

**Subject** Lecture series on Advanced Microscopy Fall semester 2023

When Friday, 8.15 - 10.00 am  
 Where AULA, Gertrud-Woker-Str. 5 (GeWo 5) - **AULA**  
 Lecture hall 220, Gertrud-Woker-Str. 5 (GeWo 5) - **GH**  
 lecture hall S481, Chemie und Biochemie, DCB, Freiestrasse 3 - **S481**  
 Lecture hall S003, UniS, Schanzeneckstrasse 1 - **UniS**  
 Lecture hall A224, Institute of Anatomy, Bühlstrasse 26 - **ANA**

Registration [via KSL 9256,](#)

Handouts [via ILIAS](#)

Responsible Ruth Lyck, Theodor Kocher Institute, UniBE

**Exam** 12. January 2024, 8.30 - 11.00 am, GH Gertrud-Woker-Str 5

Abbreviations and color coding

Basic knowledge (Digital image analysis, Physics)
LM, Light microscopy
FM, Fluorescence microscopy
LSM, Laser scanning microscopy
MP, Multiphoton
SEM, Scannen electron microscopy
TEM, Transmission electron microscopy
Specific applications (Atomic force microscopy, Stereology, microtomography)

Date	Unit	Title	conceptual design	Where (see explanations above)	Who	Points in Exam, Jan 2024	learning objectives
22-Sep-2023	1	Introduction to Microscopy	introduction, MIC and lecture	AULA	Lyck	0	Organization of lecture - microscopy landscape at the University of Bern
22-Sep-2023	2	Fundamentals of Digital Image Processing	Basic knowledge	AULA	Witz	4	The different parts of microscopy digital images (pixels, metadata) and how they are stored (format, compression); common image processing techniques (thresholding, filtering); practical applications of image processing (classification, segmentation, rendering); insight into cutting edge image processing: machine learning, high performance computing
29-Sep-2023	3	Contrast, Magnification and Resolution - Laws of Physics for Microscopists (1)	Basic knowledge	GH	Frenz		
29-Sep-2023	4	Contrast, Magnification and Resolution - Laws of Physics for Microscopists (2)	Basic knowledge	GH	Frenz	8	Understanding what contrast, magnification and resolution means; understand the difference between rays and waves.
6-Oct-2023	5	Fluorescence Microscopy	LM and FL-Mic, basics	GH	Blank	4	Overview of fluorescence microscopy from sample preparation to acquisition to image analysis. This lecture aims to serve as a basis for the following lectures focusing on laser scanning microscopy and image processing.
6-Oct-2023	6	Intravital Microscopy	FL-MIC, special applications	GH	Proulx	4	Definition of "epifluorescence intravital microscopy" and introduction to near-infrared fluorescence microscopy, examples of IVM microscopic observation of leukocyte endothelial interactions and lymphatic vessel function in the live, anesthetized animal; Quantification and interpretation of IVM; Limitations of the IVM approach.
13-Oct-2023	7	Total internal reflection fluorescence microscopy	FL-MIC, special applications	AULA	Belyaev	4	Basics of TIRF theory; Typical TIRF applications; Quantitative aspects of TIRF.
13-Oct-2023	8	Live cell imaging: Colorful cells and the time factor	FL-Mic, basics	AULA	Lyck	4	Time intervals for image acquisition; time acceleration in fast motion movies; Origin and variants of green and red fluorescent proteins; Fluorescent proteins
20-Oct-2023	9	Laser scanning microscopy: Axial resolution by physical means	Volume imaging, LSM basics	GH	Blank	4	Basic principles and technical requirements for laser scanning microscopy; Data acquisition and data visualization; Understanding the difference to conventional fluorescence microscopy.
20-Oct-2023	11	Multiphoton-intravital microscopy	Volume Imaging, MP-Mic	GH	Nevian	4	Principle of image generation in MP-IVM including technical parts; Applications and limitations of MP-IVM.
27-Oct-2023	10	Laser scanning microscopy - specific applications	Volume imaging, LSM, specific applications	S481	Blank	4	To introduce several application possibilities using confocal microscopy and image analysis softwares.
27-Oct-2023	12	Light Sheet Microscopy	in vivo imaging, volume imaging, SPIM	S481	Mercader	4	Principle of light sheet fluorescent microscopy (LSFM)/ Selective Plain illumination Microscopy (SPIM) imaging; Applications and limitations.
3-Nov-2023	13	Super Resolution Imaging (1)	LM beyond physical limits	S481	Nevian	8	"breaking the resolution limit" - from the point spread function of a conventional microscope to the engineering of the PSF; Stimulated emission depletion microscopy (STED): Physical principle, experimental setup; Structured illumination microscopy: Physical principle of resolution enhancement, experimental setup and procedure, contrast to z-sectioning with structured illumination microscopy (SIM); STORM/PALM: Principle of localization microscopy.
3-Nov-2023	14	Super Resolution Imaging (2)	LM beyond physical limits	S481	Nevian		

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10-Nov-2023	15	Transmission Electron Microscopy (1)	EM	GH	Vanhecke	8	Basic building blocks of an electron microscope and lens aberration; Electron-material scattering; Contrast formation by elastic interactions and inelastic interactions; Obtaining analytical information.
10-Nov-2023	16	Transmission Electron Microscopy (2)	EM	GH	Vanhecke		
17-Nov-2023	17	MIC Symposium	Activity	UniS	MIC	0	MIC Symposium "New Trends in Microscopy". See MIC Web <a href="https://www.mic.unibe.ch/events/mic_symposium">https://www.mic.unibe.ch/events/mic_symposium</a>
17-Nov-2023	18	MIC Symposium	Activity	UniS	MIC		
24-Nov-2023	19	Parcours	Activity	divers, see map on ILIAS	divers	0	These two units are designed to present the microscopes on-site. In addition, online learning tools (videos and tutorials) will be available via ILIAS  During the parcours you will be introduced into 3 different microscope types: 1) Widefield light microscopy: Phase contrast, differential interference contrast and fluorescence 2) Fluorescence microscopy with resolution in z (confocal microscopy) 3) Electron microscopy (EM): Scanning EM and transmission EM
24-Nov-2023	20	Parcours	Activity	divers, see map on ILIAS	divers		
1-Dec-2023	21	Atomic Force Microscopy	specific applications	GH	Fotiadis	4	Understanding the working principle of AFM and learning about the possible applications of this microscope in biology
1-Dec-2023	22	Stereology	specific applications	GH	Tschanz	4	Basic principles of geometric quantification in microscopy (=Stereology). Awareness of sampling bias due to material reduction, loss of reference and dimension reduction. Design and application of an unbiased and efficient stereological study with examples. SURS and IUR. Precision versus Bias
8-Dec-2023	23	Scanning Electron Microscopy (1)	EM	ANA	Kässmeyer/Jaric	8	Different illumination modes in microscopy; Probe formation and electron-sample interactions; Contrast formation (topographical contrast, material contrast); Signal generation, signal collection and handling; Operating modes; Sample preparation; Common artifacts.
8-Dec-2023	24	Scanning Electron Microscopy (2)	EM	ANA	Kässmeyer/Jaric		
15-Dec-2023	25	Cryoelectron Microscopy & Serial Block Face SEM (1)	EM, cryo-EM	ANA	Iacovache	8	Artefacts commonly happening during conventional TEM preparation; Physico-chemical origin of these artefacts; Rationale for applying cryo-EM; Meaning of vitrification and ways of achieving it; Principles of single particle cryo-EM; Pros and Cons vs X-ray crystallography; Principles of cryo-electron tomography; Rationale for applying SBF-SEM; Principle of SBF-SEM procedure; Pros and Cons vs TEM serial sections; Segmentations: pitfalls and arising methods
15-Dec-2023	26	Cryoelectron Microscopy & Serial Block Face SEM (2)	EM, cryo-EM	ANA	Iacovache		
22-Dec-2023	27	X-ray Micro-Tomography (ILIAS: Micro Computer Tomography)	specific applications	AULA	Haberthür	4	Overview of microtomographic imaging process, focused on imaging biomedical samples. Principle of image generation in a microtomography scanner. Highlighting sample preparation importance. How to get quantitative numbers and nice images from the tomographic datasets
22-Dec-2023	28	Survey – Feedback from students. All lecturers are invited to attend.	Gather feedback	AULA	Lyck	0	Get feedback on the lecture series
						88	Total points to achieve