Module Name
3D Cryo Electron Microscopy

Type of Module	**Module Code**
o Advanced Module	Electron Microscopy

Identification Number	**Workload**	**Credit Points**	**Term**	**Offered Every**	**Start**	**Duration**
MN-B-SM (Z 2)	360 h	12 CP	2nd term of studying	Summer term	summer term only	7 weeks

1	**Course Types**	**Contact Time**	**Private Study**	**Planned Group Size***
	a) Lectures	24 h	48 h	max. 12
	b) Practical/Lab	150 h	106 h	max. 12
	c) Seminar	8 h	24 h	max. 12

2 Module Objectives and Skills to be Acquired

Students who successfully completed this module

- have acquired fundamental knowledge about the principles of electron microscopy (EM) as a tool in structural biology, including the physical background of electron optics, and about the computational methods required to reconstruct 3D objects from 2D images.
- are able to prepare sample grids for negative-stain EM, operate a low-kV transmission electron microscope, assess protein quality by EM, and use computational tools to process EM datasets to determine the 3D structures of proteins.
- are familiar with the use of high-performance computing resources for advanced computational tasks, and are able to write simple computer scripts to automate repetitive tasks.
- have learned how to present research results in oral and written form, and to critically discuss scientific publications related to the topic of the module on a professional level.
- are able to transfer skills acquired in this module to other fields of biochemistry.

3 Module Content

- Imaging with electrons: theory and practical aspects
- Sample preparation for EM: negative-staining and vitrification of biological macromolecules
- Data collection using electron microscopes, routine operations on electron microscopes, and strategies for automated data collection and quality assessment
- Basic introduction into using high-performance computing resources in structural biology
- Reconstruction of 3D structures from 2D EM images using single-particle refinement strategies

4 Teaching Methods

Lectures; Practical/Lab; Seminar; Computer exercises; Guidance to independent research; Training on presentation techniques in oral and written form

5 Prerequisites (for the Module)

Enrollment in the Master´s degree course “Biological Sciences”, in the Master’s degree course “Biochemistry” or in the Master´s degree course “Chemistry”

6	**Type of Examination** The final examination consists of two parts: oral presentation (20-30 min; 50 % of the total module mark), written report (50 % of the total module mark)
7	**Credits Awarded** Regular and active participation; Each examination part at least "sufficient" (see appendix of the examination regulations for details)
8	**Compatibility with other Curricula*** Biochemical subject module in the master's degree course "Biochemistry" and in the master´s degree course "Chemistry"
9	**Proportion of Final Grade** In the Master´s degree course "Biological Sciences": 15 % of the overall grade (see also appendix of the examination regulations)
10	**Module Coordinator** Prof. Dr. Elmar Behrmann, phone 470 76300, e-mail: elmar.behrmann@uni-koeln.de
11	**Further Information** **Subject module** of the Master´s degree course "Biological Sciences", **Participating faculty:** Prof. Dr. E. Behrmann, Dr. M. Gunkel, Dr. S. Pöpsel **Literature** • Frank, J. (2006) Three-Dimensional Electron Microscopy of Macromolecular Assemblies: Visualization of Biological Molecules in Their Native State. Oxford University Press • Jensen, G. Getting Started in Cryo-EM. Online course @Caltech [http://em-learning.com/] • Additional material and subject specific literature will be provided *ad hoc* **Note:** the module contains hand-on laboratory work conducted by small groups of students and is taught in course rooms and research laboratories. The module contains also computer-based research/practicals as a main component. **Location:** The course will take place at the Institute of Biochemistry, Zülpicher Str. 47, 50674 Cologne. **General time schedule:** Week 1-5 (Mon.-Fri.): Lectures from 9:00 to 10:30 three times a week, Experimental/computational work 10:30 to 16:00 including a short lunch break five times a week. Exact times can vary according to the laboratory needs; Week 6 (Mon.-Fri.): Preparation and presentation of the seminar talk and the poster; Week 7 (Mon.-Fri.): Preparation for the oral examination **Introduction to the module**: April 1, 2022 at 9:00 a.m., online (further information/link will be sent to your Smail-Account) **Oral examination:** May 20, 2022, second/supplementary examination August 05, 2022; the latter date may vary if students and module coordinator agree. More details will be given at the beginning of the module.

* 4 students from the Master's degree course "Biological Sciences", 7 students from the Master's degree course "Biochemistry" and 1 student from the Master's degree course "Chemistry".