EBERHARD KARLS
UNIVERSITÄT
TÜBINGEN

Module handbook

Computational Neuroscience

Master of Science

Winter Term 2023/24
Summer Term 2024

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Faculty of Science and Medical Faculty
Graduate Training Centre of Neuroscience

Inhalt

1. Description and objectives of the program

The Master of Science program in *Computational Neuroscience* is an international, research-oriented two-year master's program offered by the Graduate Training Centre of Neuroscience at the University of Tübingen. We invite students with a first academic degree (BSc) in physics, mathematics, computer science, cognitive science or engineering or in another relevant field of natural sciences. The theoretical and practical education focuses on the analysis and modelling of neural data from the cellular to the systems level as well as perception, cognition, and behaviour in animals and humans. Fundamental knowledge in neuroscience combines with state-of-the-art computational methods and approaches offered by our internationally renowned partner institutes.

The Graduate Training Centre of Neuroscience creates an interdisciplinary environment through its three Master of Science programs with complementary focus and curricula: *Neural and Behavioural Sciences, Cellular and Molecular Neuroscience, and Computational Neuroscience*. The curricula in all three programs are synchronized and comprise large elective modules. We encourage our students to cross borders during their theoretical training in their first year. Depending on their individual skills, interests, and motivation the students are welcome in labs beyond their specific master's program for their practical research activities in the second year.

- Our graduates have a sound standing in the interdisciplinary field of computational neuroscience and broad knowledge in neuroanatomy and neurophysiology.
- Our graduates have profound skills in mathematics and theoretical neuroscience allowing them to theoretically dissect modelling questions in neuroscience.
- Our graduates implement basic and advanced algorithms for neuroscientific data analysis and modelling and apply them to real data.
- Our graduates scrutinize and evaluate the suitability of theoretical and computational approaches for studying various neuroscientific questions, allowing them to choose the most appropriate approach for a given problem. They combine methods and approaches in a meaningful way to attack complex scientific problems.
- Our graduates communicate their findings competently and convincingly in oral and written form. They communicate and discuss with experts in the field and contribute to discussions on current neuroscientific topics.
- Our graduates acquired general competencies such as time and conflict management, coping with stressful situations, as well as social skills and the capacity for teamwork. Being part of an international community during their studies and their research in our labs and institutes they gain cross-cultural competencies.

After successful graduation, our students are prepared for a career in research and development in internationally competitive institutes and companies. Beyond research and development, our graduates excel in the acquisition of new knowledge, project management, and problem-solving.

2. Curriculum

2.1 Module Overview

(according to the module overview of the study and examination regulations)

Module Code	Compulsory Elective	Module title	Semester	CP
CN01	**c**	**Neuroanatomy and Neurophysiology**	**1**	**6**
CN02	**c**	**Neural Dynamics**	**1**	**6**
CN03	**c**	**Neural Coding**	**2**	**6**
CN04	**c**	**Neural Modelling**	**1**	**6**
CN05	**c**	**Machine Learning**	**1**	**6**
CN06	**c**	**Neural Data Science**	**2**	**6**
CN07	**c**	**Advanced Computational Neuroscience**	**1 & 2**	**9**
CN08	**c**	**Advanced Neuroscience**	**1 & 2**	**9**
CN09	**c**	**Electives**	**1 & 2**	**6**
CN10	**c**	**Current Research and RCR**	**1 & 2**	**3**
CN11	**c**	**Laboratory Rotations**	**3**	**27**
CN12	**c**	**Master's thesis**	**4**	**30**

c = compulsory, ce = compulsory elective, e = elective

Semesters 1 and 2 comprise theoretical courses with a total workload equivalent to 61 CPs. A core curriculum of compulsory courses (c) accounts for 37 CPs (CN01 – CN06, CN10).

In the compulsory elective (ce) modules CN07 and CN08 the students complete 1-3 courses, which sum up to 9 CPs. In contrast to the compulsory modules, the students can choose from multiple courses that all address the respective module's title and general description. The individual module descriptions for CN07 and CN08 in chapter 3.2 comprise an exclusive list of available courses for the current academic year.

The elective module CN09 allows the students to choose courses from any master's program at the University of Tübingen except for sports courses. While all other modules contribute to the final grade, the elective module CN09 does not. The students are invited to explore the field of cellular and molecular neuroscience and other disciplines.

In the program's 2nd year the students join labs of their choice for two lab rotations and, finally, their master's thesis.

2.2 Module overview by suggested time course

The coursework is completed in the semesters 1 and 2 with the only exception of a block course in module CN10.

For the compulsory elective and elective modules CM06 – CM08 the workload per semester is determined by the individual students' choice of available courses. A workload of 36 CPs per semester should not be exceeded.

It is strongly recommended to complete all coursework requirements before the commencement of the 1st lab rotation. Depending on the lab and the project to be completed during a rotation, additional coursework during this period represents an additional burden that must not be taken lightly.

Modules CN01 – CN11 must be completed before admission to the master's thesis.

Study area	Nr.	Module	Semester				Σ CP
			1	2	3	4	
Foundations	CN01	Neuroanatomy and Neurophysiology	6				6
	CN02	Neural Dynamics	6				9
	CN03	Neural Coding		6			6
	CN04	Neural Modelling	6				6
	CN05	Machine Learning	6				6
	CN06	Neural Data Science		6			6
Advanced Specialisations	CN07	Advanced Computational Neuroscience	0-9	0-9			9
	CN08	Advanced Neuroscience	0-9	0-9			9
Individual Perspectives	CN09	Electives	0-6	0-6			6
Research Practise	CN10	Current Research and Conduct	0.5	0.5	2		3
	CN11	Laboratory Rotations			27		27
	CN12	Master thesis				30	30
		Σ Compulsory	24.5	12.5	29	30	
		Σ Electives	6	18			120

2.3 Overview by study progress and credit requirements

The allocation of CPs to courses is for information only. Credits are only awarded upon completion of the module. Abbreviations are explained below in chapter 3 (Module descriptions).		Assessment				Course			Total CP	Semester			
		Grading	Type of exam	Duration of the exam	Weight for the module	Credit hours (SWS)	Status	Type of course		The allocation of exams to semesters is only a recommendation. Compulsory allocations are marked as such.			
										1.	2.	3.	4.
										CP	CP	CP	CP
Foundations													
CN01	Neuroanatomy and -physiology								6				
CN01-1	Functional Organization of Vertebrate CNS	ne				2	c	L/P		3			
CN01-2	Neurophysiology	g	w	90	100	2	c	L/T		3			
CN02	Neural Dynamics								6				
CN02-1	Lecture	g	w	120	100	2	c	L		3			
CN02-2	Exercises	ne				2	c	E		3			
CN03	Neural Coding								6				
CN03-1	Lecture	g	w	90	100	2	c	L			3		
CN03-2	Exercises	ne				2	c	E			3		
CN04	Neural Modelling								6				
CN04-1	Lecture	g	w	90	100	2	c	L		3			
CN04-2	Exercises	ne				2	c	E		3			
CN05	Machine Learning								6				
CN05-1	Lecture	g	w	90	100	2	c	L		3			
CN05-2	Exercises	ne				2	c	E		3			
CN06	Neural Data Science								6				
CN06-1	Lecture	g	hw		100	2	c	L			3		
CN06-2	Exercises	g				2	c	E			3		
Advanced Specialisations													
CN07	Advanced Computational Neuroscience								9				
CN07-1	Elective Adv Comp Neuro 1	g/ng/ne				2	ce	L/S/E/P					
CN07-2	Elective Adv Comp Neuro 2	g/ng/ne				2	ce	L/S/E/P					
CN07-3	Elective Adv Comp Neuro 3	g/ng/ne				2	ce	L/S/E/P					
CN08	Advanced Neuroscience								9				
CN08-1	Elective Adv. Neuroscience 1	g/ng/ne				2	ce	L/S/E/P					
CN08-2	Elective Adv. Neuroscience 2	g/ng/ne				2	ce	L/S/E/P					
CN08-3	Elective Adv. Neuroscience 3	g/ng/ne				2	ce	L/S/E/P					
Individual Perspectives													
CN09	Free Elective								6				
CN09-1	Free Elective 1	g/ng/ne				2	e	L/S/E/P					
CN09-2	Free Elective 2	g/ng/ne				2	e	L/S/E/P					
Research Practise													
CN10									3				
CN10-1	Neurocolloquium	ne				2	c	L		0.5	0.5		
CN10-2	Scholarly Research	ne				2	c	S/P				2	
CN11	Laboratory Rotations								27				
CN11-1	Laboratory or Essay Rotation 1	g	lr/pr				c	P/S				13	
CN11-2	Laboratory Rotation 2	g	lr/pr				c	P/S				14	
Final module													
CN12	Master thesis	g											30

2.4 Suggested timeline for individual courses

1. Semester // Winter Semester	Credits	
Functional Organization of Vertebrate CNS *(block, 1st week lecture period))*	3	
Neurophysiology	3	
Neural Dynamics (with exercises)	6	
Neural Modelling (with exercises)	6	
Machine Learning (with exercises)	6	
Advanced Computational Neuroscience – Course I	3	
Advanced Neuroscience – Course I	3	
NeuroColloquium	0,5	**Σ 30,5**

2. Semester // Summer Term	Credits	
Neural Coding (with exercises)	6	
Neural Data Science (with exercises)	6	
Advanced Computational Neuroscience – Course II	3	
Advanced Computational Neuroscience – Course III	3	
Advanced Neuroscience – Course II	3	
Advanced Neuroscience – Course III	3	
Individual Perspectives – Course I	3	
Individual Perspectives – Course II	3	
NeuroColloquium	0,5	**Σ 30,5**

3. Semester // Winter Semester	Credits	
Scholarly conduct of research *(1-week block, before rotations)*	2	
Essay / Laboratory Rotations	27	**Σ 29**

4. Semester // Summer Term	Credits		
Master Thesis	30	**Σ 30**	
			Σ 120

3. Module descriptions

The following module descriptions provide an overview of the *Computational Neuroscience* master's program for the current academic year. Please note that the content elements of individual modules and the lecturers might be subject to changes between academic years. The following abbreviations are used in the following module descriptions and in the previous overview of the study progress.

Key	
Grading:	g = graded; ng = not graded (pass/fail); ne = no examination
Type of exam:	w = written exam; pj = project; hw = homework; lr = lab report, pr = presentation, lr = lab report
Duration:	Duration of the examination in minutes.
Weight:	Courses: Weighting of the examination grade towards the module grade. Modules: Weighting of the module grade towards the final grade.
Credit hours (SWS):	Hours spent in the classroom per week during the semester.
Status:	c = compulsory; e = elective
Type of course:	L = lecture; S = seminar; E = exercise, T = tutorial, P = practical work
CP:	credit points (ECTS)

3.1. Foundations

Modul code: CN01	**Module title:** Neuroanatomy and Neurophysiology							**Type of module:** compulsory	
CP (ECTS credits)	6								
Workload - Contact hours - Self-study	Total workload: 180 h		Contact hours: 60 h / 4 SWS					Self-study: 120 h	
Duration	1 Semester								
Frequency	once a year, during the winter semester								
Language of instruction	English								
Teaching methods	Lectures with practical work and tutorials.								
Content	This module teaches the fundamental anatomy and physiology of the mammalian CNS with an emphasis on the human brain.								
Qualification goals	Students understand and can explain basic principles of the functional and anatomical organization of the nervous system. Students understand the electrical signal generation, signal processing and integration in neurons, the transmission of the neuronal signal at the chemical synapse, as well as the underlying molecular building blocks. They understand the basics of the techniques used to study neuronal processing at the single cell and small neuronal network level.								
Requirements for Obtaining Credit, Grading, weight if applicable:		*Type of course*	*Status*	*Contact hours (SWS)*	*CP*	*Type of exam*	*Exam duration*	*Grading*	*Weight for module*
	Functional Organization of Vertebrate CNS	*L/P*	*c*	*2*	*3*				
	Neurophysiology	*L/T*	*c*	*2*	*3*	*w*	*90*	*g*	*100*
Applicability and Transfer	Compulsory module MSc Computational Neuroscience, MSc Cellular and Molecular Neuroscience.								
Participation requirements	Basic knowledge of cell biology, physiology, and brain organisation.								

Modul code: **CN02**	**Module title:** **Neural Dynamics**		**Type of module:** **compulsory**
CP (ECTS credits)	6		
Workload **- Contact hours** **- Self-study**	Total workload: 180 h	Contact hours: 60 h / 4 SWS	Self-study: 120 h
Duration	1 Semester		
Frequency	once a year, during the winter semester		
Language of instruction	English		
Teaching methods	Lectures with exercises.		
Content	The activity of neurons results from dynamic interactions between many neurons, or compartments of individual neurons. Neural models capture the fundamental properties of such dynamical processes, making them accessible for mathematical analysis and computer simulation. This module covers basic biophysics of signal generation and transmission in neurons and the approximation of underlying physical and physiological phenomena by mathematical models. The course provides a basic introduction in dynamical systems and discusses examples of phenomena arising in linear and nonlinear dynamical systems related to neurons.		
Qualification goals	The students learn to use biophysically-inspired neural models with different levels of abstraction. They know fundamental mathematical techniques to implement simulations of such models numerically, and to analyse mathematical properties of simplified models. The students understand fundamental dynamical phenomena in neurons and cortical and subcortical networks.		

Requirements for Obtaining Credit, Grading, weight if applicable:

	Type of course	*Status*	*Contact hours (SWS)*	*CP*	*Type of exam*	*Exam duration*	*Grading*	*Weight for module*
Lecture	*L*	*c*	*2*	*3*	*w*	*120*	*g*	*100*
Exercises	*E*	*c*	*2*	*3*				

Applicability and Transfer	Compulsory module MSc Computational Neuroscience.
Participation requirements	Basic knowledge of analysis and linear algebra. Basic programming skills (Python). Elementary knowledge about neurons and the structure of the nervous system.

Modul code: CN03	**Module title:** Neural Coding		**Type of module:** compulsory
CP (ECTS credits)	6		
Workload **- Contact hours** **- Self-study**	Total workload: 180 h	Contact hours: 60 h / 4 SWS	Self-study: 120 h
Duration	1 Semester		
Frequency	once a year, during the summer semester		
Language of instruction	English		
Teaching methods	Lectures with exercises.		
Content	The study of neural coding involves measuring and characterizing how stimulus attributes or motor actions are represented by action potentials and spike patterns. Neural encoding refers to the mapping from stimulus to response, whereas neural decoding refers to reverse mapping. The link between stimulus and response is hardly ever deterministic but probabilistic. Information about relevant stimulus features may be distributed over populations of neurons. Many sensory signals are very high-dimensional, adding another source of complexity to understanding the language of neural communication. From a different perspective, representations of stimuli in neural activity might emerge from learning processes. Thus, a part of the course will discuss approaches for useful representations of inputs by the neural networks and mechanisms for learning them. This module provides tools and approaches from probability theory, information theory, coding theory, and probabilistic machine learning for studying neural codes and learning stimulus representation in biological neural networks.		
Qualification goals	Participants acquire the necessary knowledge to build and analyze neural encoding and decoding models, learn about various types of plasticities, and learning in biological networks and their models. Through homework assignments and computer exercises, they gain hands-on experience in simulating neural representations, decoding stimulus attributes from the neural responses, and quantifying the statistical dependency between stimulus and response using information-theoretic approaches.		

Requirements for Obtaining Credit, Grading, weight if applicable:

	Type of course	*Status*	*Contact hours (SWS)*	*CP*	*Type of exam*	*Exam duration*	*Grading*	*Weight for module*
Lecture	*L*	*c*	*2*	*3*	*w*	*90*	*g*	*100*

	Exercises	*E*	*c*	*2*	*3*				
Applicability and Transfer	Compulsory module MSc Computational Neuroscience.								
Participation requirements	Applied probability theory and linear algebra, programming skills (python).								

Modul code: CN04	**Module title:** Neural Modelling		**Type of module:** compulsory
CP (ECTS credits)	6		
Workload **- Contact hours** **- Self-study**	Total workload: 180 h	Contact hours: 60 h / 4 SWS	Self-study: 120 h
Duration	1 Semester		
Frequency	once a year, during the winter semester		
Language of instruction	English		
Teaching methods	Lectures with exercises.		
Content	This module introduces the formalisation of behavioural and neurobiological phenomena in mechanistic and explanatory terms across multiple levels of description and multiple scales of analysis. Theories and models resulting from such formalisations provide a rich understanding of the phenomena and make predictions that lead to the refutation or refinement of the models. The module provides the understanding and methodological tools required to design and build models of diverse experimental results in behavioural neuroscience, and also to embed modelling questions into the heart of the specification of new empirical questions that will decide between and refute models.		
Qualification goals	The students understand the progress of large-scale theory and modelling efforts in critical example areas of current research. They understand the essential roles of abstraction and simplification, and how data drive modelling and simulation and vice-versa. The students gain hands-on experience in building elements of these models themselves.		

Requirements for Obtaining Credit, Grading, weight if applicable:

	Type of course	*Status*	*Contact hours (SWS)*	*CP*	*Type of exam*	*Exam duration*	*Grading*	*Weight for module*
Lecture	*L*	*c*	*2*	*3*	*w*	*90*	*g*	*100*
Exercises	*E*	*c*	*2*	*3*				

Applicability and Transfer	Compulsory module MSc Computational Neuroscience.
Participation requirements	Calculus, linear algebra, basic analysis, basic probability theory and familiarity with a programming language (e.g. Matlab, Python).

Modul code: CN05	**Module title:** Machine Learning							**Type of module:** compulsory	
CP (ECTS credits)	6								
Workload - Contact hours - Self-study	Total workload: 180 h		Contact hours: 60 h / 4 SWS					Self-study: 120 h	
Duration	1 Semester								
Frequency	once a year, during the winter semester								
Language of instruction	English								
Teaching methods	Lectures with exercises.								
Content	Machine Learning is concerned with developing and studying algorithms that learn structure from data. It provides theoretical concepts for understanding how sensory systems can infer structure from empirical observations as well as practical tools for data analysis. The module introduces concepts and algorithms with a focus on algorithms that have a statistical interpretation. The module introduces students to the practical side of machine learning through worked examples programming exercises.								
Qualification goals	The students can derive basic machine techniques using e.g. maximum likelihood or maximum a posteriori estimation. The students learn how to use software tools to analyse small data sets								
Requirements for Obtaining Credit, Grading, weight if applicable:		*Type of course*	*Status*	*Contact hours (SWS)*	*CP*	*Type of exam*	*Exam duration*	*Grading*	*Weight for module*
	Lecture	*L*	*c*	*2*	*3*	*w*	*90*	*g*	*100*
	Exercises	*E*	*c*	*2*	*3*				
Applicability and Transfer	Compulsory module MSc Computational Neuroscience.								
Participation requirements	Students should have a basic knowledge of linear algebra and probability theory. Some exercise-sheets will involve programming. Preferred languages are Python or R.								

Modul code: CN06	**Module title:** Neural Data Science							**Type of module:** compulsory	
CP (ECTS credits)	6								
Workload - Contact hours - Self-study	Total workload: 180 h		Contact hours: 60 h / 4 SWS					Self-study: 120 h	
Duration	1 Semester								
Frequency	once a year, during the summer semester								
Language of instruction	English								
Teaching methods	Lectures with exercises and tutorials.								
Content	As the complexity of the data acquired in neuroscience increases, neural data analysis becomes ever more important: The complex multidimensional signals recorded with e.g. multi-electrode arrays or two-photon imaging require rigorous data analytic techniques. This module covers a selection of topics related to the analysis of different kinds of neural data based on concepts of machine learning: time series analysis, spike sorting, spike triggered average/covariance, dimensionality reduction techniques and information theory. The focus will be on applying state-of-the-art concepts in hands-on data analysis of real data sets.								
Qualification goals	The students know different applications scenarios for machine learning algorithms and other data analysis techniques in modern neuroscience. They can implement basic algorithms and apply them to real data. They have gained practical experience in the challenges of working with neuroscientific data and they are able to handle them.								
Requirements for Obtaining Credit, Grading, weight if applicable:		*Type of course*	*Status*	*Contact hours (SWS)*	*CP*	*Type of exam*	*Exam duration*	*Grading*	*Weight for module*
	Lecture	*L/T*	*c*	*2*	*3*	*hw*		*g*	*100*
	Exercises	*E*	*c*	*2*	*3*				
Applicability and Transfer	Compulsory module MSc Computational Neuroscience.								
Participation requirements	Calculus, linear algebra and analysis (series, integrals, derivatives); basics of machine learning and neural coding; familiarity with a programming language.								

3.2. Advanced Specialisations

The compulsory elective study area *Advanced Specialisations* offers the students a choice of courses that build on knowledge and skills acquired in the compulsory study area *Foundations* and during their individual first-degree studies. The study area consists of two modules with 9 CPs each, one module comprising methods and applications, and another module focusing on specific topics in neuroscience. A list of available courses for these modules is curated by the study commission before each semester. Criteria for the selection of courses in these modules are the fit to the course program and the general theme of the respective module, the quality and reliability of the courses, and the range of interests among the students in the program. Available courses for each semester are published in the updated module handbook and in the university's course catalogue.

Modul code: CN07	**Module title:** Advanced Computational Neuroscience		**Type of module:** compulsory/elective
CP (ECTS credits)	9		
Workload **- Contact hours** **- Self-study**	Total workload: 270 h	Contact hours: 90 h / 6 SWS	Self-study: 180 h
Duration	2 Semester		
Frequency	once a year, during the summer or winter semester		
Language of instruction	English		
Teaching methods	Depends on chosen course: lecture, seminar, exercise, tutorial, practical work.		
Content	Students can choose from a closed list of computational neuroscience courses beyond the study area *Foundations*. These courses extend topics that have been introduced in *Foundations*, e.g. Machine Learning II or Computational Psychiatry or introduce new topics, e.g. Quantitative Psychophysics or Computational Motor Control. Students choose courses with a total workload of 9 CP irrespective of the number of courses, e.g. 1 course of 9 CP or 3 courses of 3 CP each. At least 3 CP must be graded and will be included in the cumulative, final grade. The list of available courses is curated by the study commission. Students can choose from: **Winter term 2023/24:** • Data-driven Computational Psychiatry (Kaufmann; 3 CP; graded) • Machine Learning for Single Cell Biology (Claasen; 9 CP; WiSe; graded) • Medical Data Science (Pfeifer; 6 CP; graded) • Mathematic Basis for Comput Neurosci (Levina; 3 CP; WiSe; not graded) • Adv Comp Approaches in Theoretical Neurosci (Giese; 3 CP; not graded)		

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- Network science and complex networks (Levina; 6 CP; not graded)

Summer term 2024:

- Machine Learning for Neuroscience (Giese; 6 CP; graded)
- Probabilistic Machine Learning (Macke; 9 CP; graded)
- How does vision work? (Li Zhaoping; 6 CP;graded)
- Bionic Intelligence (Giese & Schwarz; 3 CP; not graded)

</td></tr>
<tr><td>Qualification goals</td><td>The students build on their individual skills and interests. They extend their theoretical and practical expertise in an advanced methods area of their choice.</td></tr>
<tr><td>Requirements for Obtaining Credit, Grading, weight if applicable:</td><td>
<table>
<tr><th></th><th>Type of course</th><th>Status</th><th>Contact hours (SWS)</th><th>CP</th><th>Type of exam</th><th>Exam duration</th><th>Grading</th><th>Weight for module</th></tr>
<tr><td>Adv Comp Neuro I</td><td>L/S/E/P</td><td>e</td><td>2</td><td>3-9</td><td></td><td></td><td>g</td><td>100</td></tr>
<tr><td>Adv Comp Neuro II</td><td>L/S/E/P</td><td>e</td><td>2</td><td>0-6</td><td></td><td></td><td>g/ng/ne</td><td></td></tr>
<tr><td>Adv Comp Neuro III</td><td>L/S/E/P</td><td>e</td><td>2</td><td>0-6</td><td></td><td></td><td>g/ng/ne</td><td></td></tr>
</table>
</td></tr>
<tr><td>Applicability and Transfer</td><td>Compulsory module MSc Computational Neuroscience.</td></tr>
<tr><td>Participation requirements</td><td>Depends on the student’s choice.</td></tr>
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Modul code: CN08	**Module title:** Advanced Neuroscience		**Type of module:** compulsory/elective
CP (ECTS credits)	9		
Workload **- Contact hours** **- Self-study**	Total workload: 270 h	Contact hours: 90 h / 6 SWS	Self-study: 180 h
Duration	2 Semester		
Frequency	once a year, during the summer or winter semester		
Language of instruction	English		
Teaching methods	Depends on chosen course: lecture, seminar, exercise, tutorial, practical work.		
Content	Students can choose from a closed list of courses on topics beyond the study area *Foundations*. These courses extend topics, which have been introduced in the study area *Foundations*, e.g. Cellular and Molecular Neuroscience, or add new topics, not yet covered, e.g. Learning and Memory and Social and Affective Disorders. Students choose courses with a total workload of 9 CP irrespective of the number of courses, e.g. 1 course of 9 CP or 3 courses of 3 CP each. At least 3 CP must be graded and will be included in the cumulative, final grade. The list of available courses is curated by the study commission. Students can choose from: **Winter term 2023/24:** • Physiol and Physic Basis of Brain Imaging (Bartels & Siegel; 3 CP; graded) • Neural Experimental Techniques (Euler; 3 CP; graded) • Sensory Systems I (Reisinger, Rüttiger; 3 CP; graded) • Genetic and Molecular Basis of Neural Diseases I (Jucker; 3 CP; graded) • Regulation of Eating Behaviour (Giel; 3 CP; not graded) • Birdsong as a Model (Veit; 3 CP; WiSe; not graded) • Current Topics in Sleep & Circadian Health (Spitschan; 3 CP; not graded) • Motor Systems (Schwarz; 3 CP; not graded) **Summer term 2024:** • Evolutionary Cognitive Neuroscience (Nieder; 6 CP; graded) • Neuropsychology (Karnath; 3 CP; graded) • Genetic and Molecular Basis of Neural Diseases II (Hedrich; 3 CP; graded) • Sensory Systems II (Clark; 3 CP; graded) • Sleep: Phenomena, Physiology and Function (Gais; 3 CP; graded) • Theory-driven Computational Psychiatry (Hauser; 3 CP; graded) • Method Frontiers in the Cogn Neurosci (Himmelbach; 3 CP; not graded) • MRI-appl for Neurosc & Clin Res VL + Sem (Hagberg; 6 CP; not graded) • Progress in Motor Systems (Schwarz; 3 CP; SoSe; not graded) • The Philosophy of Artificial Intelligence (Genin & Wong; 3 CP; not graded)		

Qualification goals	The students build on their individual knowledge and interests. They extend their theoretical expertise in topic areas of their choice.								
Requirements for Obtaining Credit, Grading, weight if applicable:		*Type of course*	*Status*	*Contact hours (SWS)*	*CP*	*Type of exam*	*Exam duration*	*Grading*	*Weight for module*
	Advanced Neuroscience I	L/S/E/P	*e*	*2*	*3-9*			*g*	*100*
	Advanced Neuroscience II	L/S/E/P	*e*	*2*	*0-6*			*g/ng/ne*	
	Advanced Neuroscience III	L/S/E/P	*e*	*2*	*0-6*			*g/ng/ne*	
Applicability and Transfer	Compulsory module MSc Computational Neuroscience.								
Participation requirements	Depends on the student's choice.								

3.3. Individual Perspectives

The study area *Individual Perspectives* gives students the opportunity to learn about related fields of research, development, and applications (e.g., robotics, neurorehabilitation), improve their language skills in German (for foreign students) or English (for German students), or reflect upon ethical or philosophical aspects and challenges in neuroscience.

Modul code: CN09	**Module title:** Free Electives		**Type of module:** elective
CP (ECTS credits)	6		
Workload **- Contact hours** **- Self-study**	Total workload: 180 h	Contact hours: 60 h / 4 SWS	Self-study: 120 h
Duration	2 Semester		
Frequency	every semester		
Language of instruction	English		
Teaching methods	Depends on chosen courses: lecture, seminar, exercise, tutorial, practical work.		
Content	In the study area *Individual Perspectives* students can choose courses from all courses, except for sports courses, offered for students in master's programs at the University of Tübingen. This includes particularly the University's Transdisciplinary Course Program. The students can also choose additional courses from the study area *Advanced Specialisations* (please see above).		
Qualification goals	The students build on and extend their individual knowledge and interests. They develop and broaden transdisciplinary competencies. They extend their theoretical expertise in topic areas of their choice.		
Requirements for Obtaining Credit, Grading, weight if applicable:	Depends on the student's choice. **Courses taken in this area are included in the transcript of records, but the grades will not be considered for the cumulative grade of the master's program.**		
Applicability and Transfer	Elective module MSc Computational Neuroscience.		
Participation requirements	Depends on the student's choice.		

3.4. Research Practise

The study area *Research Practise* comprises three modules. It offers students an overview of frontiers topics in neuroscience across the three master's programs of the Graduate Training Centre of Neuroscience. It lays the foundations for the scholarly, good conduct of research and offers each student active participation in current research projects during two laboratory rotations of their choice. The study area comprises the master's thesis, which concludes the master's program in *Computational Neuroscience* with a 6 months research project.

Modul code: CN10	**Module title:** Current Research and Responsible Conduct of Research		**Type of module:** compulsory
CP (ECTS credits)	3		
Workload **- Contact hours** **- Self-study**	Total workload: 90 h	Contact hours: 30 h / 2 SWS	Self-study: 60 h
Duration	3 Semester		
Frequency	once a year, during the summer or winter semester		
Language of instruction	English		
Teaching methods	Lecture, Seminar with exercises and practical work.		
Content	This module introduces the students not only to current research in the field of neuroscience but also initiates and fosters discussions among students and with guests and lecturers about a broad range of topics. The NeuroColloquium is a lecture series organized by the Tübingen Neuroscience Campus. It presents internationally renowned researchers from various fields of neuroscience. The speakers provide an overview of state-of-the-art neuroscience topics, from genes to behaviour and new methodologies. Every semester, students from the three master's programs at the GTC choose a speaker of their interest. The seminar on scholarly conduct of research offers the opportunity to learn about, discuss and practice scholarly writing and good scientific conduct. The seminar is offered as a block course immediately before the first laboratory rotation.		
Qualification goals	The NeuroColloquium introduces students to a wide range of neuroscience research and invites them to look beyond their own noses and think outside the box of their immediate interests and studies. The students learn to participate in and contribute to discussions with speakers and the audience. In the seminar on scholarly conduct of research, the students understand and acquire current standards of research practise and communication.		

Requirements for Obtaining Credit, Grading, weight if applicable:		*Type of course*	*Status*	*Contact hours (SWS)*	*CP*	*Type of exam*	*Exam duration*	*Grading*	*Weight for module*
	Neurocolloquium	L	*c*	*1*	*1*			*ne*	
	Scholarly conduct of research	S/E/P	*c*	*2*	*2*			*ne*	
Applicability and Transfer	Compulsory module MSc Computational Neuroscience.								
Participation requirements	none								

Modul code: CN11	**Module title:** Laboratory rotations		**Type of module:** compulsory
CP (ECTS credits)	27		
Workload **- Contact hours** **- Self-study**	Total workload: 820 h	Contact hours: 680 h	Self-study: 140 h
Duration	1 Semester		
Frequency	once a year, during the winter semester		
Language of instruction	English		
Teaching methods	Supervised practical work and seminar.		
Content	Students perform two laboratory rotations working on small projects in laboratories of their choice. In general, the assigned study is in line with currently ongoing research in the respective laboratory. The lab projects are concluded with a written report and an oral presentation during a seminar at the end of each rotation period. Each student presents the project and results to all fellow students from the master's programs at the GTC Neuroscience and answers questions from fellow students and supervisors. Ideally, the students accomplish their two lab rotations in two different research groups with distinct scientific questions and different methods. **The first laboratory rotation can be an exploration and review project, i.e. an *Essay Rotation*. The students are given a wide topic or research area to be reviewed in a first step and to derive relevant research questions in a second step.**		
Qualification goals	The students acquire a wide range of practical skills in state-of-the-art methods. Further skills trained during lab rotations include literature survey, planning of a research project and the design of experiments, documentation of data, evaluation and interpretation of results, compiling data for and writing of a report. The students learn to prepare and give an oral presentation on their research project for a large expert audience.		

Requirements for Obtaining Credit, Grading, weight if applicable:		*Type of course*	*Status*	*Contact hours (sum)*	*CP*	*Type of exam*	*Exam duration*	*Grading*	*Weight for module*
	Lab rotation I or Essay Rotation	P/S	*c*	*320*	*13*	*lr/pr*	*lr: 20 h pr: 20 min*	*g*	*50*
	Lab rotation II	P/S	*c*	*360*	*14*	*lr/pr*	*lr: 20 h pr: 20 min*	*g*	*50*

Applicability and Transfer	Compulsory module MSc Computational Neuroscience.
Participation requirements	At least 50 of 60 CPs from CN01 – CN09 must be completed.

Modul code: CN12	**Module title:** Master's thesis								**Type of module:** compulsory
CP (ECTS credits)	30								
Workload **- Contact hours** **- Self-study**	Total workload: 900 h		Contact hours: 30 h			Self-study: 870 h			
Duration	1 Semester								
Frequency	once a year, during the summer semester								
Language of instruction	English								
Teaching methods	Independent, individually supervised research project.								
Content	In-depth study of a problem in neuroscience. Independent implementation of a relevant research project, which includes literature search and review, formulating a research question, planning, data collection, data analysis, and evaluation of the findings in the context of current research. The research project is reported in the master's thesis and in an oral presentation in a colloquium of the host workgroup, department, or institute.								
Qualification goals	The students familiarize themselves independently with a complex, new subject area and develop new, relevant questions in this subject area. They can investigate new questions using appropriate methods, i.e. plan and implement a scientifically sound approach. Students can evaluate, prepare, and communicate the resulting findings in writing and orally in the context of the research field.								
Requirements for Obtaining Credit, Grading, weight if applicable:		*Type of course*	*Status*	*Contact hours (sum)*	*CP*	*Type of exam*	*Exam duration*	*Grading*	*Weight for module*
	Master's thesis		*c*	*30*	*30*	*th*	*-*	*g*	*100*
Applicability and Transfer	Compulsory module MSc Computational Neuroscience.								
Participation requirements	CN01 – CN11 must be completed.								