

## **PHOTONS AND ELECTRONS IN ORGANIC SYNTHESIS. PHOTOCATALYSIS AND SYNTHETIC ORGANIC ELECTROCHEMISTRY.**

**Objectives.** The aim of the course is to give the student the basic concept to understand a photochemical and electrochemical reactions, the methodology to study it and the synthetic possibilities of photo- and electro-induced reactions to apply them in the synthesis of a target compound. The course covers the broad synthetic tools of photocatalytic process, electrocatalysis, mediated electrochemistry and the emerging field of synthetic photoelectrocatalysis.

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**Dates:** February 2-3 and 6-8, 2023.

### **Contents**

**Topic 1: Photochemistry.** Photophysical processes. Primary photoreactions Energy transfer, electron transfer, quenching and sensitization. Classification of photochemical reaction pathways. Photochemical reaction mechanisms and reaction intermediates. Steady-state and time-resolved Absorption and emission spectroscopy. Quantum yields.

**Topic 2: Photocatalysis in organic synthesis.** Basic Concepts in Photocatalysis. *Energy Transfer Photocatalysis:* Single Oxygen as Reagent in Organic Synthesis, enantioselective catalysis of photochemical reaction. *Electron Transfer Photocatalysis:* Photoredox Catalysis with visible light, homogeneous photocatalysis with transition metal catalysts and organic dyes, heterogeneous photocatalysis with semiconductors. Consecutive photoredox catalysis and photon-up conversions. Combination of Photoredox catalysis with other catalysis (dual or synergistic catalysis). Hydrogen Atom Transfer Photocatalysis. Computational modeling in Photocatalysis. Problems

**Topic 3: Synthetic organic electrochemistry.** *Electrode processes:* Electron transfer kinetics, mass transfer, coupled chemical steps, chemical and electrochemical reversibility, investigations with cyclic voltammetry. *Reaction control:* Cell types, galvanostatic and potentiostatic conditions, electrode materials, batch and flow electrolysis, solvents and supporting electrolytes. Selected examples from academia and industry (anodic oxidations and cathodic reductions).

**Topic 4. Molecular electrocatalysis (indirect electrosynthesis).** *Basic principles:* Preconditions and use cases, redox catalysis and chemical catalysis, catalyst types, in-cell and ex-cell mediation. *Investigations with cyclic voltammetry:* Diagnostic criteria, kinetic zone diagrams, catalyst benchmarking. Implementation on the preparative scale. Selected indirect electrosyntheses from academia and industry.

**Topic 5: Synthetic photoelectrocatalysis.** Sequential Activation of Substrates by Electro- and Photochemistry. Enhancing Mediator Reactivity with Light/Electrochemically Mediated Photoredox Catalysis: Electrochemistry as a Sacrificial Electron Acceptor/Donor, Photoexcitation of Electrochemically Generated Ions. Photoelectrochemical HAT Reaction. Transformations at Photoelectrodes. Problems

#### **References:**

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