

QBio302: Cell Structure and Dynamics

Module Responsible:
Prof. Dr. Guido Grossmann

Version:
02/01/2021

Module Organizer:
Prof. Dr. Guido Grossmann

Type:
Compulsory

Lecturer:

Prof. Dr. Guido Grossmann, Jun.-Prof. Dr. Mathias Beller, Dr. Sebastian Hänsch, Dr. PiauSiong Tan

Total Working Time
180 h

Credit Points
6 CP

Contact Time
75 h

Self Study
105 h

Duration
1 Semester

Course Components

Lecture: 2 SWS
Practical: 3 SWS

Group Size

P: 40
P: 20

Frequency

Every Winter Semester

Learning Competencies:

After completing this module, students will be able to

- describe the fundamental differences of cellular organization among kingdoms of life
- describe emergence mechanisms, structures and functions of sub-cellular compartments and organelles
- explain the optical light-path and components of a basic optical microscope
- choose the appropriate microscopic technique to address specific biological questions
- employ computational analysis to extract quantitative information from imaging datasets

Content:

This module will use qualitative and quantitative microscopy to explore cell biological structures and processes. Through imaging of fixed and live specimens, the students will learn about the organization of cells across a range of uni- and multicellular species. To this end, the students will be introduced to the physical basics of optics, build their own fluorescence microscopes from scratch and perform image acquisition and quantitative analysis on cellular structures. In addition, students will become familiar with the use of labeling techniques and sample preparation, as well as various modern microscopy methods.

The module is subdivided into two parts - a technical and a biological part - which will be taught in an alternating fashion (topics with same numbers below will be taught on subsequent days).

Part A - Imaging Technology

A1 - Optics: properties of light (e.g. refraction, diffraction, magnification, image, optical aberrations); Optoelectronics: excitation light sources and detectors

A2 - Labeling techniques: fusions of fluorescence proteins, antibody/ nanobody staining tag constructs & fluorophores).

A3 - Optical sectioning: principles of confocal and two-photon microscopy

- A4 - Sample preparation and time lapse imaging of labelled structures, genetically encoded biosensors or markers in live specimens, microfluidic imaging platforms.
- A5 - Image processing and quantitative analysis: Do's and Don'ts in data processing, filtering, thresholding & segmentation, particle tracking, co-localization.
- A6 - Electron microscopy, super-resolution microscopy, F-techniques.

Part B - Cell Biology

- B1 - Biological scales, cell organization, differences between bacterial and eukaryotic cells, types of extracellular matrices including cell walls and capsules
- B2 - Cellular organelles; nucleus, ER, vacuoles, mitochondria, chloroplasts, symbiogenesis, organelle contact sites
- B3 - Cytoskeleton & cell-cell contacts, cellular membranes, TGN
- B4 - Dynamic processes in cells; vesicle trafficking, mitosis, cell movement
- B5 - Cell metabolism, cellular signaling, homeostasis
- B6 - Subcompartments of cellular organelles, membrane nanodomains, phase separation

In addition to lectures and practical parts, students will present selected techniques in microscopy and related topics in oral presentations (15 min).

Conditions of Participation:

Passed Modules QBio101 and QBio201

Examination:

Learning portfolio consisting of

- Written Exam (60% of the final grade)
- Practical performance (20% of the final grade)
- Oral presentation (20% of the final grade)

Prerequisites for Awarding Credits for this Module:

- Participation in practical exercises: Minimum 1 of possible 20 pt
- Participation in oral presentation: Minimum 1 of possible 20 pt
- Passing the written exam: Minimum 30 of 60 pt
- Minimum total cumulative points: 50 of 100 pt

Factor for the Overall Grade:

The grade is weighted according to the credit points (CP) in the overall grade.

Language:

English

Literature:

Recommended: Alberts et al. (2015) Molecular biology of the cell. Norton & Company, 6th ed.; ISBN: 978-0815344643

Optional: Hecht, Eugene (2016) Optics. Pearson; 5th edition; ISBN: 978-1292096933

Further Information: