

**SCIENTIFIC AND METHOD MODULES**

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| <b>Module name</b>                                | <b>Multifunctional scaffolds</b>  |
| <b>Number</b>                                     | 2008-M10  |
| <b>Aims</b>                                       | 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, force-generation, motile polymeric machines, etc.  |
| <b>Basics</b>                                     | The topics covered in biophysics lectures from existing master courses; polymer physics, liquid crystal physics, properties and isolation of biopolymers (DNA, actin, intermediate filaments, microtubule), viscoelasticity, basic statistical physics and thermodynamics of polymers   |
| <b>Contents</b>                                   | The module introduces the participants to physical, chemical and biological perspectives onto various multifunctional scaffolds as well as to modern experimental techniques. Topics comprise general soft matter background, statistical physics and MC simulation approaches, protein folding assembly and aggregation, the complex interactions in aqueous media, biopolymers and biopolymer networks, molecular motors, artificial nanomotors, structure and mechanics of the cytoskeleton, cell-cell interactions via artificial extracellular scaffolds   |
| <b>Methods</b>                                    | Single molecule imaging, optical tweezers, scanning atomic force microscopy digital polarization microscopy, confocal/multiphoton microscopy, dielectric spectroscopy, single particle tracking, soft lithography and microfluidics, biochemistry, recombinant DNA. Theory: statistical mechanics, thermodynamics, MC simulations   |
| <b>Type</b>                                       | Two-day block course/ yearly recurrence with modification   |
| <b>Date (month/year)</b>                          | 23./24. September 2008  |
| <b>Time</b>                                       | 9.00 – 18.00  |
| <b>Work load</b>                                  | 15 hours presence/ 45 hours self-study  |
| <b>Examination</b>                                | Oral  |
| <b>Credit points</b>                              | 2   |
| <b>Responsible scientists</b>                     | Käs, Kremer, Kroy   |
| <b>International guest lecturers</b>              | X. Trepát (Harvard School of Public Health, Boston), P. Fernandez, T Hugel (TU Munich) N.N. (Inst.-Marie-Curie, Paris)  |
| <b>Industrial partners</b>                        | <b>Beiersdorf, Novocontrol</b>  |
| <b>Recommendations for literature, e-learning</b> | <p><b>Introductory:</b></p> <p>A. Karshikoff, <i>Non-covalent interactions in proteins</i>, Imperial Coll. Press, 2006. J. D. Gunton, A. Shiryayev, D. L. Pagan, <i>Protein Condensation. Kinetic Pathways to crystallization and disease</i>, Cambridge Univ. Press, 2007. J. Howard, <i>Mechanics of motor proteins and the cytoskeleton</i>, Sinauer Ass. 2001 Y. Fung, <i>Biomechanics: Mechanical Properties of Living Tissues</i>, Springer, 1993. M. Mickler, T. Hugel, <i>Von molekularen Motoren zu künstlichen Nanomaschinen</i>, Physik in unserer Zeit, 1, 14 (2008). A. R. Bausch, K. Kroy, <i>A bottom-up approach to cell mechanics</i>, Nature Phys. 2 (2006) 231. E. E. Meyer, K. J. Rosenberg, J. Israelachvili, <i>Recent progress in understanding hydrophobic interactions</i>, Proc. Natl. Acad. Sci. (USA) 103 (2006) 15739.</p> <p><b>Further Reading:</b></p> <p>1) X. Trepát, L. Deng, S. S. An, D. Navajas, D. J. Tschumperlin, W. T. Gerthofer, J. P.</p> |

Butler, and J. J. Fredberg, *Universal physical responses to stretch in the living cell*, Nature 447 (2007) 592. T. Hugel, J. Michaelis, C. Hetherington, P. J. Jardine, S. Grimes, J. M. Walter, W. Falk, D. L. Anderson, C. Bustamante, "Experimental Test of Connector Rotation during DNA Packaging into Bacteriophage phi29 Capsids" PLoS Biol 5(3): e59 (2007). C. Semmrich, T. Storz, J. Glaser, R. Merkel, A. R. Bausch, and K. Kroy, *Glass Transition and Rheological Redundancy in F-Actin Solutions*, Proc. Natl. Acad. Sci. (USA), 104 (2007) 20199. S. Schnabel, M. Bachmann, and W. Janke, *Two-State Folding, Folding through Intermediates, and Metastability in a Minimalistic Hydrophobic-Polar Model for Proteins*, Phys. Rev. Lett. 98 (2007) 048103. P. Fernandez, A. Ott, *Single cell mechanics: stress stiffening and kinematic hardening*, Phys. Rev. Lett. 100 (2008) 238102. Salomo, M.; U. F. Keyser, M. Struhalla, F. Kremer, *Optical tweezers to study single protein A/Immunoglobulin G interaction at varying conditions*, European Biophysics. J. 37 (2008): 927-934. Kegler, K.; M. Konieczny, G. Dominguez-Espinosa, C. Gutsche, M. Salomo, F. Kremer and C. N. Likos, *Polyelectrolyte-Compression Forces between Spherical DNA Brushes*, Phys. Rev. Lett. 100, (2008) 118302.

| Time                                 | Lecturer                 | Programme  | Location         |
|--------------------------------------|--------------------------|--|------------------|
| <b>Tuesday 23 September 2008</b>     |                          |  |                  |
| 9:00                                 | F. Kremer, K. Kroy       | Opening  | SR 221           |
| 9:15-10:00                           | K. Kroy (Leipzig)        | What can colloids and polymers teach us about proteins?  | SR 221           |
| 10:00-10:45                          | C. Friedrich (Freiburg)  | Thermorheological properties of fibre networks   | SR 221           |
| <i>Coffee break</i>                  |                          |  |                  |
| 11:15-12:00                          | S. Egelhaaf (Düsseldorf) | Concentrated Colloidal Suspensions in Shear and Light Fields                                     | Theoretischer HS |
| <i>Lunch break</i>                   |                          |  |                  |
| 14:00-14:45                          | F. Kremer (Leipzig)      | Optical tweezers to study the interaction between soft and solid surfaces                        | Theoretischer HS |
| 14:45-15:30                          | M. Salomo (Leipzig)      | Optical tweezers to study receptor/ ligand interactions on a single contact level                | SR 221           |
| <i>Coffee break</i>                  |                          |  |                  |
| 16:15-17:00                          | W. Richtering (Aachen)   | Probing colloidal systems with 2 focus Fluorescence Correlation Spectroscopy                     | Theoretischer HS |
| <b>Wednesday, 24. September 2008</b> |                          |  |                  |
| 09:00-09:45                          | W. Goedel (Chemnitz)     | Combining particle assisted wetting and breath figure patterns to create hierarchical structures | Theoretischer HS |
| 09:45-10:30                          | R. Vincent (Paris)       | Mechanics of the pectin scaffolds of plant cells   | SR 221           |
| <i>Coffee break</i>                  |                          |  |                  |
| 11:00-11:45                          | T. Hugel (Munich)        | From biological towards artificial molecular motors  | SR 221           |
| 11:45-12:30                          | P. Marcq (Paris)         | Active gels  | SR 221           |
| <i>Lunch break</i>                   |                          |  |                  |
| 14:00-14:45                          | X. Trepap (Boston)       | Universality in cell mechanics and the cytoskeleton  | SR 221           |
| 14:45-15:30                          | P. Fernandez (Munich)    | Cooperative effects in mechano-sensing   | SR 221           |
| <i>Coffee break</i>                  |                          |  |                  |
| ab 16:00                             | Lab course (M.Salomo)    | Optical tweezers lab   | 131              |

**Didactic elements:**

Lecture, discussions, practical training – lab demonstration, etc.

**Expected performance:**

Active participation in discussions and during lab demonstration (selected work stations), etc.