

Molecular Science

| Course Code | Course | Credit | Content of Subject |
|-------------|----------------------------|--------|---|
| 40COM003** | Practical Spoken English 1 | 1 | The course focuses on improving and building the communication and presentation skills necessary for researchers. |
| 40COM004** | Practical Spoken English 2 | 1 | Following "Practical Spoken English 1", the course focuses on improving and building the communication and presentation skills necessary for researchers. |
| 40COM005** | Practical Spoken English 3 | 1 | Following "Practical Spoken English 2", the course focuses on improving and building the communication and presentation skills necessary for researchers. |
| 40COM006** | Practical Spoken English 4 | 1 | Following "Practical Spoken English 3", the course focuses on improving and building the communication and presentation skills necessary for researchers. |
| 40COM007** | Practical Spoken English 5 | 1 | Following "Practical Spoken English 4", the course focuses on improving and building the communication and presentation skills necessary for researchers. |
| 40COM008** | Practical Spoken English 6 | 1 | Following "Practical Spoken English 5", the course focuses on improving and building the communication and presentation skills necessary for researchers. |
| 40COM009** | Practical Spoken English 7 | 1 | Following "Practical Spoken English 6", the course focuses on improving and building the communication and presentation skills necessary for researchers. |
| 40COM010** | Practical Spoken English 8 | 1 | Following "Practical Spoken English 7", the course focuses on improving and building the communication and presentation skills necessary for researchers. |

Molecular Science

| Course Code | Course | Credit | Content of Subject |
|-------------|---|--------|--|
| 40COM011** | Practical Spoken English 9 | 1 | Following "Practical Spoken English 8", the course focuses on improving and building the communication and presentation skills necessary for researchers. |
| 40COM012** | Practical Spoken English 10 | 1 | Following "Practical Spoken English 9", the course focuses on improving and building the communication and presentation skills necessary for researchers. |
| 40MLS001** | Biomolecular Simulation | 1 | Basic theories and computational methods for molecular simulations for biomolecules will be introduced. For example, basic and various advanced methodologies for molecular simulations as well as fundamentals of analytical mechanics and statistical mechanics will be lectured. |
| 40MLS002** | Fundamental Chemistry and Physics of Solids | 2 | To understand fundamental physical properties of solid materials, basic principles concerning solid state physics will be discussed. Structures, thermal properties, electronic structures, transport properties, magnetism, and superconductivity of solids will be introduced. |
| 40MLS003** | Fundamentals of Biomolecular Science | 2 | Core aspects of biophysical chemistry will be overviewed with the life-science student in mind. This course aims at cultivating the fundamentals necessary to complete the advanced courses of Structural Biomolecular Science and of Functional Biomolecular Science. The lectures will be given with life-science examples using a textbook covering the laws of thermodynamics, biological standard state, chemical equilibrium and its temperature dependence, chemical kinetics, enzyme kinetics, and molecular dynamics. |
| 40MLS004** | Introduction to Coordination Chemistry | 2 | Structure and bonding of transition metal complexes including organometallic complexes, with emphasis on electronic structures, spectroscopy, and elementary reactions. |

Molecular Science

| Course Code | Course | Credit | Content of Subject |
|-------------|----------------------------------|--------|---|
| 40MLS005** | Fundamental Electronic Physics | 2 | This lecture introduces the research field of the electronic structure and physical properties of materials using synchrotron radiation. The first half of the lecture will outline the generation of synchrotron radiation and basic experimental techniques, and the second half will describe advanced research using photoelectron spectroscopy and other techniques. |
| 40MLS006** | Synchrotron radiation science | 2 | Synchrotron radiation is an important tool for elucidating the electronic and atomic structures that govern the properties and functions of matter. In the first half, we will give a lecture on electromagnetic radiation generation from relativistic electron beams (synchrotron radiation) and basic knowledge of optics. In the second half, we will summarize the interaction between light and matter, and outline the basic technology and application development of physical property analysis methods (photoelectron spectroscopy, X-ray absorption spectroscopy, etc.) using synchrotron radiation. A tour of UVSOR will also be conducted. |
| 40MLS007** | Fundamental Physical Chemistry 1 | 2 | This course gives an introductory overview of quantum chemistry and machine learning. In particular, this course focuses on electronic structure theories which describe molecular electronic states and properties, and machine learning methods in Molecular Science. |
| 40MLS008** | Fundamental Physical Chemistry 2 | 2 | This course gives an introductory overview of fundamental theories in physical chemistry with a focus on quantum mechanics and statistical mechanics. A special emphasis is placed on the fundamental understanding of dynamical processes in molecular systems and light-matter interaction. |

Molecular Science

| Course Code | Course | Credit | Content of Subject |
|-------------|------------------------------------|--------|---|
| 40MLS009** | Fundamental Photo-science | 2 | Photoexcitation and photoionization processes can provide detailed information on the molecular properties and are in widespread use of the physical and chemical sciences. This lecture provides the student with a firm grounding in the basic principles and experimental techniques employed. Use of case studies illustrates how photoabsorption and photoelectron spectra are assigned and how information can be extraced. |
| 40MLS010** | Structural Photo-Molecular Science | 2 | The basic frameworks of various spectroscopic methods such as laser spectroscopy, nonlinear and time-resolved spectroscopy and microscopic methods, for investigation of structures and dynamics of small molecules to molecular assemblies are overviewed. Examples of applications of those methods for understanding/control of materials functionalities are also introduced. |
| 40MLS011** | Materials Chemistry | 2 | The basic concept of structure-property relationship in organic/inorganic chemistry, materials chemistry, and solid-state physics and relevant experimental methods are overviewed. Actual examples of structural analysis, physical property measurement, and elucidation of functional activation mechanisms based on spectroscopic and surface science methods are also introduced. |
| 40MLS012** | Structural Biomolecular Science | 2 | In this lecture, we will explain the structures of biomolecules such as proteins, DNA/RNA, and lipids, as well as the structures of organelles and cells formed by these biomolecules. We will also discuss how sophisticated activities of life are realized from structural perspectives. Furthermore, we will cover computational methods for predicting and designing the structures of proteins and DNA, accompanied by hands-on training. |

Molecular Science

| Course Code | Course | Credit | Content of Subject |
|-------------|---------------------------------|--------|---|
| 40MLS013** | Complex Catalysis | 2 | Molecular structures and functions of complex catalysts will be overviewed based on the understanding the features of transition metal catalysis, Lewis acid-Lewis base catalysis, and organo catalysis in catalytic molecular transformations. |
| 40MLS014** | Functional Biomolecular Science | 2 | 1. Basic and applications of solution and solid-state NMR spectroscopy in structural analyses of biomolecules 2. Basic of microscopy, Single-molecule imaging, Optical tweezers, Magnetic tweezers, Super resolution microscopy, High-speed atomic force microscopy 3. Functional mechanisms of biomacromolecules including glycoproteins, membrane proteins, and multidomain proteins, Working mechanisms of motor proteins, Molecular basis of protein assembly |
| 40MLS015** | Quantum dynamics | 2 | Lecture on principles of direct observation and control of ultrafast quantum dynamics of matter (in femto- and attosecond time scale) by using light and recent experimental trials in the relevant field. |
| 40MLS016** | Molecular Functional Materials | 2 | Omnibus lectures on the functions and physical properties of organic molecules, molecular assemblies, and inorganic materials will be given. |
| 80MLS001** | Seminar on Molecular Science IA | 2 | In seminars held by the research team to which the student belongs, the student will acquire basic knowledge of molecular science by taking a series of lectures on papers related to his/her own research project and participating in seminars to discuss the results of his/her research. |

Molecular Science

| Course Code | Course | Credit | Content of Subject |
|-------------|-----------------------------------|--------|--|
| 80MLS002** | Seminar on Molecular Science I B | 2 | In seminars held by the research team to which the student belongs, the student will read papers related to his/her own research topics and present his/her research results, thereby learning how to interpret data rationally and how to make logical arguments based on the interpretation of data. |
| 80MLS003** | Seminar on Molecular Science IIA | 2 | In seminars held by the research team to which the student belongs, the student will understand the level of achievement of his/her own research by studying advanced papers related to his/her research topics. In addition, the student will learn the basics of English presentation by presenting his/her research results in English in the seminars. |
| 80MLS004** | Seminar on Molecular Science II B | 2 | In seminars held by the research team to which the student belongs, the student will prepare his/her interim report, through which he/she will learn the basics of describing research results logically. |
| 80MLS005** | Seminar on Molecular Science IIIA | 2 | In the seminars of the research team to which the student belongs, the student will set and discuss issues on his/her own initiative. The student will deepen his/her discussions in preparation for conference presentations. |

Molecular Science

| Course Code | Course | Credit | Content of Subject |
|-------------|------------------------------------|--------|---|
| 80MLS006** | Seminar on Molecular Science III B | 2 | In the seminar of the research team to which the student belongs, the student will study papers related to the research topic comprehensively and systematically so that the student can obtain international recognition for his/her research results. |
| 80MLS007** | Seminar on Molecular Science IVA | 2 | In the seminar of the research team to which the student belongs, the student considers the future development of his/her own research results and proposes upgrading/extension of the research. |
| 80MLS008** | Seminar on Molecular Science IVB | 2 | In the seminar of the research team to which the student belongs, the student will be required to propose a novel research project with a view to developing his/her own research results into an unexplored research area. |
| 80MLS009** | Seminar on Molecular Science VA | 2 | In the seminar of the research team to which the student belongs, the student will gain a bird's-eye view of his/her own research results and understand their academic and social significance. The student will be expected to actively engage in discussions with related researchers. |

Molecular Science

| Course Code | Course | Credit | Content of Subject |
|-------------|---------------------------------|--------|--|
| 80MLS010** | Seminar on Molecular Science VB | 2 | <p>In the seminar of the research team to which the student belongs, with the aim to prepare his/her PhD thesis, the student will summarize the scientific background of his/her own research, clarify the significance of his/her own research results, and proactively conduct a general seminar.</p> <p>The value of the research results as intellectual property will be discussed in consideration of their application and development.</p> |