科目名 Course Title	総合化学特別研究[Laboratory Exercise in Chemical Sciences and Engineering I]		
講義題目 Subtitle			
責任教員 Instructor	総合化学院代議員（大学院総合化学院）		
担当教員 Other Instructors	Provided by supervisor		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	
期間 Semester	Full Year	**単位数 Number of Credits**	10
授業形態 Type of Class	Experiment	**対象年次 Year of Eligible Student**	1～2
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQUI 6302		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Chemical Sciences and Engineering, Master's thesis

授業の目標 Course Objectives

You will develop the ability to identify various problems in chemistry, solve them, and to conduct research. In addition, you will pursue research in individual fields under the guidance of instructors in order to acquire the ability to complete the achievements with excellent academic research papers.

到達目標 Course Goals

Complete Master's thesis.

授業計画 Course Schedule

Research under the guidance of supervisor(s). Please contact to your supervisor for specific research plan.

準備学習（予習・復習）等の内容と分量 Homework

It takes a lot of time to conduct experiments, to analyze the data, to prepare for presentation, and to write a paper.

成績評価の基準と方法 Grading System

Submission of a master thesis is required. Evaluation is based on the thesis and daily activity in laboratory.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

備考 Additional Information

Register this course at the semester of graduation.

科目名 Course Title	物理化学先端講義[Advanced Lecture of Physical Chemistry]		
講義題目 Subtitle			
責任教員 Instructor	佐田　和己 [SADA Kazuki] (大学院理学研究院)		
担当教員 Other Instructors	ISHIMORI Koichiro (理学研究院), TAKEUCHI Hiroshi (理学研究院)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094051
期間 Semester	Summer	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 5002		
補足事項 Other Information			
授業実施方式 Class Method	2 対面授業科目《一部遠隔》		

キーワード Key Words

Condensed matter, Macromolecules, Molecular structure, Magnetic resonance

授業の目標 Course Objectives

Firstly, this course reviews a part of fundamental physical chemistry (physical properties of molecules and macromolecules, nuclear magnetic resonance). Secondly, this course provides the skill of understanding advanced application of physical chemistry in material science.

到達目標 Course Goals

Students are expected to understand the important matters of physical chemistry and to apply them to design, synthesis, and study of functional properties of new materials.

授業計画 Course Schedule

Session 1 (1 ~ 3) Instructor: Lecturer Takeuchi, Hiroshi (Faculty of Science)
Basic concepts of nuclear magnetic resonance and its application.
(reference: ATKINS' Physical Chemistry 10th edition; chapter 14, Magnetic resonance)

Session 2 (4 ~6) Instructor: Professor Sada, Kazuki (Faculty of Science)
Basic theory and physical properties of macromolecules
(reference: ATKINS' Physical Chemistry 10th edition; chapter 17, Macromolecules and self-assembly)

Session 3 (7, 8) Instructor: Professor Ishimori, Koichiro (Faculty of Science)
Molecular interactions: Basic theory and its application of dipole-dipole interactions
(reference: ATKINS' Physical Chemistry 10th edition; chapter 16, Molecular interactions)

準備学習 (予習・復習)等の内容と分量 Homework

Preparation for ATKINS' Physical Chemistry 10th edition; chapter 14 (Magnetic resonance), chapter 16 (Molecular interactions), chapter 17 (Macromolecules and self-assembly) or equivalent chapters of previous editions. Review according to instructors.

成績評価の基準と方法 Grading System

Final paper for each instructor (75%), quiz and attendance attitude (25%)
Participation more than 70% is required for grading

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

参考書:アトキンス「物理化学」

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

備考 Additional Information

Prerequisite:
Students are requested to have basic knowledge of physical chemistry

科目名 Course Title	無機化学先端講義[Advanced Inorganic Chemistry]		
講義題目 Subtitle			
責任教員 Instructor	松井　雅樹 [MATSUI Masaki] (大学院理学研究院)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094052
期間 Semester	Summer	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 5012		
補足事項 Other Information			
授業実施方式 Class Method	2 対面授業科目《一部遠隔》		

キーワード Key Words

Powder X-ray diffraction, Bravais lattice, space group, crystal structural factor, Rietveld refinement

授業の目標 Course Objectives

Powder X-ray diffraction is the most popular structural analyses method in inorganic materials chemistry. In this class we revisit undergrad level crystallography and XRD technique. Advanced measurement and analysis techniques are also introduced in the class.

到達目標 Course Goals

Understand the rietveld refinement technique.

授業計画 Course Schedule

1. Fundamental of powder X-ray diffraction
2. Measurement and analysis of diffraction data1
3. Measurement and analysis of diffraction data2
4. Description of crystallographic data
5. Point group and space group
6. Calculation of peak intensity
7. Rietveld refinement 1
8. Rietveld refinement 2

準備学習（予習・復習）等の内容と分量 Homework

Check the class text in advance.
Summarize your questions just after the class.

成績評価の基準と方法 Grading System

Attendance 30%, Homework: submit20%, Content50%

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

Materials will be provided via ELMS in advance.

講義指定図書 Reading List

粉末 X 先回席の実際　第 3 版／中井泉、泉富士夫(編)：朝倉出版, 2021
物質の対称性と群論／今野豊彦：共立出版, 2001
X 線構造解析／早稲田嘉夫、松原英一郎：内田老鶴圃, 1998

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	基礎生物有機化学特論[Introductory Bio-organic Chemistry]		
講義題目 Subtitle			
責任教員 Instructor	永木　愛一郎 [NAGAKI Aiichiro] (大学院理学研究院)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094053
期間 Semester	Summer	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 5022		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Flow Chemistry, Microflow System, Integrated Synthetic Chemistry, Organic Synthetic Chemistry

授業の目標 Course Objectives

Integrated synthetic chemistry, or reaction-integrated synthetic chemistry, is a synthetic chemistry in which a series of reactions are planned and carried out in a coordinated manner, rather than in which each of the reactions required for synthesis is planned and carried out separately and independently. In this lecture, the characteristics of organic synthetic reactions using microflow systems and the integration of reactions using these characteristics will be discussed, and the latest examples will be introduced.

到達目標 Course Goals

Understand the features related to microflow synthesis and acquire the ability to construct integrated synthesis based on these features.

授業計画 Course Schedule

1. Organic synthesis based on fast mixing
2. Organic synthesis based on reaction time control
3. Organic synthesis based on use of short-lived active species
4. Reaction integration

準備学習（予習・復習）等の内容と分量 Homework

It is effective to review the handouts distributed during the lecture.

成績評価の基準と方法 Grading System

The attendance rate must be over 70% to be qualified to take the final exam. Evaluations will be made based on report scores.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

Lecture 時に指定する。
Introduced as appropriate in class.

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

https://wwwchem.sci.hokudai.ac.jp/~yuhan/index_e.html

備考 Additional Information

科目名 Course Title	生物化学先端講義[Intermediate Biological Chemistry]		
講義題目 Subtitle			
責任教員 Instructor	坂口　和靖 [SAKAGUCHI Kazuyasu] (大学院理学研究院)		
担当教員 Other Instructors	KAMADA Rui (理学研究院), NAKAGAWA Natsumi (理学研究院)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094054
期間 Semester	Spring/Summer	**単位数 Number of Credits**	2
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 5032		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Biomolecule, Protein, Protein Structure, Regulation of Protein Function, Folding, Molecular Recognition, Enzyme, Bioinformatics

授業の目標 Course Objectives

The protein function is attributed to its 3D structure and is regulated via control of protein level, activity, and localization by interactions with other biomolecules and posttranslational modification. The class focuses on fundamental aspects of the mechanisms for regulation of protein function based on protein structures. This course also introduces frontier topics of protein function and structures and the course will help the student to expand an understanding of fundamentals of protein structure and function.

In the latter part of the lecture, students participate in virtual research proposals on raising problems and their solutions related to protein structure, function, and control, in Active learning method by the group.

到達目標 Course Goals

After successful completion of this course, you will be able to:

1. Understand the regulation mechanism of protein function based on protein structures.
2. Obtain basic abilities to search the problems in scientific fields and solve them.

授業計画 Course Schedule

In the half of the course, the following items are outlined.

1. Basic structure and stability of protein
2. Molecule recognition of proteins and enzymes
3. Control of protein function
4. Complex formation and ligand binding
5. Protein structure / function prediction

We will also conduct a virtual research proposal by the group on raising problems and their solutions related to protein structure, function and control.

準備学習 (予習・復習)等の内容と分量 Homework

Students are expected to review the material provided by the instructors.

成績評価の基準と方法 Grading System

Problem-based learning on a specific topics of this course (35%). Term examination (40%)

In addition, we also consider it as the important factor for assessment how actively students participate in each class (25%).

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

Materials will be provided in each lecture

講義指定図書 Reading List

タンパク質の構造と機能／グレゴリー A. ペツコ, ダグマール リンゲ著 ; 宮島郁子訳:メディカル・サイエンス・インターナショナル, 2005

“Protein Structure and Function”／Gregory A. Petsko and Dagmar Ringe:New Science Press, 2004

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

https://wwwchem.sci.hokudai.ac.jp/~biochem/en/

備考 Additional Information

科目名 Course Title	実践的計算化学[Practical Computational Chemistry]		
講義題目 Subtitle			
責任教員 Instructor	武次　徹也 [TAKETSUGU Tetsuya] (大学院理学研究院)		
担当教員 Other Instructors	ITOH Hajime (工学研究院), SHIMADA Toshihiro (工学研究院), HASEGAWA Junya (触媒科学研究所)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094055
期間 Semester	Fall	**単位数 Number of Credits**	2
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 5200		
補足事項 Other Information			
授業実施方式 Class Method	4 遠隔授業科目《遠隔のみ》		

キーワード Key Words

Computational Chemistry, Theoretical Chemistry, Molecular Orbital Theory, Density Functional Theory

授業の目標 Course Objectives

Computational chemistry has been a very important research technique in chemistry field. This course is for the students who have no experience of calculation. Objectives of this course is to make the students master how to use calculation on their research issues in accompany with understandings on general aspects of computational chemistry.

到達目標 Course Goals

1. Understand the basics of computational chemistry, theoretical chemistry, molecular orbital theory, density functional theory, excited state calculation.
2. Use Gaussian and GaussView.

授業計画 Course Schedule

1. General Introduction of Computational Chemistry – Prof. T. Taketsugu
2. Computational Analysis of Organic Reactions – Prof. H. Ito
3. Physical Properties Calculations of Inorganic Materials and Organic Semiconductors – Prof. T. Shimada
4. Excited State Calculations – Prof. J. Hasegawa

準備学習 (予習・復習)等の内容と分量 Homework

Students should have a note PC with Windows 7 or later.
Calculation homework and reports.

成績評価の基準と方法 Grading System

The attitude at the lecture (20%) and report scores (80%) are evaluated.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

新版 すぐできる 量子化学計算ビギナーズマニュアル (KS 化学専門書)／武次 徹也 (編集), 平尾 公彦 (監修):講談社サイエンティフィク, 2015

講義指定図書 Reading List

Gaussian プログラムで学ぶ情報化学・計算化学実験／堀 憲次, 山本 豪紀:丸善, 2006
電子構造論による化学の探究

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

備考 Additional Information

Notre PC with Windows7 or later and anti-virus application is necessary.
If many applicant, the student will be determined by lottery.
Campus licensed software will be used (no extra cost). No advance preparation is required. Students aiming to real skill acquisition are favorable.

科目名 Course Title	構造有機化学[Structural Organic Chemistry]		
講義題目 Subtitle			
責任教員 Instructor	鈴木　孝紀 [SUZUKI Takanori] (大学院理学研究院)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094056
期間 Semester	Fall	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 5050		
補足事項 Other Information			
授業実施方式 Class Method	4 遠隔授業科目《遠隔のみ》		

キーワード Key Words

Structural Organic Chemistry
Host-guest complexation
Supramolecules

授業の目標 Course Objectives

Various functions of materials can be derived by proper designing organic pi-electron systems. Students are provided with the the important concepts which are necessary to comprehend this area of organic chemistry, by using the topic of host-guest complexation.

到達目標 Course Goals

Students will learn the background and basic idea to understand the various intriguing phenomena in the functionalized organic pi-electron systems/organic solids.

授業計画 Course Schedule

The major topic is the "Host-guest complexation and supramolecule formation"

The class instruction will be done in Japanese.

準備学習（予習・復習）等の内容と分量 Homework

The following text book is used. (only Japanese version is available)

成績評価の基準と方法 Grading System

Presentations and reports

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

構造有機化学　基礎から物性へのアプローチまで／中筋　一弘：東京化学同人, 2020

講義指定図書 Reading List

構造有機化学　基礎から物性へのアプローチまで／中筋　一弘：東京化学同人, 2020

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	超分子化学[Supramolecular Chemistry]		
講義題目 Subtitle			
責任教員 Instructor	猪熊　泰英 [INOKUMA Yasuhide] (大学院工学研究院)		
担当教員 Other Instructors	ITOH Hajime (工学研究院)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094058
期間 Semester	Fall	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 5102		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

host-guest chemistry, intermolecular interactions, hydrogen bond, macrocyclic molecules, ion recognition, structure, stereochemistry, chirality

授業の目標 Course Objectives

The goal of this course is to understand the basis of supramolecular chemistry including driving forces of intermolecular non-covalent interactions, molecular design and synthesis, higher-order structures, and functions as materials.

到達目標 Course Goals

Students will be able to explain

1. the origin of non-covalent intermolecular interactions (hydrogen bond, CH-π interactions, dipole-dipole interactions, Coulomb interactions) from the viewpoint of quantum organic chemistry
2. methods of structural analysis of supramolecular structures and their principles
3. methodology of efficient synthesis of macrocyclic compounds, rotaxanes, and catenanes, and their drawback and advantage
4. expected 3-dimennsional structures and functions from chemical structures of building units

授業計画 Course Schedule

1. what is 'supramolecules', intermolecular interactions
2. molecular recognition, ion recognition, host-guest chemistry
3. self-assembly, giant supramolecular structures
4. reactions and supramolecular chemistry
5. from current research topics
6. summary

準備学習 (予習・復習)等の内容と分量 Homework

Students are expected to prepare the lecture by reading textbook or handouts which will be delivered in class, and to read reference scientific papers which will be introduced in the lecture.

成績評価の基準と方法 Grading System

Evaluation will be based on report submission (50%) and examination (50%).

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

大学院 Lecture　有機化学　Ⅰ. 分子構造と反応・有機金属化学／野依良治ほか:東京化学同人, 1999
超分子化学／Jean-Marie Lehn(著)、竹内敬人(訳):化学同人, 1997

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

https://www.eng.hokudai.ac.jp/labo/lor/HP/index_e.html

備考 Additional Information

Students are strongly recommended to check ELMS frequently.

科目名 Course Title	化学工学熱力学特論[Chemical Engineering Thermodynamics]		
講義題目 Subtitle			
責任教員 Instructor	菊地　隆司 [KIKUCHI Ryuji] (大学院工学研究院)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094059
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 5111		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Chemical Engineering Thermodynamics, Phase Equilibrium, Chemical Equilibrium, Material-Energy Conversion, Exergy

授業の目標 Course Objectives

Thermodynamics is lectured to utilize it in chemical engineering. Basic laws of heat phenomena are reviewed for advanced applications. This lecture helps you understand that thermodynamics deals with conversion of materials and energy. Preservation and loss of energy is lectured by introducing a concept of “exergy”. You can learn the quality of energy is expressed in terms of exergy, and energy/material conversion systems are to be analyzed to minimize exergy loss for designing clean energy systems. Fuel cell systems and hydrogen production processes are used as examples for exergy analysis.

到達目標 Course Goals

You can extend basic knowledge on thermodynamics in small closed systems to large open systems such as reactors, power plants, and chemical plants. You can understand the concept of exergy, that is, exergy quantifies the available amount of energy based on environmental conditions, and learn the method to calculate exergy for respective energy forms. You can also learn to express exergy losses accompanied with energy conversion by using energy conversion diagram.

授業計画 Course Schedule

First half of this course you will review and expand the concept of chemical thermodynamics to chemical engineering thermodynamics. Second half you will learn the concept of exergy, calculation procedure of exergy, and drawing of energy conversion diagram.

1. World trends regarding hydrogen and energy, introduction to hydrogen production
2. Basic concept of chemical engineering thermodynamics, chemical thermodynamics, energy balance in closed and flow systems, energy balance of chemical processes
3. Ideal gas and real gas, compression and expansion
4. Chemical equilibrium, equilibrium of heterogeneous reactions
5. Introduction to exergy concept, exergy change in energy conversion, energy diagram for energy conversion
6. Calculation procedure for exergy of various energy forms
7. Exergy for mixing and separation processes, synthesis of process systems
8. Exergy analysis of conversion processes in chemical engineering

準備学習 (予習・復習)等の内容と分量 Homework

It is required to study physical chemistry for preparation for the class. Materials are distributed for each class. Homework is assigned every class to well understand the course content. Unit of class is 1, which corresponds to 45 hours study. By considering total time of class, additional study of 3.6 hours is necessary before and after each class.

成績評価の基準と方法 Grading System

Grade will be evaluated based on the grades of small questions and report assignments assigned during the lecture. The evaluation is based on 40% of the small questions and 60% of the report assignments.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

必要な教材は毎回配布する。参考書は，講義指定図書のとおり。
Handout made by the instructor will be delivered.

講義指定図書 Reading List

熱力学(基本の理解と応用)／石田愈：培風館, 1995
演習化学工学熱力学(第 2 版)／大竹伝雄・平田光穂：丸善, 1991
エクセルギー工学／吉田邦夫編：共立出版, 1999

参照ホームページ Websites

This course will be provided as part of the Hokkaido Summer Institute., For more information (invited lecturers, course details, etc.), please visit the website below:, https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G061

研究室のホームページ Websites of Laboratory

https://apchem.eng.hokudai.ac.jp/en/lab/chemical-system-engineering/

備考 Additional Information

科目名 Course Title	有機反応・構造論[Organic Chemistry of Reaction Mechanism and Molecular Structure]		
講義題目 Subtitle			
責任教員 Instructor	大熊　毅 [OHKUMA Takeshi] (大学院工学研究院)		
担当教員 Other Instructors	ARAI Noriyoshi (工学研究院)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094060
期間 Semester	Spring/Summer	**単位数 Number of Credits**	2
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 5122		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Molecular Orbital, Chemical Bonding, Reactive Intermediates, Stereochemistry, Molecular Recognition, Pericyclic reactions, The Woodward-Hoffmann rules, Cycloaddition reactions, Electrocyclic reactions, Sigmatropic rearrangements, Group transfer reactions

授業の目標 Course Objectives

1. Pericyclic reactions are the third type of organic mechanism along with ionic and radical reactions. This course explains features of these reactions using a basic molecular orbital theory without the mathematics. The Woodward-Hoffmann rules are introduced to analyze the stereochemical outcome of a series of pericyclic reactions, including cycloaddition reactions, electrocyclic reactions, sigmatropic rearrangements, and group transfer reactions.
2. In the first half of this course, students learn the behavior of electrons in an atom and/or a molecule from a quantum theoretical point of view, and understand the chemical bonding and the electronic properties of molecules. Based on this achievement, they learn the structure and properties of chemical species, such as carbocations, carbanions, radicals, and carbenes. In order to understand the chemical behavior of molecules, they also learn the stereochemistry that includes the concept of chirality, diastereomeric isomerism, and conformational analysis. Finally, the molecular recognition through intermolecular interaction, mainly hydrogen bonding, is briefly explained. The lecture materials will be uploaded in on-demand form by using "lecture group" at the ELMS. Students will be assigned homework to check understanding.

到達目標 Course Goals

1. Pericyclic reactions include some of the most useful synthetic reactions, such as the Diels-Alder reactions, 1,3-dipolar cycloadditions, and Claisen rearrangements. By learning to recognize the various types of pericyclic reactions and details of their mechanisms through the cyclic transition structures, students will learn to predict whether these reactions are allowed in individual cases.
2. Our goal is understanding of
- the chemical bondings and the electronic properties of molecules based on the behavior of electrons.
- the structure and properties of chemical species , such as carbocations, carbanions, radicals, and carbenes.
- the concept of chirality, diastereomeric isomerism, and conformational analysis.
- the molecular recognition.

授業計画 Course Schedule

1. The nature of pericyclic reactions (1): The basis and four classes of pericyclic reactions are introduced.
2. Cycloaddition reactions (2): A wide range of cycloadditions and their regio- and stereochemical properties are presented.
3. The Woodward-Hoffmann rules and molecular orbitals (2): The Woodward-Hoffmann rules based on the fundamental molecular orbital theory are discussed.
4. Electrocyclic reactions (1): The reaction pathway and the stereoselective outcome are interpreted by using the Woodward-Hoffmann rules.
5. Sigmatropic rearrangements and group transfer reactions (1): [1,n] and [m,n] rearrangements of suprafacial or antarafacial type are examined. The features of group transfer reactions are explained using two typical examples, diimide reductions and the ene reactions.
6. Electronic structure of atoms (1): The behavior of electrons in an atom is introduced based on the quantum theory.
7. Chemical bonding, molecular orbital, orbital interaction (2): Expression of molecular orbitals by the linear combination of atomic orbital and their interaction are discussed, followed by an explanation of some electronic properties of molecules.
8. Structure and properties of reactive intermediates (2): Chemical structure and properties of typical reactive intermediates, such as carbocations, carbanions, radicals, and carbenes are discussed.
9. Stereoisomerism, chirality, and conformational analysis (1): The way of expression of molecular chirality and stereoisomerism are instructed, followed by introducing the relationship between structure and properties. The method for the conformational analysis is also discussed.
10. Molecular recognition (1): Molecular interaction through hydrogen bonding is briefly discussed.

準備学習 (予習・復習)等の内容と分量 Homework

1. The first half of this course: Students are expected to review the lessons presented in the textbook as well as their own lecture notes. Students are sometimes required to submit assignments.

2. The second half of this course: Students are expected to read relevant contents in the textbook previous to each class (apprx. 15 pages). Students may have short exam or homework, if necessary.

成績評価の基準と方法 Grading System

Grades are awarded based on attitudes through the course and regular assignments (20%) as well as examinations (80%). Students should attend more than 70% of classes.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

Pericyclic Reactions, Second edition／Ian Fleming：Oxford University Press, 2015
大学院 Lecture 有機化学 I 第2版／野依良治 他：東京化学同人, 2019
March's advanced organic chemistry: reactions, mechanisms, and structure, 7th Ed.／Smith, M. B.：John Wiley & Sons, 2013

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

https://orgsynth.eng.hokudai.ac.jp/en/

備考 Additional Information

科目名 Course Title	反応工学特論[Chemical Reaction Engineering]		
講義題目 Subtitle			
責任教員 Instructor	中坂　佑太 [NAKASAKA Yuta] (大学院工学研究院)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094061
期間 Semester	Spring/Summer	**単位数 Number of Credits**	2
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 5132		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Reaction rate, Reactor, Conversion, Selectivity, Ideal/non-ideal flow, Diffusion rate, Transport phenomena

授業の目標 Course Objectives

To design a suitable chemical reactor, it is important to understand ideal and non-ideal flow patterns in the reactor and their effects on chemical reactions. Basic models, concepts, and methods for the chemical reactions in ideal and non-ideal reactors will be explained. Mass transport phenomena through the interfaces between solid-gas and solid-liquid phases are discussed using a simple numerical model. Study the derivation of differential equations describing the mass transport phenomena with chemical reactions. Moreover, the effects of diffusion and reaction rates on rate-limiting step are discussed, based on the Thiele modulus and Effectiveness factor.

到達目標 Course Goals

By the end of this course, you will
1. estimate pressure drop and residence time in the reactor.
2. analyze non-ideal flow reactor.
3. estimate diffusion coefficient in gas and liquid phase.
4. analyze simultaneous reaction and diffusion phenomena around the interface between different phases and within the porous materials.
5. design porous catalysts utilizing effectiveness factor.

授業計画 Course Schedule

1. Reaction kinetics and homogeneous reactions
2. Flow patterns in reactors
3. Continuous reactions in the non-ideal flow reactor.
4. Base of mass transport phenomena, Fick's 1st and 2nd lows.
5. Simultaneous reaction and diffusion phenomena around the interfaces between different phases.
6. Simultaneous reaction and diffusion phenomena within the porous catalysts.
7. Thiele modulus and effectiveness factor for the catalytic reaction.

準備学習 (予習・復習)等の内容と分量 Homework

You are required to review lecture content about 2 hours per 1 lecture. You are recommended to derive equations shown in lecture by yourself.

成績評価の基準と方法 Grading System

Grading will be based on quizzes (30%) and reports (70%).

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

Chemical Reaction Engineering／O. Levenspiel：John Wiley & Sons, 1999
Elements of Chemical Reaction Engineering／H. Fogler：Pearson, 2020
反応工学／橋本健治：培風館, 1993

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

備考 Additional Information

Basic understanding of reaction kinetics and chemical reaction engineering is required. Students should have calculators for each class.

科目名 Course Title	有機合成化学[Advanced Organic Synthesis]		
講義題目 Subtitle			
責任教員 Instructor	石山　竜生 [ISHIYAMA Tatsuo] (大学院工学研究院)		
担当教員 Other Instructors	SENBOKU Hisanori (工学研究院)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094062
期間 Semester	Fall	**単位数 Number of Credits**	2
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 5142		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Organic Synthesis, Molecular Transformation, Reaction Mechanism, Selectivity, Control of Stereochemistry

授業の目標 Course Objectives

"Selectivity" is one of important key words in organic synthesis. In this course, students learn several selectivities in organic transformations and their reaction mechanisms for realizing these high selectivities. Moreover, there are many selective transformations in practical organic synthesis. Some papers published in academic journals are picked up as examples for this course and students also learn how to explain the reasons why these high selectivities can be realized from the basis of learned reaction mechanism.

到達目標 Course Goals

・Understanding selectivities and reaction mechanisms for realizing high selectivities in organic transformations.
・Verifying and understanding concrete selective transformations used in synthesis of natural products and highly functional organic molecules.
・Being able to discuss and explain reasons of selectivities in several organic transformations.

授業計画 Course Schedule

1. Oxidation of Organic Compounds
2. Reduction of Organic Compounds
3. Generation of Enolate and Aldol Reaction
4. Olefination Reaction including Wittig Reaction and Reaction of Ylides
5. Stereoelectronic Effects and Baldwin Rule
6. Cram Rule and Felkin-Anh Model
7. Radical Reaction and Cyclization
8. Protection of Functional Groups
9. Attend a seminor or a lecture
10. Drill problems on organic synthesis

準備学習 (予習・復習)等の内容と分量 Homework

Before a lecture, students have to learn basic organic reactions, such as oxidation, reduction, aldol reaction and Wittig reaction, and their mechanisms sufficiently.
After a lecture, students have to learn again organic transformations, their selectivities, and the reason why their selectivities can be realized, which are given in the lecture.

成績評価の基準と方法 Grading System

Examination (100%) (Senboku)
Attendance attitude (20%) and report (80%) (Ishiyama)

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

教科書は使用しない。必要な資料は適宜配布する。

講義指定図書 Reading List

大学院 Lecture 有機化学 I　分子構造と反応・有機金属化学／野依良治他：東京化学同人, 1999
大学院 Lecture 有機化学 II　有機合成化学・生物有機化学／野依良治他：東京化学同人, 1998

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

備考 Additional Information

For attending this course, general knowledge on organic chemistry should be needed.

科目名 Course Title	無機材料化学特論[Inorganic Materials Chemistry]		
講義題目 Subtitle			
責任教員 Instructor	忠永　清治 [TADANAGA Kiyoharu] (大学院工学研究院)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094063
期間 Semester	Spring/Summer	**単位数 Number of Credits**	2
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 5152		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Solution process, glass formation, powder preparation, sintering, microstructure and properties, Structural materials, Electric and electronic materials, Optical materials

授業の目標 Course Objectives

This course provides major processes for obtaining various ceramics such as thin films, powders, polycrystals, glasses and so on, which can efficiently yield the excellent property of each ceramic material and lead to practical usage. Additionally, important and close relationship between their physical and chemical properties and microstructure can be also understood. Students also learn the basic properties, production and future issues of ceramic materials, such as structural materials, electric and electronic materials, and optical materials which are particularly important among those produced industrially.

到達目標 Course Goals

1. Understanding of a basic relationship between a variety of functions of ceramics, material forms which can realize those excellent functions, and various processes for fabricating each ceramic with specified material form
2. Understanding of the features of the physical and chemical processes to produce functional ceramics and factors to be controlled in each process
3. Understanding various properties of ceramics such as brittleness, electrical conduction, optics and luminescence.
4. Understanding applications of ceramics to high strength and high toughness materials, semiconductors, polarizers, phosphors, scintillators and solid state laser materials.

授業計画 Course Schedule

1. Introduction of Preparation of Ceramics by sol-gel process
2. Preparation of Ceramics by various solution processes
3. Preparation of thin films by solution processes
4. Preparation of thin films by CVD and PVD
5. Glass formation: process, composition and structure
6. Structural analysis of glasses, crystallization of glasses
7. Ceramic powder synthesis from gas, liquid and solid phases
8. Sintering and microstructure control of ceramics
8. Midterm examination
9. Microstructure and physical properties of ceramics: Characteristics and control of microstructures such as crystal particles, grain boundaries and pores in ceramics
10. Mechanical properties of Ceramics
11. Ceramic dielectrics: classification of dielectrics, properties, and applications
13. Ceramic based ioinc conductores
14. Ceramic-based optical materials
15. Ceramics-based Luminescence materials: phosphors, scintillators, laser materials.
16. Examination

準備学習（予習・復習）等の内容と分量 Homework

Students are expected to read relevant contents in the text beforehand. After class, students are also requested to understand the lecture by reading additionally the related bibliography and solving problems provided there.

成績評価の基準と方法 Grading System

50%: reports, 50%: examination

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

Sol-Gel Science: The Physics and Chemistry of Sol-Gel Processing／C.J. Brinker and G.W. Scherer：Academic Press, 1990
Synthesis of Inorganic Materials 2nd ed／U. Schubert and N. Husing：Wiley-VCH, 2004

Physical Ceramics –Principles for Ceramic Science and Engineering／Y-M. Chiang, D. Birnie III, and W. D. Kingery：John Wiley & Sons, 1997

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

https://www.eng.hokudai.ac.jp/labo/inorgsyn/

備考 Additional Information

Basic understanding of Physical chemistry, Inorganic chemistry, Solid state chemistry and Inorganic materials chemistry is required.

科目名 Course Title	エネルギー材料特論[Materials for Energy Conversion and Storage]		
講義題目 Subtitle			
責任教員 Instructor	幅﨑　浩樹 [HABAZAKI Hiroki] (大学院工学研究院)		
担当教員 Other Instructors	KITANO Sho (工学研究院)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094064
期間 Semester	Summer	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 5162		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Energy conversion, Energy storage, ionic conductivity, solar energy conversion, electrochemical devices

授業の目標 Course Objectives

Secondary batteries, solar cells and fuel cells are of importance for efficient energy conversion and storage for realizing cabon neutrality at 2050. In this lecture, students learn about functional materials such as ion conductors, electrocatalysts, and semiconductors required for such energy conversion and energy storage, focusing on the relationship between their structures and functions, and develop basic knowledge for the design of energy conversion and energy storage materials.

到達目標 Course Goals

- Understand phenomena such as semiconductor electrode reactions, ionic conduction, and electrocatalytic reactions from the viewpoint of material chemistry.
- Understand the principles of various solar cells, fuel cells, and rechargeable batteries, and the material properties required to achieve high performance in these electrochemical devices.
- Get necessary knowledge on materials design for energy conversion and storage through understanding the correlation between the structural characteristics of materials and their functionality.

授業計画 Course Schedule

1. Materials for fuel cells: Characteristics of various fuel cells and materials used in the fuel cells will be discussed.
2. Semiconductor electrodes: Based on a band model, fundamentals of photoenergy conversion on semiconductor electrodes will be discussed.
3. Ion conductors: Structural design and mechanism of ion conduction in inorganic solids will be introduced and discussed.
4. Electrocatalysts: Structural and electronic design of electrocatalysts for hydrogen evolution and oxygen evolution/reduction will be introduced and discussed.
5. Presentations: Characteristics of several electrochemical energy storage and conversion devices and their materials will be presented by individual students and discussed.

準備学習 (予習・復習)等の内容と分量 Homework

Students are requested to prepare presentations of specific topics allocated to each student.

成績評価の基準と方法 Grading System

Presentations (50%) and exam (50%)

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

教科書は使用しない。必要に応じ，プリントを配布する。

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

備考 Additional Information

Students need basic knowledge on inorganic chemistry and electrochemistry.

科目名 Course Title	応用生化学特論[Advanced Applied Biochemistry]		
講義題目 Subtitle			
責任教員 Instructor	松本　謙一郎 [MATSUMOTO Kenichiro] (大学院工学研究院)		
担当教員 Other Instructors	HACHISUKA Shin-ichi (工学研究院), FUJITA Masahiro (RIKEN)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094065
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 5171		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Genetic information, protein structure, molecular mechanism, biosynthetic mechanism, animal cells, secondary metabolites, biopolymers, bioremediation, physical chemistry

授業の目標 Course Objectives

To learn synthesis, structure, function, and novel engineering subjects on of biomolecules in the fields of life science, information, medicine, and environment.

到達目標 Course Goals

Students are expected to understand deeply the topics of genetic information, protein structure, animal cell cultivation, secondary metabolites, biopolymers, and clean environments in the fields of life science, information, medicine, and environment.

授業計画 Course Schedule

1-4: Structure, function and analytical methods of RNA and other biomolecules
5-8: Strategies of metabolic pathways, and principles of enzymatic reactions

準備学習（予習・復習）等の内容と分量 Homework

Students review the lecture contents by the next time. Students submit a report after the lecture.

成績評価の基準と方法 Grading System

Active class participation and reports
The attendance rate must be over 70% to be qualified to be graded.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

This course will be provided as part of the Hokkaido Summer Institute., For more information (invited lecturers, course details, etc.), please visit the website below:, https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G046

研究室のホームページ Websites of Laboratory

https://biosynchem.eng.hokudai.ac.jp/

備考 Additional Information

科目名 Course Title	分子材料化学特論[Molecular Materials Chemistry]		
講義題目 Subtitle			
責任教員 Instructor	磯野　拓也 [ISONO Takuya] (大学院工学研究院)		
担当教員 Other Instructors	LI FENG (工学研究院)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094066
期間 Semester	Fall	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 5182		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Polymer synthesis, architectural polymers, functional polymers, environmentally benign polymers

授業の目標 Course Objectives

Polymer materials are used in various fields from general-purpose to specialized applications, and the polymer properties are basically optimized by controlling the molecular weight, monomer composition, and so on for each application. However, especially in the cutting-edge fields, novel polymer materials having properties that are difficult to achieve at the same time are required, and the material design requirements are becoming much severe. Therefore, it is not easy to meet the demands from the modern society only with the material design guidelines based on the conventional knowledge. The goal of this courses to quire how to create novel polymer materials through learning various polymer materials, such block copolymers, architectural polymers, and environment-friendly polymers, from the perspective of their synthesis, structure, function, and application based on actual examples.

到達目標 Course Goals

The goal is to acquire methodologies for creating novel polymer materials required by future society through studying the latest topics related to block copolymers, architectural polymers, environment-friendly polymers, and so on.

授業計画 Course Schedule

1. Guidance and introduction
2. Block copolymers
3. Architectural polymers
4. Environment-friendly polymers
5. Functional polymer materials via advanced synthetic strategy
6. Report preparation

準備学習 (予習・復習)等の内容と分量 Homework

Carefully reading handouts distributed in advance, if available.

成績評価の基準と方法 Grading System

Attendance of 70% or more of the number of class hours shall be the condition of the grade evaluation. The grade is evaluated by (1) attitude in the class (20%) and (2) the report assignments (80%).
To pass, students must earn at least 60 points out of 100 points.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

特に指定はない。授業時に資料を配付する。
Reference materials will be distributed as necessary.

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

https://poly-ac.eng.hokudai.ac.jp/index_e.html

備考 Additional Information

科目名 Course Title	化学計測学特論[Instrumentation Chemistry]		
講義題目 Subtitle			
責任教員 Instructor	長谷川　靖哉 [HASEGAWA Yasuchika] (大学院工学研究院)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094067
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 5191		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Chemical Information, elemental analysis, conditional analysis, structural analysis in nano- and micro-area.

授業の目標 Course Objectives

Grounding in physical, organic and inorganic chemistry.
In this course, instrumentation chemistry containing elemental analysis, configurational analysis, structural analysis in nano- and micro-area are introduced. Based on their studies, students learn fundamental knowledges and various information about chemical analysis of organic and inorganic materials.

到達目標 Course Goals

Students learn principle, variety and characterization of instrumentation chemistry for material analysis. Based on instrumentation chemistry containing elemental analysis, configurational analysis, structural analysis in nano- and micro-area, students make the most of their knowledges for construction of their chemical research.

授業計画 Course Schedule

1-2. introduction of instrumentation chemistry: importance for structural analysis on the material surface, classification of chemical instruments, grounding in high vacuum engineering
3. configurational analysis (TEM, SEM, AFM, STM)
4. elemental analysis (AES, EPMA, XPS, XRF)
5. structural analysis (XRD, EXAFS, HEED, LEED, SAXS)
6. photo-physical analysis (UV-Vis absorption spectra, fluorescence and phosphorescence spectra, emission lifetime, Raman spectra)
7. MS spectral analysis (EI-MS, CI-MS, ESI-MS, MALDI-MS, SIMS)
8. examination

準備学習（予習・復習）等の内容と分量 Homework

Pre-examination for review of instrumentation chemistry

成績評価の基準と方法 Grading System

The attendance rate must be over 70% to be qualified to take the final exam. Evaluations will be made based on (1) learning attitude (20%), (2) exercise (10%), (3) final examination scores (70%).

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

This course will be provided as part of the Hokkaido Summer Institute., For more information (invited lecturers, course details, etc.), please visit the website below:, https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G051

研究室のホームページ Websites of Laboratory

https://www.eng.hokudai.ac.jp/labo/amc/en/index.html

備考 Additional Information

科目名 Course Title	科学倫理安全特論[Advanced Ethics and Safety for Science and Engineering]		
講義題目 Subtitle			
責任教員 Instructor	松本　謙一郎 [MATSUMOTO Kenichiro] (大学院工学研究院)		
担当教員 Other Instructors	中川　浩行 (京都大学)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094068
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 5210		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Engineering Ethics, Safety Engineering

授業の目標 Course Objectives

Students will learn fundamentals of ethics and safety engineering for scientists and engineers. In the ethics education, students will understand the influences and effects of science and technology on society and nature, and the responsibilities that scientists and engineers owes to the society. In safety education, students will learn risk avoidance, safety related laws and process safety design methods, through various examples. By understanding these, students will deepen the knowledge to take responsible judgments and actions, that are essential to be a self-independent scientist or engineer.

到達目標 Course Goals

By taking this course, students will be expected to

1. understand procedure to improve a process with consideration of safty, when a proces technology is introduced to the society to enrich the human society.
2. undestand ethics and morals as a scientist or engineer.

授業計画 Course Schedule

1. Basis of engineering ethics (2 periods)

Learn the idea of engineering ethics and role of scientists and engineers. Understand technique and structure for taking ethical behavior.

2. Safety engineering and process design (6 periods)

Understand the system of the safety engineering, the hazards caused by handled substances and risk control techniques, and the purpose and outline of safe assessment method.

Learn basis of process safety design.

準備学習 (予習・復習)等の内容と分量 Homework

Lecture materials will be distributed.

One credit for a lecture is given for 45 hours of study. Since the actual lecture is 90 minutes (counted as 2 hours) × 8 periods = 16 hours, the credit acquisition requires about 4 hours review per period. Keep in mind this point and review the lecture using the lecture materials.

成績評価の基準と方法 Grading System

For grade evaluation, students are required to attend all.

Grade will be evaluated by the degree of accomplishment based on the submitted assignment.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

備考 Additional Information

Students who already got a credit of "Engineer ethics and safety" of Department of Applied Science and Engineering cannot take this lecture.

科目名 Course Title	総合化学実験指導法[Laboratory Exercise in Chemical Sciences and Engineering II]		
講義題目 Subtitle			
責任教員 Instructor	総合化学院代議員 (大学院総合化学院)		
担当教員 Other Instructors	Provided by supervisor		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	
期間 Semester	Full Year	**単位数 Number of Credits**	2
授業形態 Type of Class	Experiment	**対象年次 Year of Eligible Student**	1～2
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 5302		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Teaching skills: teaching assistant

授業の目標 Course Objectives

Graduate students are requested to teach undergraduate-level laboratory experiments. This course examines how to gain teaching abilities and skills in conducting chemical experiments.

到達目標 Course Goals

Through the course, the students will be able to gain proper abilities and skills to teach undergraduate-level chemical experiments.

授業計画 Course Schedule

On the basis of evaluation of student's achievements, the course offers on-the-job-training to

- gain fundamental principle/knowledge on a given chemical experiment and abilities/skills to operate/conduct the experiment
- gain teaching abilities/skills to undergraduate-level students
- play leadership in teaching and laboratory experiments

準備学習 (予習・復習)等の内容と分量 Homework

Daily preparatory works for teaching

成績評価の基準と方法 Grading System

Evaluate based on daily achievements (50%) and seasonal reports (50%)

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

備考 Additional Information

Register this course at the semester of graduation.

科目名 Course Title	総合化学実験研究法[Laboratory Exercise in Chemical Sciences and Engineering III]		
講義題目 Subtitle			
責任教員 Instructor	総合化学院代議員 (大学院総合化学院)		
担当教員 Other Instructors	Provided by supervisor		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	
期間 Semester	Full Year	**単位数 Number of Credits**	2
授業形態 Type of Class	Seminar	**対象年次 Year of Eligible Student**	1～2
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 5312		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Experimental skills: Teaching skills: Presentation skills

授業の目標 Course Objectives

Students are requested to gain proper knowledges and experiences on various chemical experiments and to manage his/her scientific research. This course examines how to manage various chemical research and to present student's achievements in both Japanese and English.

到達目標 Course Goals

Through the course, students will be able to

- gain experimental and presentation skills/abilities
- play leadership in research works

授業計画 Course Schedule

On the basis of evaluating student's achievements, the course offers the on-the-job-training to

- understand fundamental principles of chemical experiments
- gain experiences in chemical experiments
- gain presentation abilities/skills in both Japanese and English
- play leadership in each research fields

準備学習 (予習・復習)等の内容と分量 Homework

Daily preparatory works on laboratory experiments

成績評価の基準と方法 Grading System

Evaluate based on daily achievements (50%) and seasonal reports (50%)

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

備考 Additional Information

Register this course at the semester of graduation.

科目名 Course Title	分子化学(先端物理化学)[Molecular Chemistry (Advanced Physical Chemistry)]		
講義題目 Subtitle			
責任教員 Instructor	村越　敬 [MURAKOSHI Kei] (大学院理学研究院)		
担当教員 Other Instructors	FUKUSHIMA Tomohiro (理学研究院)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094101
期間 Semester	Fall	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELMOL 6002		
補足事項 Other Information			
授業実施方式 Class Method	2 対面授業科目《一部遠隔》		

キーワード Key Words

Electronic structures, Surface electronic structure, Surface morphology, Surface spectroscopy, Catalysis

授業の目標 Course Objectives

Physical and chemical phenomena such as adsorption and catalytic reaction occur at the solid surface due to the interaction between molecules and solids. Learn basic knowledge and latest research to understand these fundamental chemical properties.

到達目標 Course Goals

Understand the intermolecular force and the structure and electronic state of the solid surface. Understand the origin of the unique physical properties of the surface / interface. In addition, we also acquire basic knowledge on advanced nanostructure analysis methods to understand surface science from physicochemical point of view.

授業計画 Course Schedule

(1) Structure and electronic state of solid surface
(2) Foundations of atomic and intermolecular forces
(3) Outline of the latest surface / interface evaluation method (atomic force microscope, scanning tunneling microscope, etc.)

準備学習 (予習・復習)等の内容と分量 Homework

Homework will be handed out in the class.

成績評価の基準と方法 Grading System

Grading will be evaluated based on attendance and homeworks.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

https://wwwchem.sci.hokudai.ac.jp/~pc/en/

備考 Additional Information

科目名 Course Title	分子化学(有機構造化学特論)[Molecular Chemistry (Structural and Physical Organic Chemistry)]		
講義題目 Subtitle			
責任教員 Instructor	鈴木 孝紀 [SUZUKI Takanori] (大学院理学研究院)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094102
期間 Semester	Winter	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELMOL 6000		
補足事項 Other Information			
授業実施方式 Class Method	4 遠隔授業科目《遠隔のみ》		

キーワード Key Words

Structural Organic Chemistry

授業の目標 Course Objectives

Various functions of materials can be derived by proper designing organic pi-electron systems. This course will provide students with the two of the important concepts which are necessary to comprehend this area of organic chemistry.

到達目標 Course Goals

Students will learn the background and basic idea to understand the various intriguing phenomena in the functionalized organic pi-electron systems/organic solids.

授業計画 Course Schedule

Two major topic are as follows:

1) "Disappearance of polymorphs": Intriguing behavior of crystallizaion, rapid/reluctant phase transition of crystalline materials

2) "Orbital interaction through bonds/through space": extremely long C-C bond, X-ray structural analysis, theoretically optimized structure

The class instruction will be done in Japanese.

準備学習(予習・復習)等の内容と分量 Homework

Printed material will be handed out in the class

成績評価の基準と方法 Grading System

Presentations and reports

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

構造有機化学　基礎から物性へのアプローチまで／中筋　一弘:東京化学同人, 2020

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	分子化学(高分子機能科学)[Molecular Chemistry (Macromolecular Science)]		
講義題目 Subtitle			
責任教員 Instructor	中野　環 [NAKANO Tamaki] (触媒科学研究所)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094103
期間 Semester	Spring	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELMOL 6002		
補足事項 Other Information			
授業実施方式 Class Method	2 対面授業科目《一部遠隔》		

キーワード Key Words

Polymer, Stereochemistry, Stereoregular, Conformation, Optically Active, Chirality, Helix

授業の目標 Course Objectives

Synthesis, structure, and functions of various polymers will be introduced. A focus will be on polymer chirality. Aiming to understand the basic and advanced concepts of polymer stereochemistry, we will discuss examples of polymers and related small molecules.

到達目標 Course Goals

Students aim to learn basic and advanced concepts of synthesis, structure, and properties of polymers. In addition, they understand concepts of general chirality, extend their understanding to polymer chirality, and obtain in-depth insights into the relation between chiral functions and chiral structures of polymers.

授業計画 Course Schedule

Beginning from the basis aspects of polymer synthesis and its classification, we discuss polymer structure and functions with an emphasis on chirality. The planned contents are as follows:

1. Basics of polymer science (1)
2. History of polymer science (1)
3. Polymer structure: structural features unique to polymers such as mola mass dispersity, tacticity (stereoregularity), and helicity. Nomenclature, classification, and analytical methodologies (2)
4. Synthesis of chiral polymers: asymmetric polymerization (2)
5. Functions of chiral polymers: structure-property relations (2)

準備学習 (予習・復習)等の内容と分量 Homework

Students are asked to read through literature relevant to polymer synthesis and polymer chirality and summarize the points that they wish to discuss in the class. After each class, they are asked to find and read journal articles that are related to the contents of class teaching and discussions.

成績評価の基準と方法 Grading System

Evaluation will be conducted based on report papers submitted after all planned class teaching is finished and also on attitude toward learning.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

Polymer Chemistry: An Introduction (3rd Ed.)／Malcom P. Stevens：Oxford, 1999
高分子化学入門／蒲池幹治：NTS, 2009
大学院高分子科学／野瀬卓平、中浜精一、宮田清蔵：講談社, 1997

講義指定図書 Reading List

pi-Stacked Polymers and Molecules／T. Nakano Ed.：Springer, 2014
Stereochemistry of Organic Compounds／E. L. Eliel, S. H. Wilen：Wiley, 1994
NMR Spectroscopy of Polymers／K. Hatada, T. Kitayama：Springer, 2004
Macromolecular Design of Polymeric Materials／K. Hatada, T. Kitayama, O. Vogl：Dekker, 1997
Protein Structure and Function／G. A. Petsko, D. Ringe：New Science Press, 2004
Circular Dichroism／N. Berova, K. Nakahishi, R. W. Woody：Wiley-VCH, 2000

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

https://polymer.cat.hokudai.ac.jp/index-e.html

備考 Additional Information

科目名 Course Title	分子化学(触媒理論)[Molecular Chemistry (Catalysis Theory)]		
講義題目 Subtitle			
責任教員 Instructor	長谷川　淳也 [HASEGAWA Junya] (触媒科学研究所)		
担当教員 Other Instructors	IIDA Kenji (触媒科学研究所), SHROTRI Abhijit (触媒科学研究所), MIYAZAKI Ray (触媒科学研究所)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094104
期間 Semester	Winter	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELMOL 6002		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Catalysis, Catalytic chemistry, Theoretical and computational chemistry of catalysis

授業の目標 Course Objectives

Catalysts are key materials for the effective utilization of resources and energy and for the resolution of environmental issues. On the other hand, the challenge is in the difficulty in developing catalysts and controlling catalytic reactions due to the various complexities such as active site structure, components of reactions, reaction mechanism, reaction mode, etc. In this lecture, you will learn about methods for understanding basic catalytic phenomena using theoretical and computational chemistry. Although solid catalysts are mainly dealt with, we will theoretically consider the general catalytic principles including molecular catalysis and biocatalysis.

到達目標 Course Goals

By the end of this course, you are able to apply your theoretical perspective to the catalytic phenomena. Specifically, you can theoretically recognize the energetics, kinetics, equilibrium, electronic theory, and properties of catalyst materials of catalytic phenomena. In addition, students understand theoretical calculation approaches that are useful for developing catalyst materials to optimize catalytic reactions. On the other hand, you will gain deeper knowledges through the presentations and question-and-answer sessions in a round lecture format.

授業計画 Course Schedule

Students read through an English textbook to learn the basics of catalyst theory. This course will be held in a round lecture format. Each student summarize the content and give a presentation. Teachers give additional explanation and supplements. The specific contents are as follows.

Part 1 Introduction, potential energy diagrams: Adsorption, reaction, diffusion, surface dependence (chapters 1 and 2)

Part 2 Chemical equilibrium on surfaces: Adsorption isotherms, free energy diagrams (chapter 3)

Part 3 Rate constant: Time scale of chemical reactions, transition state theory (Chapter 4)

Part 4 Kinetics: Microscopic kinetics, application to ammonia synthesis reaction (Chapter 5)

Part 5 Energy trends in catalysis, mapping of catalytic activity: Scaling relationships, activity maps, selectivity maps, Sabatier analysis (chapters 6 and 7)

Part 6 Electronic factors: band structure, d-band model, relation between reaction and electronic structure, ensemble effect, ligand effect (chapters 8 and 12)

Part 7 Catalyst structure, catalyst poisons and promoters: Structure of real catalysts, poisoning and promotion of catalysts (chapters 9 and 10)

Part 8 Surface Electrocatalysis: Solid-electrolyte interface, interfacial electron transfer, hydrogen electrode model, potential dependence of rate, overpotential, limiting potential (Chapter 11)

準備学習（予習・復習）等の内容と分量 Homework

Read the relevant sections of the textbook for each class in advance to acquire an overview of the knowledge required for discussion. Create a presentation file summarizing the content for the part you are responsible for, print out copies for each person, and present using a computer. One or two practice problems from the textbook may be assigned as a review.

成績評価の基準と方法 Grading System

The learning achievement will be evaluated comprehensively based on (1)presentation (levels of presentation skill, logic, comprehension, etc.) , (2) discussion (positivity and quality of comments, etc), and (3) learning attitude.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

Fundamental Concepts in Heterogeneous Catalysis／Jens K. Nørskov, Felix Studt, Frank Abild-Pedersen, Thomas Bligaard: Wiley, 2014

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

https://www.cat.hokudai.ac.jp/hasegawa/

備考 Additional Information

Basic knowledges of physical chemistry, inorganic chemistry, and organic chemistry are prerequisite for taking this course.

科目名 Course Title	分子化学(光化学)[Molecular Chemistry (Photochemistry)]		
講義題目 Subtitle			
責任教員 Instructor	上野　貢生 [UENO Kosei] (大学院理学研究院)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094105
期間 Semester	Spring	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELMOL 6002		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Electronically Excited State: Fluorescence/Phosphorescence: Nonradiative Processes: Photophysical Processes: Photochemical Reactions: Spectroscopy

授業の目標 Course Objectives

Characteristics of the excited state of molecules and the physicochemical processes from the excited states which are the basis of photochemistry of organic molecules are studied.

到達目標 Course Goals

Characteristics of photochemical reactions and physicochemical phenomena are studied by learning the nature of the electronically excited state of the molecules and various physicochemical processes from the excited states. Principles and usage of related spectroscopy are also learned.

授業計画 Course Schedule

This course describes photochemical and photophysical processes of organic compounds. Fundamental background of photochemical experiments is also described. The main topics of the course is as follows.
1) Photochemistry in chemistry 2) Excited singlet and triplet states 3) Radiative (fluorescence/phosphorescence) and nonradiative processes (internal conversion/intersystem crossing) 4) Characteristics of absorption and emission (fluorescence/phosphorescence) spectra and physicochemical information obtained from spectrum measurements 5) Spectroscopic measurement methods: emission spectrum, emission yield, lifetime, and dynamics of photochemical processes 6) Photochemical reactions 7) Photo-induced electron transfer 8) State-of-the-art of photochemical researches

準備学習 (予習・復習)等の内容と分量 Homework

It is desirable to take basic courses on physical chemistry and instrumental methods in analytical chemistry at the undergraduate school.

成績評価の基準と方法 Grading System

Assignments in classes (30 %), attitude to learning in classes (20 %), and term-end report (homework) (50 %)

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

https://wwwchem.sci.hokudai.ac.jp/~bunseki/

備考 Additional Information

Recommended textbook 1) "Principles of Molecular Photochemistry: An Introduction", N. J. Turro et al., University Science Books, 2009. 2)「光化学 I」, 井上晴夫他著, 丸善, 1999.

科目名 Course Title	分子化学(化学反応創成学特論)[Molecular Chemistry (Advanced Chemical Reaction Design and Discovery)]		
講義題目 Subtitle			
責任教員 Instructor	陳　旻究 [JIN Mingoo] (創成研究機構化学反応創成研究拠点)		
担当教員 Other Instructors	Min Gao (ICReDD), HUANG Chung-Yang (ICReDD), SIDOROV Pavel (ICReDD), AKAMA Tomoko (ICReDD), LIST Benjamin (ICReDD)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094106
期間 Semester	Fall	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELMOL 6201		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Design of Chemical reaction and molecular assembly with functions, Chemoinformatics, Computational Chemistry

授業の目標 Course Objectives

This course introduces a brand-new research way for investigating molecular chemistry. Especially, advanced examples of the design of new chemical reactions and molecular assembly systems with photo-physical functions will be gently introduced, and the methodology for these research subjects will be described. Also, the advanced level of computational chemistry and chemoinformatics to solve chemical problems will be introduced. Totally four sessions will be delivered to introduce these contents.

1. Advanced course: Introducing Photocontrol to Molecular Systems:
In these lectures, we will describe technologies that allow researchers to control the molecular systems by light and photochemical methods. Specifically, the course will focus on photoredox catalysis and photoswitches.

2. Design of Molecular Dynamics in Crystals and Evaluation Methodology:
In this session, molecular dynamics in crystalline media will be described with recent research. Especially, crystalline molecular rotors system will be focused as well as how to investigate the molecular motion in solid state.

3. Chemoinformatics in advanced topics:
The class covers the advanced topics in the field of chemoinformatics. Chemoinformatics provides useful tools for chemical search, rational design of compounds with desired properties, synthesis prediction, etc. This part is dedicated to topics such as representation of chemical reactions and modeling their properties, as well as current machine learning techniques, focusing on Deep Learning.

4. Advanced Course for Computational Catalysis
The lectures related to advanced computational catalysis are aimed to deeply understand how does the computational chemistry establish catalytic concept and how computational results explain experimental phenomena of catalytic reactions.

到達目標 Course Goals

The main goal of this course is ″Knowing the molecular chemistry research fields with experimental and computational methodologies″.
Especially, students will know ″the photoredox catalysis and photoswitches on molecular system″, ″the basic ideas to design molecular dynamics in crystal″, ″Chemical reaction in Chemoinformatics with current machine learning techniques″ and ″Applications in Computational Catalysis″.

授業計画 Course Schedule

The entire course contains four sessions as below;

1. Advanced course: Introducing Photocontrol to Molecular Systems:
- Photoredox Catalysis
- Photoswitches

2. Design of Molecular Dynamics in Crystals and Evaluation Methodology:
- General Introduction of Crystalline Molecular Rotors and Structural Design
- Application and Evaluation for the Molecular Motions in solid state

3. Chemoinformatics in advanced topics:
- Chemical reactions in Chemoinformatics;

・ Current machine learning techniques.

4. Advanced Course for Computational Catalysis:
・ Applications in Computational Catalysis
・ Challenges in Computational Catalysis

準備学習（予習・復習）等の内容と分量 Homework

Basic knowledge of chemistry at the undergraduate level might be required. And, the students who got the introduction course (化学反応創成学入門: CHEM_ELCOM 5271) would be encouraged to have this advanced course to boost their skills.

成績評価の基準と方法 Grading System

We will give a take-home exam with several open-answer questions for each session, that students have to submit before some deadline.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

https://www.icredd.hokudai.ac.jp/all-members/the-huang-lab
https://www.icredd.hokudai.ac.jp/the-jin-group
https://www.icredd.hokudai.ac.jp/the-sidorov-group
https://www.icredd.hokudai.ac.jp/the-gao-group

備考 Additional Information

科目名 Course Title	分子化学A(分子理論化学)[Molecular Chemistry A (Theoretical Chemistry)]		
講義題目 Subtitle			
責任教員 Instructor	武次　徹也 [TAKETSUGU Tetsuya] (大学院理学研究院)		
担当教員 Other Instructors	HASEGAWA Junya (触媒科学研究所), MAEDA Satoshi (理学研究院), IIDA Kenji (触媒科学研究所), KOBAYASHI Masato (理学研究院), IWASA Takeshi (理学研究院), Min Gao (ICReDD), MIYAZAKI Ray (触媒科学研究所)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094107
期間 Semester	Spring/Summer	**単位数 Number of Credits**	2
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELMOL 6012		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Schroedinger equation, molecular orbital, Hartree-Fock theory, multiconfigurational self-consistent field theory, density functional theory, potential energy surface, geometry optimization, intrinsic reaction coordinate, Born-Oppenheimer approximation, Rotational-vibrational state, Reaction dynamics

授業の目標 Course Objectives

This course aims to provide elementary ideas and concepts in quantum chemistry. First, the basics of the electronic structure theory will be addressed. Second, potential energy surface will be explained. Third, reaction-path-based dynamics, molecular vibrational theory, reaction dynamics, and theoretical approaches to condensed phases will be given to learn the methodology in modern computational chemistry.

到達目標 Course Goals

Students are expected to understand the basic concepts in electronic structure theory, such as Schroedinger equation, wave function, molecular orbital, angular momentum, Hartree-Fock theory, multi-configurational self-consistent field theory, density functional theory. Students are also expected to achieve the basic ideas on the potential energy surface to understand the mechanism of chemical reactions and reaction dynamics, such as potential energy surface, geometry optimization, intrinsic reaction coordinate, and reaction path dynamics. As a result, students understand

1. Scientific papers that describes quantum chemical computations of electronic structures and chemical reactions
2. Knowledges to design, perform, and understand the result of quantum chemical calculations

授業計画 Course Schedule

1. Schroedinger equation, Hydrogen atom, Angular momentum
2. Slater determinant, Molecular orbitals
3. Hartree-Fock theory
4. Electron correlations, Density functional theory
5. Potential energy surface, Vibrational analysis, Geometry optimization
6. Transition state, Intrinsic reaction coordinate
7. Born-Oppenheimer approximation
8. Theory of molecular vibration and rotation
9. Reaction Path dynamics
10. Transition state theory
11. Ab initio Molecular dynamics approach

準備学習 (予習・復習)等の内容と分量 Homework

Students are expected to derivate the equations introduced in the class and to solve some exercises.

成績評価の基準と方法 Grading System

The attitude at the lecture (30%) and report scores (70%) are evaluated.

テキスト・教科書 Textbooks

講義指定図書 Reading List

分子理論の展開／永瀬茂、平尾公彦:岩波書店, 2002
新版 すぐできる　量子化学計算ビギナーズマニュアル／平尾公彦(監修)、武次徹也(編集):講談社サイエンティフィク, 2015

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	分子化学A(有機金属化学)[Molecular Chemistry A (Organometallic Chemistry)]		
講義題目 Subtitle			
責任教員 Instructor	澤村　正也 [SAWAMURA Masaya] (大学院理学研究院)		
担当教員 Other Instructors	ITOH Hajime (工学研究院), SHIMIZU Yohei (理学研究院)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094108
期間 Semester	Spring/Summer	**単位数 Number of Credits**	2
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELMOL 6212		
補足事項 Other Information			
授業実施方式 Class Method	2 対面授業科目《一部遠隔》		

キーワード Key Words

Organometallic Chemistry, Catalysts for Organic Synthesis, Design of Reactions, Mechanisms of Organometallic Reactions, Structures of Organometallic Complexes, Asymmetric Synthesis, Hydrogenation, Cross-coupling

授業の目標 Course Objectives

Spring Term: Objectives of this course is to acquire the basis for designing new metal-catalyzed organic reactions. To this end, students learn that organometallic chemistry is playing important roles to solve problems in synthetic organic chemistry in various aspects and gain a systematic understanding on how organometallic complexes participate in organic reactions.
Summer Term: This course is intended to familiarize the student with advanced concepts in organometallic chemistry. This course mainly focuses on the organic synthetic reactions where the transition-metal-catalyzed process is a key step.

到達目標 Course Goals

Spring Term: The goal of this course is understand various modes of metal?carbon bonds and their reactivities in a systematic way based on molecular orbital considerations.
Summer Term: The goal of this course is to provide graduate students with comprehensive understandings of organometallic chemistry. Students will be familiar with various transition-metal-catalyzed reactions, reaction mechanisms, application of catalysis, basic concept of catalyst design.

授業計画 Course Schedule

Spring Term: The course goes forward along the recommended reading (Hegedus, Chapter 1, Chapter 2, Chapter 9).
Summer Term:
1. Synthetic Applications of Transition Metal Hydrides I
2. Synthetic Applications of Transition Metal Hydrides II
3. Synthetic Applications of Complexes Containing Metal-Carbon sigma-Bonds I
4. Synthetic Applications of Complexes Containing Metal-Carbon sigma-Bonds II
5. Synthetic Applications of Complexes Containing Metal-Carbon sigma-Bonds III
6. Synthetic Applications of Transition Metal Carbene Complexes
7. Synthetic Applications of Transition Metal Carbene Complexes II

準備学習 (予習・復習)等の内容と分量 Homework

Students will be expected to have read the assigned materials prior to each class period.

成績評価の基準と方法 Grading System

Attendence rate over 70% is mandatory.
Spring Term: Evaluation is performed based on the score of final exam.
Summer Term: Midterm (30%) and final exam (70%).

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

ヘゲダス遷移金属による有機合成　第3版／L. S. Hegedus 著・村井真二訳：東京化学同人, 2011

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

https://wwwchem.sci.hokudai.ac.jp/~orgmet/index.php?id=25
https://itogrouphp.eng.hokudai.ac.jp/en.html
https://www.icredd.hokudai.ac.jp

備考 Additional Information

It is advisable to take all lectures and experiments on organic chemistry in the undergraduate study.
Moodle in ELMS will be used in case of distance learning.

科目名 Course Title	応用分子化学(化学エネルギー変換)[Applied Molecular Chemistry (Chemical Energy Conversion)]		
講義題目 Subtitle			
責任教員 Instructor	坪内 直人 [TSUBOUCHI Naoto] (大学院工学研究院)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094109
期間 Semester	Winter	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELMOL 6102		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Material Balance, Enthalpy Balance, Chemical Equilibrium, Reaction Rate, Combustion, Steam Reforming, Energy Efficiency, Cold Gas Efficiency, Heat Loss

授業の目標 Course Objectives

About 80% of total primary energy supply depends on oil, coal and natural gas, and this dependency will be almost unchanged in the not-too-distant future according to a recent IEA (International Energy Agency) world energy outlook. It is thus probable that ultimately-efficient utilization of fossil fuels is the best way to reduce CO2 emissions in a carbon-constrained economy. This course will provide students with basic theories about chemical energy conversion systems of organic resources through the designing of an adiabatic fixed bed reformer for methane steam reforming.

到達目標 Course Goals

・Understand the fundamentals of chemical reaction engineering, such as material balance, enthalpy balance, chemical equilibrium and reaction rate.
・Eluciate methane steam reforming in a fixed bed reformer at adiabatic conditions.

All students are also required to present and discuss their own research subjects from a view of reactor designing.

授業計画 Course Schedule

1. Fundamentals of chemical reactor theory: Material balance calculation method
2. Fundamentals of chemical reactor theory: Enthalpy balance calculation method
3. Fundamentals of chemical reactor theory: Chemical equilibrium calculation method
4. Fundamentals of chemical reactor theory: Reaction rate calculation method
5. Simulation of properties of an adiabatic fixed bed reformer: Steam reforming and combustion of methane
6. Simulator development: Homogeneous gas phase reaction, gas-solid reaction, gas-solid catalytic reaction

準備学習 (予習・復習)等の内容と分量 Homework

Students are expected to read relevant contents in the text beforehand. After class, students are also requested to understand the lecture by reading additionally the related bibliography and solving problems provided there.

成績評価の基準と方法 Grading System

Grades are awarded based on regular assignments, presentation and discussion in the class.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

教科書は特に指定せず, Lecture 時にプリントを配布する。
Handout made by the instructor will be delivered.

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

https://chemeng-hokudai.jp/en/

備考 Additional Information

Students are required to understand the basic knowledge of related Chemical Engineering Stoichiometry, Thermodynamics and Reaction Kinetics in advance.

科目名 Course Title	応用分子化学(分離プロセス工学Ⅰ)[Applied Molecular Chemistry (Separation Process Engineering I)]		
講義題目 Subtitle			
責任教員 Instructor	向井 紳 [MUKAI Shin] (大学院工学研究院)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094110
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELMOL 6101		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Porous Materials, Adsorption

授業の目標 Course Objectives

In this course, you can learn the basic principles of separation processes with a particular focus on processes using porous materials such as adsorption.

到達目標 Course Goals

By the end of this course, a successful learner will:
1. Understand the mechanisms which cause adsorption
2. Understand methods to obtain adsorption isotherms, and become able to describe the characteristics of the material from its isotherm
3. Understand general adsorption theories and adsorption equations, and become able to analyze adsorption isotherms using them

授業計画 Course Schedule

This course will be held as an in-person class at Sapporo Campus.

1. Overview of Adsorption Phenomena and Adsorbents
2. Adsorption Phenomena
3. Typical Adsorbents and Their Production Processes
4. Adsorption Mechanisms
5. Adsorption Isotherms
6. Adsorption Theories and Adsorption Equations (Henry Equation, Freundlich Equation, Langmuir Equation)
7. Adsorption Theories and Adsorption Equations (BET Equation)
8. Examination

準備学習（予習・復習）等の内容と分量 Homework

Students are encouraged to read relevant materials ahead of time and review what they have been taught, especially the contents of quizzes after classes to deepen their understanding.

成績評価の基準と方法 Grading System

The attendance rate must be over 70% to be qualified to take the final project. Evaluations will be made based on (1) learning attitude (20%), (2) quiz scores (20%) and final examination scores (60%). Quizzes will be used to evaluate the level of understanding of each class and examinations will be used to evaluate the achievement level of this course.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

This course will be provided as part of the Hokkaido Summer Institute., For more information (invited lecturers, course details, etc.), please visit the website below:, https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G059

研究室のホームページ Websites of Laboratory

備考 Additional Information

Prerequisite courses include undergraduate-level mathematics, transport phenomena, thermodynamics, statistical thermodynamics, and separation process

科目名 Course Title	応用分子化学(分離プロセス工学Ⅱ)[Applied Molecular Chemistry (Separation Process Engineering II)]		
講義題目 Subtitle			
責任教員 Instructor	荻野 勲 [OGINO Isao] (大学院工学研究院)		
担当教員 Other Instructors	Ron C. Runnebaum (University of California, Davis)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094111
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELMOL 6101		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Porous Materials, Adsorption, Membrane Separation, Chromatography

授業の目標 Course Objectives

To understand the basic principles of separation processes with a particular focus on processes using porous materials such as adsorption and membrane separation.

到達目標 Course Goals

1. Understand the roles of separation operation in industrial processes
2. Understand the classification of separation processes in terms of rate and equilibrium
3. Deepen understanding on thermodynamics and transport phenomena relevant to the design of separation processes
4. Understand the fundamental principles of industrial adsorption and membrane separation processes and perform basic design of these processes
5. Perform the basic design of devices and products equipped with adsorption and membrane-separation functions

授業計画 Course Schedule

1. Roles of industrial separation processes
2. Thermodynamics and transport phenomena relevant to separation processes
3. Adsorption process
4. Case study 1
5. Case study 2
6. Membrane separation process
7. Case study 3
8. Project

準備学習(予習・復習)等の内容と分量 Homework

Students are encouraged to read the textbook and relevant materials ahead of time. Students are required to submit assigned homework.

成績評価の基準と方法 Grading System

Students must maintain a 70% attendance rate or higher to be eligible for the final project. Evaluations will be performed using three factors: learning attitude (20%), which includes engagement and participation, assignment scores (30%), which assess understanding of class material and separation principles, and the final project score (50%), which evaluates practical application of skills learned.

テキスト・教科書 Textbooks

1. Separation Process Principles: With Applications Using Process Simulators, 4th Edition／J. D. Seader, Ernest J. Henley, D. Keith Roper：John Wiley & Sons, Inc., 2016
2. Product and Process Design Principles: Synthesis, Analysis and Evaluation, 4th Edition／Warren D. Seider, Daniel R. Lewin, J. D. Seader, Soemantri Widagdo, Rafiqul Gani, Ka Ming Ng：Wiley, 2016

講義指定図書 Reading List

現代化学工学／橋本健治、荻野文丸 編：産業図書, 2001

参照ホームページ Websites

This course will be provided as part of the Hokkaido Summer Institute., For more information (invited lecturers, course details, etc.), please visit the website below:, https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G060

備考 Additional Information

Prerequisite courses include undergraduate-level mathematics, transport phenomena, thermodynamics, statistical thermodynamics, and separation process

It is desirable for students to be able to understand numerical methods to solve differential equations.

科目名 Course Title	応用分子化学A(触媒設計)[Applied Molecular Chemistry A (Catalyst Design)]		
講義題目 Subtitle			
責任教員 Instructor	清水　研一 [SHIMIZU Kenichi] (触媒科学研究所)		
担当教員 Other Instructors	TOYAO Takashi (触媒科学研究所)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094112
期間 Semester	Fall/Winter	**単位数 Number of Credits**	2
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELMOL 6112		
補足事項 Other Information			
授業実施方式 Class Method	3 遠隔授業科目《一部対面》		

キーワード Key Words

Catalysis, surface chemistry, environmental catalysis, kinetics, industrial chemistry

授業の目標 Course Objectives

To understand recent research on the mechanism and design concept of heterogeneous catalysts, students should understand surface spectroscopy and physical chemistry. The goal of this lecture is to understand spectroscopy, kinetics and thermodynamics in terms of catalysis and use these basic knowledge for catalyst design and catalysis research. In addition, we discuss design concept and practical role of heterogeneous catalysis in current catalytic processes for automotive emission control and organic synthesis.

到達目標 Course Goals

Exercises for understanding spectroscopy, kinetics and thermodynamics in terms of catalysis. Application of the knowledge to understand recent catalytic research and presentation on it. We will also learn important catalytic processes in petroleum refining, petrochemical industry, and emission control. In the presentation, students explain the role of the catalysis in the energy and environment technologies. Presentation techniques of students will be improved.

授業計画 Course Schedule

1. Geometry of solid surface
2. Evaluation of catalytic activity
3. Characterization of catalyst I
4. Characterization of catalyst II
5. Design of solid catalyst
6. Catalyst preparation
7. Computational chemistry for catalysis
8. Intermediate exam
9. Environmental catalysis
10. Catalysis for fossil fuel conversions
11. Catalysis for industrial production of chemicals
12. Catalysis for green chemistry
13. Presentation
14. Presentation
15. Final exam

準備学習 (予習・復習)等の内容と分量 Homework

For the former-half lectures, PDF files to be used in the lectures are uploaded in ELMS prior to each lecture. Attendee must print and bring it for each lecture. Students should understand basic physical chemistry, reading textbooks. Using scientific electronic calculator, students' laptop, they solve kinetic problems, draw solid surface and create a presentation file.

成績評価の基準と方法 Grading System

Intermediate exam (50%), final exam (20%), the number of questions in the latter-half (30%)

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

https://www.cat.hokudai.ac.jp/shimizu/

備考 Additional Information

科目名 Course Title	物質化学(固体物性化学)[Materials Chemistry (Organic Solid State Chemistry)]		
講義題目 Subtitle			
責任教員 Instructor	原田　潤 [HARADA Jun] (大学院理学研究院)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094201
期間 Semester	Spring	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELMAT 6000		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

molecular materials, crystal structures, symmetry, intermolecular interactions, charge-transfer interactions, hydrogen bonding, band structures, electrical conductivity, solid-state reactions, molecular motions

授業の目標 Course Objectives

This course deals with the chemistry of solid-state materials, which are aggregates of molecules and atoms. In this course, you can learn the relationship between intermolecular interactions and the structures/functions/physical properties of molecular crystals. You can also learn how crystal and electronic structures of molecular materials are related to their physical properties and how molecular motions and reactions in crystals can be understood in terms of crystal structures.

到達目標 Course Goals

After successful completion of this course, you will be able to

1. Understand the principles by which molecular crystals are constructed.
2. Understand the relationship between structural features of molecular crystals and their physical properties, molecular motions, and reactivities.
3. Acquire basic idea of functional material design: from molecular design to crystal design.

授業計画 Course Schedule

The following topics will be lectured in order:

1. Molecular structures and symmetry of crystals

The relationship between the shapes of molecules and the structure/symmetry of their crystals will be discussed.

2. Intermolecular interactions and molecular arrangements in crystals

The influence of charge-transfer interaction and hydrogen bonding on crystal structures will be discussed. Guidelines for controlling the molecular arrangement will be presented.

3. Electronic structures of molecular crystals

The electronic structures (band structures) of radical crystals will be discussed. Neutral-to-ionic transitions and formal charges of component molecules in charge-transfer complex crystals will be explained.

4. Chemical reactions and molecular motions in crystals

Chemical reactions and molecular motions in crystals will be illustrated and explained in terms of the crystal structures.

準備学習 (予習・復習)等の内容と分量 Homework

You are expected to have basic knowledge of physical chemistry and need to review it beforehand. The lecture materials are available in Moodle in advance. Reports will be assigned.

成績評価の基準と方法 Grading System

Unless there are special circumstances, more than 70% class attendance is required for the grade evaluation. The grade will be evaluated based on the reports assigned during the course.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	物質化学(ナノデバイス材料特論)[Materials Chemistry (Materials for Nanodevice)]		
講義題目 Subtitle			
責任教員 Instructor	松尾　保孝 [MATSUO Yasutaka] (電子科学研究所)		
担当教員 Other Instructors	NAGASHIMA Kazuki (電子科学研究所), YOMOGIDA Yohei (電子科学研究所)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094202
期間 Semester	Summer	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELMAT 6000		
補足事項 Other Information			
授業実施方式 Class Method	2 対面授業科目《一部遠隔》		

キーワード Key Words

Photonics materials, Photonic devices, Subwavelength Optics, Plasmonics, Electronic materials, Electron transport, Charge storage, IoT, energy conversion, sensors.

授業の目標 Course Objectives

The purpose of this lecture is to understand the relationships between functions and structures of several materials and devices. Especially, this lecture focuses on the fabrication and analysis of photonics materials, electronic materials and you will learn photonics and electronics properties and their applications.

到達目標 Course Goals

1. Understanding on he fundamentals of nanophotonics and nanoelectronic devices from the electronic state, fabrication method, property and evaluation of their functions
2. Acquiring basic knowledge of plasmonics and photonics materials such as interaction between photons and electrons, light wave propagation, diffraction, reflection and polarisation control, in order to understand the correlation between structure and function of photonics materials based on oxides and metal-based plasmonics materials
3. Understanding the electron transport properties and interface properties of silicon-based semiconductors and the charge storage properties of dielectrics, mainly oxides, and learning design guidelines from advanced electronic materials and devices

授業計画 Course Schedule

This lecture will review the photonic and electronic materials, the device applications, and the engineering innovations in the advanced information society.
(1) Photonics materials
(2) Fundamentals on refraction, diffraction and interference,
(3) Phtonic devices using diffraction and phase of light and materials supporting them
(4) Plasmonics and its application for analysis
(5) Fundamentals of electronics materials
(6) Fundamentals and evaluation methods for electron transport properties, physical properties of interface and charge storage properties.
(7) Advanced electronics materials and devices
(8) New trends in electronics for IoT, environmental and medical applications

準備学習 (予習・復習)等の内容と分量 Homework

The outline can be understood from the deliverd documents in each lectures.
The report works will be given at end of each section.

成績評価の基準と方法 Grading System

As a general rule, attendance of 70% or more of the lectures is a requirement for the evaluation.
The evaluation is based on the total score of the mini-examination for each lecture.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

半導体デバイス―基礎理論とプロセス技術／S.M. Sze：産業図書
固体の電子構造と化学／P.A. Cox：技報堂出版
物質構造と誘電体入門 (物性科学入門シリーズ)／高重正明：裳華房
はじめての光学 (KS物理専門書)／川田善正：講談社

参照ホームページ Websites

https://www.es.hokudai.ac.jp

研究室のホームページ Websites of Laboratory

https://sites.google.com/view/nagashima-lab/

https://nanostructure.es.hokudai.ac.jp/

備考 Additional Information

When you want to study the fundamental of optics including lens, grating, hologram, or you use optical microscope or laser, feel free to attend this lecture.

科目名 Course Title	物質化学(材料化学)[Materials Chemistry (Introduction to Material Science)]		
講義題目 Subtitle			
責任教員 Instructor	髙橋　啓介 [TAKAHASHI Keisuke] (大学院理学研究院)		
担当教員 Other Instructors	Lauren TAKAHASHI (理学研究院)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094203
期間 Semester	Fall	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELMAT 6002		
補足事項 Other Information			
授業実施方式 Class Method	4 遠隔授業科目《遠隔のみ》		

キーワード Key Words

Data science, machine learning, materials informatics, statistics, visualization

授業の目標 Course Objectives

This course introduces the fundamentals and concepts of Materials Informatics.
The lecture will cover the concept of materials informatics, environment construction for implementation, data preprocessing (data cleansing) for materials and catalyst science data, scientific data visualization and analysis, and supervised and unsupervised learning,
The objective of the course is to gain insight into the design and knowledge extraction of materials and catalysts from data, with a focus on supervised and unsupervised learning.
Data science and technology will deal with the python language, explaining data science and technology that can be started from zero without any programming experience.

到達目標 Course Goals

The goal of the course is to enable students to master basic data science techniques in materials informatics and to be able to design materials and catalysts and extract knowledge from the data.

授業計画 Course Schedule

Lecture 1: Overview of Materials Informatics
Lecture 2 Data and Data Preprocessing
Lecture 3 Data Visualization
Lecture 4 Machine Learning Basics
Lecture 5 Machine Learning 1 Supervised
Lecture 6 Machine Learning 2: Supervised
Lecture 7 Machine Learning 3 Unsupervised
Lecture 8 Examination and Report

準備学習 (予習・復習)等の内容と分量 Homework

Since the mid-term and final exams will focus on the content explained in class, students are encouraged to review the material after class and before the exams.

成績評価の基準と方法 Grading System

Grading will be based on reports.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

An Introduction: Materials Informatics and Catalyst Informatics／Keisuke Takahashi：Springer, 2024
テキスト、参考書使用しない。
No text book in the class.

講義指定図書 Reading List

参照ホームページ Websites

https://www.anaconda.com/, https://pandas.pydata.org/, https://scikit-learn.org/stable/

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	物質化学(現代化学反応理論)[Materials Chemistry (Advanced Chemical Reaction Rate Theory)]		
講義題目 Subtitle			
責任教員 Instructor	小松﨑 民樹 [KOMATSUZAKI Tamiki] (電子科学研究所)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094204
期間 Semester	Winter	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELMAT 6002		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

chemical reactions, nonequilibrium, collective motion, dynamical systems theory, machine learning, AI

授業の目標 Course Objectives

Chemical reactions inevitable for maintaining living systems correspond to the change of rearrangement of atoms constituting molecules. Even though the corresponding scale differs from that of the molecular level at the order of 10^20, the motion of the planets in our universe is also regarded as that of molecules at the same footing. However, because the motions of particles are interacting with each other in complicated fashions nonlinearly, the prediction of the future is apparently almost impossible due to arbitrary small uncertainty at the initial condition. People will understand that mathematical science enables us to provide a special route in the phase space along which one can predict the fate of reactions, and actually is utilized for controlling reactions and designing a route of a spacecraft to travel different plants with the minimum cost.

到達目標 Course Goals

We will understand the motion of particles from the viewpoint of the geometry of the phase space composed of the coordinates and the conjugate momenta of particles. We will understand the history of the development of chemical reaction theories from the viewpoint of not chemistry but Hamiltonian systems, and learn a set of problems forgotten in the history of chemistry. Then, we learn the so-called normal form and that even under the existence of chaos there exists a deterministic regularized route in the phase space. We will learn the question of whether such deterministic regularized route exists or not will shed light on the question of why reactions occur, i.e., chance and necessity of the changes, which has been asked from the day of alchemy. Furthermore, we will learn the applications of quantum computing and machine learning to chemical reaction design and discovery.

授業計画 Course Schedule

The lecture will be organized for students who have not learned chemical reactions theory and Hamiltonian dynamical systems more than Newton's law.
We will take an ample of time to accept questions from students and ask students to write a short report on which you must write what you learned at each lecture and what the most difficult to follow were.
0: An overview of the history of chemical reactions: from dynamical system viewpoint.
1: Universal chemical reaction theories based on high-dimensional phase space geometry
2: Breakdown of normally hyperbolic invariant manifolds: alternation of degree of freedom between reactive and nonreactive degrees of freedom
3: Reinforcement learning on chemical reaction design and discovery
4: Quantum Computing on chemical reaction design and discovery

準備学習 (予習・復習)等の内容と分量 Homework

I make a timeslot of Q&A, and ask a report to write any questions he/she feel during each lecture.

成績評価の基準と方法 Grading System

Grading is mainly based on the report on the exercises that were given in the class, and based on activity (how much he/she made questions as a report) in a class as well.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

I do not supply any books, but hope that all students learn how the interdisciplinary research between chemistry and mathematics is potentially deeper than the design of a spacecraft pathway, and that students actively imagine and dig what type of new research may exist in between chemical reactions and the other research arena.

講義指定図書 Reading List

参照ホームページ Websites

http://mlns.es.hokudai.ac.jp/

研究室のホームページ Websites of Laboratory

https://mlns.es.hokudai.ac.jp/english.html

備考 Additional Information

科目名 Course Title	物質化学A(ナノ物質化学)[Materials Chemistry A (Mesoscopic Material Chemistry)]		
講義題目 Subtitle			
責任教員 Instructor	佐田　和己 [SADA Kazuki] (大学院理学研究院)		
担当教員 Other Instructors	MATSUOKA Keitaro (理学研究院), TSUTSUMI Takuro (理学研究院)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094205
期間 Semester	Spring/Summer	**単位数 Number of Credits**	2
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELMAT 6012		
補足事項 Other Information			
授業実施方式 Class Method	2 対面授業科目《一部遠隔》		

キーワード Key Words

Polymer Chemistry, Self-organization, Molecular Networks, Molecular Assembly, Supermolecular Chemistry, Gel, Nanoporous Materials, Crystals, Radiation Chemistry, Computational Chemistry

授業の目標 Course Objectives

Based on the understanding of the essence of materials, this lecture will provide specialized knowledge for designing and developing the functions of inorganic, metallic, organic, and biomaterials and composite materials. In particular, students will learn the fundamentals to consider the physical properties design and application guidelines for materials ranging from hard materials such as crystals to soft artificial materials such as gels and biomacromolecules such as proteins and nucleic acids. In particular, three topics, molecular network materials, astatine-based radiotherapy, and chemical reaction analyses based on computational chemistry, will be reviewed and their applications to nanotechnology and other fields will be introduced based on cutting-edge research.

In addition, we will discuss what research is, reflect on our own research, and discuss how to solve problems or deepen our own research through PBL or presentation-style exercises that transcend the boundaries of engineering and science.

(I) Material Design

Preparation, structure, and function of materials with network structures such as supramolecular chemistry, gels, crystals, and MOFs will be reviewed and their applications will be introduced.

(II) Astatine-based radiotherapy

Organic chemistry using astatine, an α-ray emitting nuclide emitted by accelerators for radiotherapy, and its applications will be introduced.

(III) Reaction analysis theory based on computational chemistry

Several methodologies for analyzing chemical reaction mechanisms based on potential energy surfaces and actual applied research will be reviewed.

(IV) Deepening research through PBL (Problem-Based Learning)

Students will discuss how to solve problems or deepen their own research by using their own research as a subject matter.

到達目標 Course Goals

Firstly this course reviews fundamentals of molecular network structures and bio-molecular machines with respect to self-organization.

Students will be able to acquire basic knowledge both on preparation and molecular design of network structures and on bio-molecular machines, understand their construction and working principle in advanced applications of physical chemistry and material science. Students will be able to discuss problem solving or deepening their own research using their own research as a subject.　Students will be able to know organic chemistry of alpha-ray emitting astatine prepared by using an accelerator for radiotherapy.Students will be able to understand the advantages of various reaction analysis theories based on potential energy surfaces.

授業計画 Course Schedule

(Topic I) Material Design provided by K. S.

(Topic II) Astatine-based radiotherapy by K. M.

(Topic III) Reaction analysis theory by T. T.

(Topic IV) Problem Based Learning (PBL) for deepening of own research by K. S., K. M. and T. T.

Based on your own research as the subject, discuss how to solve problems or deepen your own research.

準備学習（予習・復習）等の内容と分量 Homework

Students will read reviews and the primary literature on each topic, and submit questions for instrutor after every classes and some written reports on the topics.

成績評価の基準と方法 Grading System

Attendance more than 11 times among 15 classes is essentail for evaluation of the credit.
The grade is evaluated in the following three items;(1) learning attitude (15%), (2) report/homework or presentation (70%), (3) term paper (15%). Understanding for each class is evaluated by report/homework/presentation, and the basic knowledge for whole subjects is confirmed by term examination.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

「科学的思考」のレッスン：学校で教えてくれないサイエンス／戸田山和久：NHK 出版, 2011

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

https://wwwchem.sci.hokudai.ac.jp/~matchemS/english/index.html

備考 Additional Information

科目名 Course Title	応用物質化学(有機物性化学)[Applied Materials Chemistry (Physical Chemistry of Organic Materials)]		
講義題目 Subtitle			
責任教員 Instructor	田地川　浩人 [TACHIKAWA Hiroto] (大学院工学研究院)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094206
期間 Semester	Fall	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELMAT 6100		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Pi-stacking, Sigma-Huckel method, Soliton, Anderson localization, Degradation Mechanism

授業の目標 Course Objectives

Approach of a condensed matter chemistry is an important method for understanding the structure and driving mechanisms of electronic materials, such as organic thin-film solar cells and organic electroluminescent (EL) materials, which are based on organic molecules. In this course, the physical properties of several organic molecules, their aggregates, oligomers, and polymers will be lectured from theoretical approaches such as quantum chemistry.

到達目標 Course Goals

By the end of the lecture, you should be able to:
- Acquire the basic ability to understand the relationship between molecular functions and physical properties, and
- Develop the ability to discover problems in actual materials chemistry and to solve them using a theoretical approach.

授業計画 Course Schedule

Physical properties of the following systems will be discussed mainly by quantum chemical approach. (in no particular order)
(1) Charge-transfer complex (Pi-stacking)
(2) Thiophene system (degradation mechanism)
(3) Silane system (sigma-Huckel, Anderson localization)
(4) Graphene-based system (polycyclic aromatic compounds)
(5) Polyacetylenes (solitons)
(6) Spectroscopy (spectroscopic approach)
(7) Current topics

準備学習 (予習・復習)等の内容と分量 Homework

Students should review quantum mechanics or quantum chemistry from the undergraduate course.

成績評価の基準と方法 Grading System

In principle, attendance of 70% or more of the class sessions is a requirement for grading. The attitude at the lecture (20%) and report (30%) are evaluated.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

Lecture 用資料は、適宜配布する。

講義指定図書 Reading List

有機半導体のデバイス物性 (KS 物理専門書)／安達千波矢：講談社, 2012
有機エレクトロニクス入門／筒井 哲夫(他)：日刊工業新聞社, 2012

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	応用物質化学(界面電子化学)[Applied Materials Chemistry (Interfacial Electrochemistry)]		
講義題目 Subtitle			
責任教員 Instructor	伏見　公志 [FUSHIMI Koji] (大学院工学研究院)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094207
期間 Semester	Summer	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELMAT 6102		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Electrode structure, interfacial reaction, charge transfer process, mass transport process, electrochemical methods, micro-electrochemistry

授業の目標 Course Objectives

In this course, you can discuss the reactions occurring at interfaces between electrolyte and materials, i.e., electrodes. You learn electrode reactions from views of interfacial thermodynamics, charge transfer kinetics, and mass transport process at the interface, and then proceed to principle and application using electrochemical methods as well as physical chemistry at the interface. You are finally required to present and discuss electrochemical or interfacial subjects as well as your own research subjects.

到達目標 Course Goals

By the end of this course, a successful learner will

1 . be able to discuss basic aspects of electrochemistry, mainly for electrode structure including atomic level surface, electric double layer, electrode potential, etc.

2. be able to fullfil to interfacial reaction such as charge transfer process and mass transfer process.

3. be able to understand details of electrochemical methods both to evaluate and to apply electrochemical reaction.

授業計画 Course Schedule

1-3. Fundamentals of electrochemistry; electrode structure, electrode potential, non-Faradaic and Faradaic processes, energy conversion, electrolyte

4. Outline of electrochemical methods; apparatus, electrochemical cell, and electric circuit used in electrochemistry

5-6. Polarization technique; controlling processes of interfacial reaction (charge transfer process and mass transfer process), cyclic voltammetry, hydrodynamic method, microelectrode technique

7. Transient technique; potentiometry, ammerometry, coulometry, AC impedance spectroscopy, electrochemical sensor

8. Presentation; electrochemical theory and methods in newest research topics are introduced and discussed.

準備学習（予習・復習）等の内容と分量 Homework

You are requested to read relevant contents in the documents beforehand. You are also expected to study journal articles in interfacial electrochemistry and prepare presentation materials to be used in class discussions.

You are requested to submit a report about class.

成績評価の基準と方法 Grading System

Students will be evaluated by presentations (50%) and reports (50%).

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

Electrode Dynamics／A.C. Fisher：Oxford University Press, 1996

講義指定図書 Reading List

電気化学測定法（上）／藤嶋昭,相澤益男,井上徹：技報堂出版, 1984

Electrochemical Methods, Fundamentals and Applications, 2nd ed.／Allen J. Bard, Larry R. Faulkner：Wiely, 2001

Analytical and Physical Electrochemistry／Hubert H. Girault：EPFL Press

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

https://elechem.eng.hokudai.ac.jp/

備考 Additional Information

科目名 Course Title	応用物質化学(無機物性化学)[Applied Materials Chemistry (Inorganic Solid State Chemistry)]		
講義題目 Subtitle			
責任教員 Instructor	鱒渕 友治 [MASUBUCHI Yuji] (大学院工学研究院)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094208
期間 Semester	Fall	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELMAT 6102		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Sintering, Thin film, Single crystal, Nano materials, Morphology

授業の目標 Course Objectives

Inorganic solids are known to show various properties depending on their constituent elements and crystal structure. Additionally, from the viewpoint of “material” their morphology and microstructure must be optimized to achieve their applications. This lecture will be dealing with preparation process of sintered body, thin film, single crystal, and nano materials for inorganic materials. We will also discuss how their physical properties relate to their morphology and micro structure.

到達目標 Course Goals

To explain a relationship between various properties and microstructures in functional inorganic solids.
To explain preparation methods of sintered body, thin film, single crystal, and nano materials of functional inorganic solids.
To explain fundamental mechanisms of diffusion, nucleation, crystal growth, and grain growth in functional inorganic solids.

授業計画 Course Schedule

1. Introduction: properties and morphology of inorganic solids
2. Sintering: solid and liquid phase diffusion, sintering of metal nitrides
3. Thin film: deposition process, vacuum deposition, vapor and liquid phase deposition
4. Single crystal: crystal growth mechanism, various crystal growth process
5. Nano material: properties, nano particles, composites, assemblage

準備学習(予習・復習)等の内容と分量 Homework

In order to improve the learning, students are encouraged to prepare for and review the topics in ″Course Schedule″ by referring to the appropriate sections of the handouts and scientific papers, etc., in the time allotted by the regulations of the Faculty of Engineering.

成績評価の基準と方法 Grading System

Comprehensively evaluate the degree of ″Course Goals″ from the results of the exercise during the class and a final report. Breakdown of the evaluation shall be exercise: 30%, final report: 70%, a total of more than 60 points are required to obtain the credit.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

適宜、資料を配付する。

講義指定図書 Reading List

参照ホームページ Websites

https://www.eng.hokudai.ac.jp/labo/strchem/

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	応用物質化学(電子材料化学特論)[Applied Materials Chemistry (Physical Chemistry of Electronic Materials)]		
講義題目 Subtitle			
責任教員 Instructor	青木　芳尚 [AOKI Yoshitaka] (大学院工学研究院)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094209
期間 Semester	Winter	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELMAT 6102		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Energy devices, semiconductors, ion conductors, heterojunctions, defect thermodynamics

授業の目標 Course Objectives

solid state electrochemical devices including solid oxide fuel cells, all solid state battery, hybrid solar cells

到達目標 Course Goals

Fundamentals of all solid state electrochemical devices.
To understand the phenomena at solid electrolyte-electrode interfaces.
Band structures at meta/semiconductor hetero junctions.
Interplays between ion and electron carriers in solid state electrolytes.

授業計画 Course Schedule

1. Introduction of band theory
2. Correlation between catalytic activity and electronic properties of Pt ORR catalysts
3. Fundamental of electrochemical impedance analysis of interfacil polarization
4. Correlation between elecronic carriers and defects in metal oxides
5. Design of solid state ionics devices based on interfacial properties
6. Novel solid state energy devices with the inter-plays between ion and electron carriers.

準備学習 (予習・復習)等の内容と分量 Homework

Students are encouraged o understand the working principals of fuel cells and all solid state batteries, fundamentals of defect thermodynamics and basic concepts of electronic properties at hetero-interfaces.

成績評価の基準と方法 Grading System

The scores are determined by (1) questions or discussion after lectures (30%), (2) learning attitude (10%) and (3) reports at end of semester

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

Physics of semiconductor devices／S. M. Sze
電極化学　上／佐藤教男

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

https://ionics.eng.hokudai.ac.jp/index-e.html

備考 Additional Information

科目名 Course Title	応用物質化学(機能固体材料化学)[Applied Materials Chemistry (Functional Solid State Materials Chemistry)]		
講義題目 Subtitle			
責任教員 Instructor	島田　敏宏 [SHIMADA Toshihiro] (大学院工学研究院)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094210
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELMAT 6101		
補足事項 Other Information			
授業実施方式 Class Method	4 遠隔授業科目《遠隔のみ》		

キーワード Key Words

electronic materials and devices, thermoelectrics, solar cells, hard materials, solid state physics

授業の目標 Course Objectives

The first goal is to understand the "heart" of chemistry and physics of solid state functional materials and obtain the ability to design and crate new materials. The second goal is to understand what is written in literature with theoretical description. The lecture and the homeworks will be organized to achieve this goal.

到達目標 Course Goals

By the end of this course you will be able to
1. Explain how the devices explained in the lecture works.
2. Obtain basic knowledge of solid state materials.
3. Read advanced literature about the related topics.

授業計画 Course Schedule

Topics other than the following list can also be lectured according to request.
1. Introduction to solid state chemistry / physics and thermoelectricity
2. Semiconductors focused on solar cells
3. Transparent conductors (oxides, nanowires, graphene)
4. Advanced ligand field theory and basics of photophysics – lasers, nonlinear optics, optical fibers
5. Interfaces: work function and chemistry of semiconductor junction devices
6. Phase memory materials (DVD-R/W, shape memory alloys)
7. Ferroelectrics and liquid crystal
8. Thermography and strongly correlated electron systems
Related theoretical concepts will be introduced every time.

準備学習 (予習・復習)等の内容と分量 Homework

Preparation: read the handout posted on the website (URL will be given at the first lecture).
Homework: solve the problem given in the lecture and write a brief final report.

成績評価の基準と方法 Grading System

Grading is based on the quiz given at each lecture and the final report.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

Handout will be given prior to the lecture via website

講義指定図書 Reading List

参照ホームページ Websites

This course will be provided as part of the Hokkaido Summer Institute., For more information (invited lecturers, course details, etc.), please visit the website below:, https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G052

研究室のホームページ Websites of Laboratory

https://www.eng.hokudai.ac.jp/labo/kotai/en/index.html

備考 Additional Information

科目名 Course Title	応用物質化学(先端材料化学)[Applied Materials Chemistry (Advanced Materials Chemistry)]		
講義題目 Subtitle			
責任教員 Instructor	北川　裕一 [KITAGAWA Yuichi] (大学院工学研究院)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094211
期間 Semester	Summer	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELMAT 6102		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Molecular photochemistry, light absorption, luminescence, organic compound, metal complex

授業の目標 Course Objectives

In this course, advanced photofunctional materials and fundamental principles of photochemistry are presented. This course enhances the understanding of advanced photofunctional research and the ability to design photofunctional materials.

到達目標 Course Goals

Students will be able to understand basic concepts of photochemistry such as electronic energy in materials, light absorption, and excited state dynamics to understand the basic principles of designing photofunctional materials and advanced photofunctional material studies. The goal of this course is to provide students with sufficient background to understand photofunctional studies in various research fields.

授業計画 Course Schedule

1-2. Fundamentals of photochemistry
3. Light absorbing materials
4-5. Luminescent materials
6. Polarized absorbing and luminescent materials
7. Photo-induced electron transfer・Photochemical reaction
8. Examination

準備学習 (予習・復習)等の内容と分量 Homework

Students are requested to review the contents in the lecture slide. To enhance a learning effect, the students are expected to review and prepare for about two hours using handouts.

成績評価の基準と方法 Grading System

According to the class attitude and test, the score will be calculated.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	応用物質化学(応用材料化学Ⅰ)[Applied Materials Chemistry (Applied Inorganic Materials Chemistry I)]		
講義題目 Subtitle			
責任教員 Instructor	忠永　清治 [TADANAGA Kiyoharu] (大学院工学研究院)		
担当教員 Other Instructors	KIJIMA Norihito (AIST), SUE Kiwamu (AIST)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094212
期間 Semester	Fall	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELMAT 6100		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Functional inorganic materials, Secondary batteries, Nanostructural analysis, High-temperature/high-pressure solvent, Flow production, Data-driven materials development

授業の目標 Course Objectives

The relation between the functionality of materials, especially inorganic functional materials, and their nanostructure and macroscopic form such as bulk will be lectured.
The appearance mechanism of various functionality obtained by controlling the composition and microstructure of the materials, the process development method for production of functional materials with desired structures, and feature of high-temperature / high-pressure solvent properties and controlling methods of the properties, will be addressed.
The prospects for industrial application in the future will be discussed by taking up some topics, including the synthesis and characterization of electrode and electrolyte materials for lithium ion batteries, and the production of nanoparticles and nanocomposites.

到達目標 Course Goals

The relation between the materials properties and nano/micro-structures drawing the required functions will be understood. In addition, the basic science and skills for materials processing and analysis will be mastered. The task to find a topic for oneself and investigate it will be given to the students as training to select and treat information scientifically.

授業計画 Course Schedule

Lectures will be given by Professor Professor Norihito KIJIMA and Kiwamu SUE(AIST).

The following contents will be lectured using the documents edited for the class by the lecturers:

1. Materials chemistry of secondary batteries (Rechargeable Batteries): Overview of secondary batteries, component materials for secondary batteries, and situation surrounding storage batteries.
2. Materials chemistry for secondary batteries: Preparation and characterization of materials for batteries
3. Fundamentals for development of functional materials production process: high-temperature / high-pressure solvent properties, controlling method of the properties such as flow production, application to functional materials production
4. Data-driven method for development of materials production process: how to develop apparatus, how to collect and analyze data, application to functional materials production

準備学習（予習・復習）等の内容と分量 Homework

Review the distributed documents and blackboard demonstration contents, and ask any questions at the next class.

成績評価の基準と方法 Grading System

Your attitude in classes (20%) and reports (80%) will affect your final grade.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

なし。適宜資料を配布する。
None. Materials will be distributed as appropriate.

講義指定図書 Reading List

参照ホームページ Websites

https://www.aist.go.jp/

研究室のホームページ Websites of Laboratory

備考 Additional Information

Materials will be distributed as appropriate.

科目名 Course Title	応用物質化学(応用材料化学Ⅱ)[Applied Materials Chemistry (Applied Inorganic Materials Chemistry II)]		
講義題目 Subtitle			
責任教員 Instructor	忠永　清治 [TADANAGA Kiyoharu] (大学院工学研究院)		
担当教員 Other Instructors	KUWATA Naoaki (NIMS), KUBOTA Kei (NIMS)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094213
期間 Semester	Fall	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELMAT 6100		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Inorganic solid materials, materials processing, battery materials, materials analysis, diffusion in solids, thermodynamics of batteries, ion dynamics measurements

授業の目標 Course Objectives

For various materials, mainly inorganic materials, you will learn about the functionality obtained by controlling the composition, crystal structure and microstructure, and the mechanism by which they are expressed. For example, solid-state battery materials will be subjected to understand the fundamentals of material properties through a physicochemical approach. Ion dynamics measurement methods including nuclear magnetic resonance will be introduced too. Students will also learn about processing and characterization methods (instrumental analysis, spectroscopy, etc.) for fabricating functionally designed materials.

到達目標 Course Goals

Students will be able to understand the relationship between various properties of materials and nano-micro-macro structures through the example of battery materials and the mechanism by which these various physical properties are expressed. In addition, you will be able to consider what microstructure should be designed to maximize the desired function, and what kind of method should be used to obtain such a structure in terms of "materials processing".

授業計画 Course Schedule

The following contents will be lectured using the distributed materials.

1. Introduction ･･ About the structure and function development of materials.
2. Synthesis: Synthesis theory and process chemistry for grinding, sintering, and microstructure control.
3. Characteristic evaluation ･･ Relationship between nano-micro-macro structure of materials and electrochemical properties. Also, about their evaluation methods.
4. Summary: Industrial application and future prospect of material sciences and materials technology. About the role and potential of materials in a sustainable society.

準備学習 (予習・復習)等の内容と分量 Homework

Review the distributed lecture materials and contents, and ask questions in the next class.

成績評価の基準と方法 Grading System

Attendance of 75% or more of the number of classes is a condition for grade evaluation. Grades are evaluated based on (1) learning attitudes (20%) and (2) reports (80%).

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

なし。適宜資料を配布する。
No textbook required. Materials will be distributed each time.

講義指定図書 Reading List

参照ホームページ Websites

https://www.nims.go.jp/

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	生物化学A(Ⅰ)[Biochemistry A (I)]		
講義題目 Subtitle			
責任教員 Instructor	髙橋　正行 [TAKAHASHI Masayuki] (大学院理学研究院)		
担当教員 Other Instructors	ABE Kazuhiro (理学研究院)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094301
期間 Semester	Fall/Winter	**単位数 Number of Credits**	2
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELBIO 6012		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Membrane proteins, primary transporters, ion channels, structural biology, cryo-EM, drug design, motor protein, muscle contraction, cell motility, cytoskeleton, cell shape

授業の目標 Course Objectives

As an important basis of living systems, various substrates including cations are asymmetrically distributed across the membrane, which is generated and maintained by ATP-driven primary active transporters; Free energy derived from ATP is also utilized for muscle contraction and various cellular processes. In this lecture, students will learn about the molecular mechanisms of membrane proteins that generate asymmetric distribution of materials, and also for the function of various proteins that involved in the maintenance and alteration of cellular morphology.

到達目標 Course Goals

Students are expected to deeply understand the molecular mechanism of membrane proteins, including primary transporters, from the viewpoint of structural biology, and the molecular mechanism of muscle contraction and various cell motile processes.

授業計画 Course Schedule

1) How to “look at” the protein shape
2) Understand protein functions in terms of Chemistry
3) Membrane proteins
4) Molecular mechanism of primary transporters
5) Structural physiology of primary transporters
6) Structural based drug development 1
7) Structural based drug development 2
8) Molecular mechanism of muscle contraction and its regulation
9) Structure and mechanism of motor proteins
10) Dynamics of cytoskeletal proteins
11) Molecular mechanism of cell migration
12) Molecular mechanism of cell division
13) Morphological changes of neuronal cells

準備学習 (予習・復習)等の内容と分量 Homework

Students are expected to review the material provided by the instructors.

成績評価の基準と方法 Grading System

In principle, attendance of 70% or more of the class is a requirement for grading. Evaluation is based on (1) attitude towards study (20%), (2) reports (20%) and (3) final examinations (60%). The reports will assess the depth of understanding of the class topics, while the end-of-term examinations will determine the ability to apply the knowledge gained.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

特にもうけない。

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	生物化学A(Ⅱ)[Biochemistry A (II)]		
講義題目 Subtitle	生体システムのシグナル伝達―形態形成と生体防御[Signal Transduction for Biological Morphogenesis and Host Defense Systems]		
責任教員 Instructor	茂木　文夫 [MOTEGI Fumio] (遺伝子病制御研究所)		
担当教員 Other Instructors	TAKAOKA Akinori (遺伝子病制御研究所)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094302
期間 Semester	Fall/Winter	**単位数 Number of Credits**	2
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELBIO 6012		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Signal transduction, genetic mutations, cellular architectures and morphogenesis, host defense, molecular mechanisms of diseases, immunology, basic medicine, infectious diseases, cancer, basic skills for scientific writing, experimental techniques of cell biology/molecular biology/immunology

授業の目標 Course Objectives

Life system can be considered as an orchestral unit, which is composed of multiple biomolecular components. Each part of the orchestra exquisitely responds and/or adjusts to various external and internal stresses to keep the whole harmony, which is important for the homeostasis of life system. On the other hand, dysfunction of some part makes the orchestra play an inharmonic music as a whole, leading to breakdown in the homeostasis of life system, that is, developing a disease. Thus, the life system is spatiotemporally regulated under the molecular networks, which are controlled by the biochemical machinery. This course aims at the stepwise understanding about the static organization of life system and its dynamic changes in response to stresses, from molecular to cellular, and further to individual aspects. In particular, we focus on the signaling transduction system that underlies the host defense against pathogen invasion and cancer development.

到達目標 Course Goals

The final goal of this course is to foster an integrative understanding and research view of chemistry by learning physiological functions of biomolecular components and their dysfunctions as a pathogenic condition (i.e., a disease development) from an interdisciplinary view of chemistry and medicine. We hope that this course contributes to rearing a researcher with a broad-based knowledge below the chemistry as well as the ability of creative and imaginative thinkings. This course will also support students to learn the general process of paper publication, how to write a “fascinating” research paper as well as how to prepare the accessory documents, and basic skills to make better use of molecular biological or immunological approaches.

授業計画 Course Schedule

This module will cover two major topics in (1) Cellular and tissue morphogenesis and (2) The host defense system during normal and disease contexts. A major challenge in biology is how to comprehend the enormous complexity underlying biological systems, and how to translate this knowledge into biomedical technologies. A set of lectures aims to understand how molecules interact with each other to produce the signals that orchestrate complex physiological functions. The detailed schedule will be informed in the first day of the course. Lecture contents, such as color-printed synopsis and/or lecture slide notes, will be provided in advance of each lecture.

Section 1: Molecular mechanisms of cellular and tissue morphogenesis

This section aims to understand the basic principles in animal body plan by introducing molecular mechanisms underlying “morphogenesis of cells and tissues” during normal development and in disease conditions. Growth and form are fundamental to all living organisms, and crucial to health and diseases. Development in methods and tools for molecular imaging has transformed biological and biomedical sciences. In particular, this section will introduce several basic concepts in molecular imaging with light microscopy and their applications. Introduction of each imaging technology will be linked with a set of biological problems of fundamental interests and biomedical implications. With a quantitative and holistic understanding of how molecular functions are ensured during normal development and how they are maladapted in disease, students will gain better insights into biomedical implications that effectively protect and regenerate organ functions and to better treat human diseases.

Section 2: The host defense system against pathogen invasion and cancer development

The second section will introduce the physiological functions of human organs from a macroscopic viewpoint, zooming them down to the functions at cellular and molecular levels. Next, we provide additional explanation about host responses to external and internal stresses to keep homeostasis in human living organism. Particularly, we focus on host defense against microbial infection that is an external stress, i.e., immunity. Students explore the following issues from the point of view of signal transduction as a cascade of intracellular chemical reactions: How does a living organism recognize invasion by microbes? What is the molecular mechanism for the specific elimination of the invading pathogens? In addition, we further review a mechanism for host defense against oncogenesis, which can be considered as an internal stress.

Students will also learn about the molecular mechanism for disease pathogenesis, particularly in terms of immunodeficiency that develops as a result of impairment of the immune system due to genetic abnormalities. Here, students further explore the outcome of abnormalities of biochemical events in human at the molecular to cellular and in vivo levels. This is helpful to students to acquire the relevant knowledge about basic medicine and to deepen their understanding of not only disease pathogenesis, but also the molecular-based strategy for disease treatment.

Section 3: Practical techniques to write "attractive" scientific papers.
This course will provide students the opportunity to learn research-based knowledge and skills in a more practical way. Students have a 10-min explanation about basic experimental techniques of molecular biology/immunology at the end of every class, by introducing a scientific paper published in a major journal such as Nature and Science. In addition, this part covers an overview of manuscript process (from submission to revision, resubmission, and acceptance) and also conveys essentials to a high-quality paper, by introducing actual examples of a manuscript and its related documents (Cover letter, Review comments, Rebuttals, Proof, etc.), which were successfully accepted in high-profile journals.

Section 1: Cellular and tissue morphogenesis in normal and disease contexts
(1) Visualization of biological molecules in vivo
(2) Visualization of biochemical reactions in vivo
(3) Cell and tissue morphogenesis (I)
(4) Cell and tissue morphogenesis (II)
(5) Basics of scientific presentation
(6) How to make effective scientific presentation (I)
(7) How to make effective scientific presentation (II)
(8) Practical exercise of scientific presentation

Section 2: The host defense system against pathogen invasion and cancer development
§2.1:Physiology of life system
(1) Macroscopic presentation of human body including a anatomical structure, biochemical, physiological functions of each organs
(2) General introduction of host defense (innate immunity and adaptive immunity)
(3) Basic knowledge of antibody molecules and their clinical application
(4) Roles of immune cells (e.g., dendritic cells, lymphocytes) and molecular mechanisms whereby these cells are functionally activated.
(5) Soluble factors that regulate the immune system, and their mechanisms of action
§2.2:Pathology of life system
(6) Fundamental knowledge of pathogenic microbes (e.g., viruses and bacteria)
(7) Diseases and pathological conditions as a result of breakdown in life system (e.g., infectious diseases, cancers)
(8) Molecular mechanisms for disease pathogenesis (genetic abnormalities and immunodeficiency)
(9) Therapeutic principle that is based on a molecular abnormality responsible for a disease (e.g., gene therapy)

Section 3:Basic knowledge of research and its practical application
(1) Basic and application of experimental methods that are often used in the research field of molecular biology/immunology
(2) Overview of manuscript process (from submission to revision, resubmission, and acceptance)
(3) Essentials to a high-quality paper

準備学習（予習・復習）等の内容と分量 Homework

There is no obligatory assignment that students have to prepare or review during this course. We think that what is essential is that students can maximally concentrate their attentions on each class and find something interesting to move them to spontaneously explore it further. We therefore will make maximum efforts to make each class attractive and to support students to learn the topic of each class in an extended manner.

成績評価の基準と方法 Grading System

During our interactive classes, we consider it as one of the important factors for assessment how actively students participate in each class (PARTICIPATION). In this respect, for example, to spontaneously participate in Q&A activity and to think logically are much more important than to simply make a correct answer. Basically, there is no written exam for assessment, but students will be required to submit a report once at the end of this course. This report is regarded as a main factor for assessment (REPORT). As a theme of report, students can make a choice of one topic that they have become most interested in during this course. No specific format of report, and students are recommended to describe a topic of interest together with more detailed information that they additionally investigate by themselves, and to include some content of their research themes in a way that creates a link to a topic of their choice.
The course employs the grading system that is generally used for the student assessment in this university: Excellent plus, excellent, very good, good, and not good. In addition to the basic score of ATTENDANCE, the following major factors are

considered to comprehensively and fairly make the final assessment:
1) Course assignment such as presentation and report: 70%
2) Active attitude to lectures and learning: 30%

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory
Motegi lab homepage: https://www.motegilab.com
Takaoka lab homepage: https://www.igm.hokudai.ac.jp/sci/

備考 Additional Information
Feel free to contact us for further information.

Fumio Motegi, Ph. D. Division of Developmental Physiology, Institute for Genetic Medicine, Hokkaido University
Tel:011-706-5527; ext. 5527
E-mail: motegi@igm.hokudai.ac.jp

Akinori Takaoka, M.D., Ph.D., Division of Signaling in Cancer and Immunology, Institute for Genetic Medicine, Hokkaido University
Phone 011-706-5020; ext. 5020
E-mail takaoka@igm.hokudai.ac.jp

科目名 Course Title	生物化学A(Ⅲ)[Biochemistry A (III)]		
講義題目 Subtitle			
責任教員 Instructor	内田　毅 [UCHIDA Takeshi] (大学院理学研究院)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094303
期間 Semester	Spring/Summer	**単位数 Number of Credits**	2
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELBIO 6012		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Absorption Spectroscopy, Infrared Spectroscopy, Fluorescence Spectroscopy, Raman Scattering, Magnetic Resonance, Single-molecular Detection

授業の目標 Course Objectives

Spectroscopies have been revealed detailed structures of biological molecules such as proteins, nucleic acids, and other related molecules. This course will provide students with basic theories of spectroscopies and knowledge about their biological applications.

到達目標 Course Goals

Students will learn the background and basic theories of various kinds of spectroscopies for analyzing structures and functions of biological molecules.

授業計画 Course Schedule

[1st Half]
Explain the basic theory of some spectroscopies.
Week 1: Orientation and Introduction
Week 2: Basic Theory of Mass Spectroscopy in Biochemistry
Week 3: Basic Theory of Absorption Spectroscopy in Biochemistry
Week 4: Basic Theory of Infrared Spectroscopy in Biochemistry
Week 5: Basic Theory of Raman Spectroscopy in Biochemistry
Week 6: Basic Theory of Fluorescence Spectroscopy in Biochemistry
Week 7: Basic Theory of Circular Dichroism Spectroscopy in Biochemistry
Week 8: Basic Theory of Nuclear Magnetic Resonance Spectroscopy in Biochemistry
Week 9: Basic Theory of Single-Molecule Detection and Other Spectroscopic Techniques in Biochemistry
Week 10: Presentation by students

[2nd Half]
Explain the application of the spectroscopies to bimolecular studies.
Week 11: Biological Application of Absorption Spectroscopy
Week 12: Biological Application of Raman Scattering
Week 13: Biological Application of Fluorescence Spectroscopy
Week 14: Biological Application of Nuclear Magnetic Resonance
Week 15: Exercise

準備学習 (予習・復習)等の内容と分量 Homework

Assignment is required for every lecture.

成績評価の基準と方法 Grading System

Quiz & Assignment, 70%; examination, 30%

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

Methods in Molecular Biophysics／Serdyuk, I. N.,他：Cambridge, 2007
アトキンス 物理化学(下) 第 10 版／P. Atkins：東京化学同人, 2017
生体分子分光学入門／尾崎 幸洋、岩橋 秀夫：共立出版, 1992

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

https://wwwchem.sci.hokudai.ac.jp/~stchem/

備考 Additional Information

On-site classes are expected.

In principle, attendance of 70% or more of the class sessions is required for credit.

科目名 Course Title	生物化学A(IV)[Biochemistry A (IV)]		
講義題目 Subtitle			
責任教員 Instructor	谷野　圭持 [TANINO Keiji] (大学院理学研究院)		
担当教員 Other Instructors	SUZUKI Takahiro (理学研究院)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094304
期間 Semester	Fall/Winter	**単位数 Number of Credits**	2
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELBIO 6012		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Carbocation, Lewis acid, Enol silyl ether, Allylsilane, Electrophilic addition reaction, Carbon radical, Radical reduction, Radical addition reaction, Radical cyclization reaction

授業の目標 Course Objectives

The chemistry of enol silyl ethers as well as allylsilanes provides powerful methods in modern organic synthesis. The reactions of these compounds usually proceed through cationic intermediates, and it is very important to know the properties of carbocation species. This course increases students' understanding of useful carbon-carbon forming reactions mediated by Lewis acids.

This lecture also discuss about the features of carbon radicals such as the relationship between structure and stability, typical generation methods, and the addition to the multiple bonds. The attainment target is acquirement of practical knowledge, which enable comprehension of the complex synthetic schemes.

到達目標 Course Goals

At the end of the course each student should be able to:

1. explain the relationship between structure, stability, and reactivity of various carbocation species.
2. explain the "scope and limitations" in reactions involving carbocation intermediates, comparing with those in reactions of carbanion species or organometallic compounds.
3. discuss the mechanism of the reactions mediated by a Lewis acid by assuming appropriate reactive intermediates.
4. explain the relationship between structure, stability, and reactivity about various carbon radicals.
5. explain the "scope and limitations" about the reactions using radicals in comparison with the common ionic reactions.
6. discuss the mechanism of the cascade reactions involving radical species.
7. suggest appropriate schemes involving a several-step transformation for the synthesis of small organic molecules.

授業計画 Course Schedule

1. general properties of carbocation species
2. methods for generating carbocation species
3. preparation and reactions of enol silyl ethers
4. preparation and reactions of allylsilanes
5. reactions of vinylsilanes and alkynylsilanes
6. Prince reaction and carbonyl-ene reaction
7. alkylation reaction using organometallic reagents
8. basic property and generation of radical species
9. radical reduction by using alkyltin hydrides
10. radical reduction by using low valent metal salts
11. addition reactions of carbon radical with alkenes
12. radical cyclization leading to carbocycles or heterocycles

準備学習 (予習・復習)等の内容と分量 Homework

Students are requested to take enough time to go over each subject noted down during the lecture. A full understanding of the reaction mechanisms is especially important.

成績評価の基準と方法 Grading System

based on a mid-term examination (50%) and a term examination (50%)

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

Textbooks are not assigned.

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

https://wwwchem.sci.hokudai.ac.jp/~oc2/

備考 Additional Information

科目名 Course Title	応用生物化学(生合成工学)[Applied Biochemistry (Biosynthetic and Metabolic Engineering)]		
講義題目 Subtitle			
責任教員 Instructor	大利　徹 [DAIRI Toru] (大学院工学研究院)		
担当教員 Other Instructors	OGASAWARA Yasushi (工学研究院), SATOH Yasuharu (工学研究院)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094305
期間 Semester	Fall	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELBIO 6102		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

microorganism, natural products, biosynthesis, genes, enzymes, bioinformatics

授業の目標 Course Objectives

Understanding of basic knowledge and techniques essential for biotechnology/bioengineering with microorganisms. 1. Principle of bioinformatics, 2. Michaelis Menten kinetics of enzyme reaction, 3. Outline of primary/secondary metabolites and metabolic pathways.

到達目標 Course Goals

Students are requested to understand papers about the microbial metabolites/metabolic pathways and the enzymes responsible for them, and to apply the basic knowledge/technology to their own research subjects.

授業計画 Course Schedule

1. Introduction
2. Principle of bioinformatics
3. Michaelis Menten kinetics of enzyme reaction-1-
4. Michaelis Menten kinetics of enzyme reaction-2-
5. Review of the primary metabolic pathway.
6. Diversity of the primary metabolic pathway in microorganisms
7. Review of the representative secondary metabolites and their biosynthetic pathways
8. Examples of microbial production of useful compounds based on biosynthetic engineering and metabolic engineering

準備学習 (予習・復習)等の内容と分量 Homework

Students are requested to understand papers related to biochemistry and summarize its contents concisely.

成績評価の基準と方法 Grading System

Minimum 70% attendance is required and grade is evaluated by learning volition (20%) and the quality of reports (80%).

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

適宜資料を配布する。下記の参考書を推奨するが教科書は使用しない。

講義指定図書 Reading List

マクマリー生化学反応機構 : ケミカルバイオロジー理解のために／John McMurry, Tadhg Begley 著 ; 浦野泰照 [ほか] 訳:東京化学同人, 2007

Antibiotics : actions, origins, resistance／Christopher Walsh:ASM Press, 2003

レーニンジャーの新生化学／レーニンジャー, ネルソン, コックス [著] ; 中山和久編集:廣川書店, 2010

バイオインフォマティクス, 2nd Edition ／David W. Mount 監訳:岡崎康司、坊農秀雅 :株式会社メディカル・サイエンス・インターナショナル, 2005

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

https://www.eng.hokudai.ac.jp/labo/tre/ABCLab_en/

備考 Additional Information

Students are requested to have basic knowledge of biochemistry.

科目名 Course Title	応用生物化学(生命システム工学)[Applied Biochemistry (Biosystem Engineering)]		
講義題目 Subtitle			
責任教員 Instructor	菊川　寛史 [KIKUKAWA Hiroshi] (大学院工学研究院)		
担当教員 Other Instructors	HIRAISHI Tomohiro (RIKEN)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094306
期間 Semester	Fall	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELBIO 6100		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

gene, protein, transcription, translation, enzyme, biochemistry, evolutionary engineering, molecular design, protein engineering, physical chemistry, bioplastic, biodegradation, biotechnology, genome, omics, metabolic engineering, synthetic biology, bacteria, fungi

授業の目標 Course Objectives

Organisms have an excellent synthetic mechanism to produce complex molecules and to properly degrade and utilize them. This system contributes to the natural element cycle. Enzymes play a central role in this cycle. Biotechnologies that apply such advanced biological functions to engineering applications are used in a wide range of fields, such as the synthesis of chemicals and pharmaceuticals, and environmental protection.In this lecture, we aim to learn about examples of applied engineering research, with a chemical understanding of life systems at the molecular level, centering on the function of enzyme molecules. The first stage explains the mechanism of the underlying gene and transcription / translation system, analysis methods, and further, taking bioplastics as an example, the molecular mechanism of biosynthesis and biodegradation, artificial modification technology of enzyme molecules, structure and Learn about function, how to measure activity, and the thermodynamic understanding of biological reactions. In the next stage, we aim to understand the modification and construction of the cell.

到達目標 Course Goals

Understand the mechanism and methodology for synthesizing and functioning the target protein (enzyme molecule) by genetic engineering. Understanding enzyme reactions and metabolism based on chemistry and thermodynamics. Understand the structure and function of enzyme molecules and their analysis methods. To understand how to use exhaustive analysis methods and data such as genomic DNA sequences, transcriptomes, proteomes and metabolome. Using these biological functions, we will learn the ideas for making them applicable to the field of engineering.

授業計画 Course Schedule

Microbial Engineering: metabolic engineering, enzymatic transformation
Protein Engineering: Protein mutagenesis, engineering
Genetic engineering: genetic modification, genome editing
Synthetic biology: molecular design, modeling

準備学習 (予習・復習)等の内容と分量 Homework

It is desirable to have at least 2 hours of preparation and 2 hours of review for each course content.

成績評価の基準と方法 Grading System

The minimum standard for evaluation is attendance rate 70% or more. The degree of achievement is comprehensively evaluated by the questions and answers during the lecture, and the contents of the report given as appropriate. Failure to submit a report will also not meet the evaluation criteria. The attendance of intensive lectures is essential to be credited.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	応用生物化学(生物分析化学)[Applied Biochemistry (Analytical Biochemistry)]		
講義題目 Subtitle			
責任教員 Instructor	谷　博文 [TANI Hirofumi] (大学院工学研究院)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094307
期間 Semester	Fall	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELBIO 6102		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Molecular recognition, Enzyme assay, Immunoassay, Biomolecular interaction, Analytical biochemistry

授業の目標 Course Objectives

In this subject, through learning the principles and applications, students will understand how in-vivo reactions such as enzyme reactions and immune reactions, which have sophisticated molecular recognition functions, are used in analytical chemistry. Additionally, based on these understandings, students will be able to construct an appropriate analytical system depending on the target to be measured when necessary to obtain substance information in their future research.

到達目標 Course Goals

The goals of this course are to be able to;
- Explain the basics of molecular recognition in biological and biochemical processes, and the applications to analytical chemistry exploiting biomolecules as a probe.
- Design a suitable bioanalytical system for a target molecule.

授業計画 Course Schedule

1. Biological and biochemical reactions exploited in analytical chemistry: Chemical analysis, molecular recognition in biological and biochemical reactions, biomimetics, biochemical and biological analyses, selectivity and sensitivity, spectrophotometry, fluorometry, bioluminescence
2. Enzyme assay: Structure and activity of enzyme, kinetics, and equilibrium of enzyme reaction, assays for enzyme activity using synthetic substrates, substrate assays using enzymes, and enzymatic cycling method
3. Immunoassay: Basic of immunoreaction, antibody, antigen, hapten, epitope, immunoprecipitation, immuno-enzymometric assay, labels in immunoassay
4. Nucleic acid analysis: Fundamental and type of nucleic-acid hybridization, Detection techniques of nucleic acid probes, Analysis of nucleic acid sequence, DNA chip
5. Proposal of new bioanalytical methods: Students will be divided into multiple teams, and then team discussion to propose new bioanalytical methods and presentation will be carried out.

準備学習 (予習・復習)等の内容と分量 Homework

Students are expected to read the handouts that are given at least a week ahead. Students are also requested to review each lecture and study the journal articles quoted in the lecture.
The total time for preparation and review is approximately 4 hours.

成績評価の基準と方法 Grading System

A comprehensive evaluation is based on the degree of achievement judged from the learning status and understanding of the analytical methods using/of in-vivo reactions. Specifically, the term-end report, presentation in the class, and the contribution to the class (remarks in discussions, answers to question during class) will be assessed.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

テキストは指定せず，適宜 Lecture 資料を配布する。その他，参考となる文献を適宜紹介する。
Not specify texts. Handouts will be distributed. In addition, reference documents will be introduced as appropriate.

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

備考 Additional Information

It is advisable to master biochemistry, analytical chemistry, and instrumental analysis in advance.

科目名 Course Title	応用生物化学A(マイクロシステム化学)[Applied Biochemistry A (Microsystem Chemistry)]		
講義題目 Subtitle			
責任教員 Instructor	渡慶次　学 [TOKESHI Manabu] (大学院工学研究院)		
担当教員 Other Instructors	MAEKI Masatoshi (工学研究院), ISHIDA Akihiko (工学研究院), HIBINO Mitsue (工学研究院)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094308
期間 Semester	Fall	**単位数 Number of Credits**	2
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELBIO 6112		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Micro total analysis system, Microfluidic device, Microanaltyical device, Micro medical diagnostic device

授業の目標 Course Objectives

This course will understand the principles of microfluidic device development and biochemical analysis, drug discovery and medical diagnostic applications. In addition, acquire the latest knowledge and ideas regarding the development of microanalytical devices and their application to biochemical analysis and medical diagnosis. Through these, it becomes possible to construct an appropriate measurement system according to the measurement target.

到達目標 Course Goals

The goals of this course are to be able to;
- Explain the fundamentals and techniques of the microdevices for biochemical and biomedical analyses.
- Design a suitable micro analysis system for a target molecule.
- Explain the fundamentals and techniques of the microfluidic devices for drug design and therapy.

授業計画 Course Schedule

This course will be held twice a week by multiple lecturers.

1. Concept of analysis using microdevices
2. Blood analysis system using microdevices: immunoassay, circulating tumor cells, cell-free DNA
3. Separation analysis using microdevices
4. Drug design and therapy using microfluidic devices: microdroplet, nanoparticles, drug delivery system and genome editing, structure analysis of biomolecules, particle separation method and devices
5. Paper-based analytical device
6. Microfluidic-based separation system
7. Electrochemical biosensors
8. Portable analytical systems and wearable sensing systems

準備学習（予習・復習）等の内容と分量 Homework

Students are expected to read the handouts that are given at least in a week ahead. Students are also requested to review each lecture and study the journal articles quoted in the lecture.

成績評価の基準と方法 Grading System

Learning attitude and report

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

テキストは指定せず，適宜 Lecture 資料を配布する。その他，参考となる文献を適宜紹介する。
Not specify texts. Handouts will be distributed. In addition, reference documents will be introduced as appropriate.

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

https://microfluidic.chips.jp/en/

備考 Additional Information

It is advisable to master biochemistry, analytical chemistry, and instrumental analysis in advance.

科目名 Course Title	応用生物化学A(機能性高分子特論)[Applied Biochemistry A (Advanced Functional Polymer)]		
講義題目 Subtitle			
責任教員 Instructor	佐藤 敏文 [SATOH Toshifumi] (大学院工学研究院)		
担当教員 Other Instructors	YAMAMOTO Takuya (工学研究院), LI FENG (工学研究院)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094309
期間 Semester	Spring/Summer	**単位数 Number of Credits**	2
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELBIO 6111		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Polymer synthesis, Precise polymerization, Controlled/Living polymerization, Radical polymerization, Cationic polymerization, Anionic polymerization, Coordination polymerization, Functional polymer, Polymer structure, Polymer design, Polymer solution, Phase separation behavior

授業の目標 Course Objectives

To utilize polymeric materials and to design new functionality, the methodology of the polymer synthesis must be understood. To learn various polymerization-methods and the various polymerization mechanisms is mainly studied as the basics of the macromolecular synthesis, and to understand the latest macromolecular synthesis method is a goal. Moreover, students study and understand the precise syntheses based on the free-radical polymerization, the cationic polymerization, the anionic-polymerization, and coordination polymerization, which is used for the design and synthesis of functional macromolecules.

到達目標 Course Goals

Our goals are to learn various polymerization-methods and the various polymerization mechanisms and to understand the latest macromolecular synthetic method. Moreover, students learn the precise synthesis based on the living polymerization, which is used for the design and synthesis of functional polymeric materials as a goal of this course.

授業計画 Course Schedule

1. Polymerizations by Zieglar-Natta.
2. Polymerizations by metallocene catalysts.
3. Metathesis polymerization
4. Ring-opening polymerization leading to environment-conscious polymer and medical polymer
5. polycondensation and chain-growth polycondensation leading to engineering plastic and electrofunctional polymer
6. Radical polymerization: characteristics of radical polymerization and the primary structure of the resulting polymers.
7. Anionic polymerization: characteristics of anionic polymerization and the primary structure of the resulting polymers.
8. Cationic polymerization: characteristics of cationic polymerization and the primary structure of the resulting polymers.
9. Functional materials by assembly of polymers with designed architectures.

準備学習 (予習・復習)等の内容と分量 Homework

Students are required to carefully read distributed handouts (30 min), if any, beforehand and submit reports for assigned problems by specified dates (30 min). Also, students present a report for problems after the class ends (30 min).

成績評価の基準と方法 Grading System

In principle, students who attend 70% or more classes are graded. The final grade is determined by his/her learning attitude (20%) and reports (80%). The reports are evaluated based on the student's understanding on the synthesis and design of polymers and the logic of the writing. A, 100-90; B, 89-80; C, 79-70; D, 69-60; F, < 60.

テキスト・教科書 Textbooks

特に指定はしないが,「高分子合成化学」(大津隆行著, 化学同人)と「大学院高分子科学」(野瀬卓平, 中濱精一, 宮田清蔵編, 講談社サイエンティフィク)を参考にしていただきたい。The documents will be distributed.

講義指定図書 Reading List

大学院 高分子科学／野瀬卓平・中浜精一・宮田清蔵:講談社サイエンティフィック, 2000

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

https://poly-ac.eng.hokudai.ac.jp/index_e.html
https://cma.eng.hokudai.ac.jp/

備考 Additional Information

The class is opened by face-to-face.
Please carefully see ELMS.

科目名 Course Title	総合化学研究先端講義[Internship]		
講義題目 Subtitle			
責任教員 Instructor	仙北　久典 [SENBOKU Hisanori] (大学院工学研究院)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094401
期間 Semester	Fall	**単位数 Number of Credits**	1
授業形態 Type of Class	Internship	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELCOM 6212		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Internship (domestic and oversea)

授業の目標 Course Objectives

Students improve their skill and knowledge by being engaged in an actual work relating their future career.
For overseas internship, students develop global vision by their experience overseas, gain expertise and experimental techniques which seem to be hard to obtain in Japan.

到達目標 Course Goals

Students start to contact with where to do internship, then improve skills of communication, language, research practice, research network and community formation etc, so that they can raise consciousness as an engineer or a researcher.
For overseas internship, students should try not to keep the experience at only level of basic studies, try to apply the experience to collaborative researches with a practical level in the future.

授業計画 Course Schedule

The program will be generally conducted following the schedule below.

1. Announcement
2. Application (not equal to Registration)
3. Preparation
4. Internship for about between two weeks and two months
5. Submission of a report for the internship, presentation

準備学習（予習・復習）等の内容と分量 Homework

Students need to do preliminary search and to prepare ecperiments in advance.

成績評価の基準と方法 Grading System

Basically, students must submit a report and do a presentation (in English language for overseas internship).
They will be evaluated by the above elements.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

使用しない

講義指定図書 Reading List

使用しない

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	化学特別講義[Advanced Chemistry]		
講義題目 Subtitle	物理化学特別講義 2024[Physical Chemistry 2024]		
責任教員 Instructor	村越　敬 [MURAKOSHI Kei] (大学院理学研究院)		
担当教員 Other Instructors	羽馬　哲也 (東京大学)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094411
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELCOM 6400		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Interstellar chemistry, chemical kinetics, ion-molecule reaction, surface science, quantum tunneling

授業の目標 Course Objectives

We learn elementary physico-chemical processes occurring in interstellar space from the viewpoint of chemical kinetics and reaction dynamics. In addition to observational and theoretical studies, some key laboratory experiments are also reviewed.

到達目標 Course Goals

We learn that interstellar astrochemistry is an interdisciplinary science covering astronomy, planetary science, chemistry, spectroscopy, and surface science, and that approaches from each discipline are needed to understand the meaning of astrochemical phenomena.

授業計画 Course Schedule

1. Introduction to interstellar chemistry
2. The formation of hydrogen molecules in the early universe
3. Langevin rate coefficient in ion-molecule reactions
4. Why are laboratory experiments necessary for studying chemical kinetics?
5. Quantum tunneling in chemistry
6. Dust surface chemistry
7. Future perspective on interstellar chemistry

準備学習 (予習・復習)等の内容と分量 Homework

To read the basic parts of Physical and Quantum Chemistry textbooks at undergraduate level is highly recommended.

成績評価の基準と方法 Grading System

Comprehensively evaluate course status including attendance and report.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

http://www.hamalab.c.u-tokyo.ac.jp/research-english-ver/

備考 Additional Information

科目名 Course Title	化学特別講義[Advanced Chemistry]		
講義題目 Subtitle	無機分析化学特別講義 2024[Inorganic and Analytical Chemistry 2024]		
責任教員 Instructor	上野　貢生 [UENO Kosei] (大学院理学研究院)		
担当教員 Other Instructors	坪井　泰之 (大阪公立大学)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094412
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELCOM 6402		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Semiconductor, Materials for electronics, Photochemistry, Laser, Plasmonics, Nanomaterials、Photomedicine

授業の目標 Course Objectives

Recent remarkable advances of science and technology are due to the explosive development of semiconductor engineering. The semiconductor engineering should be closely related to chemistry, especially inorganic chemistry. Actually, the main business of major chemical industries has a close relation with the conductor engineering in Japan. In this meaning the chemistry of semiconductors will presumably centered in the field of inorganic chemistry. On the other hand, nanotechnology has been a powerful driving force of the development of semiconductor engineering and their current and future promising applications should be “photonics”. In the lecture, the basics and modern/future applications of nanotechnology and photonics will be explained from the viewpoint of inorganic chemistry.

到達目標 Course Goals

Understanding the subjects noted below

1) Fundamentals of light-matter interactions
2) Inorganic chemistry of semiconducting materials
3) Photonic functions of molecular / inorganic materials
4) Photonics control of Functional Materials
5) Photonic measurements of Functional Materials
6) Photonics functions based on nanostructures
7) Modern Applications at the state-of-art

授業計画 Course Schedule

1) Introduction of semiconductor engineering and chemistry
2) Concepts of nanotechnology and photonics
3) Fundamentals of light-matter interactions
4) Photonics function, control, and measurement of Functional Materials
5) Photonics functions based on nanostructures
6) Modern Applications at the state-of-art

準備学習 (予習・復習)等の内容と分量 Homework

Homework will be handed out in the class.

成績評価の基準と方法 Grading System

Reports (homework, 80) and Quiz (20 %)

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	化学特別講義[Advanced Chemistry]		
講義題目 Subtitle	有機化学特別講義 2024[Organic Chemistry 2024]		
責任教員 Instructor	澤村　正也 [SAWAMURA Masaya] (大学院理学研究院)		
担当教員 Other Instructors	野崎　京子 (東京大学)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094413
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELCOM 6400		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Organic Chemistry, Catalysis, Organometallic Chemistry, Polymer Synthesis, Organic Synthesis, Green Chemistry

授業の目標 Course Objectives

Catalysts play a central role in material conversion by participating in the breaking and forming of covalent bonds. In this lecture, we will learn about the material synthesis that the presenter is working on and the development of catalysts for it from two perspectives: (1) social problem-solving type and (2) curiosity-driven type.

The organic chemical industry has developed by producing useful substances from fossil resources. However, when we think about sustainability, we realize that there are many unused carbon resources. In this lecture, together with the instructor, we will consider what scientists can do to effectively utilize unused carbon resources and develop new materials with low environmental impact.

On the other hand, organic molecules with unique structures may exhibit physical properties due to special orbitals. These molecules often have beautiful structures, and being able to appreciate them is a privilege in academia. We will also touch on the appeal of chemistry that is not limited to being "useful" and consider its significance.

到達目標 Course Goals

The goal of this lecture is to understand the characteristics of transition metal catalysts and typical elements, and acquire the ability to think integrative, take on challenges, and come up with ideas that will contribute to the development of organic chemistry.

授業計画 Course Schedule

1. Catalyst development for effective use of unused carbon resources
2. Aiming at creating new sustainable materials
3. The appeal of organic molecules with unique structures

準備学習 (予習・復習)等の内容と分量 Homework

Preparation is not necessary, but basic knowledge of transition metal catalysts and organic synthetic chemistry is desirable. Assign a report assignment related to the lecture content.

成績評価の基準と方法 Grading System

Attendance status and report assignments will be comprehensively evaluated.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

当日に資料を配布する。

Materials will be distributed on the day.

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

https://park.itc.u-tokyo.ac.jp/nozakilab/indexE.html

備考 Additional Information

科目名 Course Title	化学特別講義[Advanced Chemistry]		
講義題目 Subtitle	生物化学特別講義 2024[Biochemistry 2024]		
責任教員 Instructor	坂口　和靖 [SAKAGUCHI Kazuyasu] (大学院理学研究院)		
担当教員 Other Instructors	後藤　佑樹 (京都大学)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094414
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code		CHEM_ELCOM 6400	
補足事項 Other Information			
授業実施方式 Class Method		1 対面授業科目《対面のみ》	

キーワード Key Words

Biological Chemistry, Chemical Biology, Peptide Chemistry, Biosynthesis Engineering, Ribosomal Synthesis

授業の目標 Course Objectives

In living organisms, ribosomes drive the translation reaction, in which proteins (polypeptide chains) are produced using genetic information as a template. Considering the translation reaction as a synthetic system of chemical compounds, it has many advantages over other synthetic systems. Therefore, there have been many studies to engineer the translation reaction as a synthetic tool to produce artificial peptides. Moreover, by combining with selection techniques such as phage display, ribosome display, and mRNA display, it has been also utilized for the development of functional peptides. In this course, after reviewing the mechanism of translation reaction, we will discuss examples of its engineering and applications, highlighting the significance and potential of chemical biology based on ribosomal synthesis.

到達目標 Course Goals

· To be able to explain the mechanism of prokaryotic translation reactions.
· To understand the significance of engineered ribosomal synthesis as synthetic tools.
· To understand the significance of engineered ribosomal synthesis as compound discovery tools.

授業計画 Course Schedule

1. Basics of the translation reaction
2. Methodologies for the production of artificial proteins/peptides by translation
3. Methodologies for the development of functional peptides by engineered translation
4. Recent examples of the production of pseudo-natural peptides by in vitro engineered translation
5. Recent examples of the discovery of pseudo-natural peptides by in vitro selection

準備学習 (予習・復習)等の内容と分量 Homework

Review your previous knowledge about ribosomal synthesis and peptide chemistry.

成績評価の基準と方法 Grading System

You will be evaluated by active participation including investigation, consideration, and discussion (70%), and assignment on a specified topic (30%, mandatory).

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

適宜、資料を配布する。
Hand out materials.

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	化学特別講義[Advanced Chemistry]		
講義題目 Subtitle	キャリアマネジメント特別セミナー[Career Management Special Seminar]		
責任教員 Instructor	中冨　晶子 [NAKATOMI Akiko] (大学院理学研究院)		
担当教員 Other Instructors	七澤　淳 (理学研究院)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094415
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELCOM 6400		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Company, Research and Development, Career Path, Management Education

授業の目標 Course Objectives

1. From the early stages, students will learn what society expects from its Ph.D.s.
2. Students will acquire the knowledge of social situations which help set research themes.

到達目標 Course Goals

1. Through logical and mathematical thinking with a high level of expertise, students will be actively involved in non-specialized social issues.
2. Students will connect social issues with their own specialties (strength), then incorporate them into a “research theme”.
3. Students will actively involve themselves in group discussions while considering other participants.

授業計画 Course Schedule

Classes will be conducted in small groups (generally around 5 students).
1: Introduction of economics, patents, and corporate research cases by visiting professor Atsushi Nanasawa, who was active in the private sector for many years. (60min)
2: Read books on social issues and practice (1) problem identification and (2) suggest solutions in the form of workshops.
3: Individual interviews (specialization / research situation / career preference) will be held around the 1st and 2nd classes. A follow up meeting will be held in March 2025.

[Themes of lecture / Work shop] Total 6 classes, 120 min each
1. Concept of production cost / Objectives and operational issue of group work and workshop
2. What is a patent? / Environment, natural resources and energy
3. Research cases of young employees / Artificial intelligence
4. Research cases of veterans / Life science
5. Research cases of responsible people / Population and generational attitudes
6. Summary of workshops / Theme setting for Company Consortium

Classes will generally be held during the week around the 20th of each month, the dates decided in consultation with students. Classes will generally be conducted face-to-face, but online (hybrid) participation is also possible depending on the situation. Slack and Miro online whiteboard will be used for information exchange.

準備学習 (予習・復習)等の内容と分量 Homework

Choose and read one book on each designated lecture theme in advance so that you can discuss it.

成績評価の基準と方法 Grading System

Students will be evaluated by i) attitude toward learning (20%), ii) status of homework efforts (degree of information collection and understanding) (30%), iii) contribution to group discussions and group work in each class (e.g., active participation and quality of comments) (30%), iv) quality of reports and other submissions (20%).

他学部履修の条件 Other Faculty Requirements

Priority will be given to participants in degree programs and fellowships, and this may limit the available places.

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

https://phdiscover.jp/alp/
https://sites.google.com/eis.hokudai.ac.jp/dxphd-fellow/home
https://sites.google.com/elms.hokudai.ac.jp/ambitious-phd-fellow/home

研究室のホームページ Websites of Laboratory

備考 Additional Information

· For convenience, this course is offered as a subject at the graduate level, but it is recommended for doctoral course participants.

· Priority will be given to participants in degree programs and fellowships who are required to complete this course. If there are too many applicants for the course, the instructor in charge will contact you via the ELMS to confirm your place.

*The first class will be held between 4/22-26. Students interested in attending must complete the scheduling form (Deadline for responses: April 10). Information on scheduling is available on the ELMS.

科目名 Course Title	化学特別講義[Advanced Chemistry]		
講義題目 Subtitle	実践的データ科学[Practical Data Science]		
責任教員 Instructor	中冨　晶子 [NAKATOMI Akiko] (大学院理学研究院)		
担当教員 Other Instructors	和田　陽一郎 ((株)D4c アカデミー)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094416
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELCOM 6400		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Data Science, Social Implementation, Programming, Presentation, Career Making

授業の目標 Course Objectives

As we move to Society 5.0, people who can implement various methods of data science in society (hereafter, simply described as “social implementation”) are required. Since the process of social implementation is similar to the process of conducting academic research, there are cases where people who have received an academic research education at graduate school will proceed to be social implementation specialists. The purpose of this class is to acquire skills necessary for social implementation (programming, various methods of data science, quality control, output for society) regardless of current knowledge of data science. Students are expected to become leaders in various fields by adding data science to the skills they have cultivated in their current specialized field.

到達目標 Course Goals

Students will

1. be able to understand various methods of data science and implement them.
2. be able to learn and practice how to manage quality control when implementing data science in society.
3. be able to learn and practice the techniques to communicate results obtained by data science methods to society.

授業計画 Course Schedule

This class will be offered as an intensive lecture by Dr. Yoichiro Wada (CEO, D4c Academy /Executive Officer, Data4c’s /Visiting Professor, Hokkaido University /Visiting Professor, The University of Electro-Communications) who has been active as a data scientist for more than 10 years.

Units 1 to 5: lecture (60 minutes), exercises (20 minutes), and explanations (10 minutes)
Units 6 to 9: Students will be divided into groups to perform social implementation role play. Therefore, discussions and data analysis are mainly conducted by students.

Unit 1: Introduction to Data Science for Social Implementation, Programming-1 (introduction to Python)
Unit 2: Programming-2 (control syntax, data handling)
Unit 3: Understanding and practice of data science methods-1 (modeling and validation)
Unit 4: Understanding and practice of data science methods-2 (various modeling methods and their implementation)
Unit 5: Quality control in data science (project management, program test, output check), Communicating to society (reporting / presentation)
Unit 6: Explanation of the case, scheduling / division by group, presentation of the results of each group
Unit 7: Performing data analysis, creation of presentation file
Unit 8: Performing data analysis, creation of presentation file
Unit 9: Presentation and question-and-answer session for each group, summary of the lecture

準備学習（予習・復習）等の内容と分量 Homework

Advance preparation
It is necessary to bring your personal PC. Install the necessary software (all free) before class. Procedure manual will be distributed.
Pre-learning materials will be provided for computer language beginners.

If the exercises are not completed in time, take them home and submit them by the deadline announced during class.
If you want to revise the contents of the presentation in Unit 9, please do so and submit it before the deadline announced during class.

The e-mail address for submission will be given during class.

成績評価の基準と方法 Grading System

(1) Submit assignments that will be given during class by e-mail to the designated address.

Accuracy and logical consistency of the submitted content will be evaluated.
The level of understanding of the lecture will also be evaluated through the the submitted content.
(2) Present the output of the role play that the group worked on.
Then, Submit presentation file by e-mail to the designated address.
Originality of the problem setting, accuracy of the analysis, logical consistency of the presentation and ease of understanding of the submitted content will be evaluated.
The percentage of the total evaluation is 40% for (1) and 60% for (2).

他学部履修の条件 Other Faculty Requirements

Priority will be given to participants in the Ambitious program for smart materials science (SMatS) and other degree programs who are required to complete this course. If there are too many applicants for the course, the instructor in charge will contact you to confirm your place.

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

https://phdiscover.jp/hu/smats/, https://sites.google.com/eis.hokudai.ac.jp/dxphd-fellow/home, https://sites.google.com/elms.hokudai.ac.jp/ambitious-phd-fellow/home

研究室のホームページ Websites of Laboratory

備考 Additional Information

This class will be held on the following dates.
Jun 24 (Mon) 3rd-5th period (13:00-18:00)
Jun 25 (Tue) 3rd-5th period (13:00-18:00)
Jun 26 (Wed) 3rd-5th period (13:00-18:00)
The lecture room is Room 2-409、Science Bldg. 2.

科目名 Course Title	化学特別講義[Advanced Chemistry]		
講義題目 Subtitle	Leading and Advanced Molecular Chemistry and Engineering IIB - 2024[Leading and Advanced Molecular Chemistry and Engineering IIB - 2024]		
責任教員 Instructor	村越　敬 [MURAKOSHI Kei] (大学院理学研究院)		
担当教員 Other Instructors	Yang-Hsiang CHAN (National Yang Ming Chiao Tung University)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094421
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELCOM 6401		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Fluorescence techniques, NIR-II emission, Organic dyes, Fluorescence-guided surgery, FDA-approved fluorescent dyes

授業の目標 Course Objectives

In this course, students will learn about the history and evolution of fluorescence technology. They will then delve into the optical and chemical properties of fluorescent dyes from a molecular perspective. The course will introduce the most popular NIR-II (1000-1700 nm) fluorescence technology of the past decade and discuss the current challenges scientists face in designing and synthesizing NIR-II organic molecules. On the application front, the course will cover the distinctive imaging advantages of NIR-II and its current applications in clinical surgery. Finally, the course will explore the future prospects of fluorescence technology.

到達目標 Course Goals

The main objectives of this course are to assist students in: 1) Understanding the working principles of fluorescence imaging technology, as well as its technical developments and limitations; 2) Grasping the design concepts of fluorescent molecules and their impact on optical properties; 3) Understanding the types of fluorescent dyes available in the market and future trends.

授業計画 Course Schedule

1. Introduction to fluorescent techniques
2. Design of bright organic fluorophores
3. Development of NIR-emissive dyes
4. The role of fluorescence technique in biomedical diagnosis
5. Current advanced of NIR-II fluorescence-guided imaging in clinical and future challenges

準備学習（予習・復習）等の内容と分量 Homework

To read the basic parts of Physical and Quantum Chemistry textbooks at undergraduate level is highly recommended.

成績評価の基準と方法 Grading System

One final written exam will be given to students for the grading.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

This course will be provided as part of the Hokkaido Summer Institute., For more information (invited lecturers, course details, etc.), please visit the website below:, https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G056

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	化学特別講義[Advanced Chemistry]		
講義題目 Subtitle	Leading and Advanced Molecular Chemistry and Engineering IIC - 2024[Leading and Advanced Molecular Chemistry and Engineering IIC - 2024]		
責任教員 Instructor	村越　敬 [MURAKOSHI Kei] (大学院理学研究院)		
担当教員 Other Instructors	ZeeHwan KIM (Seoul National University)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094422
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELCOM 6401		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Physical Chemistry, Nano-Optics, Plasmonics, Molecular Spectroscopy, Photo-Catalysis, Light-Harvesting

授業の目標 Course Objectives

This course aims to offer the students with the principle and application of modern spectroscopy, optical imaging, and photochemistry enabled by light-field confined at nanometer scale. Students will learn (1) how to confine light to a few nanometer scales, (2) how such a confined field interacts with molecules, and (3) the application of the interactions to physics, chemistry, materials science, and bio-imaging. For the field confinement, we will primarily focus on the physics of field confinement caused by plasmonic nanostructures and their validation. The application includes nanoscale spectroscopy at a single-molecule regime, nano-scale chemical imaging, and plasmon-induced / enhanced photo-catalysis.

到達目標 Course Goals

The goal of this course is to help students (1) understand the quantum mechanics and optics of nanoconfined light-molecule interaction and (2) gain a general perspective on what is currently possible with the state-of-art spectroscopy, imaging, and photochemistry techniques enabled by the nano-confined electromagnetic field.

授業計画 Course Schedule

1. Introduction: how to focus light to a nanometer scale and what it can do
2. Fundamentals: Molecular quantum mechanics and elementary electrodynamics of light
3. Fundamentals: Quantum mechanics of light-molecule interaction
4. Plasmonics of nanostructure: field enhancement and field confinement
5. Nano-scale molecular spectroscopy and imaging
6. Plasmon-induced and polaritonic chemistry

準備学習（予習・復習）等の内容と分量 Homework

To read the basic parts of Physical and Quantum Chemistry textbooks at undergraduate level is highly recommended.

成績評価の基準と方法 Grading System

One final written exam will be given to students for the grading.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

This course will be provided as part of the Hokkaido Summer Institute., For more information (invited lecturers, course details, etc.), please visit the website below:, https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G057

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	化学特別講義[Advanced Chemistry]		
講義題目 Subtitle	Leading and Advanced Materials Chemistry and Engineering IIA - 2024[Leading and Advanced Materials Chemistry and Engineering IIA - 2024]		
責任教員 Instructor	村越　敬 [MURAKOSHI Kei] (大学院理学研究院)		
担当教員 Other Instructors	Mengning DING (Nanjing University)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094423
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELCOM 6401		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Electrochemistry, Surface Chemistry, Catalysis, Physical Chemistry, Sustainable Chemistry

授業の目標 Course Objectives

This course introduces the fundamental principles in electrochemistry and electrochemical processes at the molecular level to enable the in-depth understanding for their diverse applications in clean energy and sustainable chemistry technologies. The class will cover the concepts such as electrochemical methods, electron transfer, double layer structure, interfacial processes, electro-kinetics, electro-catalysis, etc. Examples of state-of-the-art design, synthesis and applications of catalytic materials for sustainable energy/chemical conversions such as CO2 conversion, biomass upgrading, C-H oxidation, water electrolysis for green hydrogen energy will be introduced.

到達目標 Course Goals

The goal of this course is to help students (1) understand the fundamental working principles of electrochemistry and electrochemical interfacial processes; (2) understand the examples of application of electrochemical technology in the sustainable chemistry, such as electrocatalysis, electrosynthesis and electrochemical devices; (3) understand the surface/interfacial processes at the atomic level, and structure-property relationships to achieve optimal function of materials and properties; (4) familiar with the synthetic methods to prepare and characterize state-of-the-art electrocatalytic materials.

授業計画 Course Schedule

1. Introduction to electrochemistry
2. Characterization of the electrochemical processes
3. Advanced technology for the in-depth investigation on micro-electrokinetics and their modulation
4. Electrocatalytic water splitting for hydrogen production
5. Electrocatalytic conversion of CO2 (and other chemicals) to value-added products

準備学習（予習・復習）等の内容と分量 Homework

To read the basic parts of Physical Chemistry textbook at undergraduate level is highly recommended.

成績評価の基準と方法 Grading System

One final written exam will be given to students for the grading.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

This course will be provided as part of the Hokkaido Summer Institute., For more information (invited lecturers, course details, etc.), please visit the website below:, https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G048

研究室のホームページ Websites of Laboratory

https://mdinglab.weebly.com/

備考 Additional Information

科目名 Course Title	化学特別講義[Advanced Chemistry]		
講義題目 Subtitle	Leading and Advanced Materials Chemistry and Engineering IIIA - 2024[Leading and Advanced Materials Chemistry and Engineering IIIA - 2024]		
責任教員 Instructor	村越　敬 [MURAKOSHI Kei] (大学院理学研究院)		
担当教員 Other Instructors	YOSHIO Masafumi (NIMS), MASUDA Takuya (NIMS)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094424
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELCOM 6401		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Supramolecular Chemistry, Printed Electronics, Electrochemistry, Advanced Characterization Techniques

授業の目標 Course Objectives

In this course, students will delve into molecular assembly chemistry, exploring the design and device applications of ion and electron functional organic and polymer materials, including printed electronics. They will also delve into advanced interface analysis techniques. The lectures will primarily focus on the intricate process of creating functional organic materials through nanostructure formation via molecular self-assembly. This encompasses various applications such as soft actuators and separation membranes utilizing liquid crystals, block copolymers, and covalent organic frameworks. Moreover, the course will cover advanced characterization techniques, including X-ray photoelectron spectroscopy, X-ray absorption/fluorescence spectroscopy, vibrational spectroscopy, electron microscopy, scanning probe microscopy, etc, specifically targeting cathode, anode, and electrolyte materials used in lithium-ion and fuel cells. Throughout the course, students will explore how structural design and orientational control in organic materials can enhance their electrical and mechanical properties in functional devices. Additionally, they will gain insights into the changes occurring in the surface chemistry of electrodes and electrolyte interfaces during capacitor and battery charging.

到達目標 Course Goals

The goal of this course are as follows: Understand the intermolecular interactions in organic assemblies and grasp the fundamental working principles of organic ionic and electronic devices. Gain insight into materials design, engineering, processing, and the relationships between structure and properties to achieve optimal material function. Develop problem-solving skills and explore solutions based on acquired knowledge. By pursuing these objectives, students will develop the skills necessary to make global contributions in their field.

授業計画 Course Schedule

1. Supramolecular materials chemistry
2. Soft Actuators and Sensors
3. Functional Nanostructured Membranes
4. Printed Electronics
5. Lithium-ion batteries and Fuel Cells
6. Advanced Characterization Techniques

準備学習（予習・復習）等の内容と分量 Homework

To read the basic parts of Organic and Physical Chemistry textbooks at undergraduate level is highly recommended.

成績評価の基準と方法 Grading System

Two reports will be given to students for the grading.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

This course will be provided as part of the Hokkaido Summer Institute., For more information (invited lecturers, course details, etc.), please visit the website below:, https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G050

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	化学特別講義[Advanced Chemistry]		
講義題目 Subtitle	Leading and Advanced Biological and Polymer Chemistry and Engineering I - 2024[Leading and Advanced Biological and Polymer Chemistry and Engineering I - 2024]		
責任教員 Instructor	坂口　和靖 [SAKAGUCHI Kazuyasu] (大学院理学研究院)		
担当教員 Other Instructors	Pascale Legault (University of Montreal), KAMADA Rui (理学研究院), NAKAGAWA Natsumi (理学研究院)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094425
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELCOM 6401		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

RNA structure and function, microRNAs, microRNA biogenesis, microRNA regulation, let-7, Parkinson's Disease, alpha-synuclein, viral infections, Zika Virus

授業の目標 Course Objectives

MicroRNAs (miRNAs) constitute an important class of small non-coding RNAs that, like transcription factors, play a central role in regulating gene expression. They function by targeting complementary sequences of mRNA, generally resulting in translational inhibition. Misregulation of miRNA levels can change gene expression patterns, and these changes have been directly linked to developmental defects and several human diseases, such as cancer and neurodegenerative diseases.

The course will focus on better understanding the following topics:
1. The importance of miRNA in gene regulations for health and diseases
2. The general pathway of miRNA biogenesis and the main enzymes involved in post-transcriptional regulation
3. The different mechanisms for regulating miRNA levels
4. The discovery of novel regulators of miRNA levels

到達目標 Course Goals

Here are some of the key concepts and skills students will develop:
1. Appreciate the importance of miRNA levels in health and disease
2. Appreciate the role of RNA in regulating gene expression
3. Understand the structure and function of key proteins involved in miRNA maturation
4. Understand the role of RNA-binding proteins in regulating miRNA levels
5. Apply simple web-based tools for miRNA research
6. Become familiar with experimental techniques used in miRNA biology
7. Critical evaluation of miRNA research litterature

授業計画 Course Schedule

July 29th (Mon)
10:30 ~ 12:00 Lecture
13:00 ~ 14:30 Computer exercise using web-based tools (students will need to bring their own computer)

July 30th (Tue)
10:30 ~ 12:00 Lecture
13:00 ~ 14:30 Discussion

July 31st (Wed)
10:30 ~ 12:00 Lecture
13:00 ~ 14:30 Discussion

August 1st (Thu)
10:30 ~ 12:00 Lecture
13:00 ~ 14:30 Seminar

準備学習 (予習・復習)等の内容と分量 Homework

To be provided at the first class

成績評価の基準と方法 Grading System

Assignment on specified topics regarding "microRNA function" and "microRNA maturation" (60%); Active student participation in class (40%)

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

None

講義指定図書 Reading List

To be provided at the first class

参照ホームページ Websites

This course will be provided as part of the Hokkaido Summer Institute., For more information (invited lecturers, course details, etc.), please visit the website below:, https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G042

研究室のホームページ Websites of Laboratory

http://airen.bcm.umontreal.ca
https://wwwchem.sci.hokudai.ac.jp/~biochem/

備考 Additional Information

Other Instructor: Prof. Pascale Legault (University of Montreal)

科目名 Course Title	応用化学特別講義[Advanced-Applied Chemistry]		
講義題目 Subtitle	有機プロセス工学特別 Lecture 2024[Chemical Process Engineering 2024]		
責任教員 Instructor	猪熊　泰英 [INOKUMA Yasuhide] (大学院工学研究院)		
担当教員 Other Instructors	久木　一朗 (大阪大学)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094431
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code		CHEM_ELCOM 6410	
補足事項 Other Information			
授業実施方式 Class Method		1 対面授業科目《対面のみ》	

キーワード Key Words

Supramolecules, Organic Crystals, Organic Synthesis, Chirality

授業の目標 Course Objectives

Reversible and weak intermolecular interactions among organic molecules play an important role in producing giant functional molecules. In this lecture, you can learn fundamental intermolecular interactions such, as hydrogen bonds, to understand how molecular assemblies are formed from small organic molecules. This will lead to an understanding of the functions of large molecular assemblies and porous organic crystals created by reversible intermolecular interactions. In the latter half of the lecture, this lecture helps you to understand the functions of cavities surrounded by supramolecular assemblies, such as uptake of small molecules and the discrimination of molecular chirality, from basic principles to the latest research in a cross-sectional manner.

到達目標 Course Goals

After successful completion of this course, you will be able to

1. explain how and why giant molecular assemblies are formed from small molecules.
2. acquire the basic knowledge necessary to understand the latest research papers and gain insight into the molecular design of supramolecules-based functional organic materials.

授業計画 Course Schedule

1. Basic concept of Supramolecules
2. Intermolecular interactions between small molecules
3. Formation of Giant Molecular Assemblies
4. Synthetic chemistry of supramolecules

5~7. Chemical phenomena in void space of supramolecules

8. Public lecture

準備学習（予習・復習）等の内容と分量 Homework

The lecture will proceed based on the prerequisite knowledge of organic chemistry taken in the undergraduate course. You are required to read and understand English research papers on supramolecules and organic crystals introduced in the lecture before the next lecture. You are expected to spend approximately 2 hours each for preparation and multiple assignments using the textbook and the assigned papers.

成績評価の基準と方法 Grading System

You will be evaluated by the score of short tests during the lecture (20%) and the report assignment (80%).

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

大学院 Lecture 有機化学 I 分子構造と反応・有機金属化学 第 2 版／野依良治・中筋一弘・玉尾皓平・奈良坂紘一・柴崎正勝・鈴木啓介(編)：東京化学同人

大学院 Lecture 有機化学 II 有機合成化学・生物有機化学 第 2 版／野依良治・中筋一弘・玉尾皓平・奈良坂紘一・柴崎正勝・橋本俊一・鈴木啓介・山本陽介・村田道雄(編)：東京化学同人

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

http://www.chem.es.osaka-u.ac.jp/mac/en/

備考 Additional Information

科目名 Course Title	応用化学特別講義[Advanced-Applied Chemistry]		
講義題目 Subtitle	物質化学特別講義 2024[Materials Chemistry 2024]		
責任教員 Instructor	島田　敏宏 [SHIMADA Toshihiro] (大学院工学研究院)		
担当教員 Other Instructors	浅川　鋼児 (キオクシア(株))		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094432
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code		CHEM_ELCOM 6411	
補足事項 Other Information			
授業実施方式 Class Method		1 対面授業科目《対面のみ》	

キーワード Key Words

semiconductor processes and materials, integrated circuits, memory, nano-fabrication. lithography, resists, electronics

授業の目標 Course Objectives

This course is intended to provide basics of fabrication process and materials of modern large-scale digital integrated circuits (CPUs, memories etc.). It is also aims at teaching basics of related electronics for students who do not major in electronics.

到達目標 Course Goals

Through a series of lectures, students understand processes of semiconductor fabrication including physics and chemistry behind the process.

授業計画 Course Schedule

Detailed schedule will be informed one month before the start of this course. The contents will be as follows:
- Introduction to modern electronics
- History of semiconductor miniatualization (scaling)
- Memory devices
- Overview of semiconductor processing
- Lithography: Optics and resists for nanofabrication
- Thin film growth: Chemical vapor deposition (CVD) and atomic layer deposition (ALD)
- Etching: Plasma and reactive-ion etching (RIE)
- Chemical mechanical polishing (CMP)

準備学習（予習・復習）等の内容と分量 Homework

The materials for the lecture will be handed in advance. Students are expected to study before and after each lecture.

成績評価の基準と方法 Grading System

The grading will be based on the report submitted after the lecture and the degree of participation in the lecture.

他学部履修の条件 Other Faculty Requirements

The participation might not be granted based on criteria about the economic security of the company the lecturer belongs to.

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	応用化学特別講義[Advanced-Applied Chemistry]		
講義題目 Subtitle	生物機能高分子特別 Lecture 2024[Advanced Applied Biochemistry 2024]		
責任教員 Instructor	松本　謙一郎 [MATSUMOTO Kenichiro] (大学院工学研究院)		
担当教員 Other Instructors	山田　美和 (岩手大学)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094433
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELCOM 6410		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

environmentally friendly polymers, biodegradable plastics, bioplastics, microorganisms, enzymes, metabolic engineering, protein engineering, biomass utilization, chemical recycling

授業の目標 Course Objectives

The aim of this course is to develop human resources who can respond to the global environmental problems we are facing today and to develop technologies that can contribute to solving these problems.
In this lecture, students will learn about the synthesis and degradation of bioplastics, as well as the current status of degradation of persistent plastics.
The objective of this course is to understand the synthesis and degradation of bioplastics, as well as the current status of degradation of persistent plastics, from both practical and basic research perspectives.

到達目標 Course Goals

In this class, students will mainly learn about the synthesis and degradation mechanisms of bioplastics. In addition, students will learn about enzymatic degradation technologies for persistent plastics.

授業計画 Course Schedule

Synthesis and degradation of plastics using microorganisms and enzymes

Lecture 1: ″Environmental Problems and Bioplastics
Students will learn about the global environmental problems we are facing today, the general concept, types, and synthesis methods of bioplastics, and why bioplastics are expected to contribute to solving environmental problems.

Lecture 2: ″Bioplastics Biosynthesized by Microorganisms
Students will learn about bioplastics biosynthesized by microorganisms, their properties, the current status of industrialization, biosynthesis pathways in microbial cells, and the mechanism of polymerization by enzymes.

Lecture 3: ″Frontiers of Research on Bioplastic Synthesis by Microorganisms
Students will learn about the latest research on bioplastic synthesis by microorganisms using microbial screening, metabolic engineering, and protein engineering. In addition, potential future applications will be discussed.

Lecture 4: ″Degradation Mechanisms of Bioplastics
Students will understand the degradation mechanisms of bioplastics that exhibit biodegradability and the factors that influence degradation.

Lecture 5: Degradation of Biodegradable Plastics in the Environment and the Plastisphere
Students learn about the plastisphere and discuss the impact of biodegradation of biodegradable plastics on the environment.

Lecture 6: Enzymatic Degradation of Biodegradable Plastics by Microorganisms and Recycling Technologies
Learn about the latest research and applications of enzymatic degradation and recycling technologies for persistent plastics.

準備学習 (予習・復習)等の内容と分量 Homework

Read carefully the materials distributed in advance, if any. Students are expected to spend approximately 2 hours preparing for and reviewing the material. During the class, students will be asked for their opinions on their own ideas and will be given opportunities to discuss them with each other.
After the class, students are required to submit a written report on the issues they have set.

成績評価の基準と方法 Grading System

Attendance of 70% or more of the class sessions is a prerequisite for grading. Grades will be based on (1) attitude toward study (40%) and (2) reports (60%).

The report will be evaluated based on the level of understanding of the lecture content, the depth of discussion, and the logical development of the description.
Excellent (100 to 90 points), Superior (89 to 80 points), Good (79 to 70 points), Acceptable (69 to 60 points), Impossible (less than 60 points)

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory
http://appl-micro.agr.iwate-u.ac.jp/index.html
https://biosynchem.eng.hokudai.ac.jp/

備考 Additional Information

科目名 Course Title	応用化学特別講義[Advanced-Applied Chemistry]		
講義題目 Subtitle	異分野ラボビジット		
責任教員 Instructor	髙橋　正行 [TAKAHASHI Masayuki] (大学院理学研究院)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094434
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELCOM 6412		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Interdisciplinary research, Cross-disciplinary exchange, comprehensive perspective

授業の目標 Course Objectives

The goal is to lean about the expert knowledges and skills in the different fields provided by a host laboratory. For this purpose, the students are requested to stay in the host laboratory for a period of about 2 weeks to 2 months.

到達目標 Course Goals

・To be able to conduct research with researchers with different backgrounds by cultivating a wide range of communication skills through discussions.

・To be able to correlate the student's own research and those in different fields by acquiring comprehensive perspectives, which is necessary to promote cross-disciplinary research,

授業計画 Course Schedule

・This class will be limited to graduate students of "Ambitious program for smart materials science" and those joining MANABIYA program of WPI ICReDD.

・Staying a host laboratory will be for a period of two weeks to two months between April to next March.

・Students are requested to leave their own laboratory and stay in the host laboratory to engage the research project provided by the host laboratory and to acquire specialized knowledge and skills in different fields.

準備学習 (予習・復習)等の内容と分量 Homework

・Students are requested to investigate research activities of each laboratory thoroughly and select a laboratory that matches the research field you wish to study.

成績評価の基準と方法 Grading System

・The grade is evaluated based on the content of the submitted report and the discussion with the teacher of this lecture about the training content.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

https://phdiscover.jp/hu/smats/, https://www.icredd.hokudai.ac.jp/ja/manabiya

研究室のホームページ Websites of Laboratory

備考 Additional Information

Follow the instructions of the host laboratory.

科目名 Course Title	応用化学特別講義[Advanced-Applied Chemistry]		
講義題目 Subtitle	Leading and Advanced Molecular Chemistry and Engineering I - 2024[Leading and Advanced Molecular Chemistry and Engineering I - 2024]		
責任教員 Instructor	伊藤　肇 [ITOH Hajime] (大学院工学研究院)		
担当教員 Other Instructors	Andrei K. YUDIN (University of Toronto), KUBOTA Koji (工学研究院)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094441
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELCOM 6411		
補足事項 Other Information			
授業実施方式 Class Method	2 対面授業科目《一部遠隔》		

キーワード Key Words

organic chemistry, organic synthesis, mechanochemical synthesis

授業の目標 Course Objectives

Organic chemistry is a field of study that is important for the effective use of resources and for supporting people's comfortable and healthy lives. In this lecture, leading researchers from abroad and Hokkaido University will give intensive lectures on organic chemistry fields that have been developed remarkably recently and will be useful for students to have knowledge in the future. The courses will cover new synthetic reagents, peptide conformation, and mechanochemical organic synthesis.

到達目標 Course Goals

After the completion of this course, you will be able to know concepts and recent progress in new synthetic reagents, peptide conformation, and mechanochemical organic synthesis.

授業計画 Course Schedule

Course Schedule (the order of the following lectures is subject to change)
1. Mechanochemical organic synthesis I
2. Mechanochemical organic synthesis II
3. Structure and conformation of small molecules
4. New synthetic reagents with multiple reactivities
5. Research proposal I
6. Research proposal II

準備学習（予習・復習）等の内容と分量 Homework

Students will make proposal presentations and reports.

成績評価の基準と方法 Grading System

Grades are judged based on class attitude, presentations, and reports during the course.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

This course will be provided as part of the Hokkaido Summer Institute., For more information (invited lecturers, course details, etc.), please visit the website below:, https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G054

研究室のホームページ Websites of Laboratory

https://itogrouphp.eng.hokudai.ac.jp/en.html
https://sites.chem.utoronto.ca/yudinlab/content/andrei-yudin

備考 Additional Information

科目名 Course Title	応用化学特別講義[Advanced-Applied Chemistry]		
講義題目 Subtitle	Leading and Advanced Molecular Chemistry and Engineering IIA - 2024[Leading and Advanced Molecular Chemistry and Engineering IIA - 2024]		
責任教員 Instructor	清水　研一 [SHIMIZU Kenichi] (触媒科学研究所)		
担当教員 Other Instructors	Wenxiong ZHANG (Peking University), Congyang WANG (Chinese Academy of Sciences), SON Tsui (触媒科学研究所)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094442
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELCOM 6411		
補足事項 Other Information			
授業実施方式 Class Method	2 対面授業科目《一部遠隔》		

キーワード Key Words

catalysis, chemical industry, biomass, organometallics, organic synthesis

授業の目標 Course Objectives

Modern society faces many problems such as global warming, energy crisis, and food problems that affect the survival of the human race. Chemistry is charged with the mission of finding ways to solve these problems and to protect the global environment for the future. In particular, catalytic chemistry, which supports the modern chemical industry, is the key to solving these problems. This lecture will focus on catalytic technologies for solving resource, energy and environmental problems and catalytic chemistry essential for development of next generation chemical industry. The contents will be given by professors who are engaged in pioneering research on innovative catalysis based on new concepts and solid catalysts for the derivation of key chemicals from biomass. The course ″Fundamentals and Applications of Catalytic Chemistry″ will help students develop the ability to solve modern problems and pioneer next-generation technologies.

到達目標 Course Goals

By the end of this course you will be able to understand
1. to understand principles about heterogeneous catalysis
2. to learn CO2 conversion using solid catalysts
3. to learn how to develop catalytic reactions for utilization of natural carbon resources
4. to learn how to develop nanomaterials for novel catalytic reactions
5. to learn fundamental knowledge of direct transformation of P4 or N2 into fine chemicals
6. to learn applications of transition metals in organic synthesis

授業計画 Course Schedule

1.Principals for design and characterization of heterogeneous catalysts
2.Application of heterogeneous catalysts for CO2 hydrogenation
3.Frontiers of catalyst research for utilization of natural carbon resources
4.Development of novel catalytic functions of nanomaterials
5.Activation and Transformation of White Phosphorus to Organophosphorus Compounds
6.Nitrogen Fixation: Fundamentals and Catalysis
7.The History, Current Status and Future of Rare-Earth Organometallic Chemistry
8.Titanium in Organic Synthesis

準備学習（予習・復習）等の内容と分量 Homework

Students will be asked to write a report at the end of each lecture.

成績評価の基準と方法 Grading System

Grades will be judged based on active attendance records and reports at the end of each lecture.

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

This course will be provided as part of the Hokkaido Summer Institute., For more information (invited lecturers, course details, etc.), please visit the website below:, https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G055

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	応用化学特別講義[Advanced-Applied Chemistry]		
講義題目 Subtitle	Leading and Advanced Materials Chemistry and Engineering I - 2024[Leading and Advanced Materials Chemistry and Engineering I - 2024]		
責任教員 Instructor	三浦　章 [MIURA Akira] (大学院工学研究院)		
担当教員 Other Instructors	Laurent Cario (CNRS), Shunsuke SASAKI (CNRS)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094443
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELCOM 6411		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Materials Chemistry, Interdisciplinary collaborations, Solid-state chemistry

授業の目標 Course Objectives

Materials chemistry serves as the intersection where various branches of chemistry come together to explore new materials and enhance their functionalities. For success in such interdisciplinary fields, this course will provide an idea about how to formulate research questions, adapt their expertise to other fields, and collaborate effectively with researchers from different backgrounds. The case studies will be presented to introduce various approaches in materials design and highlight common thoughts that bridge different sub-disciplines. The course also includes hands-on sessions where students participate in role-playing exercises. These exercises simulate the process of launching a new research project in a completely different field, allowing students to apply their expertise in novel contexts.

到達目標 Course Goals

By the course's end, students will cultivate adaptable mindsets, helping them to envision research projects across diverse disciplines throughout their academic and professional careers.

授業計画 Course Schedule

1. Guidance of lectures
2. Synthetic chemistry of discrete molecules and extended inorganic solids: Common concepts, differences and transversal approaches
3. A case study of transversal approach in solid-state chemistry
4. Ascending technology readiness levels (TRL) from fundamental solid-state chemistry to microelectronic devices: a case study in Mottronics applications
5. Collective brainstorming for new transversal projects
6. A short briefing about writing scientific proposals in Japanese, French and/or European styles, followed by elaboration of each student's transversal project through role playing

準備学習（予習・復習）等の内容と分量 Homework

A short questionnaire/report will be assigned at every lecture to help students to construct their transversal ideas.

成績評価の基準と方法 Grading System

提出されたレポートにより判断する

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

This course will be provided as part of the Hokkaido Summer Institute., For more information (invited lecturers, course details, etc.), please visit the website below:, https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G047

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	応用化学特別講義[Advanced-Applied Chemistry]		
講義題目 Subtitle	Leading and Advanced Materials Chemistry and Engineering IIB - 2024[Leading and Advanced Materials Chemistry and Engineering IIB - 2024]		
責任教員 Instructor	忠永　清治 [TADANAGA Kiyoharu] (大学院工学研究院)		
担当教員 Other Instructors	Masashi KOTOBUKI (Ming Chi University of Technology), FUJII Yuta (工学研究院)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094444
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELCOM 6411		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Electrochemical devices; Electrolyte; Electrode; Nano-structure; Batteries

授業の目標 Course Objectives

Recently, safe, low-cost, high-energy density, and long-lasting electrochemical devices for energy conversion and storage are highly required for mobile devices, electric vehicles, and storage for renewable energy to build a sustainable society. Development of novel materials and structural/morphological control of these materials are key issues. The aim of this course is to describe the importance of electrochemical devices and materials science involved in the development of such electrochemical devices. Fundamental concepts in electrochemical energy conversion and storage are overviewed at first, and then the materials chemistry for the electrochemical devices will be described. The preparation process for materials of electrochemical devices, the effect of nano-structures in electrodes for batteries, and the development of all-solid-state batteries are also described.

到達目標 Course Goals

By the end of this course you will be able to
1. explain and compare various electrochemical energy conversion and storage systems
2. understand the basic requirements for materials used in electrochemical energy conversion and energy storage devices
3. explain the effects of structure and morphology on the properties of electrochemical devices
4. understand and discuss materials and electrochemical devices in future energy storage system

授業計画 Course Schedule

As a HSI course, Professor Masashi Kotobuki (Battery Research Center of Green Energy, Ming Chi University of Technology) will give most of the lectures.

The following topics will be covered during this course.

1. Fundamental concepts about electrochemical energy conversion and storage
2. Materials used in electrochemical devices
3. Introduction of inorganic materials science for electrochemical devices
4. Nanostructured materials applied to electrodes for lithium and sodium ion batteries
5. Fundamentals of solid electrolyte
6. All-solid-state lithium/sodium secondary batteries
7. Overview of recent trends in materials for electrochemical devices and future energy storage system
8. Students presentation on topics in electrochemical devices

準備学習（予習・復習）等の内容と分量 Homework

Students will be expected to download class notes from WEB page and read designated chapter in advance.
Students should read some papers on electrochemical devices during this course and make presentation.

成績評価の基準と方法 Grading System

Grade will be determined by how well one's achievement in this course through
1. a report on nanostructured materials in electrochemical devices (weightage 80%), and
2. a presentation on one's research or some topics in electrochemical devices (weightage 20%).

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

No textbook required. Handouts will be distributed.

講義指定図書 Reading List

"Recent Advances in Energy Storage Materials and Devices", Li Lu edited, Materials Research Forum LLC, ISBN 978-1945291265 (2017).

"Ceramic Electrolytes for All-Solid-State Li Batteries", M. Kotobuki, S. Song, C. Chen, and Li Lu, World Scientific Pub Co Inc ISBN: 978-9813233881(2018).

参照ホームページ Websites

This course will be provided as part of the Hokkaido Summer Institute., For more information (invited lecturers, course details, etc.), please visit the website below:, https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G049

研究室のホームページ Websites of Laboratory

https://brcge.mcut.edu.tw/?Lang=en
https://www.eng.hokudai.ac.jp/labo/inorgsyn/

備考 Additional Information

科目名 Course Title	応用化学特別講義[Advanced-Applied Chemistry]		
講義題目 Subtitle	Leading and Advanced Materials Chemistry and Engineering IIID - 2024[Leading and Advanced Materials Chemistry and Engineering IIID - 2024]		
責任教員 Instructor	島田　敏宏 [SHIMADA Toshihiro] (大学院工学研究院)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094445
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELCOM 6411		
補足事項 Other Information			
授業実施方式 Class Method	4 遠隔授業科目《遠隔のみ》		

キーワード Key Words

materials informatics, python

授業の目標 Course Objectives

The course provides lectures combined with exercises. In the lecture, basic knowledge of statistical methods and machine learning for materials research. In the exercises, we start from basic python programming and instruct how to use various libraries including tensorflow, scikit learn, stan, GPy etc. and databases.

到達目標 Course Goals

1. Understanding the basics of data science and machine learning, especially about terminology.
2. Learning how to use libraries and databases for python.
3. Practical usage of packages for materials informatics.

授業計画 Course Schedule

1. Neural networks
2. Rdkit library for chemicals
3. Machine learning for molecules
4. Sckit learn - library for machine learning
5. Reinforced learning toward protein-folding analysis
6. Genetic algorithm
7. Bayesian concept
8. Interpretation of machine learning results

準備学習（予習・復習）等の内容と分量 Homework

Requirement: personal computer equipped with a keyboard and internet connection
Homework: After each day, homework will be assigned.

成績評価の基準と方法 Grading System

After each day, homework will be assigned. The answer and final report will be used for grading.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

None

講義指定図書 Reading List

Any textbooks or websites on python language

参照ホームページ Websites

This course will be provided as part of the Hokkaido Summer Institute., For more information (invited lecturers, course details, etc.), please visit the website below:, https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G053

研究室のホームページ Websites of Laboratory

https://www.eng.hokudai.ac.jp/labo/kotai/en/index.html

備考 Additional Information

Required Equipment for a class (Laptop, etc.)
A computer with python installed. Instruction of installation will be given to registered students prior to the course.The participants may be contacted in advance for preparation of python language.

科目名 Course Title	応用化学特別講義[Advanced-Applied Chemistry]		
講義題目 Subtitle	Leading and Advanced Biological and Polymer Chemistry and Engineering II - 2024[Leading and Advanced Biological and Polymer Chemistry and Engineering II - 2024]		
責任教員 Instructor	磯野　拓也 [ISONO Takuya] (大学院工学研究院)		
担当教員 Other Instructors	Hsin-Lung CHEN (National Tsing Hua University), SATOH Toshifumi (工学研究院), LI FENG (工学研究院)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094446
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELCOM 6411		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Polymer, Structure, Phase transition, Properties, Small angle scattering

授業の目標 Course Objectives

The connectivity and collective behavior of monomers give rise to intriguing properties that set polymers apart from small molecules. Polymer physics is a specialized field within polymer science that concentrates on the study of the structure, dynamics, and physical properties of polymers. The structures observed in polymers within the experimental time scale are typically metastable and exhibit distinctive features across a wide spectrum of length scales. Therefore, comprehending the fundamental thermodynamic and kinetic principles governing the structure formation is crucial for controlling and designing the hierarchical structures and properties of polymers aiming for practical applications as well as developing novel functional materials.

This course is designed to impart the fundamental concepts of polymer physics to students. We will commence with an exploration of single-chain behavior and gradually delve into the topics including polymer solution thermodynamics, glass transition, self-assembly behavior, viscoelasticity, and dynamics. Additionally, we will briefly touch upon the application of small-angle scattering techniques in the analysis of polymer nanostructures. The goal of this course is to provide students from diverse backgrounds with a foundational understanding of polymer physics that can serve as a stepping stone to grasp the intricacies of the processing-structure-property relationship and the mechanisms dictating the morphological formation of polymers.

到達目標 Course Goals

This course aims to assist students with little or no prior background in polymer science in developing a fundamental understanding of polymer physics. It will cover the essential principles that can be exploited to elucidate the structure-property relationships of polymers. We will also briefly discuss the recent developments in pertinent topics to ignite students' curiosity and motivate them to participate in the research within or related to the domain of polymer physics.

授業計画 Course Schedule

1. Brief review of thermodynamics and basic concepts of polymers
2. Conformational statistics of single polymer chain
3. Thermodynamics of polymer solution and blend
4. Glass transition of polymer
5. Self-assembly of crystalline polymer and block copolymer
6. Viscoelasticity and dynamics of polymers
7. Application of small angle scattering in polymer science
8. Seminar: Physics of the self-assembly of block copolymers

準備学習（予習・復習）等の内容と分量 Homework

Final report on the subjects relating to the structure and physical properties of polymers involving the application of the concepts learned from the lectures.

成績評価の基準と方法 Grading System

Your grade will be determined by how well you demonstrate your achievement of the course goals through

1. Participation to the discussion (10%)
2. Final report (90%)

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

Lecture notes in PDF files will be provided.

講義指定図書 Reading List

Polymer Physics／Michael Rubinstein, Ralph H. Colby：Oxford Univ Pr, 2003
Introduction to Physical Polymer Science／Leslie H. Sperling：Wiley-Interscience, 2005
Polymer Physics／U.W. Gedde：Springer, 1995

参照ホームページ Websites

This course will be provided as part of the Hokkaido Summer Institute., For more information (invited lecturers, course details, etc.), please visit the website below:, https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G043

研究室のホームページ Websites of Laboratory

https://sites.google.com/gapp.nthu.edu.tw/polymer-physics-laboratory/home
http://poly-ac.eng.hokudai.ac.jp/index_e.html

備考 Additional Information

Other Instructor: Hsin-Lung Chen (National Tsing-Hua University)
The class will be held on campus and/or in real-time web system.
We will announce the details via ELMS. Please carefully see ELMS.

科目名 Course Title	化学産業実学[Industrial Practice in Chemical Processes]		
講義題目 Subtitle			
責任教員 Instructor	長谷川　淳也 [HASEGAWA Junya] (触媒科学研究所)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094451
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELCOM 5200		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Practical Science of Chemical Industry, Research and Development, Chemical Technology, Industry-academia Collaboration

授業の目標 Course Objectives

Invited lecturers have a background in science and are working at the forefront in industry as well as academia. They share their experience, success and /or failure to educate how the things you learn at universities will help you in the future and what is requested by companies.

The aim of this course is to grasp the image of working in industry and consider your future and the way in which you relate to the society.

到達目標 Course Goals

The Course Goals are to study the real necessity of chemical technology for the society, how researches should behave in industry, and consider research ethics, ensuring safety, environmental protection, the importance of transmission of information, and to cultivate a wide field of view.

授業計画 Course Schedule

Invited lecturers are researchers as well as managers working at the forefront at a company and an national research institute. This lecture will be provided as an intensive lecture. For the schedule, see "Additional Information" below.

The concrete plan of lectures is as follows;

1. Forefront of research and development of companies

Explanation on the product development including its background as well its social significance

2. Outlook and Task of chemical research

Explanation on future outlook and agenda-setting・research strategy by point of global view including concrete examples.

3. Chemist image pursued in the society

Explanation on the necessary capability for chemical researchers who are to be involved in research in future and items which need to be studied during school days based on their experiences of the lecturers

4. Explanation on the weight of responsibility and its efforts of the chemical technology towards environmental protection.

Consideration on the chemical technology which contribute to establishing sustainable society including food issues and energy problem.

準備学習 (予習・復習)等の内容と分量 Homework

Review the lesson contents by the next time.

成績評価の基準と方法 Grading System

As a general rule, the percentage of your attendance rate should be more than 75%.

An absent report should be submitted in advance.

The test conducted in the each lecture is evaluated.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

教科書はとくに指定せず、Lecture 時はパワーポイントを使用する。

Textbooks are not used. Slides prepared with PowerPoint are used.

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

備考 Additional Information

This lecture will be offered as an intensive lecture in October 7- 9. The schedule and place of the lecture will be noticed later.

科目名 Course Title	マイクロ・ナノ化学[Micro-Nanochemistry]		
講義題目 Subtitle			
責任教員 Instructor	村越　敬 [MURAKOSHI Kei] (大学院理学研究院)		
担当教員 Other Instructors	UENO Kosei (理学研究院), TOKESHI Manabu (工学研究院), TANI Hirofumi (工学研究院), NAKASAKA Yuta (工学研究院)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094452
期間 Semester	Fall	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELCOM 5222		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Microchemistry, Nanochemistry, Microchip, Biochip, Microreactor, Single Atom/Molecule Manipulation

授業の目標 Course Objectives

This course investigates modern chemistry in micrometer – nanometer dimensions including microfabrication technologies in chemistry, microchips/biochips, and microreactors.

到達目標 Course Goals

The students will be able to learn the basic concents and characteristics of
-Fundamental aspects in microfabrication techniques
-Chemical applications of microchips/biochips and microreactors
-Single molecular and atom manipulation techniques

授業計画 Course Schedule

K. Ueno (2 lectures)
- Micro/nanofabrication techniques / Micro/nanostructures / Light-field enhancement / Radiation force

K. Murakoshi (2 lectures)
-Single atom / Molecule manipulation / Nanochemistry

M. Tokeshi (2 lectures)
-Historical background of micro-nanochemistry / State of the art technologies and recent topics in Microchips/Biochips

H. Tani (1 lecture)
-Biochip

Y. Nakasaka (1 lecture)
-Microreactors

準備学習 (予習・復習)等の内容と分量 Homework

Basic analytical and physical chemistry in undergraduate level

成績評価の基準と方法 Grading System

Learning attitude and report

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

なし。適宜, 資料を配布する

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	生命分子化学特論[Modern Trends in Biomolecular Chemistry]		
講義題目 Subtitle			
責任教員 Instructor	坂口　和靖 [SAKAGUCHI Kazuyasu] (大学院理学研究院)		
担当教員 Other Instructors	MATSUMOTO Kenichiro (工学研究院), UCHIDA Takeshi (理学研究院), TAJIMA Kenji (工学研究院), OGASAWARA Yasushi (工学研究院)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094453
期間 Semester	Summer	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELCOM 5230		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Genetic information, protein structure, molecular mechanism, biosynthetic mechanism, animal cells, secondary metabolites, biopolymers, bioremediation

授業の目標 Course Objectives

Synthesis, structure, function, and novel engineering subjects on of bio-molecules will be studied focusing on the fields of life science, information, medicine, and environment.

到達目標 Course Goals

Students are expected to understand deeply the topics of genetic information, protein structure, animal cell cultivation, secondary metabolites, biopolymers, and clean environments in the fields of life science, information, medicine, and environment.

授業計画 Course Schedule

Eight lecturers belonging to the CSE will give lectures on the following topics, from basic to cutting-edge.

1. Drug design based on protein structure
2. Mechanism of antimicrobial peptide apidecin
3. Oligomer formation and functional regulation in proteins
4. Life Science Studies using Vibrational Spectroscopy
5. Synthesis of nano cellulose using a bacterium and its application
6. Microbial exploration for enzyme conversion and fermentation production of compounds
7. Thinking about the Central Dogma from the Biosynthesis of Natural Products
8. Biosynthetic strategies for secondary metabolites in microorganisms

準備学習 (予習・復習)等の内容と分量 Homework

Students are asked to submit a report on the subject which instructor give every time.

成績評価の基準と方法 Grading System

You will be evaluated by active participation including quiz (30%), and assignment on each topic (70%).
Attendance of 70% or more of regular classes is the minimum condition to evaluate.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

適宜資料を配布する。

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	総合化学特論 I (Modern Trends in Physical and Material Chemistry)[Modern Trends in Physical and Material Chemistry]		
講義題目 Subtitle			
責任教員 Instructor	島田　敏宏 [SHIMADA Toshihiro] (大学院工学研究院)		
担当教員 Other Instructors	HARADA Jun (理学研究院), KOBAYASHI Atsushi (理学研究院), FUSHIMI Koji (工学研究院), MASUBUCHI Yuji (工学研究院), KITAGAWA Yuichi (工学研究院), TOYAO Takashi (触媒科学研究所), WAIZUMI Hiroki (工学研究院), KITANO Sho (工学研究院)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094454
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELCOM 5241		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

molecular materials, ferroelectrics, metal complexes, corrosion, electrochemistry, inorganic materials, ceramics, opto-functional materials, heterogeneous catalysts, 2D semiconductors, chemical sensors, nanomaterials

授業の目標 Course Objectives

This course is intended to provide cutting-edge research topics on physical and materials chemistry. The topics include molecular ferroelectrics, metal complexes with various functions, observation of detailed surface processes in electrochemistry, inorganic materials, opto-functional materials, heterogeneous catalysts, 2D semiconductors as sensors, chemo-functional nano-materials.

到達目標 Course Goals

Through a series of lectures, students understand various fields of chemistry and are expected to expand their horizons.

授業計画 Course Schedule

Detailed schedule will be informed one month before the start of this course.
List of lecture titles in this course:

・Molecular ferroelectrics
・Coordination chemistry for solar-fuel production
・Detailed analysis of electrode reactions on practical material surfaces using modern electrochemical methods
・New functional ceramics and inorganic materials – structure and properties
・Photofunctional lanthanide complexes designed through quantum chemistry
・Heterogeneous catalysis research using machine learning
・Chemical sensors with atomically thin two-dimensional semiconductors
・Chemical and catalytic functions of composite materials studied with in situ electrochemical spectroscopy

準備学習 (予習・復習)等の内容と分量 Homework

Students will be required to submit reports after the lectures.

成績評価の基準と方法 Grading System

Students are required to attend at least 70% of the lectures. Evaluation as pass/fail will be based on the submitted reports.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

This course will be provided as part of the Hokkaido Summer Institute., For more information (invited lecturers, course details, etc.), please visit the website below:, https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G058

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	総合化学特論Ⅱ(Modern Trends in Organic Chemistry and Biological Chemistry)[Modern Trends in Organic Chemistry and Biological Chemistry]		
講義題目 Subtitle			
責任教員 Instructor	鈴木　孝紀 [SUZUKI Takanori] (大学院理学研究院)		
担当教員 Other Instructors	TANINO Keiji (理学研究院), MITA Tsuyoshi (ICReDD), KAMADA Rui (理学研究院), SHIMIZU Yohei (理学研究院), ISHIYAMA Tatsuo (工学研究院), YAMAMOTO Takuya (工学研究院)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094455
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELCOM 5251		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Physical Organic Chemistry, Organic Synthesis, Organic Reaction, Organic Transformations, Biological Chemistry, Polymer Chemistry,

授業の目標 Course Objectives

The progress in the fields of organic chemistry and biochemistry is remarkable. In this course, you will learn the basic concepts necessary for understanding research in the fields of advanced organic chemistry and biochemistry, give an overview of the latest trends, and then learn about cutting-edge research results. You will discuss various topics in organic chemistry and biochemistry research. The goal is to be able to write reports that include suggestions for your own ideas on cutting-edge organic and biochemical research.

到達目標 Course Goals

1. You can explain the basic concepts needed to understand advanced organic chemistry and biochemical research.
2. You can explain an overview of cutting-edge organic chemistry and biochemical topics.
3. You can discuss among students with different backgrounds.
4. You can make research proposals that incorporate your own ideas.

授業計画 Course Schedule

1. Guidance (Suzuki)
2. Advanced organic synthetic chemistry (Tanino): Carbocycles, Ring Strain, Ene-diyne
3. Advanced computational reaction chemistry (Mita): Radial reaction, Carbon dioxide, Computational chemistry
4. Advanced bioorganic chemistry: Sugar chemistry, Glycosyltransferase
5. Advanced life chemistry (Kamada): Biochemistry, Innate immunity
6. Advanced organic reaction chemistry (Shimizu): Catalysis, Chemoselectivity
7. Advanced organic transformation chemistry (Ishiyama): Transition metal-catalyst, borylation, diboron
8. Advanced polymer chemistry (Yamamoto): Polycyclic polymer, Supramolecular chemistry, Self-organization

準備学習（予習・復習）等の内容と分量 Homework

In this course, you will be given an assignment each time. You choose two assignments and submit an answer (report) by the specified date.

成績評価の基準と方法 Grading System

You will be evaluated by learning attitude (20%) and two submitted reports (80% in total). You will be given assignment by instructors each time, among which you choose two assignments to submit. Attendance of 70% or more classes is the minimum condition to evaluate a student.

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

This course will be provided as part of the Hokkaido Summer Institute., For more information (invited lecturers, course details, etc.), please visit the website below:, https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G045

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	基礎物理化学特論[Introductory Physical Chemistry]		
講義題目 Subtitle			
責任教員 Instructor	丸田　悟朗 [MARUTA Goro] (大学院理学研究院)		
担当教員 Other Instructors	ISHIMORI Koichiro (理学研究院), MURAKOSHI Kei (理学研究院)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094456
期間 Semester	Spring	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELCOM 5002		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Molecular orbital theory, Spectroscopy, Surface, Equilibrium and Kinetics

授業の目標 Course Objectives

The purpose of this course is to understand the fundamental concepts of molecular orbital theory, spectroscopy, surface, equilibrium as well as kinetics in physical chemistry.

到達目標 Course Goals

Goals are to develop skills to solve problems in physical chemistry and acquire the capacity how the knowledge is applied for chemical application.

授業計画 Course Schedule

1. Processes on solid surfaces (Atkins' Physical Chemistry 10th edition, Chapter 22)
Structure of solid surfaces, the extent of adsorption, heterogeneous catalysis, processes at electrode
2. Rotational and vibrational spectra (Atkins' Physical Chemistry 10th edition, Chapter 12)
General features of spectroscopy
3. Electronic transitions and magnetic resonance (Atkins' Physical Chemistry 10th edition, Chapter 13, 14)
The characteristics of electronic transitions, the fates of electronically excited states, the effect of magnetic fields on electrons and nuclei, nuclear magnetic resonance
4. Molecular orbital theory (Atkins' Physical Chemistry 10th edition, Chapter 10)
Molecular orbital theory, diatomic molecules, chemical bonding, Hückel approximation

準備学習 (予習・復習)等の内容と分量 Homework

To be announced.

成績評価の基準と方法 Grading System

The attitude at the lecture (30%) and report scores (70%) are evaluated.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

Physical Chemistry 10th edition／P. W. Atkins, Julio De Paula：Oxford University Press, 2014

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	無機化学特論[Frontiers of Inorganic Chemistry]		
講義題目 Subtitle			
責任教員 Instructor	小林　厚志 [KOBAYASHI Atsushi] (大学院理学研究院)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094457
期間 Semester	Spring	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELCOM 5012		
補足事項 Other Information			
授業実施方式 Class Method	2 対面授業科目《一部遠隔》		

キーワード Key Words

coordination chemistry, solid state chemistry, material chemistry, nano materials, nano science, photocatalysts, bioinorganic chemistry

授業の目標 Course Objectives

The objectives of this course are: To understand the properties, structures, and functionalities of the coordination compounds which play important roles in the various fields such as materials, bioinorganic chemistry, and nano science, To get the latest information of cutting-edge research concerning inorganic and coordination chemistry.

到達目標 Course Goals

The goal of this course is total understanding of the importance of coordination compounds from the viewpoints of coordination structures and electronic states, and to develop the ability to predict structures, properties and (photo)reactivity of coordination compounds. At the same time, students learn the sense of study in the fields of inorganic and coordination chemistry (typical concepts are listed below).

1) Ligand-field theory
2) Marcus Theory
3) Nano-science of coordination compounds
4) Importance of metal complexes in applied chemistry and biochemistry

授業計画 Course Schedule

(1) Basics and application of ligand-field theory
(2) Ligand exchange and electron transfer of metal complexes
(3) Photo-induced electron transfer and artificial photosynthesis
(4) Important effect of impurities -in the cases of solar and fuel cells-
(5) Interesting properties of nano materials and porous materials
(6) Group discussion about recent research papers

準備学習（予習・復習）等の内容と分量 Homework

(1) You must answer to mini-exam in each class.
(2) You must submit a report about recently published research paper by the final class of this course. Your submitted report will be used in the group discussion.

成績評価の基準と方法 Grading System

You will be evaluated by mini-exam in each class (40%), and report and presentation (60%). More than 70% attendance is mimimum condition to evaluate a student.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

Shriver & Atkins' Inorganic Chemistry／Peter Atkins：Oxford University Press, 2010

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

備考 Additional Information

This course will be conducted in an active learning format that combines on-demand video lectures and group discussions.

科目名 Course Title	有機化学特論[Special Lecture on Organic Chemistry]		
講義題目 Subtitle			
責任教員 Instructor	谷野　圭持 [TANINO Keiji] (大学院理学研究院)		
担当教員 Other Instructors	ITOH Hajime (工学研究院)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094458
期間 Semester	Summer	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELCOM 5262		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

basic organic chemistry, physical organic chemistry, organometallic chemistry, synthetic organic chemistry, polymer chemistry

授業の目標 Course Objectives

This course aims to introduce participants to the latest trends and progresses in organic chemistry and related sciences. The class is opened to the students who have not studied the specialized course of organic chemistry.

到達目標 Course Goals

On completion of this course, students should be able to understand the recent trends and future problems in physical organic chemistry, organometallic chemistry, synthetic organic chemistry, and polymer chemistry.

授業計画 Course Schedule

Lecture 1. Electroorganic synthesis
Lecture 2. Introduction to asymmetric reduction reactions
Lecture 3. New methods for functionalization of organic compounds: the boration approach
Lecture 4. How to understand the schemes of natural product synthesis
Lecture 5. The C-H--O hydrogen bond: the role and future in controlling the alignment of molecules
Lecture 6. Lessons from enzymes for designing chiral catalysts
Lecture 7. Nature's way to synthesize natural products: Comparison between chemical synthesis and enzymatic synthesis

準備学習 (予習・復習)等の内容と分量 Homework

Students are expected to comprehend the lecture for preparing reports. Details for preparation and review for each topic are given by the lecturer.

成績評価の基準と方法 Grading System

It is required to attend at least 70% of the lectures. Evaluation as pass/fail will be based on the level of attendance (20%) and submitted reports (twice, 40% each).

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

Textbooks are not assigned.

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	基礎生物化学特論[Introduction to Basic Biological Chemistry]		
講義題目 Subtitle			
責任教員 Instructor	茂木　文夫 [MOTEGI Fumio] (遺伝子病制御研究所)		
担当教員 Other Instructors	TAKAOKA Akinori (遺伝子病制御研究所), ABE Kazuhiro (理学研究院)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094459
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELCOM 5021		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

cell growth and differentiation, gene expression, oncogene, immunity, infectious disease, cellular asymmetry

授業の目標 Course Objectives

The class focuses on fundamental aspects of molecular mechanisms that underlie basic biological phenomena such as cell growth, cell differentiation, immunity and cellular asymmetry. How disorder of the regulatory mechanism causes diseases including cancer and
infectious disease will be discussed. In addition, various technologies for imaging dynamic molecular behaviour in living cells will be also discussed.

到達目標 Course Goals

Students to be able to understand the basic regulatory mechanisms of gene expression, cell growth and immune system and developing mechanisms for the related diseases.

授業計画 Course Schedule

Day 1, 2: Fumio Motegi
Interior design of cellular asymmetry
Day 3, 4: Akinori Takaoka
Molecular signalings in host defense system

準備学習（予習・復習）等の内容と分量 Homework

Review the contents of each lecture by the next time.

成績評価の基準と方法 Grading System

Report of the task (100%)

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G044, https://www.motegilab.com, https://www.igm.hokudai.ac.jp/sci/

研究室のホームページ Websites of Laboratory

https://www.motegilab.com
https://www.igm.hokudai.ac.jp/sci/index-english.html

備考 Additional Information

科目名 Course Title	分子物理化学特論[Molecular Physical Chemistry]		
講義題目 Subtitle			
責任教員 Instructor	佐藤　信一郎 [SATOH Shinichiro] (大学院工学研究院)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094460
期間 Semester	Spring	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELCOM 5100		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Quantum Mechanics, Perturbation Theory, Stark Effect, Zeeman Effect, Photoabsorption and Emission

授業の目標 Course Objectives

Quantum theory is essential to understand molecular physical chemistry.
The lecture is intended for graduate students who have a general background in elementary quantum dynamics, and concentrates on the perturbation theory to give students a deep and essential understand on the interactions between molecular system and external fields such as electric, magnetic, and photon fields.

到達目標 Course Goals

By the end of the semester you should be able to:
-Apply the mathematical formalism of quantum mechanics to solve simple model problems.
-Analyze experiments that probe the quantum mechanical nature of matter to gain insight into the structure and dynamics of atoms, molecules, and nanomaterials.

授業計画 Course Schedule

1. Steady-state perturbation theory: first-order perturbation theory including degenerate system and second-order perturbation theory
2. Stark effects of hydrogen atom: the first-order interactions for 2s, 2px, 2py, 2pz degenerate states and the second-order interaction for 1s state. The polarizability of hydrogen atoms will be discussed on the basis of the second-order perturbation theory.
3. Time-dependent perturbation theory.
4. Photoabsorption and emission processes will be discussed on the basis of time-dependent perturbation theory.

準備学習 (予習・復習)等の内容と分量 Homework

Students are requested to read relevant contents in the textbook beforehand: page ranges will be announced at least in a week ahead.

成績評価の基準と方法 Grading System

The attendance rate must be over 70% to be qualified to take the final exam. Evaluations will be made based on (1) learning attitude (20%), (2) reports (80%).

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

現代量子化学の基礎／中島威　藤村勇一:共立出版, 1999

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

https://cma.eng.hokudai.ac.jp/index_english.html

備考 Additional Information

Attend "Quantum Chemistry" or an equivalent lecture ("Quantum Mechanics") in undergraduate school.

科目名 Course Title	物質構造解析学特論[Structural Analysis of Inorganic Materials]		
講義題目 Subtitle			
責任教員 Instructor	三浦　章 [MIURA Akira] (大学院工学研究院)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094461
期間 Semester	Spring	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELCOM 5110		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

x-ray structure analysis, electron microscope, neutron diffraction, X-ray absorption spectroscopy, solid-state NMR, Computational chemistry

授業の目標 Course Objectives

X-ray diffraction theory will be introduced to understand the relation between crystal structure and electron density distribution. Electron microscopy will also be applied for the analysis of inorganic materials. Neutron diffraction is useful to analyze the magnetic structure and the position of light elements. The principle of X - ray absorption spectroscopy and the difference from the diffraction method will be discussed. Structural analysis of inorganic materials using solid state NMR will be introduced.

到達目標 Course Goals

Understanding the principles of average structure analysis using diffraction and of a variety of local structure analysis. Understanding why we should use both average and local structure analysis.

授業計画 Course Schedule

1. What is x-ray? : Its generation, diffraction, scattering, absorption of x-ray etc.
2. X-ray diffraction for inorganic solids: powder diffractometer, qualitative and quantitative analyses, lattice parameter determination, crystallite size and distortion, crystal orientation etc.
3. Neutron diffraction: Difference from x-ray diffraction.
4. X-ray scattering and X-ray absorption spectroscopy
5. Electron microscopy: Transmission, analytical and scanning electron microscopies for microstructure and electronic structure analysis.
6. Solid State NMR
7. Computational chemistry: DFT and data science
8. Examination

準備学習（予習・復習）等の内容と分量 Homework

Report submissions are required to apply structural analysis methods for the materials under investigation by each student.

成績評価の基準と方法 Grading System

(1) report(40%) and (2) End of term examination (60%).

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

教科書は用いず，プリントを配布する。

講義指定図書 Reading List

これならわかるX線結晶解析 これならわかるX線結晶解析／安岡則武：化学同人，2000
セラミックスのキャラクタリゼーション技術：日本セラミックス協会

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

https://www.eng.hokudai.ac.jp/labo/strchem/

備考 Additional Information

Basic knowledge about physical chemistry, inorganic chemistry, solid state chemistry and inorganic materials chemistry are required.

科目名 Course Title	生物資源化学特論[Bioresources Chemistry]		
講義題目 Subtitle			
責任教員 Instructor	田島　健次 [TAJIMA Kenji] (大学院工学研究院)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094462
期間 Semester	Spring	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELCOM 5132		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Natural polymer materials, Eco-friendly material, Polyhydroxyalkanoates, Nano-fibers, Bacterial cellulose, Collagen

授業の目標 Course Objectives

Biomacromolecules are the basic units of living organisms, and can be divided into proteins, nucleic acids, and polysaccharides. Of these, the polymers that exist in large quantities are called natural polymers, and have been used by mankind since ancient times. In this course, students will understand the structure and physical properties of these natural polymers (in other words, biological resource polymers), and then acquire knowledge about their advanced utilization and functionalization.

到達目標 Course Goals

Understand the synthesis mechanism, structure, and physical properties of bioresource polymers such as proteins, polysaccharides, lignin, and biopolyesters, which are abundant in nature, and be able to read and understand the latest papers on their applications and explain their material applications.

授業計画 Course Schedule

1. Guidance and introduction
2. Natural polymers as materials
3. Cellulose
4. Polyhydroxyalkanoate
5. Nano-fiber(collagen)
6. Nano-fiber(plant cellulose)
7. Nano-fiber(bacterial cellulose)
8. Creation of a report

準備学習（予習・復習）等の内容と分量 Homework

Students will be given assignments that correspond to the content of the lecture and will be required to write reports. Students will deepen their understanding by reading the latest academic papers and writing reports on them.

成績評価の基準と方法 Grading System

Evaluation will be based on the submission of a report at the end of the lecture. Grades will be based on whether the student has a basic knowledge of the molecular structure and functionality of biomacromolecular materials and their applications, and whether the report is written in a convincing and logical manner. To pass, students must earn at least 60 points out of 100 points. [Syu]: > ca.90 points, [Yu]: > ca. 80 points, [Ryo]: > ca.70 points, [Ka]: > ca. 60 points

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

適宜資料を配布する。参考書を適宜示すが，教科書は用いない。

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

備考 Additional Information

It is desirable that the students have had previous courses in polymer chemistry and biochemistry. The maximum number of students is approximately 30.

科目名 Course Title	化学反応創成学入門[Introduction to Chemical Reaction Design and Discovery]		
講義題目 Subtitle			
責任教員 Instructor	陳　旻究 [JIN Mingoo] (創成研究機構化学反応創成研究拠点)		
担当教員 Other Instructors	Min Gao (ICReDD), HUANG Chung-Yang (ICReDD), SIDOROV Pavel (ICReDD), AKAMA Tomoko (ICReDD), LIST Benjamin (ICReDD)		
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094463
期間 Semester	Summer	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELCOM 5271		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Design of Chemical reaction and molecular assembly with functions, Chemoinformatics, Computational Chemistry

授業の目標 Course Objectives

This course introduces a brand-new research way for investigating molecular chemistry. Especially, the design of new chemical reactions and molecular assembly systems with photo-physical functions will be gently introduced, and the methodology for these research subjects will be described. Also, the basics of computational chemistry and chemoinformatics to solve chemical problems will be introduced. Totally four sessions will be delivered to introduce these contents.

1. Applications of Transition Metal Catalysis:
In these lectures, fundamentals of transition metal catalysis will be introduced to provide an overview on important chemical reactions that utilize metal catalysts. Representative examples of their applications in industry and recent research will then be described.

2. Fundamental Idea of Designing Molecular Crystals and Related Functions:
The lecture introduces basic ideas of designing molecular assembly in a solid state in terms of molecular crystals. Also how the molecular crystals can be related to photo-functional properties.

3. Introduction to Chemoinformatics:
The class introduces the field of chemoinformatics - or, simply put, the application of informatics methods to solve chemical problems. As the amount of information on chemical compounds and reactions grows, there is a need for rationalization of that information. Chemoinformatics provides useful tools for chemical search, rational design of compounds with desired properties, synthesis prediction, etc.

4. Introductory Computational Catalysis:
The lectures related to introductory computational catalysis are aimed to understand the basics of computational chemistry, and how to analyze the computational result and energy profile.

到達目標 Course Goals

The main goal of this course is "Knowing the molecular chemistry research fields with experimental and computational methodologies".
Especially, students will know "the fundamentals of transition metal catalysis and their application and recent research", "the basic ideas to design molecular crystals and photo-functions", "What the cheminformatics is and how to use it" and "fundamental knowledge to use computational chemistry on catalysis".

授業計画 Course Schedule

The entire course contains four sessions as below;

1. Applications of Transition Metal Catalysis
・Fundamentals of Organometallic Chemistry
・Examples of Transition Metal Catalysis

2. Fundamental Idea of Designing Molecular Crystals and Related Functions:
・Introduction to Molecular Crystal Engineering
・Introduction to Photo-functions with Molecular Crystals

3. Introduction to Chemoinformatics:
・Introduction to Chemoinformatics
・Machine Learning in Chemistry

4. Introductory Computational Catalysis:
・Introduction to Computational Catalysis I
・Introduction to Computational Catalysis II

準備学習（予習・復習）等の内容と分量 Homework

Basic knowledge of chemistry in the undergraduate level might be required.

成績評価の基準と方法 Grading System

We will give a take-home exam with several open-answer questions for each session, that students have to submit before some deadline.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

https://www.icredd.hokudai.ac.jp/all-members/the-huang-lab
https://www.icredd.hokudai.ac.jp/the-jin-group
https://www.icredd.hokudai.ac.jp/the-sidorov-group
https://www.icredd.hokudai.ac.jp/the-gao-group

備考 Additional Information

科目名 Course Title	有機化学と計算化学の融合論[Strategy for Integrating Organic Chemistry with Computational Chemistry]		
講義題目 Subtitle			
責任教員 Instructor	美多　剛 [MITA Tsuyoshi] (創成研究機構化学反応創成研究拠点)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2024	**時間割番号 Course Number**	094464
期間 Semester	Spring/Summer	**単位数 Number of Credits**	2
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_ELCOM 5282		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Synthetic organic chemistry, Quantum chemistry calculations, Pericyclic reactions, Radical reactions, Transition metal catalyzed reactions, DFT calculations, Automated reaction path search methods, Theoretical chemistry

授業の目標 Course Objectives

The primary objective of this course is to foster a computational understanding of organic reactions, emphasizing the comprehension of reaction mechanisms, including transition state structures, through quantum chemical calculations. Pericyclic reactions, pivotal for their direct contribution to reactions via transition state energy, will be elucidated, distinguishing thermally allowed and forbidden reactions. Through the study of pericyclic reactions, students will qualitatively discern between aromatic and antiaromatic transition states, and they will conduct calculations for each transition state using Gaussian 16. To accomplish this, a solid grasp of the Woodward-Hoffmann rules will be established initially. In the latter part of the course, alongside pericyclic reactions, students will delve into recently emphasized radical reactions and transition metal-catalyzed reactions through quantum chemical calculations, empowering them to analyze and predict organic reactions effectively.

到達目標 Course Goals

First, students will attain a comprehensive understanding of pericyclic reactions, which are considered the third reaction mechanism following ion reactions and radical reactions. They will thoroughly grasp the Woodward-Hoffmann rules, governed by orbital symmetry conservation (without using Frontier Orbital Theory), and employ the concepts of aromatic and antiaromatic transition states, as per Dewar-Zimmerman's interpretation, to comprehend the characteristics and mechanisms of pericyclic reactions. Furthermore, students will acquire the ability to independently compute these transition state structures. Subsequently, the course will introduce mechanistic analyses of radical propagation steps and catalytic cycles of transition metal-catalyzed reactions (including oxidative addition, transmetalation, insertion of unsaturated bonds, β-hydride elimination, and reductive elimination), laying the groundwork for predicting organic reactions using quantum chemical calculations.

授業計画 Course Schedule

1. Basics of quantum chemical calculations, methods for obtaining transition state structures.
2. Complete understanding of Woodward-Hoffmann rules. Difference between aromatic and antiaromatic transition states.
3. Understanding of cycloaddition reactions.
4. Understanding of electrocyclic reactions.
5. Understanding of sigmatropic rearrangement, keto-enol tautomerism.
6. Understanding pericyclic reactions that violate Woodward-Hoffmann rules, and determining the activation barrier heights for both allowed and forbidden pathways.
7. Deep understanding through exercise problems.
8. Introduction of automated reaction path search methods.
9. Basics of radical reactions_1.
10. Basics of radical reactions_2.
11. Examples of mechanistic analysis of radical reactions using quantum chemical calculations.
12. Basics of transition metal-catalyzed reactions.
13. Analysis of the catalytic cycle for transition metal-catalyzed reactions using quantum chemical calculations.

準備学習 (予習・復習)等の内容と分量 Homework

No preparation required. Only review.
Bring a laptop computer with virus protection to the designated classes.

成績評価の基準と方法 Grading System

Exercise problem (not examination) (20%)・Reports (80%)

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

資料を用意する。

Materials will be provided.

講義指定図書 Reading List

有機化学のための量子化学計算入門 Gaussian の基本と有効利用のヒント／西長 亨・本田 康 共著：裳華房, 2022

ペリ環状反応 第三の有機反応機構, I.／フレミング著, 鈴木 啓介・千田 憲孝 訳：化学同人, 2002

Pericyclic reactions (second edition)／Ian Fleming：Oxford University Press, 2015

https://pubs.acs.org/doi/10.1021/jacs.2c09830

参照ホームページ Websites

https://www.icredd.hokudai.ac.jp/ja, https://www.icredd.hokudai.ac.jp/

研究室のホームページ Websites of Laboratory

https://www.icredd.hokudai.ac.jp/mita-tsuyoshi

備考 Additional Information

A laptop with virus protection is required.

Gaussian 16 is used under a campus license. Software installation will be done during class hours.