科目ナンバリング	U-LAS13 10042 LE60						
授業科目名<英訳>	Architecture of Matter-E2 :Evolution of Organic Chemistry Through Nobel Breakthroughs Architecture of Matter-E2 :Evolution of Organic Chemistry Through Nobel Breakthroughs			担当者所属職名・氏名	理学研究科　特別招へい教授　BOUR Christophe		
群	自然科学科目群		分野(分類)	化学(基礎)		使用言語	英語
旧群	B群	単位数	2単位	時間数	30時間	授業形態	講義（対面授業科目）
開講年度・開講期	2025・前期集中	曜時限	集中	配当学年	主として1・2回生	対象学生	理系向

[授業の概要・目的]

Synopsis of the Course: This course explores the evolution of organic chemistry through groundbreaking discoveries recognized by the Nobel Prize. We will examine key moments in history where Nobel-winning research transformed our understanding of chemical reactions, molecular structures, and catalysis. By analyzing these breakthroughs, students will gain insight into how organic chemistry has advanced and why these discoveries remain crucial to modern science and industry.
The purpose of this course is to provide students with a deep understanding of the major milestones in organic chemistry, focusing on the Nobel Prize-winning innovations that have defined the field. Through the study of these breakthroughs, students will gain a greater appreciation for the science behind everyday applications and learn how organic chemistry continues to drive progress in areas such as medicine, materials science, and sustainable technologies.

[到達目標]

Understand Key Nobel Prize Breakthroughs
Identify and explore major Nobel Prize-winning discoveries in organic chemistry and their impact on the field.
Trace the Evolution of Organic Chemistry
Understand the historical development of organic chemistry through key milestones, focusing on how each Nobel-winning discovery built upon previous research.
Analyze the Practical Applications of Nobel Discoveries
Investigate how Nobel Prize-winning research has translated into real-world innovations in areas such as pharmaceuticals, materials science, and sustainable chemistry.
Appreciate the Role of Catalysis in Organic Chemistry
Examine the role of catalysis, as demonstrated in Nobel Prize-winning research, and how it has revolutionized chemical reactions and industrial processes.
Develop Critical Thinking Skills
Encourage students to critically analyze the significance of Nobel-winning discoveries and their lasting influence on scientific and industrial progress.
Foster an Appreciation for Scientific Innovation
Recognize the ongoing importance of organic chemistry in solving global challenges and pursue careers in chemistry and related fields.

[授業計画と内容]

Course Duration: 1 Week (15 Classes, 3 per day)
Day 1: Foundations & Reactive Intermediates
Lesson 1: Introduction - The Nobel Prize and Organic Chemistry (Overview of the course and Nobel Prize

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impact on organic chemistry ; The role of fundamental discoveries in shaping modern chemistry. Lesson 2: Carbocations and Superacids (1994, George A. Olah) : Structure and reactivity of carbocations : Superacids and their role in stabilizing reactive intermediates. Lesson 3: Stereochemistry and Molecular Recognition (1975, John Cornforth & Vladimir Prelog) : Fundamentals of stereochemistry : Importance of stereochemical control in enzymatic and synthetic reactions
Day 2: Organic Synthesis & Retrosynthetic Strategies
Lesson 4: Retrosynthetic Analysis and Complex Molecule Synthesis (1990, E.J. Corey) : Retrosynthetic strategies for designing synthetic pathways ; Applications to the synthesis of complex natural products. Lesson 5: Total Synthesis of Natural Products (1965, Robert Burns Woodward) : Pioneering total syntheses (Vitamin B12, Chlorophyll, etc.) ; Strategic insights from Woodward ’ s work. Lesson 6: Organometallic Chemistry and New Reactivity (1979, Herbert C. Brown & Georg Wittig) : Hydroboration and its applications in organic synthesis ; Wittig reaction for alkene formation
Day 3: Catalysis in Organic Chemistry
Lesson 7: Ziegler-Natta Polymerization (1963, Karl Ziegler & Giulio Natta) : Mechanism of Ziegler-Natta polymerization ; Industrial applications of polymer chemistry. Lesson 8: Cross-Coupling Reactions (2010, Richard Heck, Ei-ichi Negishi & Akira Suzuki) : Pd-catalyzed cross-coupling reactions ; Key applications in pharmaceuticals and materials science. Lesson 9: Metathesis in Organic Synthesis (2005, Yves Chauvin, Robert H. Grubbs, Richard R. Schrock) ; Principles of olefin metathesis ; Impact on green chemistry and sustainable processes
Day 4: Enantioselective & Sustainable Catalysis
Lesson 10: Asymmetric Catalysis (2001, Ryoji Noyori, Knowles & K. Barry Sharpless) : Asymmetric hydrogenation and oxidation ; Enantioselectivity in organic transformations. Lesson 11: Organocatalysis (2021, Benjamin List & David MacMillan) : Small-molecule catalysis as an alternative to metals ; Applications in sustainable and green chemistry. Lesson 12: Supramolecular Chemistry (1987, Donald J. Cram, Charles Pedersen & Jean-Marie Lehn) : Concepts of molecular recognition and host-guest chemistry ; Applications in catalysis, drug delivery, and nanotechnology
Day 5: Advanced Concepts & Future Perspectives
Lesson 13: Click Chemistry and Bioorthogonal Reactions (2022, Morten Meldal, Carolyn R. Bertozzi, K. Barry Sharpless) : Click chemistry and its applications in biomolecular labeling ; Bioorthogonal reactions for selective modifications in biological systems. Lesson 14: Molecular Machines (2016, Jean-Pierre Sauvage, James Fraser Stoddart, Bernard L. Feringa) : Design and synthesis of molecular motors ; Potential applications in nanotechnology. Lesson 15: Future Perspectives : Recap of major Nobel Prize discoveries ; Emerging trends ; Student-led discussions

[履修要件]

This course is designed for motivated 1st- and 2nd-year students with a fundamental background in chemistry, who are willing to engage with Nobel Prize-winning discoveries and their impact on modern organic chemistry. While no advanced knowledge is required, students should have a basic understanding of key chemical concepts.
Prerequisites:
- General Chemistry - Atomic structure, bonding, periodic trends, acid-base chemistry
- Introductory Organic Chemistry - Functional groups, nucleophile/electrophile, resonance
- Basic Stereochemistry - Chirality, isomerism

Recommended Skills (but not mandatory):
- Familiarity with reaction mechanisms (arrows, intermediates)

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[成績評価の方法・観点]

Evaluation Methods
Final Exam: 70%
Quizzes/Midterm: 30%
Evaluation Policy
Students will be assessed on their understanding of key Nobel Prize-winning breakthroughs, the historical evolution of organic chemistry, and the impact on scientific progress and real-world applications.

[教科書]

Handouts will be distributed.

[授業外学修（予習・復習）等]

Preparation for Lectures - Go over research papers and handouts in advance related to Nobel Prize discoveries.
Supplemental Learning - Explore additional resources on key topics.

[その他（オフィスアワー等）]

[主要授業科目（学部・学科名）]