Module Number **3a**	**Title:** **Modelling and regeneration of the nervous system: from animal models to iPSCs and brain organoids**		
Module type: compulsory elective	**Language:** English	**Group Size**: 6 students	
Study semester: 1	**Availability:** winter semester	**Study semester:** 1	
Workload: 420 hrs	**Credits:** 14CP	**Contact time:** 124 hrs	**Independent study:** 296 hrs

1 Courses

a) Lecture 2 PPW
b) Practical course 9 PPW

2 Intended learning outcomes

After completion of this module students
(1) will be familiar with the sterile preparation and cultivation of neural stem cells, primary neocortical cell cultures and enrichment/isolation of distinct neural cell types, human induced pluripotent stem cells (iPSCs), and human iPSC-derived neural progenitor cells (NPCs), neurons, and brain organoids
(2) will able to apply basic immunocytochemical techniques (using light and fluorescence microscopy) as well as qPCR measurements to identify and distinguish neural cell types
(3) will have solid understanding of the development and differentiation of neural cells,
(4) will understand the basis of recombinant modulation of endogenous gene expression,
(5) will get an insight in mitochondrial homeostasis and energy metabolism,
(6) will be able to work independently and accurately with laboratory equipment,
(7) will be able to analyse and document experimental results according to good scientific practise standards,
(8) will be able to present and discuss experimental results and scientific context.

3 Content

Lectures:

Neurocytology: Neurons and glial cells - morphology and function in the nervous system, Neural stem cells; Development and differentiation of the nervous system; Introduction to Neuro- and gliogenesis, cell determination, differentiation and interaction; Microglial polarization and astroglial activation during development and disease; Molecular pathophysiology and regeneration: Multiple sclerosis, traumatic nerve injury and regeneration; Oligodendroglial cell differentiation and myelin repair; Pluripotent stem cells; Energy metabolism in stem cells and neurogenesis; Disease modelling of neurological mitochondrial diseases; High-content screenings; Mitochondria in stem cells and neurons; Brain mitochondrial diversity; Neuronal differentiation of human stem cells in 2D and 3D (brain organoids); Nuclear and mitochondrial genome editing; How to prepare a scientific manuscript.

Practical course:

The Küry lab belong to the Department of Neurology and will focus on cultivation and identification of neural cell types from rat brain (neural stem cells, neurons, astrocytes, oligodendrocytes, microglia) and analysis of neural differentiation with the following sets of experiments: Preparation and cultivation of primary cortical mixed cultures; purification of precursor cells; application of light microscopy and immunofluorescence methods to demonstrate morphological cell differentiation and identification of cell maturation markers; Sorting, enrichment and isolation of distinct cell types using MACs techniques; Cell transfection to modulate endogenous gene expression and cell differentiation; RNA purification and quantification of differentiation markers using pRT-PCR; Polarization of primary microglial cells; triggering astroglial cells; Immunoassay (ELISA) to detect secreted immune-associated cytokines.
The Prigione lab belongs to the Department of General Pediatrics, Neonatology, and Pediatric Cardiology, at the University Clinic Düsseldorf (UKD) and will focus on human

	induced pluripotent stem cells (iPSCs) differentiated in 2D (neural progenitors and neurons) and 3D (brain organoids) to address changes in mitochondrial metabolism and in the context of disease modelling of neurological mitochondrial disorders. We will use the following sets of experiments: Cultivation of iPSCs, differentiation into neural progenitor cells (NPCs), neurons, and brain organoids, transfection of stem cells and neurons, DNA and RNA isolation for qPCR, cloning and CRISPR/Cas9 genome editing, Multi-electrode arrays (MEA), immunostaining of pluripotency and neuronal markers. **Final presentation:** At the last day of the module, the students will give a scientific presentation and will defend and discuss the results of the practical course within the scientific context.
4	**Teaching methods** Lectures, practical course with demonstrations and hands-on guidance (everybody will have hands-on experience), oral presentation, supervised protocol writing and data analysis
5	**Prerequisites** **Formal:** Successful completion of module 1. **With regards to content:** basic knowledge of molecular neurobiology
6	**Examination type:** cumulative examination Written exam covering lectures and practical course (90 minutes, 70% of total grade) Scientific presentation (15 minutes, 30% of total grade)
7	**Requirements for award of credit points** Regular participation in the practical training. Final presentation and discussion of experimental results. Successful participation in the written examination.
8	**Module applicability** (in other study courses) The module is closely related to module 3b and 3d. The module is also used in Master Biology and Molecular Biomedicine (in combination with Module 3d).
9	**Assessment** The mark given will contribute to the final grade in proper relation to its credits.
10	**Module convenor and main lectures** Dr. F. Bosse, Dr. P. Göttle, PD Dr. D. Kremer, MSc L. Reiche, MSc J. Gruchot, MSc Luisa Werner, Dr. Annika Zink, Prof. Dr. A. Prigione, Prof. Dr. P. Küry
11	**Further information** The regular participation in the lectures is strongly recommended. The content of the lectures is prerequisite for the practicals and relevant for the written exam.