically and by quantum mechanics • Signal detection • Basic and advanced MRI sequences • Sequence diagrams, K-space • Signal filtration issues • Advanced RF pulses • Rapid imaging • Parallel imaging
Skills	During the course the student will obtain the ability to: • Understand and conduct mathematical simulation of magnetization • Understand MR sequences and corresponding K-space movement
Competencies	By following this course, the student will be able to • Read and understand theoretical MR articles in order to address scientific research problems • Design MR based research projects • Teach MR principles for clinicians

Student requirements
Passed the Magnetic Resonance Imaging 1 course

Teaching materials
Book: Magnetic Resonance Imaging. Physical Principles and sequence design by E.M Haacke et al. Lectures notes

Teaching form
Lectures, theoretical exercises and practical demonstrations

Examination form
Written examination. 7-step grading scale. Internal censor

Neurotransmission, Neuropsychology, Psychiatry, and Neuropharmacology (5 ECTS) – NNPN

Course parameters
- 2nd semester

Course organizers:
Associate Professor Arne Møller, MD. CFIN, AU; Aarhus PET-center, Aarhus University Hospital

Summary
This course builds upon the knowledge obtained in IN, MNN, and FCN with a focus on the communication between the cells of the brain and how this is studied using EEG & other neurophysiologic methods as well as PET, autoradiography and radiochemistry. Thus, several signaling systems of the brain will be introduced together with an account of the diseases of the brain caused by changes in these systems. Furthermore, the students will be given an introduction to common psychiatric disorders and the neuropharmacological treatment of these disorders such as affective disorders - unipolar (depression) and bipolar (manic-depressive); schizophrenia; anxiety disorders; OCD; eating- and personality disorders; psychiatric disorders in children; abuse and dependence disorders and pathological gambling.

Learning objectives (Listed as in New Danish qualifications framework for higher education)	
Knowledge	The course will enable the student to understand and reflect on: • Nerve cells communication through different signaling systems of the brain • Central neuroscience topics related to both normal brain function and neuropsychiatric disorders. • How neuroanatomy affects mental functions • How drug design builds on molecular engineering
Skills	During the course the student will acquire skills in: • Basic features and applications of several important methodologies in neuroscience such as stereology, brain wave recording, transcranial magnetic stimulation, and advanced neuroimaging • Technical advances and computer software for image analysis • The molecular basis of mental function in health and disease with particular focus on serotonergic, noradrenergic, and dopaminergic mechanisms • The behavioral disturbances affected by these neurotransmitters with focus on dementia, depression, psychosis, and impulse disorders from a biopsychosocial perspective • The treatment of the described disorders
Competencies	At the end of the course the student will be able to: • Select and certify the most suitable methodologies for studying neurological disorders • Reflect on the cause of behavioral disturbances and propose research solutions • Critically review scientific publications dealing with neurological diseases • Combine molecular, anatomical and signaling knowledge to gain insight and suggest research approaches in the study of diseases of the brain

Student requirements
Passed IN, MNN, and FCN courses

Teaching materials
Book: Essential Neuroscience by Allan Siegel and Hreday Sapru; Lippincott Williams & Wilkins Book: CRASH COURSE: Psychiatry. Second Edition by Alasdair D. Cameron; Series Editor: Dan Horton-Szar; Mosby

Teaching form
Time is divided between lectures and theoretical exercises

Examination form
Written examination. 7-step grading scale. Internal censor

Statistics in Neuroscience (5 ECTS) – SNS

Course parameters
- 2nd semester

Course organizers:
Associate Professor Kim Mouridsen, MSc, PhD. CFIN, AU

Summary
The aim of this course is to introduce statistical learning and enable students to analyze complex data sets as typically encountered in neuroscience. The course introduces topics in unsupervised and supervised learning beginning with presentations of unsupervised learning techniques such as k-means cluster analysis mixture models, as well as dimension reduction techniques and hidden Markov models. Within supervised learning, In addition, SNS covers basic and advanced regression models for continuous and binary outcomes including penalized regression and basis function methods. The course emphasizes techniques for model training and assessment as well as variable selection.

Learning objectives (Listed as in New Danish qualifications framework for higher education)	
Knowledge	At the end of the course the student will be able to • Understand mathematical and statistical principles in Mixture models, Expectation maximization, Latent variable models, Dimension reduction, Hidden Markov Models, Regularized regression, Classification, and Model assessment and selection • Critically reflect on theoretical strengths and shortcomings of the approaches
Skills	At the end of the course the student will be able to • Apply unsupervised and supervised learning techniques particularly within neuroscience research • Identify relevant techniques to solve particular problems, and discuss strengths and weaknesses of different approaches • Concisely account for solution strategy and analysis results, as necessary for publication in scientific journals
Competencies	At the end of the course the student will be able to • Independently develop analysis strategies and apply combinations of statistical methodologies to solve research-based problems within neuroscience • Become proficient in novel techniques (not covered in lectures) by studying and critically reviewing research articles

Student requirements
Knowledge and competence within mathematics equivalent to the Mathematics course in the masters program. Basic knowledge in biostatistics (ANOVA, regression)

Teaching materials
Book: Pattern recognition and machine learning. Christopher M. Bishop Book: The Elements of Statistical Learning. T. Hastie, R. Tibshirani, J. H. Friedman. Springer (Note: online version available) Slides from lectures

Teaching form
Time is divided between lectures and theoretical/practical exercises

Examination form
Oral examination. 7-step grading scale. External censor

Statistical Analysis of Neuroimaging Data (5 ECTS) – SAN

Course parameters

- 2nd semester

Course organizers:
Associate Professor Torben E. Lund, MSc, PhD. CFIN, AU

Summary
SAN provides the basic understanding of the statistical analysis of data obtained from brain scans using the different modalities: structural MRI, PET, and fMRI. In addition, the students will be instructed in imaging processing prior to statistical analysis and in formulating a general linear model for the different modalities taking data and noise properties into account. Finally, statistical tests for specific and flexible testing will be discussed as well as the necessary correction for multiple testing.

Learning objectives (Listed as in New Danish qualifications framework for higher education)	
Knowledge	During the course the student will achieve and understanding of: • Rigid-body and affine registration • Non-linear registration • Segmentation • Voxel-Based morphometry • The General Linear Model • Contrasts and statistical inference • Covariance components • Random effects analysis • Analysis of variance • Convolution models for fMRI • Optimization of fMRI designs • Corrections for multiple testing
Skills	By the end of the course the student should be able to: • Describe and perform the image processing required prior to the statistical analysis • Formulate a general linear model, which, for the different modalities, takes into account both properties of data and noise • Formulate and perform statistical tests, for both specific and flexible hypotheses • Perform and understand the necessary correction for multiple testing
Competencies	The student should be able to: • Apply and combine the above mentioned knowledge and skills to novel scenarios • Include factors regarding data processing and analysis when planning neuroimaging studies • Critically review own and published neuroimaging data analysis • Disseminate neuroimaging data processing and analysis

Student requirements
Knowledge and competence within mathematics equivalent to the Mathematics course in the masters program. Basic knowledge in biostatistics (ANOVA, regression)

Teaching materials
Book: Statistical Parametric Mapping - The analysis of functional Brain Images by Karl J. Friston, et al. Elsevier, 2006

Teaching form
Lectures and Computer Exercises

Examination form
Written examination. Passed/not passed. Internal censor

Integrative Neuroimaging (5 ECTS) – INI
– How to integrate brain mapping techniques

Course parameters
- 2nd semester

Course organizers:
Professor Hartwig Siebner, DMSc. Danish Research Center for Magnetic Resonance, Copenhagen University Hospital Hvidovre

Summary
Neuroimaging techniques are capable of probing physiology and function at molecular, cellular and system levels, in animal models and humans. However, each imaging modality has its unique strength and inherent limitations. Moreover, most imaging modalities are correlative in nature, precluding causal inferences. The aim of the Integrative Neuroimaging Course is to give the students the possibility to gain experience in the rapidly advancing field of multimodal imaging. The students will learn about when, why, and how to combine different imaging modalities with a specific focus on interventional electrophysiology (i.e., electrical and magnetic brain stimulation). The course will provide the students with a "multimodal imaging framework" which will help to optimally plan scientific projects in the field of brain imaging.

Learning objectives (Listed as in New Danish qualifications framework for higher education)	
Knowledge	By the end of the course, the student will have • Acquired in-depth knowledge about how the combined use of brain mapping modalities can help overcome modality inherent weaknesses and to maximize the modality specific scientific potential • Basic knowledge about how to analyze multimodal imaging data (modeling, data mining) • The ability to understand, reflect over and explain how to best integrate two imaging modalities • Acquired knowledge to be able to identify neuroscientific questions that can best be studied with an integrative neuroimaging approach
Skills	The student will be able to • Design a multimodal neuroimaging study: Identify the most relevant neuroimaging techniques, choose the most appropriate analysis tools and discuss strengths and weaknesses of different approaches • Explain how to incorporate interventional approaches (TMS, TDCS) in brain mapping studies • Explain the technical and computational challenges of multimodal integration. • Co-register multimodal imaging data and integrate data sets acquired in different imaging modalities for subsequent analysis • Evaluate and choose the most appropriate neurostimulation techniques and protocols • Account for the solution strategy and analysis of results, as necessary for publication in scientific journals • Be able to disseminate knowledge about integrative neuroimaging and discuss related professional and scientific topics with both peers and non-specialists
Competencies	This course provides the students with the capacity to be able to: • Overview complex experimental situations that require the integration of two imaging modalities • Plan and pursue interdisciplinary cooperation with researchers using complementary imaging modalities • Develop new ideas on how to improve multimodal integration and implement novel applications for integrative neuroimaging

Student requirements
To have basic knowledge of the major brain mapping techniques (structural and functional MRI, diffusion sensitive MRI, PET, EEG, MEG) To have basic experience with Matlab and MRI data analyzing software

Teaching materials
PDF files of relevant research papers and reviews Text books (e.g. Oxford Handbook of Transcranial Stimulation (Oxford Handbooks) eds. Eric Wassermann, Charles Epstein,

Ulf Ziemann) Power point presentations

Teaching form
Time is divided between lectures and theoretical/practical exercises Lectures will also include keynote lectures to exemplify specific domains in which the integration of multiple imaging techniques have been brought to bear on a specific problem Theoretical and practical exercises: Demonstrations of multimodal imaging techniques, exposure to a variety of basic software tools

Examination form
Written examination. 7-step grading scale. External censor

Magnetic Resonance Imaging 3 (5 ECTS) – MRI3

Course parameters
- 3rd semester

Course organizers:
Associate Professor Peter Vestergaard-Poulsen, MSc., PhD, Institute of Experimental Clinical Research and CFIN, AU

Summary
MRI3 focuses on the physical principles and uses in clinical praxis and research of advanced MR imaging and spectroscopic techniques. Several techniques will be discussed including correlation spectroscopy, phase contrast imaging, perfusion imaging with contrast agents and spin tagging, BOLD fMRI, q-space diffusion imaging, diffusion tensor imaging, magnetization transfer principles and imaging, advanced cardiac imaging, MRI in oncology, molecular imaging, high field imaging (3T to 17T) and microscopy, advanced clinical applications.

Learning objectives (Listed as in New Danish qualifications framework for higher education)	
Knowledge	During the course the student will learn, understand and reflect on the principles of • MR spectroscopy • Phase contrast MRI • Perfusion imaging with contrast agents and spin labeling • BOLD fMRI • Q-space diffusion imaging • Diffusion tensor imaging • Magnetization transfer • Advanced cardiac imaging • MRI in oncology • Molecular imaging • High field imaging • Advanced clinical applications
Skills	This course enables the student to • Plan and perform MR sequence programming • Program MR analysis tools in e.g. Matlab
Competencies	At the end of the course the student will be able to • Independently plan and conduct MR based research project • Work with MR sequence development and post-processing • Teach MR theory • Work as technical responsible scientist at clinical MR departments

Student requirements
Passed the Magnetic Resonance Imaging 2 course

Teaching materials
Book: Magnetic Resonance Imaging. Physical Principles and sequence design by E.M Haacke et al. Lectures notes

Teaching form
Lectures, theoretical exercises and pulse programming exercises

Examination form
Written examination. 7-step grading scale. Internal censor

Neuroimaging Hardware Design (5 ECTS) – NHD

Course parameters
- 3rd semester

Course organizers:
Chief Physicist Søren B. Hansen, MSc, PhD. Aarhus PET-center, Aarhus University Hospital

Summary
The aim of this course is to give a comprehensive understanding of the functioning and design of the hardware in two important imaging modalities, MRI and PET. The course covers systematically key components like magnet, gradient coils, and radiofrequency (RF) coils with special attention to the analysis and design of RF coils and some major functional units in the transmission and receiving RF pathway. In addition the design and assembly of detectors for PET scanners will be discussed together with PET data acquisition, processing, corrections, and image reconstruction.

Learning objectives (Listed as in New Danish qualifications framework for higher education)	
Knowledge	The student will gain knowledge about • Relevant electromagnetic theory • Design of magnet coil, gradient coil, RF coil, RF generator and receiver, high-field-related RF issues, scintillation detector, and PET camera • Data acquisition, corrections, and image reconstruction
Skills	At the end of the course the student will be able to • Calculate magnetic fields given relevant coil geometries and inductance/capacitance parameters • Design and construct RF coils and related interface circuitry • Grasp testing methods for RF coils • Assess and evaluate important performance parameters for PET scanners • Understand and reflect on the impact of various corrections and processing parameters on the resulting PET images
Competencies	The student will be able to • Suggest optimal RF coil design depending on the scientific question • Select optimum MRI and PET equipment suitable for various scientific purposes • Optimize MRI and PET protocols for best data quality

Student requirements
Students with engineering or physics background. Prerequisites: Calculus, Physics, Electromagnetic Theory courses and some basic computer programming skills (C or MATLAB etc.)

Teaching materials
Book: Electromagnetic Analysis and Design in Magnetic Resonance Imaging by Jianming Jin. CRC Press Reference articles and books Slides and notes from lectures

Teaching form
Lectures (80%) Theoretical exercises (10%) Lab exercises (10%)

Examination form
Oral examination. 7-step grading scale. Internal censor

Advanced Molecular & Systems Neurobiology (5 ECTS) – AMSN

Course parameters
- 3rd semester

Course organizers:
Associate Professor Jens Midtgaard, MD, PhD. Department of Neuroscience and Pharmacology, Panum Institute, KU

Summary
The objective of this course is to provide the student with knowledge of optical monitoring of neuronal activity, control of neural function by molecular and genetic manipulation, and an understanding of information processing in neurons and microcircuits. The student should be able to critically read the current literature, and discuss the function and connectome of neuronal circuits in relation to animal behavior, and as the basis for indirect measurements of brain function such as PET and fMRI. In this way the student will be able to critically interpret PET and fMRI results in relation to the physiology of cells, dendrites and microcircuits as analyzed by optical, electrophysiological modeling and behavioral means.

Learning objectives (Listed as in New Danish qualifications framework for higher education)	
Knowledge	At the end of the course the student should be able to: • Demonstrate knowledge and understanding of optical live cell imaging, and molecular, genetic and electrophysiological methods for measuring and manipulating brain function and behavior • Demonstrate knowledge and understanding of the molecular, dendritic, cellular and circuit organization and physiology of the CNS in relation to the behavioral requirements and evolutionary adaptations of the organism
Skills	During the course the student will obtain the ability to • Argue for the relative merits of the above methods, and suggest new developments of methods and new physiological experiments • Find, evaluate and present relevant current scientific literature
Competencies	By the end of the course the student have acquired the capacity to: • Critically understanding optical imaging and cellular electrophysiological methods in relation to other physiological and modeling approaches for analyzing brain function • Perform independent as well as in team work, trans-disciplinary scientific projects using a variety of physiological methods for the analysis of brain function • Analytically evaluate own and general knowledge and understanding of brain function, and indicate avenues for further improvements

Student requirements
Knowledge and understanding of basic neurobiology, physics and mathematics, commensurate with a level at or above that which is the objective of the basic courses in neuroscience and neuroimaging.

Teaching materials
Current international textbooks on neurophysiology, original papers and reviews (Book: Principles of Neural Science by Eric R. Kandel et al, Mc Graw Hill Book: Neuroscience by Dale Purves, Sinauer Associates Book: Imaging in Neuroscience: A Laboratory Manual. Cold Spring Harbor Laboratory Press, 2011.)

Teaching form
Lectures, class work, and group discussions, including analysis and preparations of oral presentations of scientific topics and original research papers

Examination form
Written home-exam. 7-step grading scale. External censor

Animal Models in Neuroscience (5 ECTS) – AMN

Course parameters
- 3rd semester

Course organizers:
Professor Bente Finsen, DMSc. Department of Neurobiology, SDU

Summary
The students will be introduced to the animal model systems used in neuroscience research. The techniques for genetic manipulation of transgenic animals models e.g. *C. elegans*, *Drosophila*, mice, rats, and pigs will be described together with the use of the different types of genetic models used in the study of neurological disease. Similarly, the main important toxico-/pharmacological, immunological and microsurgical models used in the study of neurological disease will be presented and their strengths and limitations discussed. For both types of models their usage in modern neuroimaging will be discussed. Gender- and age-associated will be discussed. The selection of animal model and experimental design will be discussed, just as the students will be introduced to animal ethics (3 R's, Replacement, Reduction, Refinement) and legislative aspects of carrying out animal experimental research.

Learning objectives (Listed as in New Danish qualifications framework for higher education)	
Knowledge	During this course the student will obtain: • Knowledge in techniques for DNA cloning and genetic engineering used to generate transgenic animals • Basic knowledge of the major toxico-/pharmacological, immunological and microsurgical models used in neurological research • An understanding of the strengths and limitations of the different animal models on the basis of their human physiological and pathophysiological relevance, and understand how to select the best animal model(s) • Knowledge of the usage of particular animal models in different types of neuroimaging as a critical step in translating neuroscientific results to the clinic • Knowledge of animal ethics and the 3R's and of legislative aspects of carrying out animal experiments independently and under supervision
Skills	By the end of the course the student will be able to: • Evaluate results derived from experiments performed in animals in neuroscience research • Identify the relevant animal model or combinations of models to address a particular neuroscientific question • Design animal experiments that can generate statistically sound and conclusive results • Concisely accord for animal experimental data and transform these into results for publication
Competencies	The course provides the student with the ability to: • Evaluate particular animal models on the basis of their human physiological and pathophysiological relevance • Select the best animal models based on the above criteria, and independently design animal experiments as part of neuroscientific studies • Participate in improving/modifying existing animal models and develop new and better animal models to solve neuroscientific problems • Be able to advance experimental neuroscience research by the use of neuroimaging techniques

Student requirements
Passed NNPN and have basic knowledge of the major brain mapping techniques (structural and functional MRI, diffusion sensitive MRI, PET, EEG, MEG)

Teaching materials
PDF files of relevant review articles, methodological papers, opinion papers PowerPoint presentations

Teaching form

Mostly lectures, some theoretical exercises incl. hands-on data analysis and writing of protocol

Examination form
Written home-exam. 7-step grade. External censor

Elective Element (20 ECTS) – EE

Course parameters
- 3rd semester

Course Organizer:
Doctor Kim Ryun Drasbek, MSc, PhD. CFIN, AU
Professor Zengqiang Yuan, PhD. Institute of Biophysics, CAS Beijing

Summary
The elective element provides the student with the opportunity to focus their education in a personalized direction through the selection of individual courses offered by other educational institutions or by performing a specialized project at a research institute. The student should obtain detailed theoretical, practical and/or technical knowledge in the chosen field of neuroscience. Prior to course start, the student should obtain approval by the Course Board for individual courses or by the Course Organizer for specialized projects.

Learning objectives (Listed as in New Danish qualifications framework for higher education)	
Knowledge	The course will enable the students to: • Obtain knowledge in a specific chosen topic in neuroscience and/or neuroimaging • Understand the theories related to the topic and focus on the most relevant data
Skills	During the course the student will obtain the ability to: • Identify and understand the research topics, theory, and/or methods of the chosen field • Search for and summarize relevant literature to plan suitable experiments to investigate the chosen research aim
Competencies	At the end of the course the student will be able to: • Identify the main research problem and the perspectives in the field • Acquire knowledge from the literature in order to gain insight into interesting research topics • Scientifically disseminate data obtained during the project

Student requirements
Passed 1st and 2nd semester

Teaching materials
Hand outs and independently retrieved material including original literature

Teaching form
Individual supervision of a research project

Examination form (explain what is being examined with the chosen form)
Specialized projects at research institutions are concluded by a report of maximally 20 pages. Passed/not passed. Internal censor.

Master study (30 ECTS) – MS

Course parameters

- 4^{th} semester

Course Organizer:

Professor Kimmo Jensen, MD, PhD. Department of Physiology and Biophysics, AU
Professor Wenjun Ding. Executive Dean of College of Life Science, GUCAS Beijing

Summary
The SDC Master Degree in Neuroscience and Neuroimaging is concluded by a master project equivalent of 30 ECTS (1 semester). The student should work independently with a research topic at a suitable research laboratory under the supervision of a Chinese and/or Danish university professor affiliated with the SDC. The student should prepare a dissertation of the conducted work at the end of the master project, which will be assessed together with an oral presentation of the work.

Learning objectives (Listed as in New Danish qualifications framework for higher education)	
Knowledge	During the study the student will: • Obtain extensive knowledge and understanding in the research topic of the Master study • Reflect on the acquired knowledge to plan and execute scientific experiments
Skills	The student will acquire: • The ability to analyze, critically discuss, and review scientific articles • Disseminating skills for the presentation of personal scientific data to the nonspecialists and research community
Competencies	At the end of the study the student will be able to: • Define, describe and test scientific hypotheses • Independently plan and conduct a larger scientific research project through the use of the theory and techniques obtained during the education • Analyze, critically discuss and evaluate scientific problems

Student requirements
Passed 1^{st}, 2^{nd}, and 3^{rd} semester

Teaching materials
Hand outs and independently found material

Teaching form (lectures, theoretical exercises, etc.) – important if learning objectives depend on this
Individual supervision

Examination form (explain what is being examined with the chosen form)
Written report and oral examination. 7-step grading scale. External censor