Appendix 1: Module Descriptions for the Master's program Nanobiophysics

Module Number BT-NB 1.1.	**Module Name** Fundamentals of Biophysics	**Resp. Lecturer** Jochen Guck
Contents and qualification aims	The students are familiar with concepts of phenomenological thermodynamics: energy, entropy, transport phenomena, biologically active forces, classical reaction and enzyme kinetics, bioenergetics as well as membrane biophysics and basics of electrophysiology. They know the most important methods with respect to molecular, cellular and systems biophysics as well as structural methods (NMR, X-Ray), spectroscopy and microscopy, modern methods in biochemistry and proteomics. Students have an overview over the most important concepts and the broad methodology of modern applied biophysics. They are able to select the best method(s) for a certain practical task and have background knowledge about their prerequisites and which systems to best apply them to.	
Type of course	4 SWS lecture, 2 SWS seminar, 1 SWS lab practical	
Requirements for study	Basic knowledge in mathematics, particularly differential and integral calculus, simple differential equations on Bachelor level. Basic knowledge in classic physics (mechanics, electrodynamics, thermodynamics) on Bachelor level. Literature: • Courant & Hilbert: Methods of Mathematical Physics • Jackson: Classical Electrodynamics • Sakurai: Advanced Quantum Mechanics • Huang: Introduction to Statistical Physics	
Practical use of the module	Compulsory module of the master's program Nanobiophysics, track Molecular Biophysics	
Requirements for the award of credits	The credits are awarded if the module examination is passed. The module examination consists of: • a presentation, • a written examination (90 minutes) and • a lab protocol.	
Credits and grades	For the module 10 credit points can be acquired. The module grade is the weighted average of: • 2/5 presentation • 2/5 written examination • 1/5 lab protocol	
Frequency of the course	The module is offered every academic year in winter semester.	
Workload	The workload is 300 working hours	
Duration of the module	1 semester	

Module Number BT-NB 1.2	**Module Name** Structural and Computational Biology	**Resp. Lecturer** Maria-Teresa Pisabarro
Contents and qualification aims	The students are provided with a comprehensive overview of the fundamentals of structural biology and methods and applications in current computational biology/chemistry. The students are familiar with essential structural properties of biomolecules (proteins, peptides, sugars, nucleic acids) that underlie their great structural and functional variety in nature. The students have an overview of basic concepts needed to quantitatively understand the implications of the three-dimensional structure of these biomolecules for their stability, dynamics, molecular recognition and function. The students know how to analyze biological problems from a structural point of view. They gain insights into the bases needed to define and develop structure-based rational engineering strategies for bio- and nanotechnology.	
Type of course	2 SWS lecture and 2 SWS seminar	
Requirements for study	Basic knowledge of biology, physics and chemistry on Bachelor level. Literature: - Nelson/Cox: Lehninger Principles of Biochemistry, Worth Publishers - David Halliday, D, Resnick, R, Walter, J, 1997, Fundamentals of Physics, Wiley	
Practical use of the module	Compulsory module of the master's program Nanobiophysics, track Molecular Biophysics.	
Requirements for the award of credits	The credit-points can be acquired, if the module examination is successfully passed. The module examination consists of: - a presentation and - a written examination (90 minutes).	
Credits and grades	For this module 4 credit-points can be awarded. The module grade is the weighted average of: - ¼ presentation - ¾ written examination	
Frequency of the course	The module is offered every academic year in winter semester.	
Workload	The workload is 120 working hours	
Duration of the module	1 semester	

Module Number BT-NB 1.3	**Module Name** Introduction to Biochemistry and Molecular Cell Biology	**Resp. Lecturer** Bernard Hoflack
Contents and qualification aims	Students know the fundamentals of biochemistry, organic chemistry, biomolecules and their structure, biosynthesis, gene expression and cellular organization, enzymology, network of primary metabolic pathways, mutagenesis, genetic architecture of selected biosyntheses. Students have an overview of basic concepts in molecular and cell biology, principles of cellular organization (compartmentalization), relevance and organization of protein networks for the generation of cellular structure and function. They are familiar with the coordination of cell-cell-communication, regulation of growth, differentiation and tissue-development. They know the most important biochemical, biomolecular and technical methods of cell biology. The students know the most important basics of biochemistry and molecular cell biology and are able to perform essential biochemical and cell and biomolecular lab activities themselves.	
Type of course	4 SWS lecture, 1 SWS exercise, 1 SWS tutorial, 2 SWS lab practical	
Requirements for study	Basic knowledge in physics, biology and chemistry on Bachelor level. Literature: • Molecular biology of the Cell (Bruce Alberts), Kapitel 1 und 2 • Molecular Cell Biology (Darnell), Kapitel 1	
Practical use of the module	Compulsory module of the master's program Nanobiophysics, track Molecular Biophysics. It provides the basics for the specialisation module.	
Requirements for the award of credits	The credits are awarded if the module examination is passed. The module examination consists of • two oral examinations (individual exam, 20 minutes each) and • a lab protocol	
Credits and grades	For the module 10 credit points can be acquired. The module grade is the weighted average of: • oral examinations, each 40% • lab protocol 20%	
Frequency of the course	The module is offered every academic year, starting in winter semester.	
Workload	The workload is 300 working hours	
Duration of the module	2 semester	

Module Number BT-NB 1.4	**Module Name** Elements of Nanobiotechnology	**Resp. Lecturer** Gianaurelio Cuniberti
Contents and qualification aims	Students know the bottom-up generation of synthetic nanostructures with the help of proteins and DNA as well as structural, mechanical and electronic characteristics of DNA and proteins, DNA as construction material and the controlled generation of hybrid nanostructures using biomolecular templatings. They are familiar with biomimetic cluster synthesis, nano crystals for biological detection, new principles of (bio)molecular electronics, manipulation of nanoparticles in 3 dimensions and latest research questions and problems in the context of nanotechnology and bionanotechnology Students are in command of basic knowledge of bionanotechnology. They are able to comprehend the relevance of complex natural nanostructures for technical applications. In turn, they gain an understanding of how nanotechnological methods may be used in biology. Thanks to individually prepared papers and the subsequent discussions, students are able to communicate in a scientific manner.	
Type of course	2 SWS lecture, 2 SWS seminar, 1 SWS lab practical	
Requirements for study	Basic knowledge in physics on Bachelor level, basic knowledge in biology and chemistry on Abitur level. Literature: • W. Pompe, G. Rödel, H.-J. Weiss, M. Mertig: Bio-Nanomaterials: Designing Materials Inspired by Nature, Wiley-VCH 2013 • G.L. Hornyak et al.: Introduction to nanoscience and nanotechnology, CRC Press 2009 • N.T. Nguyen, S.T. Wereley: Fundamentals and applications of microfluidics, Artech House, 2002 • F. Leal-Calderon, V. Schmitt, J. Bibette: Emulsion science. Basic principles, Springer 2007	
Practical use of the module	Compulsory module of the master's program Nanobiophysics, track Molecular Biophysics. It provides the basics for the module Applied Nanotechnology	
Requirements for the award of credits	The credits are awarded if the module examination is passed. The module examination consists of • an oral examination (individual exam, duration 20 minutes) • an presentation and • a lab protocol Passing the module requires that the oral exam is evaluated with min. "sufficient" (4.0) or better.	
Credits and grades	For the module 6 credit points can be acquired. The module grade is composed of the weighted average of: • 50% oral exam • 35 % presentation • 15% lab protocol	
Frequency of the course	The module is offered every academic year in winter semester.	
Workload	The workload is 180 working hours	
Duration of the module	1 semester	

Module Number BT-NB 1.5	**Module Name** Concepts of Molecular Modelling	**Resp. Lecturer** Gianaurelio Cuniberti
Contents and qualification aims	The students know basics of molecular dynamics simulation for the theoretical description of elements of bio- and nanophysics. They gain an overview of classic mechanics with the help of numerical methods and the modelling of interatomic forces (classically and quantum-mechanically). The students know mathematical approaches to characterise the dynamics of molecules quantitatively and are able to model them in computer programs.	
Type of course	2 SWS lecture, 2 SWS exercise, 2 SWS lab practical	
Requirements for study	Basic knowledge in mathematics and physics on Bachelor level. Literature: D. Frenkel, B. Smit: Understanding molecular simulation: From algorithms to applications, Academic Press 2001	
Practical use of the module	Compulsory module of the master's program Nanobiophysics, track Molecular Biophysics. It provides the basics for the module Nanostructured Materials.	
Requirements for the award of credits	The credits are awarded if the module examination is passed. The module examination consists of: • a modelling project and • in the case of up to 10 students registered an oral examination (individual exam, duration 20 minutes) or in the case of more than 10 students registered a written examination (duration 90 minutes). The type of examination is announced at the end of the examination's registration period as is customary at the Biotechnology Center. Passing the module requires that the oral or written exam is evaluated with min. "sufficient" (4.0) or better.	
Credits and grades	For the module 6 credit points can be acquired. The module grade is the unweighted average of the 2 grades.	
Frequency of the course	The module is offered every academic year in winter semester.	
Workload	The workload is 180 working hours	
Duration of the module	1 semester	

Module Number BT-NB 2.1	**Module Name** Applied Nanotechnology	**Resp. Lecturer** Bernd Büchner
Contents and qualification aims	Students know molecular pathways of different proteins and their assemblies functioning in the context of the biological organism and the possibility of transferring these mechanisms and functions to nanotechnological questions. They know basics of the molecular structure and functional mechanisms of proteins and how to transform transient forms of biochemical energy into storable forms. They know protein-induced diseases caused by failure of proteins in the functional chain, and strategies to correct these dysfunctions. The students are familiar with the requirements for the in vitro application of proteins for purposes in nanotechnology. Furthermore, they are introduced to the fabrication and the basic structural, electronic and magnetic characteristics and peculiarities of various nanostructures as for example cluster, semi-conductor nanostructures, molecules and nanotubes. The students acquire an overview over the functioning mode of natural and synthetic nanostructures and –machines. They are able to inter-relate the knowledge of nanotechnology, molecular cell biology and biochemistry to apply them in continuative surveys and research projects in the context of nanobiophysics.	
Type of course	4 SWS lecture, 2 SWS seminar	
Requirements for study	Basic knowledge in polymer science, biochemistry, molecular and cell biology and bionanotechnology on Bachelor level, competences and skills of the module Elements of Nanobiotechnology Literature: • Molecular Biology of the Cell, Alberts et al, Taylor & Francis Ltd, 5th revised edition • Cell Biology, Pollard & Earnshaw, Saunders W.B., 2nd edition • Neue Kohlenstoffmaterialien, Anke Krüger, 2007, B.G.Teubner Verlag / GWV Fachverlage GmbH) English translation: Carbon Materials and Nanotechnology, Anke Krueger, 2010, Wiley • Fullerenes: Principles and Applications , Fernando Langa, Jean-Francois Nierengarten, The Royal Society of Chemistry 2007 • Nanophysics and Nanotechnology , E. L. Wolf, 2006, WILEY-VCH • Nanotechnology, M. Köhler, W. Fritzsche, 2007, WILEY-VCH • E. Meyer, H. J. Hug, R. Bennewitz, "Scanning Probe Microscopy. The Lab on a Tip", 2004, Springer-Verlag • Electronic transport in two-dimensional graphene, Das Sarma, Adam, Hwang & Rossi (Rev. Mod. Phys. 83, 407 (2011) • Transport in Mesoscopic Systems, Supriyo Datta (Cambridge Studies in Semiconductor Physics and Microelectronic Engineering, ISBN 978-0-521-59943-6) • Carbon Nanotubes: Synthesis, Structure, Properties and Applications (2001), Springer, Berlin, Eds. M. S. Dresselhaus, G.	

	Dresselhaus, Ph. Avouris • Carbon Nanotubes (2004) Wiley-VCH, S. Reich, C. Thomsen, J. Maultzsch • Carbon Nanotubes, (1997) CRC Press, Ed. T. W. Ebbesen • Carbon Nanotubes: Basic Concepts and Physical Properties, Stephanie Reich, Christian Thomsen, Janina Maultzsch • Science of Fullerenes and Carbon Nanotubes, (1996), Academic Press, M. S. Dresselhaus, G. Dresselhaus and P. C. Eklund • Carbon Nanotube Science. Synthesis, Properties and Applications, Peter J. F. Harris
Practical use of the module	Compulsory module of the master's program Nanobiophysics, track Molecular Biophysics. It provides the basics for the module Specialisation Module.
Requirements for the award of credits	The credits are awarded if the module examination is passed. The module examination consists of • a presentation • and an oral examination (individual exam, duration 20 minutes)
Credits and grades	For the module 7 credit points can be acquired. The module grade is the unweighted average of the 2 grades.
Frequency of the course	The module is offered every academic year in summer semester.
Workload	The workload is 210 working hours
Duration of the module	1 semester

Module Number BT-NB 2.2	**Module Name** Nanostructured Materials	**Resp. Lecturer** Gianaurelio Cuniberti
Contents and qualification aims	The students know the fundamentals of physics with respect to the fabrication and the characteristics of nanostructured materials, particularly the synthesis of clusters and nanotubes, nanostructuring with the help of electron beam lithography, optical lithography and scanning microscopy. Furthermore, they know the theoretical fundamentals of scanning force microscopy, chemical scanning force microscopy and optical near field microscopy. They are familiar with relevant quantum effects in mesoscopic systems, concepts of scaling laws, density of states and giant magneto-resistance. They know about electron transport in low dimensional solid-state materials and single electronics.	
Type of course	2 SWS lecture, 2 SWS exercise, 2 SWS lab practical	
Requirements for study	Basic knowledge in mathematics, and theoretical physics on Bachelor level, competences and skills of the module Concepts of Molecular Modelling. Literature: • E.L. Wolf: Nanophysics and nanotechnology, Wiley-VCH 2006 • R. Waser: Nanoelectronics and information technology, Wiley-VCH 2005 • C.W. Shong, S.C. Haur, A.T.S. Wee: Science at the nanoscale, Pan Stanford Publ. 2010 • V.V. Mitin, V.A. Kochelap, M. A. Stroscio: Introduction to nanoelectronics, Cambridge 2008 • D.A. Bonnell: Scanning tunneling microscopy and spectroscopy, VCH Weinheim 1993 • A.P. Sutton: Electronic structure of materials, Oxford 1996 • W.R. Fahrner (Ed.): Nanotechnology and nanoelectronics, Springer 2005	
Practical use of the module	Compulsory module of the master's program Nanobiophysics, track Molecular Biophysics. It provides the basics for the module Specialisation Module.	
Requirements for the award of credits	The credits are awarded if the module examination is passed. The module examination consists of: • a modelling project and • in the case of up to 10 students registered an oral examination (individual exam, duration 20 minutes) or in the case of more than 10 students registered a written examination (duration 90 minutes). The type of examination is announced at the end of the examination's registration period as is customary at the Biotechnology Center. Passing the module requires that the oral or written exam is evaluated with min. "sufficient" (4.0) or better.	
Credits and grades	For the module 6 credit points can be acquired. The module grade is the unweighted average of the 2 grades.	
Frequency of the course	The module is offered every academic year in summer semester.	
Workload	The workload is 180 working hours	
Duration of the module	1 semester	

Module Number BT-NB 2.3	**Module Name** Advanced Biophysics	**Resp. Lecturer** Stephan Grill
Contents and qualification aims	Students know the statistical physics of bio-molecules and membranes as well as stochastic processes and fluctuations. They are familiar with active transport processes and molecular motors, the physics of the cytoskeleton, collective behaviour, cellular oscillations and biological self-organization. Students have basic knowledge of theoretical biophysics allowing them to systematically and quantitatively address selected biophysical problems. Students gain a historical view on the development and the motivation behind single molecule detection: single molecule spectroscopy in solid host-guest-systems, spectral jumps, spectral hole burning, low temperature experiments, static and dynamic heterogeneity, ergodic theory, analysis of distributions rather than mean values, access to intermediate or transient states. They have extended knowledge on applications of single molecule methods such as fluorescence spectroscopy and microscopy, force spectroscopy, scanning probe microscopy for the detection, analysis and manipulation of single molecules e.g. protein folding, conformational fluctuations, enzyme kinetics, markovian and non-markovian behavior. They know common principles of Scanning Probe Microscopy (SPM) based on short range forces and principle experimental setups. They are familiar with concepts and function modes of scanning near-field microscopy (SNOM), electrochemical scanning tunneling microscopy (ESTM), scanning tunneling microscopy (STM), atomic force microscopy (AFM) and magnetic force microscopy (MFM). Furthermore, the students know the most important optical techniques for single molecule imaging and tracking by microscopy and spectroscopy: confocal setup, fluorescence correlation spectroscopy (FCS), coincidence analysis, multi-parameter burst-analysis, lifetime measurements, anisotropy measurements, fluorescence resonance energy transfer (FRET): Far-field and TIRF microscopy. Single particle tracking in 2D on membrane systems, analysis of motor proteins in surface mobility assays, optical and magnetic tweezers Students know theoretical and practical aspects of single molecule analysis and manipulation, and know the challenges of their applications to biological systems. They are able to choose the right method or combinations of methods for a certain problem, and know the experimental conditions under which they can be applied.	

Type of course	4 SWS lecture, 2 SWS exercise, 2 SWS seminar, 2 lab practicals (1 week each)
Requirements for study	Basic knowledge in statistical physics on Bachelor level, basic knowledge in polymer science, biochemistry and molecular cell biology on Abitur level. Literature: • Courant & Hilbert: Methods of Mathematical Physics • Jackson: Classical Electrodynamics • Sakurai: Advanced Quantum Mechanics • Huang: Introduction to Statistical Physics • Alberts et al, Molecular Biology of the Cell, Taylor & Francis Ltd, 5th revised edition • Pollard & Earnshaw, Cell Biology, Saunders W.B., 2nd edition
Practical use of the module	Compulsory module of the master's program Nanobiophysics, track Molecular Biophysics.
Requirements for the award of credits	The credits are awarded if the module examination is passed. The module examination consists of • two oral examinations (individual exam, 20 minutes each) and • 2 lab protocols
Credits and grades	For the module 12 credit points can be acquired. The module grade is the weighted average of: • oral examinations 40% each • lab protocols 10% each
Frequency of the course	The module is offered every academic year, starting in summer semester.
Workload	The workload is 360 working hours
Duration of the module	2 semesters

Module Number BT-NB 2.4	**Module Name** Microsystems and Bioinspired Structures	**Resp. Lecturer** Hans-Georg Braun
Contents and qualification aims	The students know the physical and chemical basics for the production of microsystems by lithographic (electron beam/optical) and soft lithographic methods. They are familiar with the microstructuring of surfaces and the resulting changes in the physical properties (wetting/dewetting). They get to know the physical characteristics of liquid phases in contact with chemically/topographically heterogeneous surfaces and in microsystems as well as technical applications in microfluidic systems. They are familiar with basic concepts of biologically inspired nanotechnology. By means of selected examples they are introduced to the physical basics of the functioning and technological applications in the production of ultra-adhesive or ultra-hydrphobic structure elements that follow biological models. They are familiar with principles of self-organisation of meso- and microscopic objects, particularly capillary phenomena.	
Type of course	2 SWS lecture, 2 SWS lab practical	
Requirements For study	Basic knowledge in physics (Optics, surface physics) and in physical chemistry on Bachelor-level Literature: • T. Engel, P. Reid Physical Chemistry, Pearson • R.A.L. Jones Soft Condensed Matter, Oxford Master Series in Condensed Matter Physics , Oxford University Press 2002	
Practical use of the module	Compulsory module of the master's program Nanobiophysics, track Molecular Biophysics.	
Requirements for the award of credits	The credits are awarded if the module examination is passed. The module examination consists of • an oral examination (individual exam, duration 20 minutes) and • a lab protocol	
Credits and grades	For this module, 5 credit points can be acquired. The module grade is the weighted average of: • oral examination 85% • lab protocol 15%	
Frequency of the course	The module is offered every academic year in summer semester.	
Workload	The workload is 150 working hours.	
Duration of the module	1 semester	

Module Number BT-NB 3.1	**Module Name** Lab Rotation Biophysics	**Resp. Lecturer** Jochen Guck
Contents and qualification aims	In this module, students work on a short scientific project from the field of experimental biophysics in an in-depth lab practical. The students gain practical experience with topical scientific methods in biophysical research teams and will be enabled to apply relevant technologies and laboratory routines.	
Type of course	2 weeks block lab practical	
Requirements for study	Basic knowledge in mathematics (esp. Calculus), simple differential calculus equations, basic knowledge in classical physics (mechanics, electrodynamics, thermodynamics) on Bachelor level. Literature: • Courant & Hilbert: Methods of Mathematical Physics • Jackson: Classical Electrodynamics • Sakurai: Advanced Quantum Mechanics • Huang: Introduction to Statistical Physics	
Practical use of the module	Compulsory module of the master's program Nanobiophysics, track Molecular Biophysics, as well as track Nanoscience and Nanotechnology/specialisation Biophysics.	
Requirements for the award of credits	The credits are awarded if the module examination is passed. The module examination is a lab protocol.	
Credits and grades	For the module 6 credit points can be acquired. The module grade is the grade of the lab protocol.	
Frequency of the course	The module is offered every academic year in winter semester.	
Workload	The workload is 180 working hours	
Duration of the module	1 semester	

Module Number BT-NB 3.2	**Module Name** Lab Rotation Nanophysics	**Resp. Lecturer** Gianaurelio Cuniberti
Contents and qualification aims	In this module, students work on a short scientific project from the field of nanotechnology or nanophysics in an in-depth lab practical. The students gain practical experience with topical scientific methods in nanoscientific research teams and will be enabled to apply relevant technologies and laboratory routines.	
Type of course	2 weeks block lab practical	
Requirements for study	Knowledge of polymer science, biochemistry, molecular cell biology and bionanotechnology, basics of mathematics and theoretical physics on Bachelor level, programming skills on Abitur level- Literature: • W. Pompe, G. Rödel, H.-J. Weiss, M. Mertig: Bio-Nanomaterials: Designing Materials Inspired by Nature, Wiley-VCH 2013 • G.L. Hornyak et al.: Introduction to nanoscience and nanotechnology, CRC Press 2009 • N.T. Nguyen, S.T. Wereley: Fundamentals and applications of microfluidics, Artech House, 2002 • F. Leal-Calderon, V. Schmitt, J. Bibette: Emulsion science. Basic principles, Springer 2007 • D. Frenkel, B. Smit: Understanding molecular simulation: From algorithms to applications, Academic Press 2001 • Alberts et al, Molecular Biology of the Cell, Taylor & Francis Ltd, 5th revised edition	
Practical use of the module	Compulsory module of the master's program Nanobiophysics, track Molecular Biophysics.	
Requirements for the award of credits	The credits are awarded if the module examination is passed. The module examination is a lab protocol.	
Credits and grades	For the module 6 credit points can be acquired. The module grade is the grade for the lab protocol.	
Frequency of the course	The module is offered every academic year in winter semester.	
Workload	The workload is 180 working hours	
Duration of the module	1 semester	

Module Number BT-NB 3.3	**Module Name** Lab Rotation Choice	**Resp. Lecturer** Jochen Guck
Contents and qualification aims	In this module, students work on a short scientific project from any of the offered fields, e.g. biology, chemistry, or theoretical biophysics in an in-depth lab practical. The students gain practical experience with topical scientific methods in research teams and will be enabled to apply relevant technologies and laboratory routines.	
Type of course	2 weeks block lab practical	
Requirements for study	Knowledge of polymer science, biochemistry, molecular cell biology and bionanotechnology, basics of mathematics and theoretical physics on Bachelor level, programming skills on Abitur level. Literature: • David Halliday, D, Resnick, R, Walter, J, 1997, Fundamentals of Physics, Wiley • W. Pompe, G. Rödel, H.-J. Weiss, M. Mertig: Bio-Nanomaterials: Designing Materials Inspired by Nature, Wiley-VCH 2013 • G.L. Hornyak et al.: Introduction to nanoscience and nanotechnology, CRC Press 2009 • N.T. Nguyen, S.T. Wereley: Fundamentals and applications of microfluidics, Artech House, 2002 • F. Leal-Calderon, V. Schmitt, J. Bibette: Emulsion science. Basic principles, Springer 2007 • D. Frenkel, B. Smit: Understanding molecular simulation: From algorithms to applications, Academic Press 2001 • Alberts et al, Molecular Biology of the Cell, Taylor & Francis Ltd, 5th revised edition	
Practical use of the module	Compulsory module of the master's program Nanobiophysics, track Molecular Biophysics.	
Requirements for the award of credits	The credits are awarded if the module examination is passed. The module examination is a lab protocol (max. 4 pages).	
Credits and grades	For the module 6 credit points can be acquired. The module grade is the grade for the lab protocol.	
Frequency of the course	The module is offered every academic year in winter semester.	
Workload	The workload is 180 working hours	
Duration of the module	1 semester	

Module Number BT-NB E	**Module Name** Specialisation Module	**Resp. Lecturer** Jochen Guck
Contents and qualification aims	The students know selected current nano- and biophysical research issues. By choosing their courses for this module, they create their own specific profile within the master's program. The selection of courses may vary according to topical academic questions and recent developments in the diverse subjects. The students gain an in-depth knowledge of the selected research fields. They are able to orientate themselves within different areas of research and know about the latest developments in the optional required subjects.	
Type of course	4 SWS lecture. The subjects incl. scope need to be chosen from the list of electives/catalogue for the master's program Nanobiophysics/Molecular Biophysics. This list/catalogue is published at the start of the semester as is customary at the Biotechnology Center and includes the type of examinations.	
Requirements for study	Competences and skills of the modules Introduction to Biochemistry and Molecular Cell Biology, Applied Nanotechnology and Nanostructures Materials.	
Practical use of the module	Compulsory module of the master's program Nanobiophysics, track Molecular Biophysics.	
Requirements for the award of credits	The credits are awarded if the module examination is passed. The module examination consists of examinations as specified in the list/catalogue of electives Nanobiophysics/Molecular Biophysics.	
Credits and grades	For the module 6 credit points can be acquired. The module grade is the unweighted average grade of the grades.	
Frequency of the course	The module is offered every academic year in winter semester.	
Workload	The workload is 180 working hours	
Duration of the module	1 semester	

Module Number BT-NB E1	**Module Name** Molecular Biophysics	**Resp. Lecturer** Jochen Guck
Contents and qualification aims	The students are familiar with concepts of phenomenological thermodynamics: energy, entropy, transport phenomena, biologically active forces, classical reaction and enzyme kinetics, bioenergetics as well as membrane biophysics and basics of electrophysiology. They know the most important methods with respect to molecular, cellular and systems biophysics as well as structural methods (NMR, X-Ray), spectroscopy and microscopy, modern methods in biochemistry and proteomics. Students will have an overview over the most important concepts and the broad methodology of modern applied biophysics. They are able to select the best method(s) for a certain practical task and have background knowledge about their prerequisites and which systems to best apply them to. The students are familiar with functional biomolecular units as machines with the specific aim to use them in more complex technological or medical processes as nanoscale functional elements. The students have an overview of potential applications of the proteins of fibrillar structures, applications of motor proteins, applications of motor proteins of the cytoskeleton, enzymes: classification, kinetics, control and use, applications of viruses, prediction, design and engineering of cellular machines. They know how to write a grant proposal. The students have an interdisciplinary research and development competence, which qualifies them both for scientific intentions (master thesis or rather subsequent doctorate) as well as for an activity in the R&D field of a biotechnology company.	
Type of course	4 SWS lecture, 2 SWS seminar, 2 SWS exercise and 2 SWS lab practical	
Requirements for study	Basic knowledge in mathematics, particularly differential and integral calculus, simple differential equations on Bachelor level. Basic knowledge in classic physics (mechanics, electrodynamics, thermodynamics) on Bachelor level, basics in biology on Bachelor level. Literature: • Courant & Hilbert: Methods of Mathematical Physics • Jackson: Classical Electrodynamics • Sakurai: Advanced Quantum Mechanics • Huang: Introduction to Statistical Physics • Cell Biology, 2nd edition (by Thomas D. Pollard, William C. Earnshaw, Jennifer Lippincott-Schwartz), ISBN-13: 978-1416022558	

Practical use of the module	Compulsory module of the master's program Nanobiophysics, track Nanoscience and Nanotechnology, specialization Biophysics
Requirements for the award of credits	The credits are awarded if the module examination is passed. The module examination is a written examination (duration 90 minutes).
Credits and grades	For the module 9 credit points can be acquired. The module grade is the grade of the written examination.
Frequency of the course	The module is offered every academic year in winter semester.
Workload	The workload is 270 working hours
Duration of the module	1 semester

Module Number BT-NB E2	**Module Name** Biological Oriented Module	**Resp. Lecturer** Francis Stewart
Contents and qualification aims	The students know research issues and recent developments in selected research areas of molecular and cell biology, developmental or systems biology and surface chemistry. By choosing a number of elective, the students create an individual profile within the master's program. They are able to orientate themselves within different areas of research and know about the latest developments in the selected subjects.	
Type of course	4 SWS lecture	
Requirements for study	Basic knowledge in Biology, Physics and Chemistry on Bachelor-level. Literature: • Molecular biology of the Cell (Bruce Alberts), Kapitel 1 und 2 • Molecular Cell Biology (Darnell), Kapitel 1	
Practical use of the module	Compulsory module of the master's program Nanobiophysics, track Nanoscience and Nanotechnology	
Requirements for the award of credits	The credits are awarded if the module examination is passed. The module examination consists of 2 oral exams (individual exam, duration 20 min each)	
Credits and grades	For the module 6 credit points can be acquired. The module grade is the unweighted average grade of the 2 grades.	
Frequency of the course	The module is offered every academic year in winter semester.	
Workload	The workload is 180 working hours	
Duration of the module	1 semester	

Module Number BT-NB E3	**Module Name** Nanooptics and Magnetism on the Nanoscale	**Resp. Lecturer** Lukas Eng
Contents and qualification aims	The students are familiar with: field of a hertz-dipole, evanescent field, far field, field distribution in focus of linear, circular, radial and azimuthal polarisation, diffraction, principles and applications of the near-field scanning optical microscopy, optical micro-cavity, impact of an optical field in a closed space on the fluorescence properties of a molecule, generation of optical near field on interfaces and through nanostructures: optical aperture, metallic nanoparticles, surface plasmon, optical antennae. The module introduces modern optics on the basis of single molecule detection. Furthermore, the students know fundamental aspects of magnetism, magnetic resonance, thermodynamics, magnetization, magnetic exchange, anisotropy on the molecular scale, molecular and nanoscale magnets in memory technology and medicine. They know modern aspects of magnetism of molecules and on the nanometer scale.	
Type of course	4 SWS lecture	
Requirements for study	Knowledge of theoretical and experimental biophysics on Bachelor level. Literature: • Courant & Hilbert: Methods of Mathematical Physics • Jackson: Classical Electrodynamics • Sakurai: Advanced Quantum Mechanics • Huang: Introduction to Statistical Physics • David Halliday, D, Resnick, R, Walter, J, 1997, Fundamentals of Physics, Wiley	
Practical use of the module	Compulsory optional module of the master's program Nanobiophysics, track Nanoscience and Nanotechnology, specialisation Nanoelectronics	
Requirements for the award of credits	The credits are awarded if the module examination is passed. The module examination consists of an oral exam (individual exam, duration 20 min).	
Credits and grades	For the module 6 credit points can be acquired. The module grade is the grade for the oral exam.	
Frequency of the course	The module is offered every academic year in winter semester.	
Workload	The workload is 180 working hours	
Duration of the module	1 semester	

Module Number BT-NB E4	**Module Name** Molecular Electronics	**Resp. Lecturer** Gianaurelio Cuniberti
Contents and qualification aims	The students know the fundamentals of molecular electronics, particularly experimental methods, physical effects and theoretical instruments. They are familiar with single molecule electronics, scanning probes and break junction techniques, transport mechanisms on the nanoscale, molecular components (diodes, transistors, sensors) and molecular structures. The students know the most important experimental and theoretical methods for the analysis of charge transfer on the molecular scale.	
Type of course	2 SWS lecture, 2 SWS exercise, 2 SWS seminar	
Requirements for study	Basics of mathematics and physics on Bachelor level. Literature: • M.C. Petty: Molecular electronics, Wiley 2007, Kapitel 1 und 2 • J.C. Cuevas, E. Scheer: Molecular electronics, World Scientific 2010, Kapitel 1	
Practical use of the module	Compulsory optional module of the master's program Nanobiophysics, track Nanoscience and Nanotechnology, specialisation Nanoelectronics	
Requirements for the award of credits	The credits are awarded if the module examination is passed. The module examination consists of • an oral exam (individual exam, duration 20 min) and • a presentation	
Credits and grades	For the module 9 credit points can be acquired. The module grade is the weighted average of: • oral exam 70% • oral presentation 30%	
Frequency of the course	The module is offered every academic year in winter semester.	
Workload	The workload is 270 working hours	
Duration of the module	1 semester	

Module Number BT-NB E5	**Module Name** Broadening Module	**Resp. Lecturer** Jochen Guck
Contents and qualification aims	The students know selected current nano- and biophysical research issues. Based on their choice of courses, the students gain an in-depth knowledge of the selected research fields. They will be able to orientate themselves within different areas of research and know about the latest developments in the chosen subjects.	
Type of course	6 SWS lecture. The subjects incl. scope need to be chosen from the list of electives/catalogue for the master's program Nanobiophysics/Nanoscience and Nanotechnology. This list/catalogue is published at the start of the semester as is customary at the Biotechnology Center and includes the type of examinations.	
Requirements for study	Basic knowledge in Biology, Physics and Chemistry on Bachelor-level. Literature: • Nelson/Cox: Lehninger Principles of Biochemistry, Worth Publishers • David Halliday, D, Resnick, R, Walter, J, 1997, Fundamentals of Physics, Wiley	
Practical use of the module	Compulsory optional module of the master's program Nanobiophysics, track Nanoscience and Nanotechnology	
Requirements for the award of credits	The credits are awarded if the module examination is passed. The module examination consists of examinations as specified in the list/catalogue of electives Nanobiophysics/Nanoscience and Nanotechnology.	
Credits and grades	For the module 9 credit points can be acquired. The module grade is the unweighted average grade of the grades obtained.	
Frequency of the course	The module is offered every academic year in winter semester.	
Workload	The workload is 270 working hours	
Duration of the module	1 semester	