

Advanced Organic Chemistry (C004125)

Course size *(nominal values; actual values may depend on programme)*

Credits 6.0 **Study time** 180 h

Course offerings and teaching methods in academic year 2023-2024

A (semester 1)	English	Gent	lecture seminar
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Lecturers in academic year 2023-2024

Madder, Annemieke	WE07	lecturer-in-charge
Cazin, Catherine	WE06	co-lecturer
Nolan, Steven	WE06	co-lecturer
Oelgemöller, Michael	WE07	co-lecturer

Offered in the following programmes in 2023-2024

	crdts	offering
Master of Science in Teaching in Science and Technology (main subject Chemistry)	6	A
Master of Science in Chemistry (main subject (Bio)Organic and Polymer Chemistry)	6	A
Master of Science in Bioscience Engineering: Chemistry and Bioprocess Technology	6	A
Exchange Programme in Chemistry (master's level)	6	A

Teaching languages

English

Keywords

Transition metals, ligands, elementary steps, M-C bonds, M=C bonds, Organic chemistry of biomolecules, solid supported chemistry, peptides, carbohydrates, oligonucleotides, diversity oriented synthesis, organocatalysis, light induced synthesis.

Position of the course

This course is taught in master 1 when the student has acquired a sound basis in organic chemistry during the bachelor through the following courses: 'Chemical structures' (Ba1); 'Organic reactivity 1', 'Organic reactivity 2', 'Structural analysis' (Ba2) and 'Synthetic methods in Organic chemistry'(Ba3). This course aims at allowing the students to gain insight in research related novel techniques and concepts in organic and organometallic chemistry more specifically focused on biomolecules and on organometallic chemistry and transition metal complexed. Furthermore it aims at familiarizing the student with the concepts and applications of photo-induced organic chemistry. It is given as module offered to all students in the '(bio) organic and polymer chemistry' track, and the contents of this course are integrated in the course 'Experiments in (Bio)Organic and Polymer Chemistry' at the end of this semester. The modules organometallic chemistry and photo/bioorganic chemistry are accessible as Advanced Topics in Chemistry.

Contents

- The lectures on organometallic chemistry will focus on:
 - (a) d-electron configuration (oxidation states, 18-electron rule)
 - (b) ligand properties (electronic, steric, hapticity, modes of coordination, Tolman electronic parameter, cone angle, percent buried volume)
 - (c) ligand families (1 to 6 electron donors, arenes, phosphines, carbenes)

- (d) synthetic access to transition metal complexes
 - (e) elementary steps of organometallic species (ligand substitution, oxidative addition, reductive elimination, sigma-bond metathesis, migratory insertion)
 - (f) chiral ligands and chirality in organometallic species
 - (g) major applications of organometallic species
2. The guided exercises on organometallic chemistry will comprise:
- (a) electron counting
 - (b) determination of steric and electronic properties of ligands
 - (c) organometallic problem solving
3. The lectures on biomolecular chemistry and organic photochemistry will focus on:
- (a) Solid Phase Chemistry and Diversity Oriented Synthesis:
 - definition and historical perspective
 - combinatorial synthesis in solution
 - synthesis on solid support
 - identification and characterisation of library members
 - applications in oligopeptide and oligonucleotide synthesis, antisense/antigene strategy
 - (b) Organocatalysis:
 - introduction to organocatalysis
 - enamine, iminium en H-bond catalysis: aldol reactions, Mannich reactions, conjugated additions
 - biomimetic catalysis
 - (c) Light induced chemistry and photochemical reactions:
 - Jablonski diagrams
 - direct photochemical reaction types
 - photo(redox)catalysis and photosensitization

Initial competences

Having followed the courses 'Chemical structures' (Ba1), 'Organic reactivity 1', 'Organic reactivity 2', 'Structural analysis' (Ba2) and 'Synthetic methods in Organic chemistry'(Ba3) or being acquainted with the competences that were aimed for in these courses

Final competences

- 1 The student will have gained knowledge and understanding of the definitions and applications of organometallic chemistry.
- 2 The student will know electronic and steric properties of ligands and how these affect reactivity.
- 3 The student will be able to solve problems related to transition metal complex reactivity and stability.
- 4 To be able to recognize and name theoretical core concepts from biomolecular chemistry and organic photochemistry, and to illustrate them with a self-given example.
- 5 Being able to recognize and name common biomolecular compounds, their building blocks and precursors.
- 6 To have knowledge and insight into recent developments in synthetic methods and applications of organic chemistry specifically aimed at carbohydrates, peptides and oligonucleotides.
- 7 To have insight into the principles and possibilities of light-induced chemistry, and to be able to apply these to a given example.
- 8 To be able to integrate information from internationally published scientific literature within the field of biomolecular and organic (photo)chemistry.
- 9 Communicate about new developments within the field.
- 10 To be able to evaluate a photochemical process and suggest suitable conditions for a given transformation.
- 11 To be able to evaluate the orthogonality of standard reagents and protecting groups in biomolecular chemistry.
- 12 To propose suitable conditions for the synthesis of a simple target biomolecular compound (carbohydrate / oligonucleotide / peptide).
- 13 To be able to solve simple synthesis problems using modern organometallic, organocatalytic and photochemical methods.

Conditions for credit contract

Access to this course unit via a credit contract is determined after successful competences assessment

Conditions for exam contract

This course unit cannot be taken via an exam contract

Teaching methods

Lecture, seminar

Extra information on the teaching methods

Because of COVID19 alternative ways of teaching could be implemented if necessary.

Learning materials and price

The course content and slides will be made available via Ufora.

References

Recommended reading but not required:

"Organotransition metal chemistry – From bonding to catalysis": John Hartwig, University Science Books (Sausalito, California), 2010, ISBN 978-1-891389-53-5.

Course content-related study coaching

The lecturer-in-charge can be approached after the lectures to answer questions, or can be contacted by email to ask questions or make an appointment for a meeting.

Evaluation methods

end-of-term assessment

Examination methods in case of periodic evaluation during the first examination period

Written assessment with open-ended questions

Examination methods in case of periodic evaluation during the second examination period

Written assessment with open-ended questions

Examination methods in case of permanent evaluation**Possibilities of retake in case of permanent evaluation**

not applicable

Calculation of the examination mark

100% Periodic evaluation.

Exam will have two partims:

- 50% on organometallic chemistry content
- 50% on biomolecular/organic photochemistry contents