Module Name
3D Cryo Electron Microscopy

Type of Module	**Module Code**
o Advanced Module	3D Cryo Electron Microscopy

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

1	**Course Types**	**Contact Time**	**Private Study**	**Group Size***
	a) Lecture	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 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

Enrollment in the Master's degree course "Biological Sciences", in the Master's degree course "Biochemistry" or in the Master's degree course "Chemistry".

For students from the Master's degree course "Chemistry" prior participation in an advanced Biochemistry module, including its practical lab part, during the Bachelor's degree course is required.

6	**Type of Examination** The final examination consists of two parts: 20-30 min oral examination about topics of the lectures and seminar presentations (50% of the total module mark), and written report on the experimental results (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": 12 % 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** **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 [https://em-learning.com/] • Additional material and subject specific literature will be provided *ad hoc* via Ilias **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 also contains computer-based research/practicals as an important 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 11:00 to 17:00 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, respective of the written report; Week 7 (Mon.-Fri.): Preparation for the oral examination **Introduction to the module**: March 31st, 2023 at 9:00 a.m., Institute of Biochemistry, Room 465, 4th floor **Oral examination:** May 19th, 2023, second/supplementary examination June 23rd, 2023; 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 Master's degree course "Biochemistry", and 1 from the Master's degree course "Chemistry".