GHENT UNIVERSITY

Course Specifications

Valid as from the academic year 2024-2025

Enzyme-Catalyzed Organic Synthesis: Principles and Applications (C004458)

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

Credits 4.0 **Study time 120 h**

Course offerings and teaching methods in academic year 2024-2025

A (semester 2)	English	Gent	lecture	0.0h

Lecturers in academic year 2024-2025

Van der Eycken, Johan	WE07	lecturer-in-charge

Offered in the following programmes in 2024-2025	crdts	offering
Master of Science in Teaching in Science and Technology(main subject Chemistry)	4	A
Master of Science in Chemistry(main subject (Bio)Organic and Polymer Chemistry)	4	A
Exchange Programme in Chemistry (master's level)	4	A

Teaching languages

English

Keywords

Enzymatic catalysis, molecular recognition, enzyme models, synzymes, abzymes, catalytic antibodies, enzyme inhibitors.
Enzyme-mediated (asymmetric) organic synthesis, enzyme-catalyzed kinetic resolution, enzyme-catalyzed enantioselective transformations, organocatalysis.

Position of the course

The principles of enzyme catalysis are discussed, making the students aware of the link between biochemical processes and organic chemistry. Mechanistic aspects of biochemical processes and molecular recognition on the molecular level are discussed.
The course illustrates how this knowledge can be applied for the design of enzyme models ("synzymes"), enzyme inhibitors for medical application, and catalytic antibodies (“abzymes”).
Further, the use of enzymes for catalyzing (asymmetric) organic transformations is thoroughly illustrated and compared with alternative non-enzymatic approaches (in this respect, the course is *complementary* to the course on Asymmetric Synthesis).
Attention will also be dedicated to combined transition metal-enzymatic approaches, and to the application of the underlying principles of enzyme catalysis to design organocatalysts (cf. the Nobel Prize Chemistry 2021 for List and MacMillan).
The course builds further on the knowledge acquired in all previous organic chemistry courses (bachelor and master 1).

Contents

- Introduction
- Enzymatic catalyses: principles
- Enzyme models (synzymes)
- Abzymes: antibodies as tailor-made biocatalysts
- Enzyme-inhibitors: way of action and rational design
- Use of enzymes in (asymmetric) synthesis: (for each enzyme type also the mechanism will be discussed

- Hydrolases: esterases, lipases, proteases
- Oxido-reductases: reduction of aldehydes and ketones with isolated enzymes; recycling of the cofactor; reduction with whole cells
- Oxidation reactions: hydroxylation, epoxidation, Baeyer-Villiger

- Formation of C-C bonds: Aldol reactions, acyloin reactions

- Addition and elimination reactions: cyanohydrin formation, addition of water and ammonia

- Halogenation and dehalogenation reactions

- Glycosyl transfer reactions

- Combined enzyme-transition metal catalyzed reactions
- Enzyme principles applied: Organocatalysis (cf. Nobel Prize Chemistry 2021 List en MacMillan!)
- Illustrations of (asymmetric) syntheses with enzymes and comparison with alternative approaches

Initial competences

Have acquired extended knowledge in the field of organic chemistry: both basic as well as advanced level.

Final competences

1 Thorough insight in the chemistry of bioorganic processes and molecular recognition.
2 Knowledge of the principles of enzyme catalysis.
3 Application of the principles of enzyme catalysis for designing enzyme models, enzymen inhibitors and catalytic antibodies.
4 Ability to recognize the relationship between "bio"chemistry and organic chemistry.
5 Thorough insight in the methods and principles of (asymmetric) enzyme-mediated synthesis.
6 Ability to compare and evaluate enzyme-mediated synthetic approaches with alternative non-enzymatic ones.
7 Insight in the principles and application of organocatalysis in synthesis.
8 Ability to use the acquired knowledge for solving synthetic problems.
9 Ability to understand and follow new developments in the field via the literature.

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

Study material

Type: Handbook

Name: K. Faber: Biotransformations in Organic Chemistry -A textbook (7th ed.), Springer Verlag, Berlin, Germany, 2018.
Indicative price: Free or paid by faculty
Optional: no
Language : English
Online Available : Yes
Available in the Library : Yes
Additional information: Textbook online available via the library. A pdf of the text is made available via Ufora.

Type: Handbook

Name: H. Dugas: Bioorganic chemistry. A chemical approach to enzyme action.(3rd ed.), Springer Verlag, Berlin, Germany, 1996.
Indicative price: Free or paid by faculty
Optional: no
Language : English

Additional information: Copies of the few chapters discussed are made available as pdf via Ufora

References

- H. Dugas: Bioorganic chemistry. A chemical approach to enzyme action.(3rd ed.), Springer Verlag, Berlin, Germany, 1996.

- K. Faber: Biotransformations in Organic Chemistry -A textbook (7th ed.), Springer Verlag, Berlin, Germany, 2018.

Course content-related study coaching

Discussion of problems is possible after each course, or upon individual appointment.

Assessment moments

end-of-term assessment

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

Oral assessment, Written assessment with open-ended questions

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

Oral assessment, Written assessment with open-ended questions

Examination methods in case of permanent assessment

Possibilities of retake in case of permanent assessment

not applicable

Extra information on the examination methods

Insight in the basic concepts of the course will be checked, as well as the ability to apply these concepts to solve concrete problems.

Calculation of the examination mark

100% periodic evaluation