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**Modulbezeichnung:** **Molecular synthesis (MSM-ME1)** **15 ECTS**  
 (Molecular synthesis)

Modulverantwortliche/r: Andreas Hirsch

Lehrende: Marcus Speck, Ivana Ivanovic-Burmazovic, Frank Wilhelm Heinemann, Nicolai Burzlaff, Andreas Scheurer, Karsten Meyer, Julien Bachmann, Svetlana Tsogoeva, Andreas Hirsch

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Startsemester: SS 2019

Dauer: 2 semester

Turnus: halbjährlich (WS+SS)

Präsenzzeit: 210 Std.

Eigenstudium: 240 Std.

Sprache: Englisch

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### Lehrveranstaltungen:

Check for other alternatives in **UnivIS**

**NB:** no overlap with courses in Mandatory Module allowed

#### **A. LAB course Molecular Synthesis**

either in Inorganic or Organic Chemistry (6LAB/1S)

(Attendance in lab course is compulsory!)

Lab course Molecular Synthesis - IC (SS 2019, Praktikum, Die Dozenten der Anorg. Chemie et al.)

Praktikum Organische Molekülsynthesen - Masterstudium / Lab Course Molecular Synthesis OC - Master-level program (WS 2019/2020, Praktikum, 7 SWS, Svetlana Tsogoeva et al.)

Praktikum Anorganische Molekülsynthesen - Masterstudium / Lab Course Molecular Synthesis IC - Master-level program (WS 2019/2020, Praktikum, Karsten Meyer et al.)

Challenges in Organic Chemistry / Seminar: Syntheseprobleme in der Organischen Chemie (SS 2019, Hauptseminar, 2 SWS, Andreas Hirsch et al.)

#### **Lectures & Seminars:**

#### **B. Advanced Inorganic Chemistry I (2L/1S)**

Advanced Inorganic Chemistry (WS 2019/2020, Vorlesung, 2 SWS, Ivana Ivanovic-Burmazovic et al.)

Advanced Inorganic Chemistry - Seminar (WS 2019/2020, Seminar, 1 SWS, Ivana Ivanovic-Burmazovic et al.)

Advanced Inorganic Chemistry - Seminar Talk (Vortragsseminar zum Fortgeschrittenenpraktikum Anorganische Chemie ) (WS 2019/2020, Seminar, 1 SWS, Andreas Scheurer)

Advanced Inorganic Chemistry - Practical / Fortgeschrittenenpraktikum Anorganische Chemie (WS 2019/2020, Praktikum, 8 SWS, Karsten Meyer et al.)

#### **C. Advanced Inorganic Chemistry II (1L)**

choice of 1 course from

C1: Bioinorganic chemistry I (1L)

C2: Metals in medicine (1L)

C3: Nanoparticles and nanostructured thin films (1L)

C4: Modern X-Ray structure determination of single crystals (2L)

Bioinorganic Chemistry I, Metalloenzymes and Metals in Medicine (WS 2019/2020, Vorlesung, 2 SWS, Nicolai Burzlaff)

Metalle in der Medizin für Molekularwissenschaftler / Metalloenzymes and Metals in Medicine (WS 2019/2020, Vorlesung, 1 SWS, Nicolai Burzlaff)

Nanoparticles and Nanostructured Thin Films / Nanopartikel und nanostrukturierte dünne Schichten (WS 2019/2020, Vorlesung, 2 SWS, Julien Bachmann)

Modern X-ray structure determination of single crystals/Einführung i. d. Kristallstrukturbestimmung von Molekülverbindungen (SS 2019, Vorlesung mit Übung, 2 SWS, Frank Wilhelm Heinemann et al.)

#### **D. Advanced Organic Chemistry I (2L)**

Advanced Organic Chemistry I - Synthesis and Catalysis/Fortgeschrittene Organische Chemie I - Synthese und Katalyse (WS 2019/2020, Vorlesung, 2 SWS, Svetlana Tsogoeva et al.)

#### **E. Advanced Organic Chemistry II (2L)**

choice of 1 course from

E1: Organocatalysis (2L)

E2: Chemie der Naturstoffe (2L)

E3: Radical Chemistry (2L)

Organocatalysis and catalytic reactions in water (SS 2019, Vorlesung, 2 SWS, Svetlana Tsogoeva et al.)

Seminar: Chemie der Naturstoffe (SS 2019, Hauptseminar, 2 SWS, Marcus Speck et al.)  
 Current issues in Organic Chemistry I/II (Advanced Organic Chemistry II) (SS 2019, Seminar, 2 SWS, Andreas Hirsch et al.)

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**Inhalt:**

**A:** Advanced chemical synthesis and molecular analysis

**B:** Inorganic and coordination chemistry principles; application of spectroscopic methods; advanced reaction mechanisms and experimental methods; important catalytic processes driven by metal complexes; design and synthesis of catalysts, physiologically active substances and new materials based on transition metals compounds

**D:** Modern synthetic methods in organic chemistry: pericyclic reactions, heterocycle syntheses, modern catalytic methodologies (metal-, organo- and biocatalysis), strategies in stereoselective synthesis

**C1:** Metal binding to proteins and DNA; functions of metal ions in enzymes; O<sub>2</sub> transport, storage and activation; electron transfer in proteins; heme and non-heme iron containing oxygenases; zinc peptidases and proteases; superoxide dismutases; copper containing enzymes; biological function of nickel, molybdenum and tungsten; concepts and synthesis of model complexes; basics of Photosynthesis

**C2:** Platinum based anticancer drugs; Ruthenium and gold based metallotherapeutics; silapharmaca; Li therapeutics; boron neutron capture therapy; MnSOD; insulin mimetic vanadium containing compounds; magnetic resonance imaging (MRI); cobalamin; metal poisoning; Hg in the biosphere; metallotherapeutic arsenic compounds; technetium radiodiagnostics; antimony in medicine; bismuth based pharmaceuticals

**C3:** Synthesis of n-dimensional nano-materials. Systematic approaches towards nano-particles of defined size and structure are the basis to prepare materials with tailor-made electronic, optical or catalytic properties. The interplay between nano-particles, nano-rods, nano-wires, 2- and 3-dimensional materials are highlighted.

**C4:** Fundamentals of crystallization; polymorphism; structural description of crystals, crystal systems, unit cell, symmetry and symmetry elements, space groups; diffraction power of crystals, diffraction conditions, structure factor; generation of X-rays, single crystal diffractometers, data collection, data reduction; structure solution and refinement, problems and pitfalls, anomalous dispersion and absolute structure, interpretation of results, graphical representations, data bases.

**E1:** General concepts of organocatalysis. Enamine/iminiumion activation by Lewis basic amines. Non-covalent catalysis with ureas, thioureas and diols. Brønsted- and Lewis-acid catalysis. Phase-transfer catalysis. Bi- and multi-functional catalysts. Iminium/Enamine cascade catalysis. Organocatalytic domino reactions; natural product and chiral drug synthesis.

**E2:** Structure, isolation and structure elucidation of natural products; biosynthesis and degradation of carbon hydrates, lipids, peptides and terpenoids; biological and medicinal aspects of tetrapyrrols and alkaloids; technical synthesis of vitamins

**E3:** Radical reactivity; time scales and radical clock experiments; electrophilic and nucleophilic radicals; radical initiators; radical generation by oxidation or reduction; tin hydrides and modern replacements; atom and group transfer reactions; generation of various carbon-centered radicals; generation of oxygen- and nitrogencentered radicals.

**Lernziele und Kompetenzen:**

The students are able

- to understand and to explain the principles of advanced chemical synthesis routes and molecular analysis in organic and inorganic chemistry
  - to understand the functionality of various molecular systems
  - to participate in planning, developing and executing of experimental routes for the synthesis of more complex molecular systems
  - to characterize molecular samples (natural compounds, e.g., peptides or vitamins, or metal-based drugs) using modern experimental methods and techniques
  - to interpret and critically summarize experimental results in written form (lab report in paper-style format)
  - to work in smaller research teams (team ability).
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### Verwendbarkeit des Moduls / Einpassung in den Musterstudienplan:

Das Modul ist im Kontext der folgenden Studienfächer/Vertiefungsrichtungen verwendbar:

[1] **Molecular Science (Master of Science)**

(Po-Vers. 2007 | NatFak | Molecular Science (Master of Science) | alte Prüfungsordnungen | Masterprüfung | Wahlpflichtmodul Molecular Science)

[2] **Molecular Science (Master of Science)**

(Po-Vers. 2013 | NatFak | Molecular Science (Master of Science) | Wahlpflichtmodul Molecular Science)

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### Studien-/Prüfungsleistungen:

Molekülsynthesen - Molecular Synthesis (Prüfungsnummer: 30801)

(englische Bezeichnung: Molecular Synthesis)

Prüfungsleistung, mündliche Prüfung, Dauer (in Minuten): 45

Anteil an der Berechnung der Modulnote: 100%

weitere Erläuterungen:

Assessment and examinations: O45 (PL) + LAB (SL): oral examination (45 min), 2 Examiners + Lab course protocol(s), ungraded

Calculation of the grade for the module: 100% from oral examination

Prüfungssprache: Englisch

Erstablesung: WS 2019/2020, 1. Wdh.: SS 2020

1. Prüfer: Karsten Meyer

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### Organisatorisches:

**Intended stage in the degree course:** Mandatory elective module (Wahlpflichtmodul) or Elective module (Wahlmodul), semester 1-3

**Frequency of offer:** start of studies is available in summer and winter term

A: upon appointment with contact persons

B & D: winter term

E1/E2: summer term; E2 also winter term;

E3: winter term

C1/C2/C3: winter term