Structural Biology: Cryo Electron Microscopy					
Identification number MN-BC-BSM13 MN-B-SM- (B 5)	Workload 360 h	Credit points 12 CP	Term of studying 1st or 2nd term of studying	Frequency of occurence Summer term, 1th half	Duration 7 weeks

1	Type of lesson	Contact times	Self-study times	Intended group size*
	a) Lecture	24 h	48 h	max. 16
	b) Practical/lab	150 h	106 h	max. 16
	c) Seminar	8 h	24 h	max. 16

2 Aims of the module and acquired skills

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 biochemisty.

3 Contents of the module

- 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/Learning methods

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

5 Requirements for participation

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

6 Type of module examination

The final examination consists of two parts: Two hours written examination about topics of the lectures and the practical/lab part (70 % of the total module mark) and oral presentation (30 % of the total module mark).

7	Requirements for the allocation of credits 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 “Biological Sciences” and combined advanced and experimental module in the Master’s degree course “Chemistry”.
9	Significance of the module mark for the overall grade In the Master´s degree course “Biochemistry”: 10 % 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	Additional information Subject module of the Master´s degree course “Biological Sciences”, Focus of research: (B) Biochemistry, Biotechnology and Biophysics Participating faculty: Prof. Dr. E. Behrmann, Prof. Dr. J. Chai, Dr. M. Gunkel, Dr. J. Jirschitzka 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://cryo-em-course.caltech.edu/] • 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. 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; Week 7 (Mon.-Fri.): Preparation for the written examination Introduction to the module: March 28, 2019 at 10:00 a.m., Institute of Biochemistry, seminar room 465 (fourth floor) Written examination: May 17, 2019, second/supplementary examination July 26, 2019; 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”, 10 students from the Master’s degree course “Biochemistry“ and 2 students from the Master’s degree course “Chemistry”.