Molecular Systems and Materials Chemistry elective package

Molecular Systems and Materials Chemistry	
Offered by	Department of Chemical Engineering and Chemistry (CE&C)
Language	English
Primarily interesting for	All students; most relevant for bachelor students of Chemical Engineering and Chemistry
Prerequisites	Required courses: A basic knowledge is required of organic chemistry as taught in the courses 6M1X0 for ST students and 8SA00 for BMT students, as well as practical skills relating to chemistry.
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Content and composition

Molecular diagnostics, biomaterials, innovative materials for solar energy, smart light-weight self-repairing, self-cleaning and/or fully recyclable polymer materials are currently attracting much interest. Practical skills and sound theoretical knowledge are essential for the design and synthesis of these functional molecules and materials.

The MSMC cluster offers a cohesive elective package that consolidates students' practical skills regarding organic chemistry and polymer materials, while deepening and broadening their theoretical knowledge of molecules and materials. The elective package consists of six courses, of which at least three are to be selected. They can be followed in any order. There are two introductory-level courses: Introduction to polymer chemistry and technology, and Biochemistry; one deepening-level course: Macro-organic chemistry, and three advanced-level courses: Physical chemistry, Topics in molecules and materials, and DBL molecules and materials.

The Polymer Chemistry and Technology course provides a solid introduction to the production, characterization and properties of polymers and polymer materials. Physical Chemistry concentrates on basic concepts and experimental techniques from this branch of chemistry. Biochemistry affords insight into molecular principles in biochemical processes, medicines and biomaterials. The Macro-Organic Chemistry course deepens the knowledge gained in the major Organic Chemistry course, looking at the design, synthesis, reactivity and properties of molecules. The Topics in Molecules and Materials course, which broadens and deepens students' knowledge, deals with the principles and the role that organic molecules and materials play in modern developments such as solar energy, nanoparticles, smart materials and coatings. The Molecules and Materials DBL increases students' experimental skills with regard to designing, producing and studying the properties of molecules and materials.

Course code[i]	Course name	Level classification
6E2X0	Introduction to polymer chemistry and technology**	1
6E3X0	Macro-organic chemistry**	2
6E4X0	Physical chemistry**	3
6E6X0	DBL Molecules and materials***	3
6E7X0	Topics in Molecules and materials***	3
8RA00	Biochemistry*	1

* This course will be taught for the last time in academic year 2022/2023. For the academic year 2023/2024, two more attempts for the final exam will be offered.[1]

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*** This course will be taught for the last time in academic year 2024/2025. For the academic year 2025/2026, two more attempts for the final exam will be offered.[1]

[1] The extra two attempts are exclusively for students that already did the final exam, but had an insufficient final grade.

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Course description

Introduction to Polymer chemistry and technology (6E2X0)
The main aim of this course is to give students insight into the principles of polymer chemistry and enable them to apply this insight to the design of polymers with a certain structure and the associated mechanical properties. By the end of this course, students will be familiar with the main concepts of polymer chemistry and technology and be able to apply them. The topics addressed are polymerization mechanism and polymerization technology, relationships between polymerization conditions, molecule weights, molecular microstructure and properties, characterization techniques relating to molecule weight and chemical composition, mechanical and thermal properties of polymers and, finally, significant applications for polymers and polymer materials.

Macro-organic Chemistry (6E3X0)
The importance of thinking at the molecular level in chemistry and chemical technology is growing daily as a result of far-reaching insights in modern science and technology. In addition, we are witnessing the rapid rise of molecular insights in nanoscience, biomedical technology and, of course, many aspects of energy and health. The Macro-organic Chemistry lecture deepens the knowledge gained from the major lecture on Organic Chemistry, examining the most commonly used molecular building blocks; how they can be designed and synthesized, while discussing the theoretical background of their reactivity and properties. The Macro-organic Chemistry lecture looks for the limits to the complexity and/or size of the molecule or molecular system from a historical perspective, while viewing the essential contributions in a contemporary context. The following topics, among others, will be treated: colorants and conjugated systems (various methods for their synthesis are discussed in conjunction with the color properties of the compounds), synthesis and properties of heterocyclic compounds and their role in medicines, asymmetric synthesis and how chiral compounds are made in only one of the enantiomers.

Physical chemistry (6E4X0)
The aim of this lecture is to familiarize students with the basic concepts and a number of experimental techniques relating to physical chemistry. By the end of the course, students will be able to reproduce the insights and apply the knowledge gained to new issues relevant to science and industry. The following topics are addressed: intermolecular forces, interfaces, colloidal stability, compounds, phase diagrams, chemical balances and electrochemistry. Introduction to Polymer chemistry and technology

DBL Molecules & Materials (6E6X0)
Within the chosen topics, students become acquainted with functional molecules and materials and learn about the most important principles and/or the synthetic compounds and materials used in this context. Students develop experimental skills relating to synthetic and analytical chemistry and, using technology, gain an understanding of how practical solutions can be found for the development of functional materials. Students learn how to interpret the question set in the project in terms of a concrete work plan for a literature study and experimental work. Students will be able to describe the results of the experiments clearly in the form of a scientific report. The teaching covers a combination of literature study, theory and experimental skills within the research topics in the MS&MC cluster.

Topics in Molecules and Materials (6E7X0)
The topics lecture deals with topics that are relevant to research within the MS&MC cluster. Knowledge of molecules and materials is deepened and broadened, while applications are also discussed. Topics will include: Functional Nanoparticle: nanomedicine, nanotechnology, artificial cells; Supramolecular chemistry and self- assembly; non-covalent interactions, smart materials, thermodynamics and kinetics; Organic semiconductors: principles of organic semiconductors, charge transport, examples; Optical properties: examples in LCD and solar concentrators, etc; Surfaces and interfaces: examples of self-healing, responsive systems, etc.

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Biochemistry (8RA00)
The Biochemistry course introduces students to the molecular principles of the biomedical sciences. It is essential to know the molecular cause in order to properly understand medicine development, tissue engineering and diseases and to find solutions for these. The lectures are richly illustrated with examples of drug discovery, biomaterials and the molecular cause of diseases. An overview is provided of substance classes and reaction types in biochemistry, as well as more detailed knowledge of the structure and function of proteins (including enzymes), nucleic acids (genetic information, protein synthesis) and lipids (biomembranes and transport processes).