

SCIENTIFIC AND METHOD MODULES

Module name	Multifunctional scaffolds
Number	2011-M10
Aims	The module aims at providing the scientific background required to study and manipulate biopolymers, biopolymer networks, proteins and protein networks, including the highly dynamic polymer scaffolds in living tissues as an organizing matrix for smart nanoelements, molecular motors, mechano-sensing, in natural and artificial nanoscopic devices for force-generation, motile polymeric machines, biomimetic devices etc.
Basics	The topics covered in soft matter and biophysics lectures from the existing master program; basic knowledge about biopolymers (DNA, actin, microtubules), viscoelasticity, statistical physics
Contents	Physical, biochemical & biological perspective on various multifunctional scaffolds and modern experimental techniques. Topics comprise general soft matter background, statistical physics and simulation approaches, protein aggregates, complex interactions in aqueous media, biopolymers, biopolymer networks, composite biopolymer networks, including molecular motors, cytoskeleton (CSK) & extra-cellular matrix (ECM), living cells.
Methods	Single molecule imaging/tracking, advanced microscopy, rheology, micro-rheology, in vitro 3-dim scaffolds, biochemistry, statistical mechanics, theoretical modeling, computer simulations
Type	Two-day block course/ yearly recurrence with modification
Date (month/year)	29.9.-30.9. 2011
Time	9h – 19:00h, 9h – 14h
Work load	15 hours presence/ 45 hours self-study
Examination	written exam 4.10.2011
Credit points	2
Responsible scientists	K. Kroy
International guest lecturers	Timo Betz (Institut Curie, F), Doris Heinrich (LMU München), Gijsje Koenderink (AMOLF, NL), Ulrich Schwarz (Univ. Heidelberg)
Recommendations for literature, e-learning	Introductory: D. Discher <i>et al.</i>, <i>Biomechanics: Cell Research and Applications for the Next Decade</i>, Ann. Biomed. Eng. 37 (2009) 847. D. A. Fletcher, R. D. Mullins: <i>Cell Mechanics and the Cytoskeleton</i>, Nature 463 (2010) 485. K. E. Kasza <i>et al.</i>, <i>The cell as a material</i>, Curr. Opin. Cell Biol. 19 (2007) 101. F. C. Mackintosh, C. F. Schmidt, <i>Active cellular materials</i>, Curr Opin Cell Biol. 22 (2010) 29. Further Reading: E. Paluch, J. van der Gucht, C. Sykes, <i>Cracking up: symmetry breaking in cellular systems</i>, J. Cell Biol. (review), 175(5), 687-92. O. Lieleg <i>et al.</i>, <i>Structure and dynamics of cross-linked actin networks</i>, Soft Matter 6 (2010) 218. E. Sackmann, F. Keber and D. Heinrich, <i>Physics of cellular movements</i>, Annu. Rev. Condens. Matter Phys. 1 (2010) 257. D. Arcizet <i>et al.</i>, <i>Temporal analysis of active and passive transport in living cells</i>, Phys. Rev. Lett. 101 (2008) 248103. I. B. Bischofs <i>et al.</i>, <i>Filamentous network mechanics and active contractility determine cell and tissue shape</i>, Biophys. J., 95 (2008) 3488. I. B. Bischofs, S. S. Schmidt, and U. S. Schwarz, <i>Effect of adhesion geometry and rigidity on cellular force distributions</i>, Phys. Rev. Lett., 103 (2009) 048101. J. Gosline <i>et al.</i>, <i>Elastic proteins: biological roles and mechanical properties</i>, Phil. Trans. R. Soc. Lond. B 357

	(2002) 121. M. Guthold, <i>et al.</i> , <i>A comparison of the mechanical and structural properties of fibrin fibers with other protein fibers</i> , Cell Biochem. Biophys. 49 (2007) 165. C. Strom, <i>et al.</i> , <i>Nonlinear elasticity in biological gels</i> , Nature 435 (2005) 191. D. Mizuno <i>et al.</i> , <i>Nonequilibrium mechanics of active cytoskeletal networks</i> , Science 315 (2007) 370.
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SCHEDULE 2011

Time	Lecturer	Title
29.9.2011		
9:00-10:00	Klaus Kroy (Leipzig)	Introduction
10:00-11:30	Gijsje Koenderink (AMOLF)	Rheology of hierarchical biopolymer networks (ECM & CSK)
11:30-13:00	Doris Heinrich (LMU)	Dynamic Micro- and Nanoarchitecture in Living Cells
LUNCH	(served on site)	Informal discussions
14:00-15:30	Timo Betz (Inst. Curie)	Construction and dynamics of biomimetic actin networks
15:30-17:00	Ulrich Schwarz (Heidelberg)	Modelling cell adhesion in structured environments
17:00-18:30	Gijsje Koenderink (AMOLF)	Myosin motor control over actin network organization and mechanics
18:30-19:00	All participants	Plenary Discussion
DINNER		
30.9.2011		
09:00-10:30	Doris Heinrich (LMU)	Dynamic Micro- and Nanoarchitecture in Living Cells
10:30-12:00	Timo Betz (Inst. Curie)	Membrane-cytoskeleton interaction in biomimetic and living cells
12:00-13:30	Ulrich Schwarz (Heidelberg)	Modelling cell adhesion in structured environments
13:30-14:00	All participants	Plenary Discussion

Didactic elements:

Lectures, plenary discussions and exercises, etc.

Expected performance:

Active participation in discussions, exercises, and written examination