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

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

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 course "Biochemistry" or in the Master's degree course "Chemistry". Prior participation in an advanced Biochemistry module, including its practical lab part, during the Bachelor's degree course (e.g. MN-B-WP I [BC 2] for Cologne students) or similar skills (after consultation) are required.

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; Passed seminar paper (= accepted laboratory notebook) 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	Significance of the module mark for the overall 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	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, Dr. M. Gunkel 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. Location: The course will take place at the research center caesar, Ludwig-Erhard-Allee 2, 53175 Bonn. 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: April 02, 2020 at 10:00 a.m., Research center caesar, Ludwig-Erhard-Allee 2, 53175 Bonn Written examination: May 22, 2020, second/supplementary examination July 31, 2020; the latter date may vary if students and module coordinator agree. More details will be given at the beginning of the module.

* 2 students from the Master's degree course "Biological Sciences", 5 students from the Master's degree course "Biochemistry" and 1 student from the Master's degree course "Chemistry".