Degree Program Documentation Bachelor's/Master's Program Biomedical Neuroscience

Part A
TUM School of Medicine
Technical University of Munich

General Information:

Administrative responsibility:	TUM School of Medicine
Name of degree program:	Biomedical Neuroscience
Degree:	Master of Science (M.Sc.)
Standard duration of study and credits:	
	4 semester of enrollment and 120 credit points (CP)
Form of study:	full time
Admission:	Aptitude assessment (EFV – Master's)
Start:	Winter semester (WiSe) 2018/2019
Language(s) of Instruction:	English
Main Location:	Munich
Academic administrator (program design):	Prof. Dr. Thomas Misgeld
Contact for further questions (regarding this document):	
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	089 4140 3518

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1 Degree Program Objectives

1.1 Purpose

The topic of 'Biomedical Neuroscience' is highly timely and relevant. **Neuroscience is currently perceived as one of the 'frontier sciences'**, in which fundamental unresolved questions (e.g. regarding the biological correlate of higher cognitive functions) and societal needs (e.g. to treat age-related nervous system diseases or neuropsychiatric disorders) coexist with unprecedented technology progress (e.g. multi-scale optophysiology imaging and opto-genetic manipulation, connectomics, genome editing). Neurological and neuropsychiatric disorders are on a rise in developed societies, so further expansion of research and development in neurology-related health care and biomedicine is to be anticipated. Hence our graduates enter a growth market – so the career prospects of the graduates of the MSc-BmN program will be extremely good in academic research, clinical settings and in industry. The overall goal of MSc-BmN is to train excellent scientific professionals in the field of biomedical neuroscience, i.e. to train graduates who have a top-level understanding of neuroscience theory and practice, as well as a focus on neurological and neuro-psychiatric disease from the get go, and who are equipped with all of the necessary key skills and competences to ensure a thorough professional personality. With this program we intend to fill the gaps between standard medical education, which often lacks in high-level scientific training, natural science curricula, which mostly do not provide deep insights into biomedicine, and a wide professional and personal development, which is often neglected in both fields.

The specific aims of MSc-BmN are as follows:

- To combine top-level understanding of neuroscience theory and practice with profound training in mechanisms and clinical aspects of neurological and neuro-psychiatric diseases.
- To deliver innovative, research-oriented education in basic neuroscience, from molecules to cells and systems, as a basis for a better understanding of the patho-physiological mechanisms underlying nervous system diseases.
- To broaden the horizon of our students, to foster critical thinking and to assure the development of a profound and comprehensive understanding of life and science, of consciousness and reality.
- To expose students to a broad range of research topics, professional environments and possible employers.
- Furthermore, to offer students an international experience by a close international cooperation with the Hebrew University. This interaction builds on the complementarity of expertise, with the TUM Medical School providing training in medical know-how and the Hebrew University providing special expertise in biomathematics.
- To establish a complete curriculum in English to be accessible for the best international students, to allow for the cooperation with the Hebrew University, to be open for visiting top international experts to contribute to the teaching program (e.g. Fellows of TUM Institute of Advanced Study), to facilitate students' access to freely accessible eLearning resources and to facilitate student research projects in the best laboratories abroad.
- To offer an individualized mentoring program for all students throughout the training period and adding an additional perspective to professional development and career planning.

1.2 Strategic Significance

Within TUM School of Medicine, MSc-BmN will implement TUM's central teaching tenets of excellence, interdisciplinarity and internationalization at the Master level. The new program will complement the existing training portfolio in TUM School of Medicine and strategically link three core aspects of teaching in TUM School of Medicine's portfolio that have been successfully developed over the past decade: (1) Didactic professionalization of the standard medical curriculum with a renewed focus on scientific principles; (2) structured doctoral programs for medical students; and (3) structured PhD training for clinician-scientists and natural scientists.

AD (1) MSc-BmN will provide an essential complement to ongoing efforts to further professionalize and anchor training in scientific competences in the medical curriculum (as recommended by the German Scientific Council/Wissenschaftsrat in 2014 and the 'National Competence-Based Learning Objectives for Undergraduate Medical Education'). By providing a track for scientists to obtain biomedical competences and by attracting outstandingly qualified scientists into clinically-relevant research, MSc-BmN will provide a basic-science parallel to the well-developed clinician-scientist training within TUM School of Medicine.

AD (2) With regards to Graduate Training, in 2009, as a result of the Excellence Initiative, TUM founded the TUM Graduate School (TUM-GS) to promote structured graduate programs and assure quality. In the School of Medicine this resulted in establishment of the TUM Medical Graduate Center (MGC), which has realized TUM-GS's mandate of structured doctoral training for all thesis work (including medical theses). To accommodate this, a specific graduation program for research-interested medical students in 'Translational Medicine' was established. This program (which awards the degree of Dr. med. sci.) offers quality-controlled scientific projects, a systematic introduction to and training in scientific research. Since 2012, over 50 candidates have been enrolled in this program. MSc-BmN will closely collaborate with this program.

AD (3) Finally, a core reference point of MSc-BmN will be the highly successful international PhD program 'Medical Life Science and Technology' (PhD-MLST), which since 2006 trains doctoral candidates with a background in medicine, natural sciences or engineering.

Hence, by being a beacon of basic and translational biomedical research education in the medical faculty, the MSc-BmN program completes the faculty's training portfolio in neuroscience and impacts the entire TUM School of Medicine's teaching program by providing a blue-print for the integration of MSc-level training in all Research Focus Areas of the faculty.

2 Qualification Profile

As new biomedical technologies will increase their impact in neurology and psychiatry (e.g. next-generation sequencing, proteomic tissue and bio-sample analysis, clinically applicable imaging modalities as diagnostics; cell replacement, genome editing, body-machine interfaces as potential next generation therapeutics), clinical implementation of such approaches will require close interactions between clinicians and scientists – for the latter. Our program provides a uniquely tailored preparation for this seminal interaction. In other words, our graduates are attractive to hire, as – from a medical department's point of view – they know their (scientific) matter as well as (clinically) matters. Typical next steps of the graduates are in PhD and a postdoc. At different time points switching to industry (r&d or customer service) is possible.

The qualification profile of the graduates includes an in depth understanding of brain function and structure, from molecules and cells to large-scale circuits, behavior and brain diseases. Through their lab rotations and practical scientific work, the students are familiar with the most relevant, cutting-edge technologies for basic research (e.g. multi-scale optophysiology imaging and opto-genetic manipulation, connectomics, genome editing). In the same time, the graduates have a detailed knowledge of disease related neuroscience. This includes both the theoretical background and the technical skills for commonly used clinical experimental approaches. Furthermore, the graduates are able to define and plan scientific studies. They have also the soft skills to know how to competently summarize and present their scientific results, by taking into consideration possible ethical consequences. They have the competencies to do independent research and they are familiar with the ethical and social aspects of neuroscience. Due to that the graduates are prepared for a fast growing academic and industrial job market. With their interdisciplinary knowledge, the graduates have a wide neuro-biomedical competence, bridging the usual gap between standard medical education and natural science curricula. After a successful finishing of his/her studies, a Master of Science of Biomedical Neuroscience has developed a portfolio of knowledge skills and competences in the field of molecular, cellular and systemic neuroscience, modern genetic, biochemical, optical and electrohysiological methods and their application in science and for diagnostic purposes and the analysis and presentation of scientific data. The qualification profile meets the requirements of the Qualifications Framework for German Higher Education Qualifications ("Hochschulqualifikationsrahmen" – HQR) from 16th February 2017. For Master's programs, the following four areas of competence have been defined: **Knowledge and understanding (1), Usage, application and generation of knowledge (2), Communication and cooperation (3), and Scientific self-understanding/ professionalism (4).**

3 Target Groups

3.1 Target Audience

The MSc-BmN is applicable to candidates who hold a Bachelor awarded from a German university in a subject of study from the field of natural science or engineering, including basic knowledge in Biology, Chemistry and Physics. Alternatively, students in Medicine, Veterinary Medicine or Dental Medicine or with an equivalent study at a foreign university can be accepted; formally this entry is based on final state examination ('Staatsexamen'), however, earlier inclusion is key. Hence, medical students will be able take courses in MSc-BmN in parallel to the clinical phase of their medical studies ('klinische Ausbildung') and obtain credits, allowing them to complete a substantial part of the curriculum and graduate with an MSc swiftly after medical school graduation. This will ensure – for a small subpopulation of exceptionally motivated and science-driven medical students – integration of the MSc-BmN into the existing framework of clinician-scientist training at TUM School of Medicine; introduce an important constituency into the student body and hence early contacts between medical and natural science graduates; and ensures that the PhD programs that accept MSc-BmN graduates will be offered well-trained graduates both with a science, as well as a medical background.

3.2 Prerequisites

Prerequisites are basic knowledge in chemistry, physics, biology and mathematics.

3.3 Target Numbers

The target figure is 15-20 students per academic year and class. This is a substantial size for an intense Elite MSc program with a strong practical element and an intense didactic concept that also includes substantial teacher training. The target figure is set so as to assure that during all labs and lectures, the capacities of the facilities are not exceeded and the student teacher ratio does not hinder close interaction between the students and lecturers. The number of applications increased by about 55% on average during the first three years and plateaued at around 300 per year. This results in about 30 interviews per intake phase and about 20 offers to applicants.

3.4. Demand Analysis

Neurological and neuropsychiatric disorders are on a rise in developed societies, so further expansion of research and development in neurology-related health care and biomedicine is to be anticipated. Hence our graduates will enter a growth market – so the career prospects of the graduates of the MSc-BmN program will be extremely good in academic research, clinical settings and in industry.

In addition to this positive outlook in general, both the characteristics of the proposed program and the local environment in Munich add further specific advantages: First, through the continuous MSc/PhD track at TUM (PhD-MLST) and the proximity of other outstanding graduate programs (e.g. Excellence graduate schools such as TUM's IGSSE and LMU's GSN; several International Max Planck Research Schools), access to outstanding post-graduate training is built into the program, and by virtue of Munich's standing as one of Europe's centers of neuroscience research and a major biomedical industry hub, the career outlook of graduates from such a program in Munich is very promising. Second, MSc-BmN graduates will have a distinctive characteristic by virtue of their 'dual training' in neuroscience and related medical questions. Dually trained researchers, i.e. either clinicians trained as scientists, and/or scientists specialized in clinically-relevant questions and technologies, will in the future be sought in growing numbers, not only in health industry, but also in academic medical departments. As true clinician-scientists are getting less available due to an increased density of clinical work and (monetarily) attractive job opportunities in pure clinical medicine, the medical departments in Germany are increasingly professionalizing their research staff. Thus in such a 'dual' system, where in medical departments pathomechanistic and clinical research will increasingly exist as parallel but intertwined 'worlds', specific training for scientists in the context of a School of Medicine's scientific and technology foci represents a unique opportunity.

The job outlook in the area of biomedical neuroscience is illustrated by the following (incomplete) list of subsequent employment opportunities:

Key academic programs: Ph.D. programs in neuroscience (locally – TUM, LMU, Munich-based International Max Planck Research Schools in Life Sciences and Translational Psychiatry; globally - similar programs exist at all major American, Asian, Australian and European universities); large-scale, long-duration (10+ years) international neuroscience initiatives such as the 'Human Brain Project' (EU), the 'BRAIN Initiative' (USA), 'Brain Mapping Initiative' (Australia); 'Brain Mapping by Integrated Neurotechnologies for Disease Studies' (Japan); multiple EU research calls in 'Horizon2020' in the Health Care and Information and Communication Technologies sectors.

Key private sector players: including 'Big Pharma', such as Merck, Bayer, Boehringer-Ingelheim, Novartis etc.; and smaller, often local biotech companies and start-ups, e.g. MorphoSys AG, Mikrogen GmbH and many more.

The pharmaceutical industry in Germany employs more than 15000 employees in the field of research and development. Besides the big pharmaceutical companies there are more than 600 biotech companies in Germany. Their number increases by 5-10 % every year. Most of them are specialized in the field of disease related innovative treatment strategies and are further potential employers for our graduates. It is assumed that there is much more demand on highly qualified neuroscientists than this study program can cover.

4 Competition Analysis

4.1 External Competition Analysis

Training programs for natural science undergraduates in Munich: Another MSc with neuroscience focus (MSc 'Neuroscience'), which originated as an Elite MSc, exits at LMU. This program is closely tied to the GSN graduate school and hence – as MSc-BmN would be – to Munich's efforts in the context of the Excellence Initiative. Both GSN and MSc-BmN will thus be close educational partners of the SyNergy Clusters (with the coordinator of GSN and its MSc elements, Prof. Grothe, being a SyNergy member, and Prof. Misgeld one of the two SyNergy coordinators). Specific initiatives, such as joint Summer Schools to entice talented students to apply to our programs, are already planned.

- Both Munich universities, the TUM and the LMU, strive to expand their training efforts at the MSc level, including a focus on biomedicine and bioengineering, as these are areas of special excellence in Munich, as well as fields of enormous growth and professional opportunity world-wide. As programs in these fields are being established (we are in close contact with those colleagues, who coordinate these efforts) points of cooperation and synergistic interaction are being proactively defined – such as credit point exchange agreements and opening of teaching events to broaden offers for our students; joint summer school and outreach activities to enhance national and international visibility of Munich-based elite training opportunities in biomedicine, bioengineering and neuroscience etc.. Such interactions are e.g. planned with the complementary Elite MSc 'Human Biology' (speakers Profs. Gudermann and Leonhardt) that is currently being initiated and will offer broader, less focused training targeted at a less technology-oriented student population. So, while MSc-BmN does not depend or overall with any of these additional initiatives, our students would benefit from a broadening of training offers via cooperation with emerging programs.

  Standard master neuroscience programs are part of the portfolio of the faculties of biology in several German universities (e.g. Univ. Freiburg, Univ. Heidelberg, HU Berlin, Univ. Göttingen, Univ. Frankfurt). Programs with a special focus on disease-related neuroscience exist (e.g. Translational Neuroscience, Univ. Würzburg and Univ. Düsseldorf, Molecular - Translational Neuroscience, Univ. Ulm, Experimental & Clinical Neuroscience, Univ. Regensburg) but are not very common. These biomedical programs cannot cover the increasing demand, especially that of the rapidly growing major research and clinical centers, such as Munich. Because of their limited training capacity, international master programs such as, for example, the "Research Master in Cognitive & Clinical Neuroscience" (Maastricht Univ.) or "Cognitive and Clinical Neuroscience" (Anglia Ruskin Univ., Cambridge), **are unable to cover** the increasing demand in biomedical neuroscientists.

4.2 Internal Competition Analysis

- *Training programs for medical students:* MSc-BmN, as the first Elite MSc in our faculty, will be closely coordinated with the ongoing teaching efforts for medical students. The MEC (with its director, Prof. Berberat, being a speaker of this initiative) will coordinate both aspects of student training and ensure their complementarity. As detailed above, we will make suitable parts of MSc-BmN's curriculum accessible to research-focused medical students, who are enrolled in the 'Translational Medicine' graduate program (just as in converse, MSc-BmN students will attend suitable classes in the latter). We will provide credit transfer between programs thus

adding high-quality content to both programs, and enable scientifically interested medical students to accrue substantial credits points towards completion of MSc-BmN after medical graduation. Importantly, we see a unique opportunity to anchor scientific competence training in our medical faculty to the mutual benefit of medical and natural science undergraduates.

Training programs for natural science undergraduates: At the TUM exists a related master program 'Neuroengineering'. This program is however, complementary and non-overlapping to this initiative, and hence offers attractive opportunities for collaboration. The Elite MSc program 'Neuroengineering' targets a different student population, namely graduates from engineering-related disciplines, in neuroscience basics aiming towards engineering implementation of neuro-inspired principles. As we intend to do the converse (educate biologically-trained students in quantitative neuroscience methodology), these two efforts complement – and we will cooperate to use synergistic opportunities (such as student-student tutoring in courses, where the initial expertise of the student population is essentially complementary; opening of lecture-format teaching and joint outreach to increase visibility). Coordination here is ensured via members of MSc-BmN (e.g. one of the speakers, Prof. Misgeld) also being faculty members in Neuroengineering. As additional MSc programs in related areas are being initiated at TUM, we will similarly expand our network of collaboration.

5 Program Structure

The MSc-BmN is designed as 4 semesters full time (120 ECTS) Master-of-Science training, in which the 3 semesters full time training (90 ECTS) will be followed by an additional semester (30 ECTS) for the master thesis. Teaching and examination language is English.

The MSc-BmN curriculum will offer cutting-edge training in biomedical neuroscience conveyed by innovative didactical teaching methods. The teaching philosophy will be to focus as much on scientific reasoning skills as on specific knowledge content, and to engrain theoretical training by matched hands-on teaching units, such as lab visits and lab rotations during the initial three terms and a Master thesis in a state-of-the art lab environment in the fourth. The curriculum will be structured in longitudinal and interactive modules following a learning spiral – starting with built-up of specific knowledge, via classification of this knowledge in a more general context, to guided practical application.

The curriculum is modularly structured to convey three types of overreaching competences:

(1) Scientific Theory & Reasoning (6 modules)
(2) Scientific Skills & Practice (7 modules incl. extensive lab time)
(3) Transferable Skills & Professional Competence (3 modules incl. colloquium)

AD (1): Together, the modules in scientific theory and reasoning cover the theoretical foundation of biomedical neuroscience. During the first semester, MSc-BmN students approach neuroscience starting with the nervous system at the molecular level (module: Molecular neuroscience) via the cellular level (module: Cellular neuroscience) to the systems level (module: Neuroanatomy and Neuropathology). In the second semester, the training of the students continues with functional analysis of systems (module: Nervous system and circuit development) followed by pathological settings (module: Systems neurology and neuroscience) and become familiar with the clinical presentation and treatment strategies for various disorders (module: Nervous system disorders and treatment). The third and fourth semester give the opportunity to apply the acquired theoretical knowledge in lab rotations and the Master´s thesis project.

AD (2): From the beginning MSc-BmN students use hands-on courses as learning opportunities for the theory-practice transfer - the modules of scientific skills and practices will dovetail with the theory modules to provide complementary practical skills and techniques for sustained understanding and competent application. In the first semester there will be two hands-on modules. One on ‘Molecular biology and -omics approaches’ will convey practical insights into modern technology for comprehensive molecular analysis of nervous system physiology and pathology. In the second module students will acquire advanced skills for structural analysis of neurons and glial cells under healthy and diseased conditions (module: ‘Microscopy of nervous system structure’). During the second semester, students will participate in intense training in ´Computational analysis and modelling´ to enable them to analyze and integrate data from neuroscientific studies. Here, we will benefit from our internationalization partner, Hebrew University’s elite training program ‘Brain Sciences: Computation and Information Processing’. The focus of this collaboration will be in the field of programming, data analysis and statistics, where our Israeli partners have unique expertise, while we will in return offer access to unique technical and disease-modelling infrastructure – this collaboration will be achieved via reciprocal exchange of students and faculty (for details on our internationalization concept, see Section 3.8). Furthermore, there will be hands on training in

methods for the functional imaging of neuronal and glial cell activity (module: Neuroimaging and electrophysiology).

With substantial compulsory elective elements of four lab visits (module: Data acquisition and presentation) (4x1 week) and two lab rotations (2x6 weeks) MSc-BmN students will get familiar with neuroscientific real-life research in their preferred specialization and also will get acquainted with the research programs of the faculty. The four lab visits during the intense and highly structured three first semesters will give the students a first opportunity to check out different areas of interest and will allow individual independent application of learned concepts. Building on this initial experience they will choose their two longer lab rotations and intensify their practice in specific fields – also with the prospect of identifying labs for future thesis work. All associated faculty and international partners agreed to offer suitable concise and tightly supervised research projects, thereby allowing students an exploration of their interests and an early specialization.

AD (3): To complete the scientific training towards fully-grown scientific professionality, as well as towards a mature personality, this program includes two explicit modules centered on transferable skills and professional competency. These modules run parallel to the neuroscientific content. Here students learn, on the one hand, all of the essential pragmatic skills of sound and successful scientific project management – this includes good scientific practice, data presentation, paper and grant writing etc. On the other hand, they will be asked to think beyond their immediate practical skill set and answer for themselves (and together with their peers and teachers) the question of what it means to be a (neuro-) scientist today. To achieve the latter, we designed a specific 'Life & Science' submodule that will encourage our students to reflect on the subjective and societal implications of neuroscience and nervous system diseases, and also immerse themselves into the historic, epistemological and science-philosophical underpinnings of modern biomedicine and neuroscience. Here we will partner with the Munich School of Philosophy. Finally, in the third semester, all students have to present their upcoming master-project in front of their peers and teachers in a qualifying colloquium, where students use all aspects of their preceding transferable skills and professional competence training. We are confident that such elements – held in appropriate context – will also be an essential step towards establishing a 'class spirit' amongst students and to truly root important ethical principles and professional competences, rather than just loosely append them as 'soft matter' to the 'hard facts'.

Course List

Courses in blue are hands on classes.

1. Semester (31 ECTS)

a)	Molecular Neuroscience	5 ECTS
b)	Cellular Neuroscience	5 ECTS
c)	Neuroanatomy and Neuropathology	5 ECTS
d)	Microscopy of nervous system structure	5 ECTS
e)	Molecular biology and -omics approaches	5 ECTS
f)	Scientific Practice	2 ECTS
g)	Life & Science	3 ECTS
h)	Data aquisition, analysis and presentation (Lab visit) compul. electiv subj.	1 ECTS

2. Semester (31 ECTS)

a)	Nervous system and circuit development	5 ECTS
b)	Systems neurology and neuroscience	5 ECTS
c)	Nervous system disorders and treatment	5 ECTS
d)	Computational analysis and modelling	5 ECTS
e)	Neuroimaging and electrophysiology	5 ECTS
f)	Scientific Practice	2 ECTS
g)	Life & Science	3 ECTS
h)	Data aquisition, analysis and presentation (Lab visit) compul. electiv subj.	1 ECTS

3. Semester (28 ECTS)

a)	Qualifying colloquium	2 ECTS
b)	Data aquisition, analysis and presentation (Lab visit) compul. electiv subj.	2 ECTS
c)	Lab rotation (I) - compulsory elective subject	12 ECTS
d)	Lab rotation (II) - compulsory elective subject	12 ECTS

4. Semester (30 ECTS)

Master´s Thesis and colloquium	30 ECTS
Total	**120 ECTS**

- A key element of the training strategy within MSc-BmN will be ‘learning by research’ using four main approaches: (1) the students learn about current research findings from leading faculty through interactive seminars (‘research-led’); (2) the students learn about the research process with emphasis on how knowledge on a specific topic is constructed and what rules of good scientific practice need to be followed (‘research-oriented’); (3) the students learn as researchers around inquiry-based activities during lab visits, lab rotations and project work (‘research-based’); and finally (4) the students learn individually and in small teams to critically reflect and discuss their research findings and their role as researchers (‘research-tutored’).
- Using validated methods of modern didactics, we aim to achieve deep and sustainable learning. For this, each topic in the ‘Scientific Theory & Reasoning’ modules will be taught in a three-step approach: (1) preparatory built-up of knowledge by eLearning, (2) content consolidation in face-to-face focus seminars, and (3) application of knowledge and problem-solving skills in application tutorials.

Step	eLearning	Focus seminar	Application tutorial
Objective	Get familiar with the basics	Consolidate contents	Apply knowledge in practice
Method	eLectures & Just-in-Time-Teaching	Expert talk	Assistant instruction

- An exemplary week in the first term will comprise all these steps within the Scientific Theory & Reasoning' module; this will be accompanied by hands-on courses of the 'Scientific Skills & Practices' modules and the longitudinal 'Transferable Skills & Professional Competence' content. As the students' progress through the program, the proportion of theory decreases and hands-on experiences increase.

	Monday	Tuesday	Wednesday	Thursday	Friday
9^{am} - 12^{pm}	Topic 1 eLearning	Topic 1 Focus Seminar	Topic 1 Application Tutorial	Topic 2 Focus Seminar	Topic 2 Application Tutorial
1^{pm} - 4^{pm}	Hands-on	Hands-on	Topic 2 eLearning	Hands-on	Hands-on
5^{pm} - 7^{pm}			Transferable Skills & Professional Competence		

The focus seminars are mainly aimed to deepen understanding and evolve the 'big picture'.

Application tutorials complete the didactic concept by providing an opportunity to apply and investigate the theoretical and conceptual knowledge learned before.

Study plan (courses in blue are hand-on classes):

<table>
<tr><th>1. Semester</th><th>2. Semester</th><th>3. Semester</th><th>4. Semester</th></tr>
<tr><td>Molecular Neuroscience

5 ECTS</td><td>Nervous system and circuit development

5 ECTS</td><td>Qualifying colloquium

2 ECTS</td><td rowspan="8">Master’s thesis and colloquium

30 ECTS</td></tr>
<tr><td>Cellular Neuroscience

5 ECTS</td><td>Systems neurology and neuroscience

5 ECTS</td><td>Lab rotation (I)

12 ECTS</td></tr>
<tr><td>Neuroanatomy and Neuropathology

5 ECTS</td><td>Nervous system disorders and treatment

5 ECTS</td><td>Lab rotation (II)

12 ECTS</td></tr>
<tr><td>Molecular biology and -omics approaches

5 ECTS</td><td>Computational analysis and modelling

5 ECTS</td><td rowspan="4"></td></tr>
<tr><td>Microscopy of nervous system structure

5 ECTS</td><td>Neuroimaging and electrophysiology

5 ECTS</td></tr>
<tr><td colspan="2">Scientific Practice

4 ECTS</td></tr>
<tr><td colspan="2">Life & Science

6 ECTS</td></tr>
<tr><td colspan="3">Data aquisition, analysis and presentation (Lab visits)

4 ECTS</td></tr>
<tr><td>31 ECTS</td><td>31 ECTS</td><td>28 ECTS</td><td>30 ECTS</td></tr>
</table>

6 Organization and Coordination

The **key responsibility** will be held by the three speakers, which will by their distinct backgrounds ensure the implementation of the outlined intensive curriculum and the demanding teaching concepts. The day-to-day by interaction between the Chair of Medical Education and the Neuroscience Chairs will be ensured by the Curriculum Coordinators.

A **Curriculum Commission** (lead by the speakers and formed by representatives of the core faculty and two student representatives) of the program will supervise all regulatory requirements and aspects of continuous curricular development, as well as the tutoring and mentoring processes in regular meetings.

Students will be encouraged to actively participate in the implementation and development of the program. Student representatives will be elected by the program participants that lead regular discussions among the students. They are members of the Curriculum Commission and stay in close direct exchange with the speakers.

The following administrative tasks are performed partly by the TUM Center for Study and Teaching (TUM CST) and its administrative units, partly by offices in the schools or departments:

- Student Advising:
  Student Advising and Information Services (TUM CST)
  Email: studium@tum.de
  Phone: +49 (0)89 289 22245
  Provides information and advising for prospective and current students (via hotline/service desk)
- Departmental Student Advising:
  Dr. Silke Herzer, silke.herzer@tum.de
  Phone: +49 89 4140 3376
  Apl. Prof. Dr. Helmuth Adelsberger
  h.adelsberger@tum.de
  Phone: +49 89 4140 3518
- Study Abroad Advising/Internationalization:
  TUM-wide: TUM Global & Alumni Office
  internationalcenter@tum.de
- Gender Equality Officer:
  TUM-wide: Dr. Eva Sandmann
  sandmann@tum.de, Tel. +49 (0)89 289 22335
- Advising – Barrier-Free Education:
  TUM-wide: Service Office for Disabled and Chronically Ill Students (TUM CST),
  Email: Handicap@zv.tum.de

Phone: +49 (0)89 289 22737

- Admissions and Enrollment: Admissions and Enrollment (TUM CST)
  Email: studium@tum.de
  Phone: +49 (0)89 289 22245
  Admissions, enrollment, Student Card, leaves of absence, student fees payment, withdrawal
- Aptitude Assessment (EV): Where applicable:
  TUM-wide: Admissions and Enrollment (TUM CST)
  Departmental: Aptitude Assessment Commission, Helmuth Adelsberger, h.adelsberger@tum.de
- Semester Fees and Scholarships: Fees and Scholarships (TUM CST),
  Email: beitragsmanagement@zv.tum.de
- Examination Board: Name (Prof. Dr. Thomas Misgeld)
  Name (Dr. Silke Herzer)
- Quality Management – Academic and Student Affairs:
  TUM-wide: Study and Teaching – Quality Management (TUM CST), www.lehren.tum.de/startseite/team-hrsl/

7 Enhancement Measures

In the first change of the study regulations at Feb. 07th 2019 examination regulations of hands-on courses (Modules MEBmN 004, 005, 012 and 013) where changed from grading to passed/non-passed. The reason for that was the fact the it is impossible to objectively grade practical tasks from student to student. Adaptations of the admission procedure were implemented in the study regulations following the TUM-wide requirements in 2021 (8.12.). Finally, modules (MEBmN 008, 009 and 010) were renamed to better reflect the contents of the respective classes at Feb. 10th, 2022).

From the first cohort on we have personal one-to-one meetings with each of the students to offer help, give advices and collect suggestions twice per semester. The result of these meetings lead to several adaptations of the studies. Therefore, the application seminars of the lecture modules are transferred from the lecture room to the labs of the participating institutes starting in 2020. This implements the students into real scientific life from the first semester on and strengthens the personal mentoring. Following the suggestions of the students we offered a Drosophila and Zebrafish hands-on course to enhance the variety of animal model systems in 2021 for the first time. Also, following a suggestion of the students we offered a python programming course and implemented these important computer language to our curriculum.

During the lock-down the lock-down period we enabled the students to have some practical experience by assembling so-called home lab kits with optic and electronic material we send them home. The supervision of the experiments was done via online-teaching.

Degree Program Documentation Master's Program Biomedical Neuroscience

Part B
TUM School Medicine
Technical University of Munich

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9 Resources

9.1 Staffing Resources

Teaching of this program is covered by lecturers from different university and extra-university institutions. The majority of the teaching personal is at the Medical School of the University. This includes research institutions (e.g. Institute of Neuronal Cell Biology, Institute of Neuroscience) as well as clinical departments (e.g. Departments of Neuroradiology, Neurology, Neurosurgery and Anaesthesiology). Lectures from extra-university institutions are located at the Max-Planck-Institute for Biological Intelligence, the German Center of Neurodegenerative Diseases (DZNE) and the Helmholtz Center Munich. For the module "Life & Science" we included lectures from the Munich School of Philosophy. In addition, lectures and classes are given by personal of our partner university, the Hebrew University in Jerusalem. It is important for the curriculum of the program, that institutions participating in classes also provide lab space for internships. The lecturers are also responsible for providing self-study material on our Moodle platform before their classes.

For more details, see resources spreadsheet below.

Study Coordination:

The study organization office provides guidance for students as well as lectures. This includes help for formal issues, advices regarding the curriculum, the online learning platform and help for the next carer steps. For this task 2.5 positions are available.

Furthermore, the students have access to the TUM study related help offers.

Additional tasks of the study coordination office include advertising, processing of applications and organisation of extra-curricular events (e.g. summer schools, carer days, social events and others).

Resources spreadsheet for the degree program …

Degree program modules						Staffing resources available			
Module			**Courses of the module**			**Personnel category**	**Lecturer**		
Module title	**Module number**	**Modul type**	**Course name**	**Type**	**SWS**		**Name**	**Professorship/Chair**	**School/ Dep.**
Molecular Neuroscience	MH560001	P	Molecular Neuroscience	VO	2	Prof.	Stefan Lichtenthaler	Proteomik	DZNE/ME
			Molecular Neuroscience	VO	1	Prof.	Angelika Harbauer	PI Neuronen und Metabolismus	MPI-BI/ME
			Molecular Neuroscience	VO	1	Prof.	Mikael Simons	Molekulare Neurobiologie	DZNE/ME
Cellular Neuroscience	MH560002	P	Cellular Neuroscience	VO	1,5	Prof.	Thomas Misgeld	Zellbiologie des Nervensystems	ME
			Cellular Neuroscience	VO	2	Apl. Prof.	Helmuth Adelsberger	Institut für Neurowissenschaften	ME
			Cellular Neuroscience	VO	0,5	PD	Monika Leischner-Brill	Zellbiologie des Nervensystems	ME
Neuroanatomy and Neuropathology	MH560003	P	Neuroanatomy and Neuropathology	VO	1,9	Prof.	Thomas Misgeld	Zellbiologie des Nervensystems	ME
			Neuroanatomy and Neuropathology	VO	1	Prof.	Angelika Harbauer	PI Neuronen und Metabolismus	MPI-BI/ME

			Neuroanatomy and Neuropathology	VO	1	PD	Monika Leischner-Brill	Zellbiologie des Nervensystems	ME
			Neuroanatomy and Neuropathology	VO	0,1	Dr.	Silke Herzer	Zellbiologie des Nervensystems	ME
Molecular biology and –omics approaches	MH560004	P	Molecular biology and –omics approaches	PR	2	Prof.	Stefan Lichtenthaler	Proteomik	DZNE/ME
			Molecular biology and –omics approaches	PR	1	Prof.	Angelika Harbauer	PI Neuronen und Metabolismus	MPI-BI/ME
			Molecular biology and –omics approaches	PR	1	Prof.	Dominik Paquet	Neurobiology	ISD LMU
Microscopy of nervous system structure	MH560005	P	Microscopy of nervous system structure	PR	2	Apl. Prof.	Helmuth Adelsberger	Institut für Neurowissenschaften	ME
			Microscopy of nervous system structure	PR	1	Prof.	Thomas Misgeld	Zellbiologie des Nervensystems	ME
			Microscopy of nervous system structure	PR	1	PD	Monika Leischner-Brill	Zellbiologie des Nervensystems	ME
Scientific practice	MH560006	P	Scientific practice	SE	1	Prof.	Angelika Harbauer	PI Neuronen und Metabolismus	MPI-BI/ME
			Scientific practice	SE	1	Prof.	Thomas Misgeld	Zellbiologie des Nervensystems	ME
Life & Science	MH560007	P	Life & Science	SE	1	Prof.	Pascal Berberat	TUMMEC	ME
			Life & Science		1		Moritz Schumm	TUMMEC	ME

Data aquistion, analysis and presentation	MH560008	P	Data aquistion, analysis and presentation	PR	4	various			
Nervous system and circuit development	MH560009	P	Nervous system and circuit development	VO	2,9	Dr.	Leanne Godinho	Zellbiologie des Nervensystems	ME
		P	Nervous system and circuit development	VO	1	PD	Monika Leischner-Brill	Zellbiologie des Nervensystems	ME
		P	Nervous system and circuit development	VO	0,1	Dr.	Silke Herzer	Zellbiologie des Nervensystems	ME
Systems neurology and neuroscience	MH560010	P	Systems neurology and neuroscience	VO	1	Prof.	Christian Sorg	Dept. Neuroradiologie	ME
		P	Systems neurology and neuroscience	VO	0,5	Prof.	Jan Kirschke	Dept. Neuroradiologie	ME
		P	Systems neurology and neuroscience	VO	1	Prof.	Simon Jacob	Dept. Neurochirurgie	ME
		P	Systems neurology and neuroscience	VO	1	PD	Thomas Fenzl	Dept. Anästhesie	ME
		P	Systems neurology and neuroscience	VO	0,5	PD	Matthias Kreuzer	Dept. Anästhesie	ME
Nervous system disorder and treatment	MH560011	P	Nervous system disorder and treatment	VO	1	Prof.	Mikael Simons	Molekulare Neurobiologie	DZNE/ME
		P	Nervous system disorder and treatment	VO	1	Prof.	Stefan Lichtenthaler	Proteomik	DZNE/ME

		P	Nervous system disorder and treatment	VO	1	Prof.	Thomas Korn	Dept. Neurologie	ME
		P	Nervous system disorder and treatment	VO	1	Prof.	Paul Lingor	Dept. Neurologie	ME
Computational analysis and modelling	MH560012	P	Computational analysis and modelling	PR	4	Prof.	Ruben Portugues	Institut für Neurowissenschaften	ME
Neuroimaging and electrophysiology	MH560013	P	Neuroimaging and electrophysiology	PR	2	Apl. Prof.	Helmuth Adelsberger	Institut für Neurowissenschaften	ME
		P	Neuroimaging and electrophysiology	PR	0,5	Prof.	Simon Schäfer	Dept. Psychiatry	ME
		P	Neuroimaging and electrophysiology	PR	0,5	Dr.	Martina Fetting	Zellbiologie des Nervensystems	DZNE/ME
		P	Neuroimaging and electrophysiology	PR	0,5	Prof.	Christine Preibisch	Dept. Neuroradiologie	ME
		P	Neuroimaging and electrophysiology	PR	0,5	Prof.	Markus Ploner	Dept. Neurologie	ME
Qualifying Colloquium	MH560014	P	Qualifying Colloquium	KO	1	Prof.	Pascal Berberat	TUMMEC	ME
			Qualifying Colloquium	KO	1		Moritz Schumm	TUMMEC	ME
Lab rotation I	MH560015	P		PR/KO	16	various			
Lab rotation II	MH560016	P		PR/KO	16	various			
Master´s Thesis and Colloquium	MH560017	P		PR/KO	20	various			

9.2 Material Resources and Workspace

Teaching in the program takes place at three locations: Biederstein Campus, University hospital campus and the German Center for Neurodegenerative Diseases (DZNE) in Großhadern. The main location is at the Biederstein Campus were we provide a lecture hall and laboratory space both dedicated to the program. In addition, there is a separate study room in the mensa building for the students for self-study or social events. For classes at the University hospital campus and at the DZNE seminar rooms and laboratories are booked for our students.

10 Schedule of Courses

See page 11-14.

2023		Date	Module	Full day		Module								
October	Monday	16		Introduction, Biederstein Campus										
	Tuesday	17		DZNE and MRI Campus										
	Wednesday	18		Wellcome week										
	Thursday	19		Public health, PhD programs										
	Friday	20		Chemical kitchen										
					Lecturer			Lecturer	Module	Topic	Coordination/Lecturer			
	Time			9-12 am			1:30-4:30 pm		5 – 8pm					
	Monday	23	MolNsci	**SelfStudy:** Introduction, Cell types in the brain, overview of macromolecules in cells; transcription, translation, protein degradation	Lichtenthaler	Comput	**Basic notions of probability:** Counting, Independent and Dependent Events. Conditional probability. Venn diagrams. Random variables	Portugues						
	Tuesday	24	MolNsci	**Lecture:** Introduction, Cell types in the brain, overview of macromolecules in cells; transcription, translation, protein degradation	Lichtenthaler	Comput	**Discrete probability distributions:** Bernoulli, uniform, binomial. The concept of mean (expectation value), variance. Displaying probability distributions.	Portugues						
	Wednesday	25	MolNsci	**SelfStudy:** DNA, RNA, tools for gene expression (plasmids, PCR, RNAi, viruses, CRISPR)	Paquet	MolNsci	**SelfStudy:** DNA, RNA, tools for gene expression (plasmids, PCR, RNAi, viruses, CRISPR)	Paquet						
	Thursday	26	MolNsci	**Lecture:** DNA, RNA, tools for gene expression (plasmids, PCR, RNAi, viruses, CRISPR)	Paquet	MolNsci	**Lecture:** DNA, RNA, tools for gene expression (plasmids, PCR, RNAi, viruses, CRISPR)	Paquet						
	Friday	27	MolNsci	**SelfStudy:** Cell biology, organelles, cytoskeleton, RNA aggregates, protein trafficking	Harbauer	Comput	Stochastic processes and the Poisson distribution. Continuous RVs. The exponential distribution, Gaussian. Joint probability distributions. Correlation and covariance.	Portugues						
	Monday	30	MolNsci	**Lecture:** Cell biology, organelles, cytoskeleton, RNA aggregates, protein trafficking	Harbauer	Comput	**The Central Limit Theorem:** Sum of RVs, averaging repeated experiments, CLT.	Portugues						
	Tuesday	31	MolNsci	**Lecture:** Cell biology, organelles, cytoskeleton, RNA aggregates, protein trafficking	Harbauer	Comput	**Inference and Statistical Testing:** Is a coin biased? Maximum likelihood estimation (include confidence intervals). Likelihood functions.	Portugues						
November	Wednesday	1		free (Allerheiligen)										
	Thursday	2	MolNsci	**SelfStudy:** Lipids, membranes, metabolism, diet, nutrients	Simons	Comput	**Hypothesis testing:** Framework. Z-test. T-test (one-sided, two-sided, paired). Goodness of fit tests. Non-parametric tests.	Portugues	Life & Science 1	Knowledge	Berberat/Schumm			
	Friday	3	MolNsci	**Lecture:** Lipids, membranes, metabolism, diet, nutrients	Simons	Comput	**Linear regression:** derivation from MLE, multiple linear regression.	Portugues						
	Monday	6	MolNsci	**SelfStudy:** Mitochondria and energy metabolism, basics of calcium signaling, nutrients and metabolism	Perocchi	Comput	**Bootstrapping:**	Portugues						

	Tuesday	7	MolNsci	**Lecture:** Mitochondria and energy metabolism, basics of calcium signaling, nutrients and metabolism	Perocchi	Comput	**Dimensionality reduction:** Principal component analysis	Portugues						
	Wednesday	8		**Host laboratory**										
	Thursday	9	MolNsci	**SelfStudy:** Protein modifications, aggregation and analytics	Lichtenthaler	Comput	**PCA more examples**	Portugues	scientific practice	What is Life?	Misgeld/Harbauer			
	Friday	10	MolNsci	**Lecture:** Protein modifications, aggregation and analytics	Lichtenthaler	Comput	**Clustering:** Otsu's method. k-means clustering	Portugues						
	Monday	13	MolNsci	**Lecture:** Protein modifications, aggregation and analytics	Lichtenthaler	Comput	**Hidden Markov models:** introns vs exons, sequence alignment	Portugues						
	Tuesday	14	MolNsci	**SelfStudy:** Signal transduction	Zhou	Comput	tba	Portugues						
	Wednesday	15		**Host laboratory**			**Host laboratory**							
	Thursday	16	MolNsci	**SelfStudy:** Molecular Structure and Function of Synapses	Schäfer	MolBio	Introduction & design of constructs	Paquet						
	Friday	17	MolNsci	**Lecture:** Signal transduction	Zhou	MolBio	Plasmid transformation	Paquet						
	Monday	20	MolNsci	**Lecture:** Molecular Structure and Function of Synapses	Schäfer	MolBio	Inoculation of mini/midi preps, genotyping of fish, mice	Paquet						
	Tuesday	21	MolNsci	**Lecture:** Repetition	Lichtenthaler	MolBio	Mini/midi prep	Paquet						
	Wednesday	22		**Host laboratory**			**Host laboratory**		Life & Science 2	Consciousness	Schumm/Rutzmoser			
	Thursday	23	CellNsci	SelfStudy	Leischner/Misgeld	MolBio	Cell culture - introduction and plating of cells	Harbauer						
	Friday	24	CellNsci	Lecture: Principles of Nervous System Structure & Analysis	Leischner/Misgeld	MolBio	Transfections	Harbauer						
	Monday	27	CellNsci	SelfStudy	Adelsberger	MolBio	primary and ex vivo models	Tahirovic						
	Tuesday	28	CellNsci	Lecture: Electrical Signaling in Neurons	Adelsberger	MolBio	antibody production	Feederle						
	Wednesday	29		**Host laboratory**			**Host laboratory**							
	Thursday	30	CellNsci	SelfStudy	Leischner/ Harbauer	MolBio	Western blots part 1	Harbauer	scientific practice	Scientific storytelling	Harbauer			
December	Friday	1	CellNsci	Lecture: Cytology of Neurons	Leischner/ Harbauer	MolBio	Western blots part 2	Harbauer						
	Monday	4	CellNsci	SelfStudy	Kenet/Priller/Simons	MolBio	Transcriptomics - introduction and sample preparation	Schormair						
	Tuesday	5	CellNsci	Lecture: Glia	Kenet/Priller/Simons	MolBio	Transcriptomics - data analysis	Schormair						
	Wednesday	6		**Host laboratory**			**Host laboratory**							
	Thursday	7	CellNsci	SelfStudy	Adelsberger	MolBio	Advanced Cellular Models	Schäfer	scientific practice	Science communication to the public	Harbauer/AvK			
	Friday	8	CellNsci	Lecture: Ion Channels, Trasnporters & Receptors	Adelsberger	MolBio	Proteomics introduction	Lichtenthaler						
	Monday	11	CellNsci	SelfStudy	Misgeld/??	MolBio	Flow cytometry	Zhou						
	Tuesday	12	CellNsci	Lecture: Structure of Synapses	Misgeld/??	MolBio	Sample preparation	Lichtenthaler						
	Wednesday	13		**Host laboratory**			**Host laboratory**							
	Thursday	14	CellNsci	SelfStudy	Adelsberger	MolBio	Sample preparation and measurement	Lichtenthaler	Life & Science 3	Metaphors	Schumm/Rathgeber			
	Friday	15	CellNsci	Lecture: Function of Synapses	Adelsberger	MolBio	Proteomic data analysis	Lichtenthaler						
	Monday	18	CellNsci	SelfStudy	Adelsberger	MolBio	Proteomic data analysis	Lichtenthaler						
	Tuesday	19	CellNsci	Lecture: Intracellular Signaling & Synaptic Plasticity	Adelsberger	MolBio	Repetion/oral exam	Lichtenthaler						
	Wednesday	20		**Host laboratory**			**Host laboratory**							
	Thursday	21												
	Friday	22												
Jahreswechsel , new year														

2024														
January	**Monday**	8	Neuroan.	SelfStudy	Marahori /Misgeld	Microsc.	Optics I	Adelsberger/Portugues						
	Tuesday	9	Neuroan.	Lecture: Macroscopy I: Parts of the brain, brain stem, cranial nerves, Advanced Topic	Marahori /Misgeld	Microsc.	Optics II	Adelsberger/Portugues						
	Wednesday	10		**10 AM Exam Cellular Neuroscience**			**Host laboratory**							
	Thursday	11	Neuroan.	SelfStudy	Leischner /Plesnila	Microsc.	Optics III	Adelsberger/Portugues	scientific practice	The publication process	Misgeld			
	Friday	12	Neuroan.	Lecture: Macroscopy II: Spinal cord & PNS/ANS & Vasculature, Advanced Topic	Leischner /Plesnila	Microsc.	Optics IV	Adelsberger/Portugues						
	Monday	15	Neuroan.	SelfStudy	Misgeld/Portugues	Microsc.	Function of a microscope/Basic electronics I	Adelsberger/Berger						
	Tuesday	16	Neuroan.	Lecture: Cortex and cerebellum	Misgeld/Portugues/Herwerth	Microsc.	Function of a microscope/Basic electronics II	Adelsberger/Berger						
	Wednesday	17		**Host laboratory**			**Host laboratory**							
	Thursday	18	Neuroan.	SelfStudy	Herzer/TBC	Microsc.	Function of a microscope/Basic electronics III	Adelsberger/Berger	Life & Science 4	Laboratory Life	Schumm/Misgeld/Samaras			
	Friday	19	Neuroan.	Lecture: Basal ganglia, Thalamus & Hippocampus	Herzer/TBC	Microsc.	Function of a microscope/Basic electronics IV	Adelsberger/Berger						
	Monday	22	Neuroan.	SelfStudy	Herzer/TBC (Obesity Pfister/Tschöpp	Microsc.	Patch clamp	Adelsberger						
	Tuesday	23	Neuroan.	Lecture: Motor system/ Limbic system-Hypothalamus, Advanced Topic	Herzer/TBC (Obesity Pfister/Tschöpp	Microsc.	Patch clamp	Adelsberger						
	Wednesday	24		**Host laboratory**			**Host laboratory**							
	Thursday	25	Neuroan.	SelfStudy	Godinho/ Adelsberger/Busse	Microsc.	Patch clamp	Adelsberger	scientific practice	Figures for Publication	Harbauer			
	Friday	26	Neuroan.	Lecture: Visual system/ Auditory-vestibular system, Advanced topic: Comparative visual system	Godinho/ Adelsberger/Busse	Microsc.	Building a microscope	Adelsberger/Marahori/ Misgeld						
	Monday	29	Neuroan.	SelfStudy	Marahori/TBC (Pain Tölle)	Microsc.	Anatomy of the microscope: basics	Misgeld/Marahori						
	Tuesday	30	Neuroan.	Lecture: Somatosensory system & pain, Advanced Topic	Marahori/TBC (Pain Tölle)	Microsc.	1-photon microscopy	Misgeld/Askari						
	Wednesday	31	Microsc.	Zebrafisch injections	Achury/Godinho		**Host laboratory**							
February	Thursday	1	Neuroan.	SelfStudy	Misgeld/TBC (ANS Engelhardt)	Microsc.	2-Photon microscopy	Adelsberger/Eichenseer	scientific practice	Graphs for scientific communication	Harbauer/Misgeld			
	Friday	2	Neuroan.	Lecture: ANS/ Olfactory & gustatory system, Advanced Topic	Misgeld/TBC (ANS Engelhardt)	Microsc.	In vivo imaging: zebrafish	Godinho/Misgeld/Achury						
	Monday	5	Microsc.	Immunohistochemistry: Fix & Section	Leischner/Zhiti/Pastor	Neuroan.	Hands-on: Human brain dissection - Demo	Misgeld/Marahori/Schlegel						
	Tuesday	6	Microsc.	Immunohistochemistry: Stain	Leischner/Zhiti/Pastor	Neuroan.	Hands-on: Human brain dissection - DIY	Misgeld/Marahori/Schlegel						
	Wednesday	7		**Host laboratory**			**Host laboratory**							
	Thursday	8	Microsc.	Immunohistochemistry: Document	Misgeld/Marahori/Askari	Neuroan.	Hands-on: Comparative neuroanatomy (fish, mouse, pig?, human)	Misgeld/Marahori/Wullimann	Life & Science 5	Scientific progress	Schumm/Berberat			
	Friday	9	Microsc.	Immunohistochemistry: Analyse & Present	Misgeld/Zhiti/Eichensee r	Neuroan.	Hands-on: Neuropathology primer	Misgeld/Marahori/Schlegel						
	April, 16th			**Exam recap Neuroanatomy**	Marahori									
	April, 17th			**Exam Neuroanatomy**	Herzer									

2023	Time	Date	Module	9-12 am	Lecturer	Module	1:30-4:30 pm	Lecturer	Module	5 – 8pm	Lecturer
April	Monday	17	Neurodev	Introduction Dev. Neurob. (e-l.)	Godinho						
	Tuesday	18	Neurodev	Introduction Dev. Neurob.	Godinho	Imag&Ephys	Basic electronics	Adelsberger/Berger			
	Wednesday	19		**9 AM Exam Neuroanatomy**			**Host laboratory**				
	Thursday	20	Neurodev	Segmentation (e-l.)	Godinho	Imag&Ephys	Basic electronics	Adelsberger/Berger	Life&Science	Nature	Berberat/Schumm
	Friday	21	Neurodev	Segmentation	Godinho	Imag&Ephys	Basic electronics	Adelsberger/Berger			
	Monday	24	Neurodev	Cell determination (e-l.)	Godinho	Imag&Ephys	Basic electronics	Adelsberger/Berger			
	Tuesday	25	Neurodev	Cell determination	Godinho	Imag&Ephys	Basic electronics	Adelsberger/Berger			
	Wednesday	26	Imag&Ephys	**Patch clamp in groups of two**	Adelsberger		**Patch clamp in groups of two**	Adelsberger			
	Thursday	27	Neurodev	Proliferation (e-l.)	Godinho	Imag&Ephys	Calcium Imaging/TMS in two groups (entrance hall Neurokopfzentrum)	Adelsberger/Krieg	Scientific Practice	TBD	
	Friday	28	Neurodev	Proliferation	Godinho	Imag&Ephys	Calcium Imaging/TMS in two groups (entrance hall Neurokopfzentrum)	Adelsberger/Krieg			
May	Monday	1		free			free				
	Tuesday	2	Neurodev	Neurite outgrouth	Leischner	Comput	Pyton course	Kaboli			
	Wednesday	3		**Host laboratory**			**Host laboratory**				
	Thursday	4	Neurodev	Neuronal survival, cell death (e-l.)	Misgeld	Comput	Pyton course	Kaboli	Life&Science	Animal rights	Harbauer
	Friday	5	Neurodev	Neuronal survival, cell death	Misgeld	Comput	Pyton course	Kaboli			
	Monday	8	Neurodev	PNS synapse formation & reorganiz. (e-l.)	Misgeld	Comput	Pyton course	Kaboli			
	Tuesday	9	Neurodev	PNS synapse formation & reorganiz.	Misgeld	Comput	Pyton course	Kaboli			
	Wednesday	10		**Host laboratory**			**Host laboratory**				
	Thursday	11	Neurodev	CNS synapse formation & reorganiz. (e-l.)	Leischner	Comput	Pyton course	Kaboli	Scientific Practice	Ethics and legislation of Animal rights	Kellermann
	Friday	12	SysNeurol	fMRI (e-l.)	Riedl, Preibisch, Wohlschläger	Comput	Pyton course	Kaboli			
	Monday	15	Neurodev	CNS synapse formation & reorganiz.	Leischner	SysNeurol	Clinical Neuroradiology (e-l.)	Kirschke			
	Tuesday	16	SysNeurol	fMRI (PC-room Lutz)	Riedl, Preibisch, Wohlschläger		fMRI Evaluation	Riedl, Preibisch, Wohlschläger			
	Wednesday	17		**Host laboratory**			**Host laboratory**				
	Thursday	18		free (Christi Himmelfahrt)			free				
	Friday	19	SysNeurol	Clinical Neuroradiology (lecture room Lutz)	Kirschke						
	Monday	22	SysNeurol	Translational Neurorad., Neurodevelopmental disorders (e-l.)	Sorg	Imag&Ephys	EEG (main entrance Translatum, Einsteinstrasse 25)	Bok, Ploner			
	Tuesday	23	SysNeurol	Translational Neurorad., Neurodevelopmental disorders (lecture room Lutz)	Sorg	Imag&Ephys	EEG (main entrance Translatum, Einsteinstrasse 25)	Bok, Ploner			
	Wednesday	24		**Host laboratory**			**Host laboratory**				
	Thursday	25	SysNeurol	Translational Neurorad., Neurodevelopmental disorders (lecture room Lutz)	Sorg				Life&Science	Health Discourses	Schumm, Samaras
	Friday	26	SysNeurol	Sleep	Fenzl	Imag&Ephys	In vivo electrophysiology	Fenzl			
	Monday	29		free			free				
	Tuesday	30				Imag&Ephys	Organoids (e-l.)	Schäfer			
	Wednesday	31		**exam Developmental N.**			**Host laboratory**				
June	Thursday	1	SysNeurol	Cognitive Neuroscience (e-l.)/Organoids (in groups)	Schäfer/Jacob	Imag&Ephys	Cognitive Neuroscience (e-l.)/Organoids (in groups) (TranslaTUM, Einsteinstr. 25, 81675 Munich)	Schäfer/Jacob	Scientific Practice	Drug Discovery	tbd
	Friday	2	SysNeurol	Cognitive Neuroscience	Jacob	Imag&Ephys	Organoids (Biederstein)	Schäfer			

	Monday	5	SysNeurol	Behavioral strategies (e-l.)	Adelsberger	Imag&Ephys	Mouse behavior I	Adelsberger			
	Tuesday	6	SysNeurol	Behavioral strategies	Adelsberger	Imag&Ephys	Mouse behavior II	Adelsberger			
	Wednesday	7		**Host laboratory**			**Host laboratory**				
	Thursday	8		free			free				
	Friday	9	SysNeurol	Auditory (e-l.)	Nelken						
	Monday	12	SysNeurol	Auditory	Nelken	Imag&Ephys	Zebrafish behavior I	Portugues			
	Tuesday	13	Nersysdis	Alzheimer (e-l.)	Lichtenthaler, Diehl-Schmid	Imag&Ephys	Zebrafish behavior II	Portugues			
	Wednesday	14		**Host laboratory**			**Host laboratory**				
	Thursday	15	Nersysdis	Alzheimer	Diehl-Schmid				Life&Science	Happiness	Berberat/Schumm
	Friday	16	Nersysdis	Alzheimer (large seminarroom U1 155, DZNE)	Lichtenthaler	SysNeurol	Anesthesiology (e-l.)	Pilge et al.			
	Monday	19	Imag&Ephys	Drosophila course	Misgeld, Schuldiner		Drosophila course	Misgeld, Schuldiner			
	Tuesday	20	Imag&Ephys	Drosophila course	Misgeld, Schuldiner		Drosophila course	Misgeld, Schuldiner			
	Wednesday	21	Imag&Ephys	Drosophila course	Misgeld, Schuldiner		Drosophila course	Misgeld, Schuldiner			
	Thursday	22	Imag&Ephys	Drosophila course	Misgeld, Schuldiner		Drosophila course	Misgeld, Schuldiner	Life&Science	Neurology and NS	Berberat/Schumm
	Friday	23	Imag&Ephys	Drosophila course	Misgeld, Schuldiner		Drosophila course	Misgeld, Schuldiner			
	Monday	26	Nersysdis	Parkinson's disease, ALS (e-l.)	Lingor	SysNeurol	Anesthesiology (Translatum, ground floor, room 22.0.44)	Pilge et al.			
	Tuesday	27	Nersysdis	Parkinson's disease, ALS (Seminarroom Gefäßchirurgie, 2. floor, Neuro-Kopf-Zentrum, Ismaninger Str. 22)	Lingor	SysNeurol	Anesthesiology (Translatum, ground floor, room 22.0.44)	Pilge et al.			
	Wednesday	28				SysNeurol	Anesthesiology (Translatum, ground floor, room 22.0.44)	Pilge et al.			
	Thursday	29	Nersysdis	Regeneration (e-l.)	Simons	Comput	Evaluation	Portugues	Life&Science	Bio Enhancement	Berberat/Schumm
	Friday	30	Nersysdis	Regeneration (CSD, large lecture hall)	Simons	Comput	Evaluation	Portugues			
July	**Monday**	3	Nersysdis	Neuroimmunology, Multiple Sclerosis (e-l.)	Korn	Comput	Evaluation	Portugues			
	Tuesday	4	Nersysdis	Neuroimmunology, Multiple Sclerosis	Korn	Comput	Evaluation	Portugues			
	Wednesday	5		**Host laboratory**			**Host laboratory**				
	Thursday	6	Nersysdis	Neurogenetics (e-l.)	Schormair	Comput	Evaluation	Portugues	Scientific Practice	AI in Neuroscience	tbt
	Friday	7	Nersysdis	Neurogenetics (Biederstein)	Schormair	Comput	Evaluation	Portugues			
	Monday	10	Nersysdis	Vascular disease (e-l.)	Liesz	Comput	Evaluation	Portugues			
	Tuesday	11	Nersysdis	Vascular disease (main entrance ISD, Feodor-Lynen-Str. 17)	Liesz	Comput	Evaluation	Portugues			
	Wednesday	12		**Host laboratory**			**Host laboratory**				
	Thursday	13	Nersysdis	**exam Systems Neurol.**		Nersysdis	Neurosurgery (e-l.)	Krieg			
	Friday	14	Nersysdis	Neurosurgery (Seminarroom 0.100, ground floor, Neuro-Kopf-Zentrum)	Krieg						
	Monday	17	Nersysdis	FTD etc. (e-l.)	Edbauer						
	Tuesday	18	Nersysdis	FTD etc. (large seminarroom (8G U1 155) DZNE)	Edbauer						
	Wednesday	19		**Host laboratory**			**Host laboratory**				
	Thursday	20	Nersysdis	Animal models in neurodegenerative diseases (e-l.)	Zhou		Scientific Practice	Brunnhuber			
	Friday	21	Nersysdis	Animal models in neurodegenerative diseases (large seminarroom (8G U1 155) DZNE)	Zhou						
	August 4th			**exam Nervous system disorders**							

11 Letters of Intent (LOI)

האוניברסיטה העברית בירושלים
THE HEBREW UNIVERSITY OF JERUSALEM
الجامعة العبرية في اورشليم القدس

Jerusalem, 14 January 2021

Prof. Dr. Thomas Misgeld, Prof. Dr. Arthur Konnerth, Prof. Dr. Pascal Berberat
Faculty of Medicine
Technical University of Munich
Munich, Germany

Dear colleagues,

It is my great pleasure to confirm the interest of the Edmond and Lily Safra Center for Brain Sciences (ELSC) and of our international Ph.D. program 'Brain Sciences: Computation and Information Processing' to continue our cooperation with the Elite Master Program in "Biomedical Neuroscience" at the Technical University of Munich. The first 2.5 years of this collaboration have been very successful, despite the challenges related to the pandemic – so we would be happy to extent our joint efforts.

Just to recapitulate: As our teaching program is provided in English, we are ready to accept international students from the MSc-BmN program, e.g. to join online classes or to join labs of ELSC for lab rotations. We will continue to provide our expertise in data analysis and statistics, machine learning, and neural computations, which is unique and at the cutting edge of current research. We offer courses in basic mathematics, data analysis, neural network modeling, machine learning, and cognitive psychology (theory and experiments) to students of the MSc-BmN program. In exchange, students from our program have the benefit of being able to participate in courses teaching imaging techniques, electronics, molecular biology, and clinical research given as part of the MSc-BmN program.

As in the first funding period, we will also continue exchange of lecturers to establish courses given jointly by teachers from the two programs – especially also during the annual joint retreats. These are alternately held at the Interuniversity Institute in Eilat (as in 2019) or in the TUM Research Station in Berchtesgaden (as planned for 2020, but postponed due to the pandemic), thus continuing the long tradition of our biannual International Summer Courses that stared in 2006.

I believe that student exchanges and joint teaching activities as outlined above will greatly enhance the academic level of both programs. I'm looking forward to the continuation of this collaboration in MSc-BmN's second funding period.

Sincerely,

Prof. Israel Nelken

I. Nelken

Prof. Israel Nelken • The Milton and Brindell Gottlieb Chair in Brain Science
Co Director, The Edmond and Lily Safra Center for Brain Sciences

פרופ' ישראל נלקן • הקתדרה ע"ש מילטון וברינדל גוטליב למחקר המוח
ראש מרכז אדמונד ולילי ספרא למדעי המוח

Prof. Adi Mizrahi • The Eric Roland Chair in Brain Sciences
Co-Director, The Edmond and Lily Safra Center for Brain Sciences

פרופ' עדי מזרחי • הקתדרה ע"ש אריק רולנד למדעי המוח
ראש מרכז אדמונד ולילי ספרא למדעי המוח

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