RESEARCH BOOK

IOCB PRAGUE

2026

IOCB Prague Research Book 2026

Ústav organické chemie a biochemie Akademie věd České republiky,
Institute of Organic Chemistry and Biochemistry of the Czech Academy of Sciences

IOCB PRAGUE

Institute of Organic Chemistry and Biochemistry
Czech Academy of Sciences

Director's note

The Institute of Organic Chemistry and Biochemistry of the Czech Academy of Sciences, aka IOCB Prague, was founded in 1953 in then-communist Czechoslovakia. It quickly became a leading center not only for excellent basic research but also, remarkably and quite uniquely, for groundbreaking and highly successful drug discovery.

If I think about what makes this institute special, at least three main features come to mind.

The first is difficult to define: there has always been, indeed, there still is, something in the very foundations of the building at Flemingovo náměstí 2 that prevents its scientists from ever settling for mediocrity. When I began working at IOCB in the 1980s, still under communism, there was never enough money, reagents, or modern instrumentation. Yet everyone understood that, as IOCB scientists, we had to measure ourselves against colleagues in London, Munich, or San Francisco. If we could not hold our own in that comparison, we had failed. Perhaps this legacy is what inspired us last year to seize the opportunity to establish our own branch in Boston, on the banks of the Charles River between MIT and Harvard.

The second defining feature is also deeply rooted in the culture of this institute: IOCB was successful in technology transfer long before the term became cool or even widely used. Some of the earliest peptide hormones developed by Josef Rudinger, Karel Jošt, and their collaborators, as well as nucleoside and nucleotide derivatives discovered by Alois Píškala and Antonín Holý as anti-leukemia and antiviral drugs, are prime examples. These discoveries not only generated millions of dollars in royalties from pharmaceutical companies, but, far more importantly, transformed the health of millions of patients worldwide. This legacy provides both a remarkable foundation to build on and a clear obligation to carry forward. We have no excuses: we must succeed.

The third and perhaps most subtle hallmark of our institute is the friendly, cooperative, and supportive environment in which our colleagues work. This is by no means something to be taken for granted. At IOCB, we help one another and celebrate each other's successes. Everyone understands that the success of one strengthens the work of all.

As you read through this yearbook, I hope you will feel the qualities that set IOCB apart. Enjoy, and if you wish to learn more about our history, present, and future, please visit us, or better yet, join us. We are always looking for talented, dedicated, and hard-working students, postdocs, and colleagues to help us carry the very special story of IOCB into the future.

Prof. Jan Konvalinka, PhD
Director

IOCB Prague – excellence in basic research and successful applications

We are a leading research institute in Central and Eastern Europe, recognized internationally for excellence in basic research and success in translating discoveries into real-world applications.

IOCB Prague employs approximately 1,060 people, including some 250 foreigners, with women and men represented in roughly equal numbers. Our diverse scientific ecosystem comprises 35 research groups, 2 joint laboratories, 1 research-service group, 11 core facilities, and 4 targeted research groups. An essential part of our community is formed by more than 220 PhD students, and we continue to seek new talent.

Beginnings

Founded in 1953 by Prof. František Šorm, IOCB quickly grew into an interdisciplinary institute linking chemistry, biology, and medicine. Šorm set the direction of the research by focusing on nucleic acids, peptides, proteins, terpenoids, steroids, and innovative organic synthesis, areas in which the institute soon made, and continues to make, pioneering contributions.

Drug discovery

IOCB has established a strong track record in applied research, especially in medicinal chemistry. What began in 1969 with an ointment called Dermazulen soon developed into work on human peptide hormones and their analogues. The institute's most far-reaching impact stems from the discoveries of Prof. Antonín Holý, whose acyclic nucleotide phosphonate antivirals, most notably tenofovir, became cornerstone components of leading HIV and HBV therapies developed by Gilead Sciences, Inc.

Prof. Holý (1936–2012) remains the most prominent scientist in the history of IOCB. His pioneering work in the synthetic and medicinal chemistry of modified nucleosides and nucleotides led to antivirals that would later transform the treatment of several viral diseases. In 1976, he began collaborating with Prof. Erik De Clercq of the Rega Institute in Leuven, Belgium, and with John C. Martin of Gilead Sciences, USA, creating one of the major success stories in modern antiviral research.

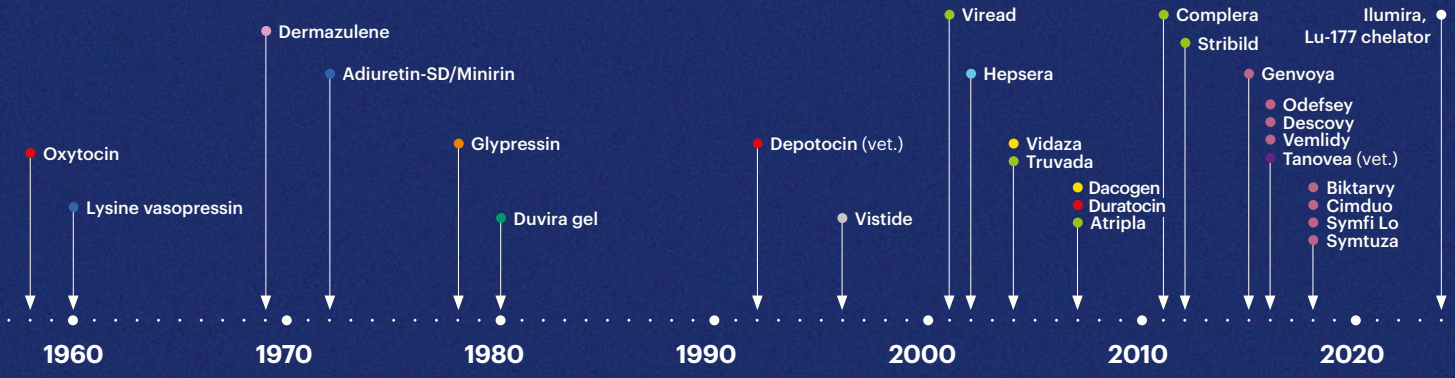
Beyond these well-known antiviral discoveries, IOCB research has produced many other approved nucleoside drugs, including Decitabine for acute myeloid leukemia and Azacytidine for myelodysplastic syndrome, both of which were discovered by Dr. Alois Pískala.

Today, Prof. Holý's legacy is carried forward by research groups devoted to nucleotide chemistry, nucleic acids, and medicinal chemistry targeting cancer and a broad spectrum of viral, bacterial, and fungal diseases.

Current research

The commercial success of IOCB-developed drugs and the resulting patent income have enabled the institute to grow substantially and transform its campus into a modern facility equipped with state-of-the-art instrumentation. IOCB is an internationally recognized institute with English as its working language, and its scientists come from dozens of countries around the world.

Registered drugs with active compounds developed at IOCB



Research clusters

Research at IOCB is organized into three major clusters of interconnected disciplines:

The CHEM cluster

The CHEM cluster covers organic synthesis, medicinal chemistry, natural products chemistry, catalysis, chemical biology, bioconjugate chemistry, drug design and discovery, photochemistry, materials chemistry, nanochemistry, and related areas.

Organic chemistry spans the development of synthetic methodologies, total synthesis of natural products, preparation of fluorinated compounds, extended aromatic systems, and helicenes, as well as the creation of modified derivatives and analogues of nucleosides, nucleotides, oligonucleotides, steroids, and peptides.

Work in medicinal chemistry centers on antivirals, cytostatics, compounds targeting neuropathic pain and inflammation, antimicrobial agents, and antiparasitic compounds.

Research in bioorganic chemistry and chemical biology focuses on nucleic acids, protein–DNA interactions, new bioconjugation reagents and reactions, and a range of tools and techniques for bioimaging.

Materials chemistry research includes synthesizing functional molecules for nanomaterials, creating modified surfaces and components for molecular electronics, studying singlet fission, examining molecules and reactions on metal surfaces, and designing modified nanodiamonds and molecular machines. Among other things, research in coordination chemistry is advancing successfully.

The BIO cluster

The BIO cluster encompasses biochemistry, molecular, structural and cell biology, virology, biochemical pharmacology, physiology, chemical ecology, diagnostic tools, bioinformatics, and related fields. Biochemical groups conduct multidisciplinary research aimed at detailed characterization of human pathogens, interactions between key pathogenic proteins and cellular machinery, RNA modifications, and regulatory processes involved in cancer growth, metabolic disorders, and neurodegenerative diseases.

Structural biology and biochemical studies focus on medicinally interesting enzymes, membrane receptors and channels, and human transcription factors, including their complexes and interactions with cellular partners or inhibitors. These projects aim not only to deepen understanding of the underlying biological processes but also to identify new therapeutic targets.

Biological activity screening, investigation of the mechanisms of action of bioactive compounds synthesized in medicinal chemistry groups, and the development of original diagnostic methods contribute to the successful identification of specific inhibitors.

Many of these studies are supported by bioinformatics. IOCB hosts one of the nodes of the pan-European ELIXIR infrastructure. Machine learning is driving progress in the study of novel enzymatic pathways found in plants.

The PHYS cluster

The PHYS cluster comprises two main branches. Theoretical and computational chemistry groups apply modern quantum-chemical and molecular-modelling approaches to problems of high chemical and biological relevance.

Theoretical chemistry teams use quantum chemistry and molecular simulations to predict the structure, reactivity, and properties of organic molecules and biomolecules; to study biomolecular interactions and systems of increasing complexity; to investigate electron-transfer processes and mechanisms of organic and enzymatic reactions; and to perform rational *in silico* design of ligands and inhibitors of biomolecular targets.

Spectroscopy and spectrometry groups carry out structure determination and investigate relationships between molecular structure and physical properties. They also perform theoretical calculations to predict spectra and provide essential support for research in both the CHEM and BIO clusters.

Evaluation and tenure-track

IOCB follows an ambitious policy of regular, rigorous evaluation of its research groups by an International Advisory Board, as well as a tenure-track program for establishing independent junior research groups.Research at IOCB is organized into three major clusters of interconnected disciplines.

Applied research

In applied research, IOCB continues its long tradition of translating results of basic research into products that help improve people's lives.

IOCB Tech

Since 2009, IOCB Tech (**www.iocbtech.cz**) has served as IOCB Prague's technology transfer office and subsidiary company. Founded by Prof. Martin Fusek, IOCB Tech supports the further development of inventions and discoveries arising from basic research at the institute and helps transfer them into new products with potential future benefit to society. These inventions originate primarily in medicinal chemistry, materials science, and related fields.

IOCB Tech's key responsibilities include identifying commercially promising projects developed at IOCB, analyzing their market potential and patentability, securing intellectual-property protection, supporting project development through dedicated project management, seeking commercial partners, and negotiating the contractual terms of license agreements.

The company has negotiated and concluded more than a dozen major license agreements with leading pharmaceutical partners, including Gilead Sciences, Merck, Novo Nordisk, and SHINE Medical Technologies.

i&i Prague

i&i Prague (**www.iniprague.com**) is a biotech incubator, venture builder, and IOCB Tech subsidiary founded in 2017. It focuses on transferring the most promising technologies into practice, with an emphasis on innovations in drug development, diagnostics, medical technologies, and other life-science fields. The company specializes in supporting startups in the early stages of their development.

i&i Biotech Fund

The investment fund i&i Biotech Fund was established in 2021 in cooperation with the European Investment Fund and i&i Prague. The fund specializes in investments in academic spinoffs and plans to support innovative projects in the area of natural sciences, with a special focus on drug discovery, innovative diagnostics, medical devices, and other biotechnologies. (**www.inibio.eu**)

PharmTheon

PharmTheon (**www.pharmtheon.cz**) was founded in May 2024 as an IOCB Tech translational research center that bridges the gap between fundamental research and its practical applications in medicine, engineering, and biotechnology.

The center supports therapeutic development by integrating medicinal chemistry expertise, including high-throughput screening, computational design, and pharmacological profiling with biophysical validation, functional assays, biomarker discovery, *in vivo* proof-of-concept models, and patient stratification.

IOCB Tech Foundation

The IOCB Tech Foundation (Nadační fond IOCB Tech, **www.nf-iocbtech.cz**) was established in 2022 by IOCB Tech to take over its philanthropic activities and develop them systematically and professionally. The foundation's mission is to advance the development of science and the application of its results in society, while at the same time strengthening public awareness of the fundamental contribution of scientific research.

IOCB Boston

In October 2024, IOCB Prague opened its first international branch in Boston, Massachusetts, USA, marking a significant milestone for Czech science. By expanding into the world's leading biotech hub, the institute strengthened global collaboration, broadened research opportunities, and enhanced its ability to attract top scientific talent. (**www.iocbboston.org**)

IOCB BOSTON

What we offer young scientists

PhD projects

IOCB Prague is looking for talented, independent, and highly motivated PhD students with an MSc degree or equivalent in life sciences or related fields. Although IOCB does not directly award PhDs, students can write their PhD thesis at IOCB in collaboration with one or more of five partner universities. PhD project topics for the following academic year are announced in January at the latest, with registration deadlines and interviews typically planned for February or March.

As part of IOCB, PhD students participate in advanced research conducted by distinguished scientists, gain experience in diverse settings, learn to use new instruments, and present their work at seminars and international conferences.

IOCB Postdoctoral fellowships

Each year, IOCB Prague offers up to ten postdoctoral positions in chemistry and biochemistry through the IOCB Fellowship Program. Fellowships are awarded for one year, with the possibility of applying for a one-year extension. The application deadlines are twice a year, on 1 April and 1 October.

Summer Student Program

IOCB's Summer Student Program is designed to provide master's students from any university within the EU (excluding the Czech Republic) with an engaging and meaningful 8-week work experience, helping them expand their professional networks and develop their skills and competencies through feedback from experienced scientists.

HR Award

The HR Excellence in Research Award, or HR Award, is granted by the European Commission to institutions that have made progress in implementing the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers.

IOCB Prague received the HR Award on 12 November 2021.

Science community initiatives

Women in Science (WiS@IOCB)

The Women in Science at IOCB initiative began in 2017 to support female scientists and address the specific challenges they encounter in their careers.

PostDoc Club

The IOCB PostDoc Club is an initiative driven by postdoctoral researchers to foster collaboration, knowledge exchange, and professional development. The club hosts talks by esteemed experts from academia and industry who share their career experiences and offer practical advice.

Green Club

The IOCB Green Club promotes environmentally responsible and sustainable practices within the IOCB community. Established in autumn 2023 with the support of IOCB management, the club brings together employees and students to develop practical ways of reducing the institute's environmental impact.

BIO

CHEM

PHYS

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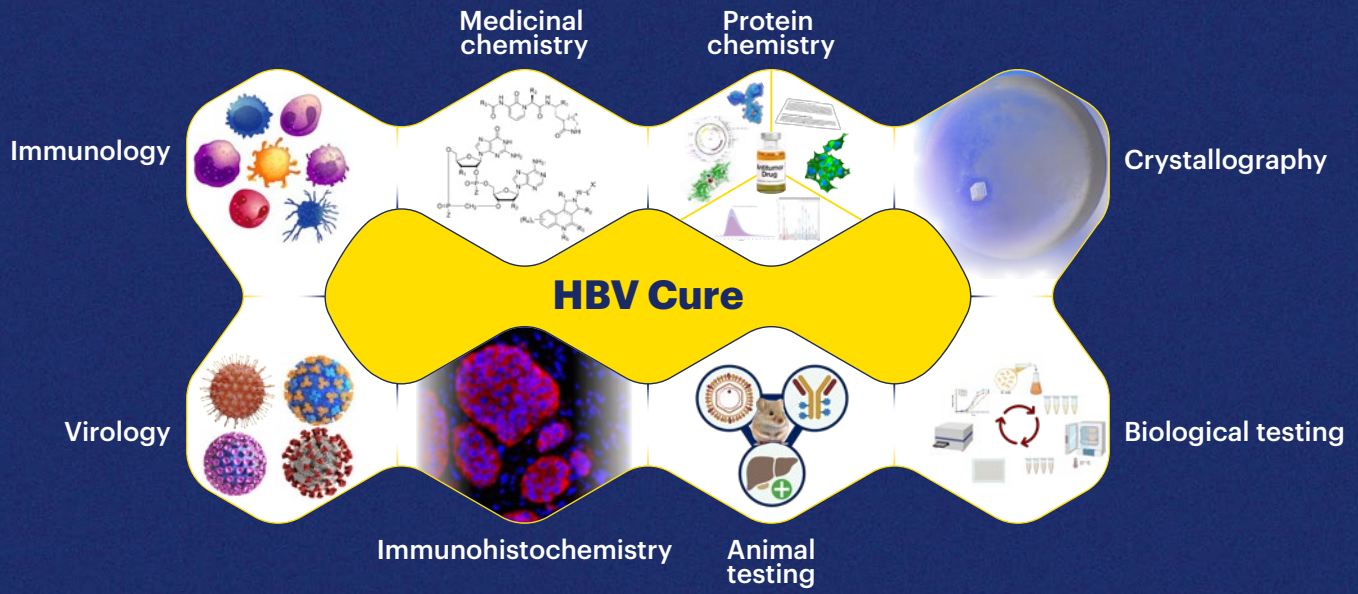
HBV Cure



Our interdisciplinary team develops therapies for chronic hepatitis B, cancer, and inflammatory disorders. In collaboration with our global partners, we have identified novel modulators of the cGAS–STING pathway.

This pathway not only detects cytosolic dsDNA but also triggers type I interferons and cytokines, activating innate and adaptive immunity to fight infections and tumors. However, its overactivation is linked to autoimmune and neurodegenerative diseases, including lupus, Aicardi–Goutières syndrome, Alzheimer's, and amyotrophic lateral sclerosis (ALS). We also target asthma and COPD exacerbations.

Our work on cyclic dinucleotides (CDNs) has yielded novel agonists effective across all STING haplotypes. Using chemical and enzymatic synthesis, we have developed potent CDNs and lipophilic prodrugs with 1000× improved cellular activity. These lead compounds have been shown to induce strong antitumor immunity in mice. We have also created tumor-targeted antibody–CDN conjugates that activate local innate immunity, expand tumor-specific CD8+ T cells, and synergize with anti-PD-1 therapy.

In parallel, we have discovered potent, brain-penetrant cGAS inhibitors with excellent oral bioavailability and pharmacokinetics that have proven effective in inflammatory disease models. We are currently advancing rhinovirus inhibitors and immunotherapies for chronic hepatitis B.

Pimková Polidarová, M.; Vaneková, L.; Břehová, P. *et al.* Synthetic Stimulator of Interferon Genes (STING) Agonists Induce a Cytokine-Mediated Anti-Hepatitis B Virus Response in Nonparenchymal Liver Cells. *ACS Infect. Dis.* **2023**, *9* (1), 23–32.

Dejmek, M.; Brázdová, A.; Otava, T. *et al.* Vinylphosphonate-Based Cyclic Dinucleotides Enhance STING-Mediated Cancer Immunotherapy. *Eur. J. Med. Chem.* **2023**, *259*, 115685.

Keywords: immuno-oncology, chronic hepatitis B, drug discovery, Alzheimer's, Parkinson's, amyotrophic lateral sclerosis

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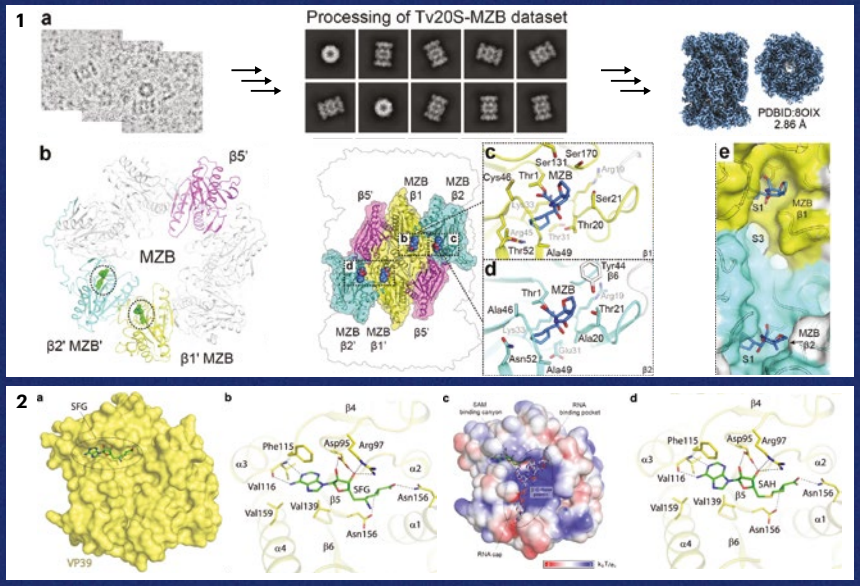
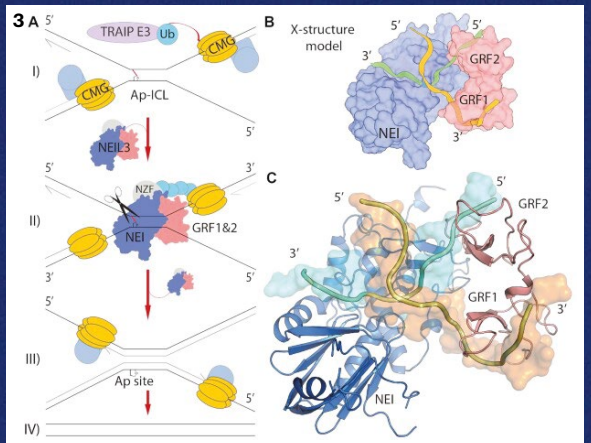
Structural Membrane Biology





1 DNA X-structure of replication-coupled DNA repair of the Ap-ICL (Huskova *et al. Nucleic Acids Res.* **2022**)

2 Processing of the cryo-EM dataset for a Tv20S bound to MZB (Silhan *et al. Nat. Commun.* **2024**)

3 Sinefungin and SAH recognition by the monkeypox virus VP39 methyltransferase (Silhan *et al. Nat. Commun.* **2023**)

Our group focuses on the structural and functional characterization of proteins involved in viral replication, DNA repair, and lipid metabolism. We primarily utilize X-ray crystallography and cryo-electron microscopy methods, supported by a wide range of biochemical and biophysical approaches. Our goals are to understand how these proteins work and design selective inhibitors with therapeutic potential.

Much of our recent work has focused on flaviviral RNA-dependent RNA polymerases (RdRps) and methyltransferases (MTases) from the Zika, dengue, and tick-borne encephalitis viruses. In collaboration with the Nencka Group, we developed inhibitors that block these viral enzymes. We also investigated the SARS-CoV-2 MTases nsp14 and nsp16, identifying inhibitors that may also act against the monkeypox virus due to structural similarities.

Building on these efforts, we performed detailed structural and functional analyses of the monkeypox virus MTase VP39. Our crystallographic data revealed inhibitor binding modes, providing a blueprint for the rational design of next-generation antivirals.

In a separate line of research, we explored the DNA repair enzyme NEIL3 and its role in the repair of damaged DNA, as well as the 20S proteasome of *Trichomonas vaginalis*, which was found to exhibit structural features that make it a promising drug target.

Silhan, J.; Klima, M.; Otava, T. *et al.* Discovery and Structural Characterization of Monkeypox Virus Methyltransferase VP39 Inhibitors Reveal Similarities to SARS-CoV-2 nsp14 Methyltransferase. *Nat. Commun.* **2023**, *14*, 2259.

Silhan, J.; Fajtova, P.; Bartosova, J. *et al.* Structural Elucidation of Recombinant *Trichomonas vaginalis* 20S Proteasome Bound to Covalent Inhibitors. *Nat. Commun.* **2024**, *15*, 8621.

Keywords: methyltransferase, protein structure, viral inhibitors, DNA repair, X-ray crystallography, cryo-EM

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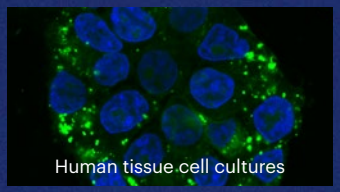
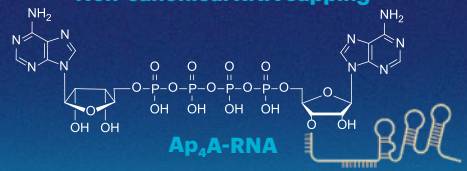
Chemical Biology of Nucleic Acids

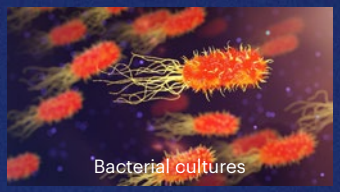


RNA isolation

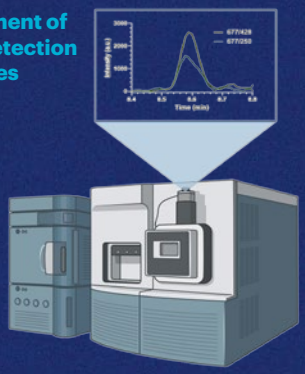
Non-canonical RNA capping



RNA isolation

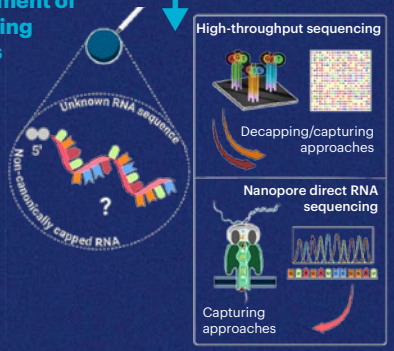


Development of LC-MS detection techniques



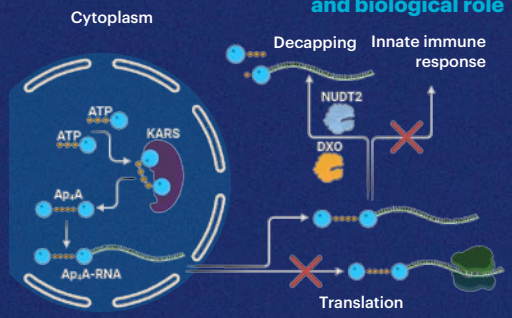
Nature Communications, **11**, 1052 (2020)

Development of sequencing methods



ChemBioChem, **26**, e202400604 (2025)

Studies of metabolism and biological role



Angew. Chem. Int. Ed., **63**, e202314951 (2024)

The aim of our group is to understand the role of RNA modifications, particularly 5′ RNA caps, in various model systems. We believe that chemical RNA modifications are responsible for the majority of distinct RNA functions. Currently, more than 170 RNA modifications are known, but the roles of many remain unknown. The 5′ RNA caps are critical structures and among the least characterized RNA modifications. Until recently only canonical structures, NAD or CoA have been known as 5′ RNA caps. However, we have discovered a new class of RNA caps based on the structure of dinucleoside polyphosphates (Np_nNs) in both bacteria and mammalian cells. The role of free Np_nNs, identified fifty years ago in all types of cells, is yet to be elucidated. Np_nNs cellular concentration increases under stress conditions. We presume that their cellular effects are mediated by the RNA, where they serve as RNA caps. To investigate these non-canonical RNA caps, we employ advanced LC-MS techniques and develop our own RNA sequencing methods for their identification. Our research explores the biosynthesis, biogenesis, and functional roles of these RNA caps across various model systems (e.g., bacteria and mammalian tissue cell cultures). Additionally, we use a range of molecular biology approaches and collaborate with structural biologists, utilizing cryo-EM to uncover the properties of non-canonically capped RNA.

Potužník, J. F.; Nešuta, O.; Škríba, A. *et al.* Diadenosine Tetraphosphate (Ap_4A) Serves as a 5′ RNA Cap in Mammalian Cells. *Angew. Chem., Int. Ed.* **2024**, *63*, e202314951.

Serianni, V.; Škerlová, J.; Knopp Dubánková, A. *et al.* Molecular Insight into 5′ RNA Capping with Dinucleoside Polyphosphates by Bacterial RNA Polymerase. *Nat. Chem. Biol.* **2026**.

Keywords: RNA caps, dinucleoside polyphosphates, RNA modifications, regulatory RNA, MS analysis of RNA, RNA-seq

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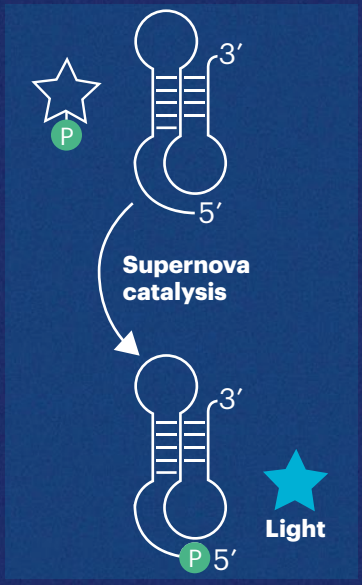
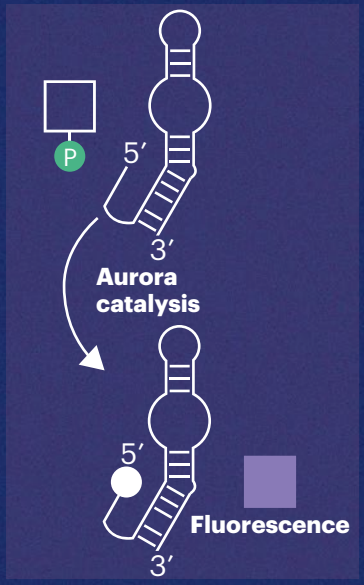
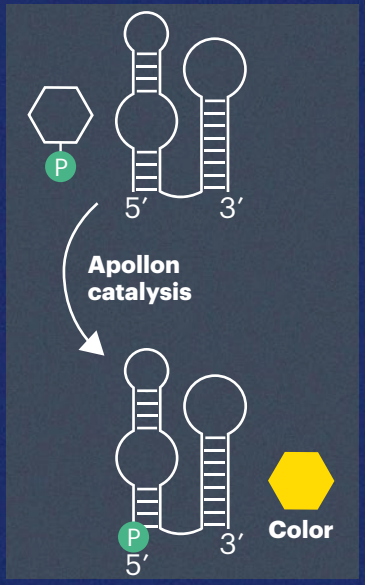
Functional Potential of Nucleic Acids







DNA and RNA can perform a wide range of functions beyond the mere storage and transmission of genetic information. These include the ability to bind ligands with high affinity and specificity and to catalyze chemical reactions.

Such motifs are typically identified using artificial evolution methods, which rely on multiple cycles of selection and amplification to isolate rare molecules with desired properties from large random sequence libraries. We apply artificial evolution and related techniques to explore the functional potential of both artificial and naturally occurring DNA and RNA molecules.

A core focus of our work is the development of nucleic acid motifs that can serve as tools for applications such as diagnostics and high-throughput screening. An exciting development in this area is our discovery of deoxyribozyme sensors capable of generating chemiluminescent, fluorescent, and colorimetric signals in the presence of ligands of interest.

We also investigate the potential application of more powerful methods to search sequence space for DNA and RNA molecules featuring new and improved functions. These experiments utilize diverse approaches such as structured libraries, single-step selections, and machine learning, allowing us to address fundamental questions about the functional capabilities of nucleic acids.

Švehlová, K.; Lukšan, O.; Jakubec, M. *et al.* Supernova: A Deoxyribozyme That Catalyzes a Chemiluminescent Reaction. *Angew. Chem., Int. Ed.* **2022**, *61*, e202109347.

Volek, M.; Kurfürst, J.; Drexler, M. *et al.* Aurora: A Fluorescent Deoxyribozyme for High-Throughput Screening. *Nucleic Acids Res.* **2024**, *52* (15), 9049–9061.

Keywords: deoxyribozyme, ribozyme, artificial evolution, functional nucleic acid, biosensor

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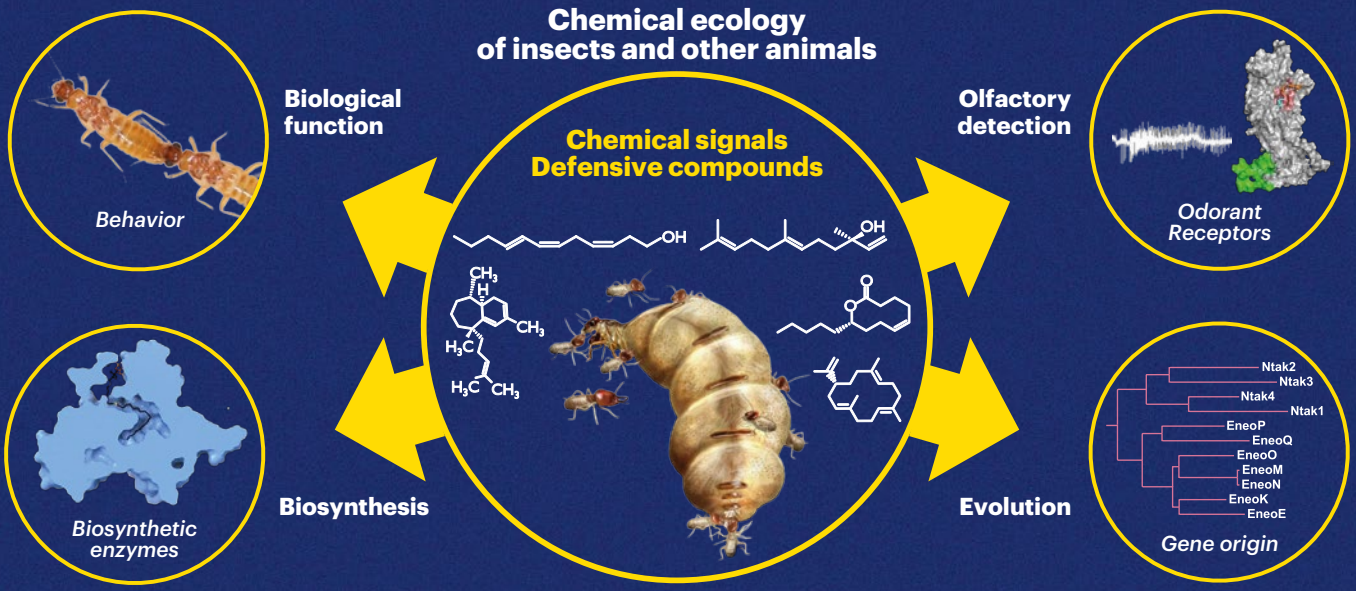
Chemical Ecology



The main focus of our research group aligns with the definition of chemical ecology: We are interested in chemical identity, biological functions, biosynthesis and evolutionary origins of small molecules secreted by organisms to interact with their environment. The main model of our research is termites, the oldest social insects with great ecological importance in tropical regions of the planet. Like other social insects, termites use chemical signals (pheromones and signature mixtures) for communication in their colonies and produce a rich repertoire of defensive chemicals. We study the chemistry and biological roles of these compounds, the function and evolution of enzymes responsible for their biosynthesis, and their detection by the olfactory system.

In pursuit of this goal, our group brings together researchers and students trained in biological and chemical disciplines and employs the techniques of chemical ecology (chemical analysis, behavioral studies, electrophysiology), complemented by biochemistry (functional characterization of enzymes) and molecular genetics (NGS sequencing, genome and transcriptome assemblies). Our projects also address additional aspects of termite biology and life history, such as breeding systems, ecology, physiology and chemical taxonomy. Besides termites, we study chemical ecology also in other animals, ranging from other insects to humans.

Macháček, S.; Tupec, M.; Horáček, N. *et al.* Evolution of Linoleic Acid Biosynthesis Paved the Way for Ecological Success of Termites. *Mol. Biol. Evol.* **2023**, *40* (4), msad087.

Diallo, S.; Kašparová, K.; Šulc, J. *et al.* Identification of the Trail-Following Pheromone Receptor in Termites. *eLife* **2025**, *13*, RP101814.

Keywords: social insects, termites, chemical communication, chemical defense, biosynthesis, pheromones, evolution, insect olfaction

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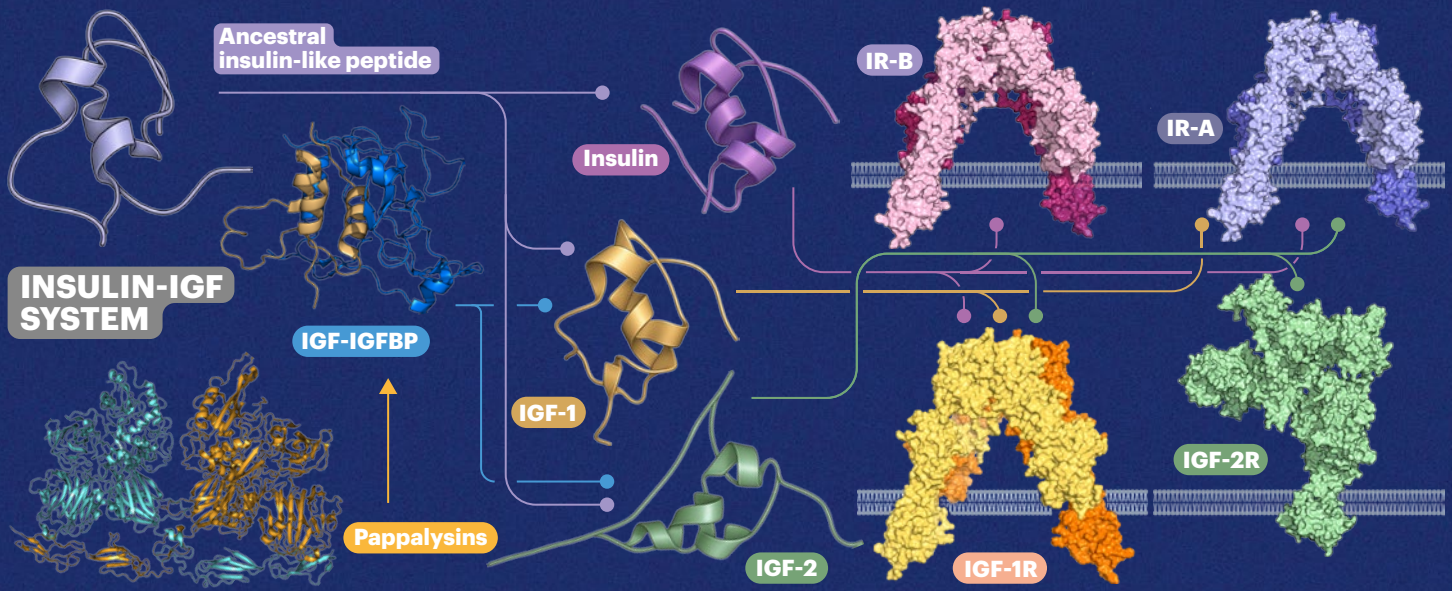
Chemistry and Biology of Insulin and Insulin-like Growth Factors



Our group investigates all physiological aspects of the insulin, IGF-1, and IGF-2 systems. Insulin-like hormones share similar 3D structures, and together with their cell membrane receptors – two isoforms of the insulin receptor (IR-A and IR-B), IGF-1 receptor (IGF-1R), IGF-2 receptor (IGF-2R or CI-M6PR), IGF-binding proteins (IGFBPs), and specific proteinases (pappalysins) – form a complex protein network that plays a central role in regulating metabolic homeostasis, development, growth, healing, and lifespan.

Insulin and IGFs cross-bind to their receptors with different affinities, triggering distinct but overlapping physiological effects, predominantly metabolic for insulin and mitogenic for IGFs. Dysregulation of these processes can lead to diseases such as diabetes, cancer, and neurological or growth-related disorders.

Our primary goal is to understand the structural basis for the metabolic and mitogenic cellular responses elicited by insulin and IGFs. To this end, we synthesize hormone analogues, peptide mimetics, and pappalysin inhibitors to study their physiological effects and develop new therapeutic candidates for treating diabetes, cancer, and neurological diseases.

Potalitsyn, P.; Mrázková, L.; Selicharová, I. *et al.* Non-Glycosylated IGF2 Prohormones Are More Mitogenic than Native IGF2. *Commun. Biol.* **2023**, *6*, 863.

Mrázková, L.; Hladoníková, K.; Toncarová, B. *et al.* Design of Potent Mannose-6-Phosphate Derivatives as Ligands for CI-M6P/IGF2R Using Fluorescence Polarization Assay. *Chem. Eur. J.* **2025**, *31* (41), e202500973.

Keywords: insulin, IGF-1, IGF-2, hormone analogues, diabetes, neurological diseases

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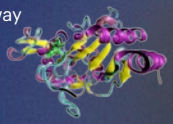
Tumor Suppressors

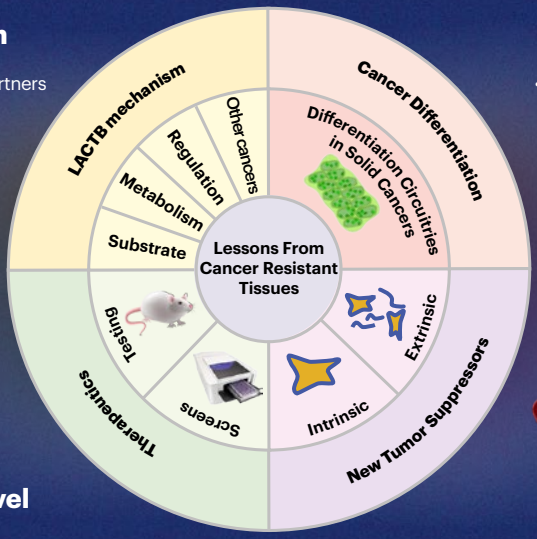
Investigating mechanism of LACTB-induced tumor suppression

- Identification of LACTB substrate/s and binding partners
- LACTB in other types of cancer (lung, pancreas)
- Structural requirements of LACTB filaments
- LACTB's role in cellular metabolism
- Regulation of LACTB pathway
- LACTB's role in immunity



- Designing compounds screen aimed at reactivation of tumor suppressor pathways
- Preclinical testing of the hit compounds

Identification of drug targets & novel therapeutic compounds



Requirements for LACTB-induced cancer cell differentiation

- Identification of molecular circuitries involved in differentiation of solid cancers
- Examining connection between mitochondrial lipids and cell differentiation

- Finding novel intrinsic or extrinsic tumor suppressors
- Finding novel intrinsic or extrinsic tumor promoters

Discovery of additional tumor suppressors pathways

The aim of our lab is to identify and characterize new tumor suppressor pathways and circuitries in human cells with the intention of translating this new knowledge into therapeutic use. Our team researches tissues / cell types that rarely undergo tumorigenesis. These are cellular models that have already found applications in battling cancer and can provide us with important knowledge on how to fight cancer in tissues susceptible to it. The scope of our work includes *in vitro*, *in vivo* and preclinical studies leveraging knowledge in biology, chemistry, biochemistry and biophysics attained through extensive collaborations with research teams all over the world. The three main areas of research are (i) the mechanism of the LACTB tumor suppressor and its role in cancer cell differentiation (basic research), (ii) identification of additional tumor suppressor pathways in human cancers (basic research), and (iii) therapeutic reactivation of researched tumor suppressors (translational research).

Gonzalez-Morena, J. M.; Escudeiro-Lopes, S.; Ferreira-Mendes, J. M. *et al.* LACTB Induces Cancer Cell Death through the Activation of the Intrinsic Caspase-Independent Pathway in Breast Cancer. *Apoptosis* **2023**, *28*, 186–198.

Cutano, V.; Ferreira Mendes, J. M.; Escudeiro-Lopes, S. *et al.* LACTB Exerts Tumor Suppressor Properties in Epithelial Ovarian Cancer through Regulation of Slug. *Life Sci. Alliance* **2023**, *6* (1), e202201510.

Keywords: cancer research, tumor suppressors, differentiation, cancer stem cells, postmitotic tissues, mitochondria, cell signaling

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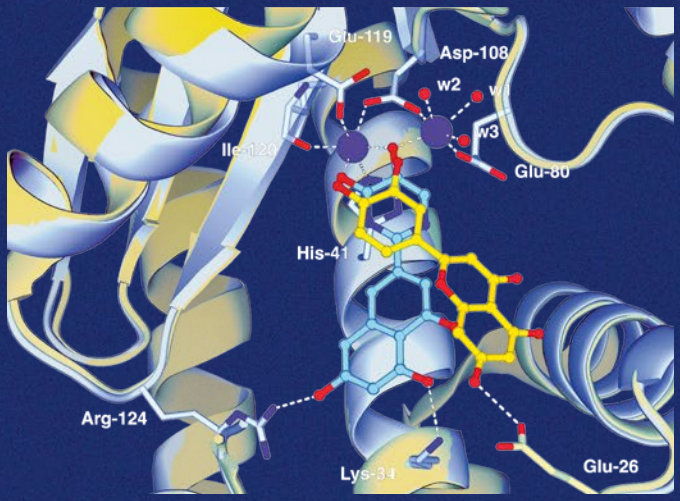
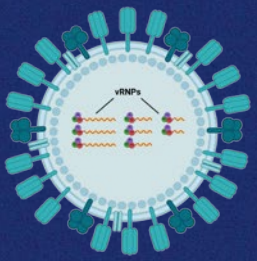
Proteases of Human Pathogens

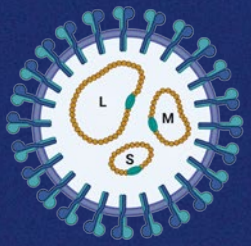
Medicinal chemistry targeting single-stranded RNA viruses



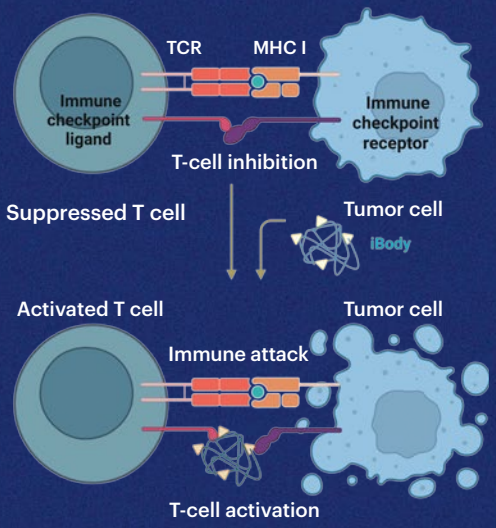
Influenza A



Riff Valley fever virus



Development of antibody mimetics against cancer targets



Our mission is to identify, characterize, and exploit enzymes and receptors as therapeutic targets. To this end, we have developed novel chemical tools, reagents, and assays for the molecular characterization of complex biological processes.

We work with RNA viruses like influenza A, Rift Valley fever virus, SARS-CoV-2, and retroviruses such as HIV. We pursue novel pathways to combat viral replication, for example, by disrupting protein–protein interactions within subunits of influenza polymerase or by inhibiting as-yet unexplored binding pockets in viral proteases.

In parallel, we study how small molecules and polymer conjugates affect immune receptors, with the aim of harnessing the immune system for cancer therapy. To visualize, quantify, and target proteins of interest, we recently developed a synthetic antibody-like polymer scaffold called iBody, which contains a specific ligand of the protein, an affinity anchor, and an imaging marker attached to a hydrophilic copolymer. This easy-to-assemble, versatile scaffold can replace monoclonal antibodies in several *in vitro* and *in vivo* applications.

We have also developed a novel assay called DIANA, suitable for detecting enzymes as diagnostic markers as well as enzyme inhibitors for effective drug development. This assay enables the quantification of zeptomolar enzyme concentrations and supports high-throughput screening of potential inhibitors.

Zamani, M. R.; Hadzima, M.; Blažková, K. *et al.* Polymer-Based Antibody Mimetics (iBodies) Target Human PD-L1 and Function as a Potent Immune Checkpoint Blocker. *J. Biol. Chem.* **2024**, *300* (6), 107325.

Král', M.; Das, A.; Kotačka, T.; *et al.* Targeting the Rift Valley Fever Virus Polymerase: Resistance Mechanisms and Structural Insights. *ACS Infect. Dis.* **2025**, *11* (11), 3364–3376.

Keywords: therapeutic targets, RNA virus replication, antibody mimetics, immune receptors, inhibitor libraries, affinity-based probes

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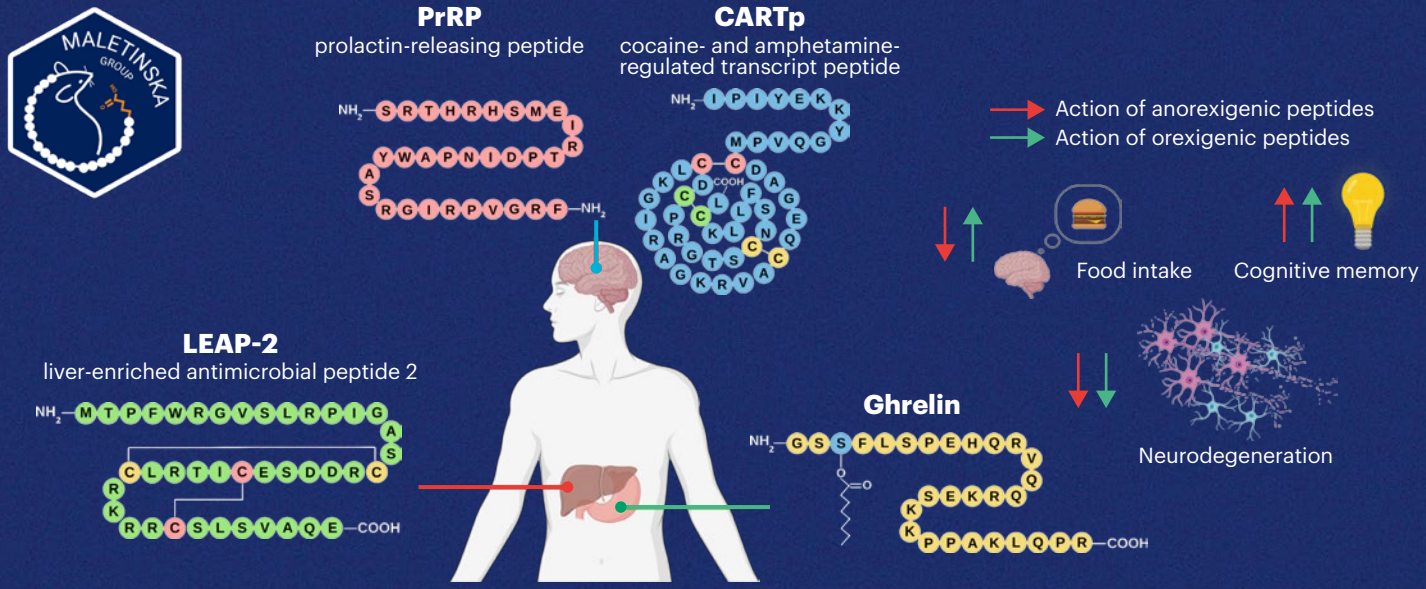
Pathophysiological Mechanisms of Food Intake Regulation



Our multidisciplinary research involving peptide chemistry, biochemistry, and pharmacology focuses on food intake regulation, with the aim of developing new treatments for obesity and related conditions like type 2 diabetes and neurodegenerative disorders.

Anorexigenic neuropeptides, such as prolactin-releasing peptide (PrRP) and cocaine- and amphetamine-regulated transcript (CART) peptide, show promise as anti-obesity agents. These peptides are expressed in brain regions involved in appetite control but cannot typically cross the blood–brain barrier when administered peripherally. To address this shortcoming, we design novel analogues that penetrate the blood–brain barrier, remain stable in circulation, and significantly decrease body weight after peripheral application in mice and rats with diet-induced obesity.

Since type 2 diabetes and obesity are risk factors for Alzheimer's disease, our compounds may also have neuroprotective effects. We have demonstrated that lipidized analogues of anorexigenic peptides improve spatial memory, reduce Tau hyperphosphorylation, decrease β-amyloid plaques, and attenuate neuroinflammation.

Conversely, orexigenic peptides such as ghrelin act as counterparts to anorexigenic signals. Therefore, our research also focuses on ghrelin antagonists, such as liver-enriched antimicrobial peptide 2 (LEAP-2), which could serve as an effective anti-obesity treatment.

Charvát, V.; Strnadová, A.; Myšková, A. *et al.* Lipidized Analogues of the Anorexigenic CART (Cocaine- and Amphetamine-Regulated Transcript) Neuropeptide Show Anorexigenic and Neuroprotective Potential in a Mouse Model of Monosodium-Glutamate-Induced Obesity. *Eur. J. Pharmacol.* **2024**, *980*, 176864.

Mengr, A.; Šmotková, Z.; Pačesová, A. *et al.* Reduction of Neuroinflammation as a Common Mechanism of Action of Anorexigenic and Orexigenic Peptide Analogues in the Triple Transgenic Mouse Model of Alzheimer's Disease. *J. Neuroimmune Pharmacol.* **2025**, *20* (1), 18.

Keywords: anorexigenic neuropeptides, obesity, metabolic syndrome, diabetes, neurodegeneration, lipopeptides

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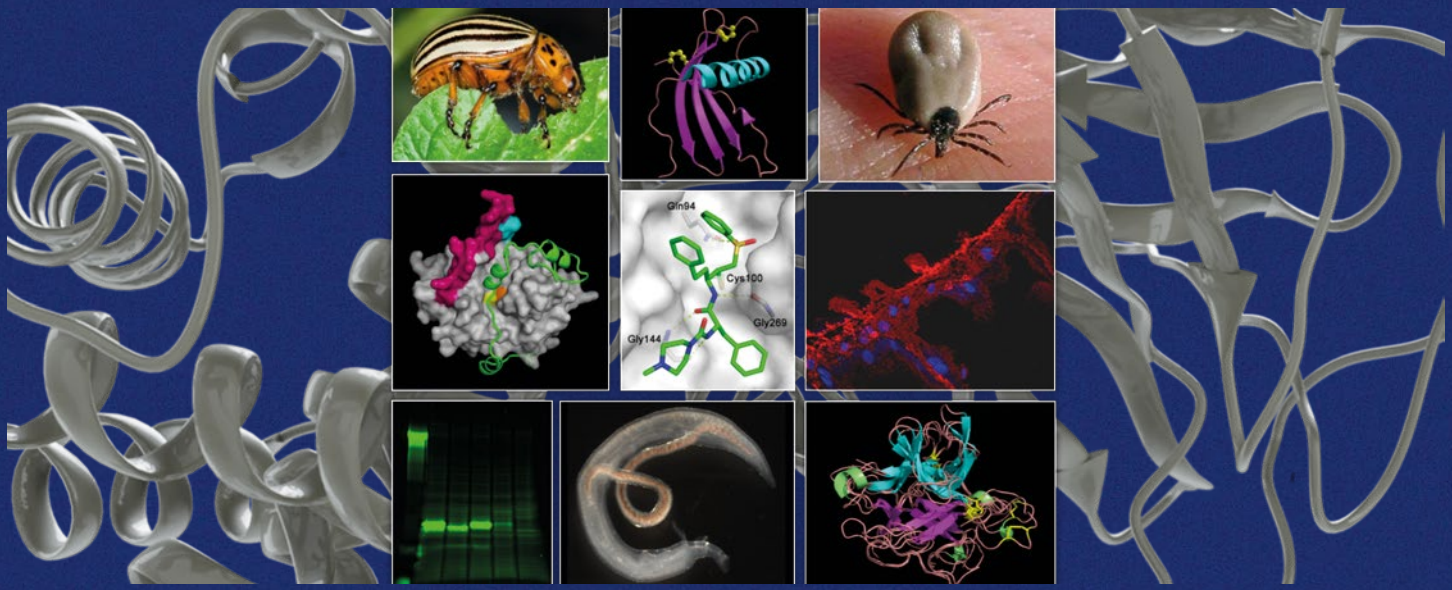
Cathepsin Proteases in Pathology



Our research focuses on cathepsin proteases and cathepsin-driven proteolytic systems that are involved in parasitic diseases, cancer, and neurodegenerative diseases. We are developing novel molecular tools and strategies to regulate cathepsins and associated pathologies.

In blood-feeding parasites, cathepsins function as digestive proteases responsible for the breakdown of host blood proteins and represent therapeutic targets. The blood flukes causing schistosomiasis infect more than 250 million people worldwide, and we investigate structure-function relationships in schistosome proteases for the rational design of inhibitory drugs. Ixodes ticks are vectors of encephalitis and borreliosis in Europe and the US, and we study proteolytic systems in the gut and saliva of ticks as molecular vaccines against ticks and tick-borne diseases.

For human cathepsins associated with cancer and neurodegenerative diseases, we explore novel biochemical mechanisms of functional regulation and their use in the development of therapeutic molecules. We focus on biomimetic inhibitors inspired by natural molecules of plant, microbial and invertebrate origin.

Mareš Pytelková, J.; Orsághová, K.; Beňová, M. *et al*. Allergenic Mites Excrete Cathepsins B and C as Active Cysteine Proteases Distinct from Group 1 Allergens. *Int. J. Biol. Macromol.* **2025**, *331*, 148383.

Spiwoková, P.; Horn, M.; Fanfrlík, J. *et al*. Nature-Inspired Gallinamides Are Potent Antischistosomal Agents: Inhibition of the Cathepsin B1 Protease Target and Binding Mode Analysis. *ACS Infect. Dis.* **2024**, *10* (6), 1935–1948.

Keywords: cathepsins, proteolytic systems, proteases as therapeutic targets, protease inhibitors, rational drug design, protein structures, blood-feeding parasites

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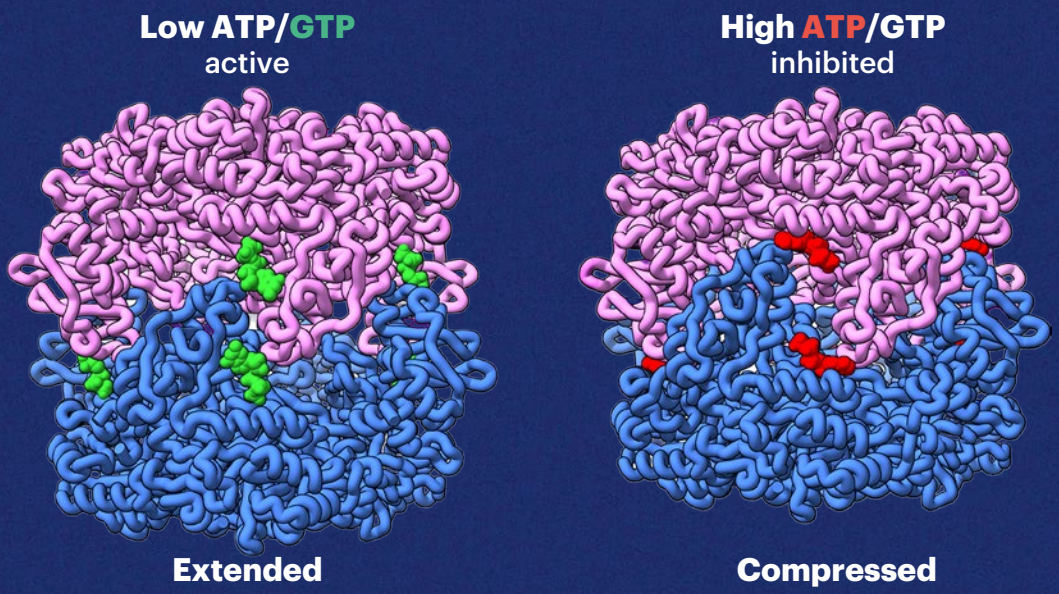
Viral and Microbial Proteins



The research conducted by our group is centered on investigating various aspects of the life cycles of mycobacteria and the hepatitis B virus (HBV). Our primary focus is on how these pathogens interact with host cells, with the aim of identifying new targets for potential drug development. Our current research extends to the evolution of enzymes involved in the biosynthesis of fatty acid derivatives.

Recently, we have used label-free differential proteomics to identify host factors implicated in HBV replication. In other studies, we have investigated the effects of the unconventional prefoldin RPB5 interactor (URI1), of secretory carrier membrane proteins (SCAMP) and of the translocon-associated protein complex (TRAP) on HBV infection.

By combining kinetic analysis, cryogenic electron microscopy and X-ray crystallography of the structures of complexes of inosine-5′-monophosphate dehydrogenase and guanosine monophosphate reductase from *Mycobacterium smegmatis* with different allosteric regulators and substrates, we have described the unique molecular mechanism by which these enzymes are allosterically regulated via the concentration ratio between ATP and GTP.

In a collaborative project with the Robert Hanus group, we have identified a previously unknown Δ12 fatty acyl desaturase capable of converting the widely abundant non-essential oleic acid (C18:1) into the less plentiful yet essential linoleic acid (C18:2). This finding elucidates the mechanism by which termites obtain this essential fatty acid.

Bulvas, O.; Knejzlík, Z.; Sýs, J. *et al.* Deciphering the Allosteric Regulation of Mycobacterial Inosine-5′-Monophosphate Dehydrogenase. *Nat. Commun.* **2024**, *15*, 6673.

Zábranská, H.; Zábranský, A.; Lubyová, B. *et al.* Biogenesis of Hepatitis B Virus e Antigen Is Driven by Translocon-Associated Protein Complex and Regulated by Conserved Cysteine Residues within Its Signal Peptide Sequence. *FEBS J.* **2022**, *289*, 2895–2914.

Keywords: hepatitis B virus, interaction of viral and cellular proteins, *Mycobacterium tuberculosis*, *Mycobacterium smegmatis*, metabolism, fatty acyl desaturases

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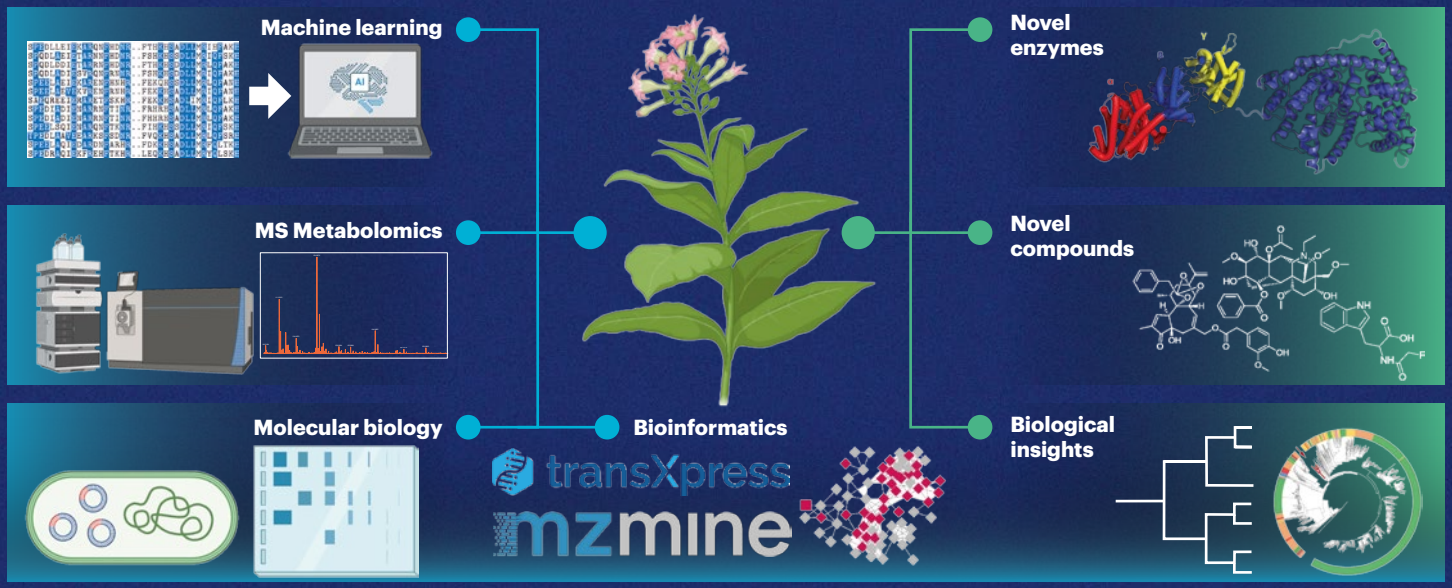
Biochemistry of Plant Specialized Metabolites



Over hundreds of millions of years of evolution, land plants have created an astonishing variety of specialized bioactive metabolites to support their defense and ecological adaptation. Such molecules often interact with human molecular receptors, providing a source of chemical scaffolds essential for the development of new medicines. Approximately 25% of the prescription drugs that are currently in use originate from plants; however, the structural and stereochemical complexity of plant metabolites often renders their chemical synthesis unfeasible.

In our lab, we combine machine learning, molecular biology and bioinformatics to uncover the biological context of secondary plant metabolites. Our machine learning team develops computational tools to analyze metabolomics data, predict enzyme functions and substrate specificities, and reveal hidden patterns in plant chemical diversity. To validate predictions obtained using these tools, our molecular biologists investigate the genes and enzymes behind metabolite biosynthesis, using heterologous expression, protein purification and functional characterization. In turn, our bioinformatics team provides tools for handling and interpreting experimental data, managing databases and developing software for mass spectrometry analysis, helping us explore plant metabolomes and link chemical structures to their biosynthetic origins.

Schmid, R.; Heuckeroth, S.; Korf, A. *et al.* Integrative Analysis of Multimodal Mass Spectrometry Data in MZmine 3. *Nat. Biotechnol.* **2023**, *41*, 447–449.

Mutabdžija, L.; Myoli, A.; de Jonge, N. F. *et al.* Studying Plant Specialized Metabolites Using Computational Metabolomics Strategies. In Plant Functional Genomics; Tugizimana, F., Pluskal, T., Eds.; *Methods in Molecular Biology*; Springer: New York, **2024**; Vol. 2788, pp 97–136.

Keywords: plant specialized metabolites, metabolomics, transcriptomics, *de novo* sequencing, bioinformatics, machine learning

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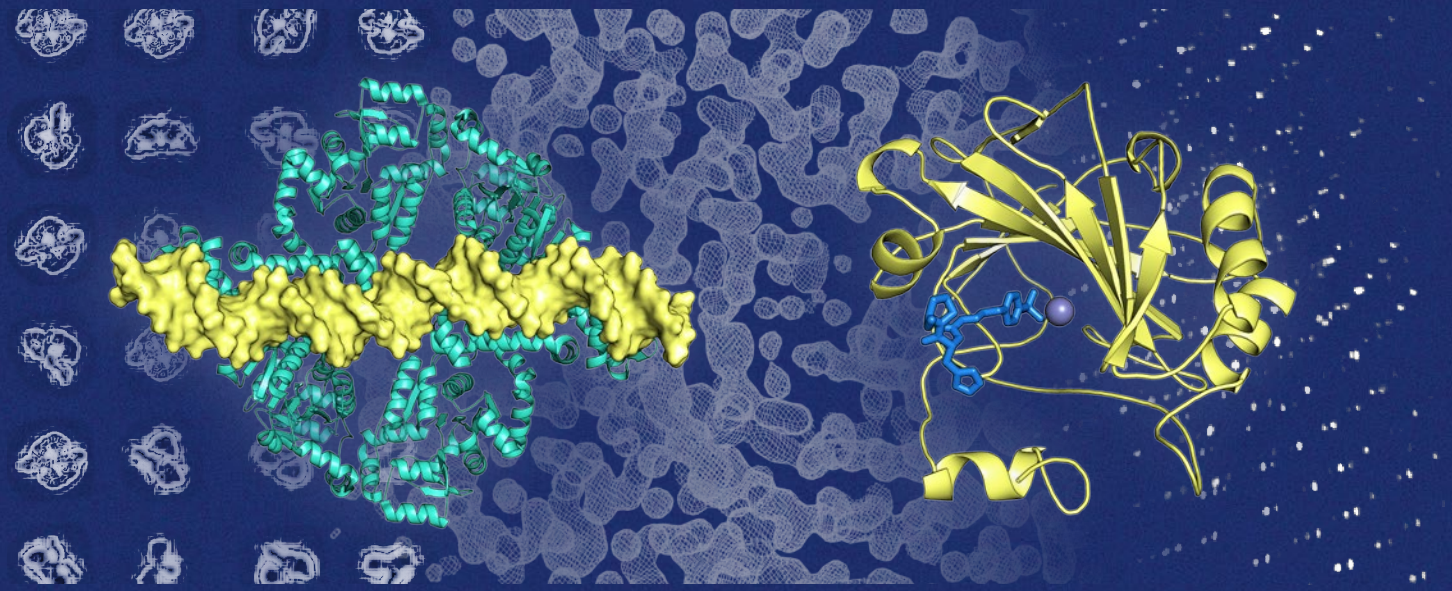
Structural Biology



Our research focuses on better understanding the three-dimensional structures of proteins and how they interact with other proteins and DNA. By studying these structures, we aim to reveal how proteins function at a molecular level and how this knowledge can be used to develop new drugs.

One key area of our work concerns bacterial transcription regulators. We investigate how these proteins bind to DNA, how they assemble into functional complexes and how they control gene expression. In doing so, we use techniques such as X-ray crystallography and biophysical analysis to determine their structures and mechanisms of action.

Another major area of our focus is structure-based drug design, which we carry out in close collaboration with medicinal chemists. We work on developing inhibitors of human enzymes linked to diseases, including carbonic anhydrases, kinases, purine nucleoside phosphorylases and purine nucleotidases.

Additionally, we work on improving techniques for macromolecular crystallization and for collecting structural data at room temperature, as well as methods for high-throughput screening to identify small molecules that bind to proteins. Our interdisciplinary research, combining structural biology, biophysics and medicinal chemistry, helps to uncover the molecular basis of protein function and guides the discovery of new therapeutic strategies.

Šoltysová, M.; Škerlová, J.; Pachl, P. *et al*. Structural Characterization of Two Prototypical Repressors of the SorC Family Reveals Tetrameric Assemblies on DNA and Mechanism of Function. *Nucleic Acids Res.* **2024**, *52* (12), 7305–7320.

Kugler, M.; Hadzima, M.; Dzijak, R. *et al*. Identification of Specific Carbonic Anhydrase Inhibitors via *In Situ* Click Chemistry, Phage Display, and Synthetic Peptide Libraries: Comparison of the Methods and Structural Study. *RSC Med. Chem.* **2023**, *14*, 144–153.

Keywords: protein structure, transcription regulators, structure-based drug design, macromolecular crystallization, medicinal chemistry collaboration

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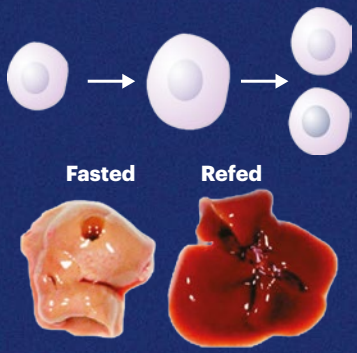
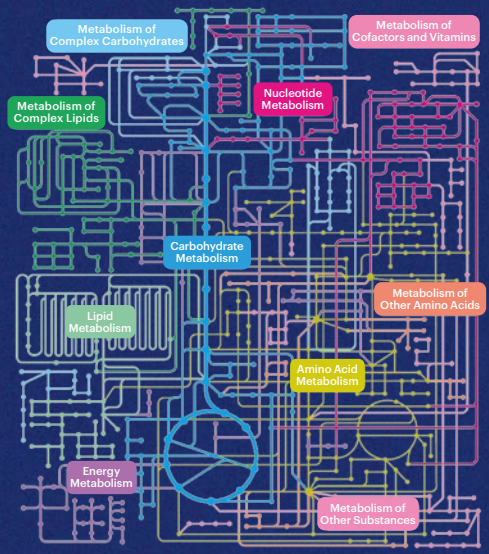
Molecular Analysis of Growth Regulation in Animals

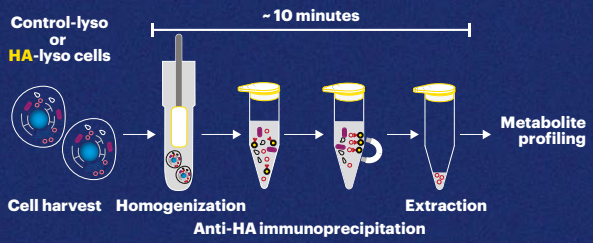
Growth control

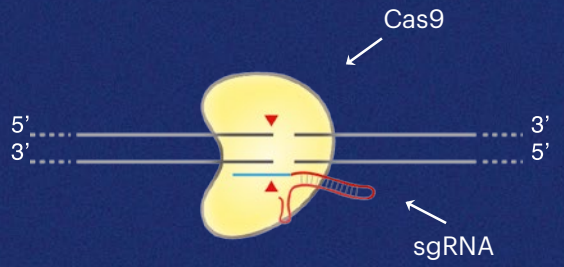


Metabolism



Tool development





Our research group investigates the regulation of growth and metabolism. This work builds on our previous research into the pathway anchored by mTOR protein kinase – now recognized as a major regulator of growth and anabolism in response to nutrients.

The discovery that lysosomes play a key role in nutrient-driven mTORC1 activation led us to expand our analysis to include lysosomes and other organelles, including mitochondria. We have since developed methods, such as Lyso-IP, for the rapid isolation and profiling of these organelles – techniques that have enabled us to uncover the functions of disease-associated genes.

Given that mTORC1 senses nutrients, our research has expanded to include metabolic pathways that cells use to incorporate biomass and generate energy. To this end, we have integrated CRISPR-based genetics, allowing us to study metabolism at the cellular level.

Our research focuses on three core areas:

(1) **Nutrient sensing by mTORC1 *in vitro* and *in vivo***: We work to identify the specific glucose sensor for the mTORC1 pathway.
(2) **Lysosomes in normal physiology and disease**: We investigate how common and rare neurodegenerative diseases impact lysosomal function.
(3) **Drug development**: In collaboration with chemists, we focus on the development of novel, drug-like molecules that target the nutrient-sensing pathway upstream of mTOR as well as key lysosomal proteins.

Valenstein, M. L.; Lalgudi, P. V.; Gu, X. *et al.* Rag–Ragulator Is the Central Organizer of the Physical Architecture of the mTORC1 Nutrient-Sensing Pathway. *Proc. Natl. Acad. Sci. U.S.A.* **2024**, *121* (35), e2322755121.

Liu, G. Y. *et al.* An Evolutionary Mechanism to Assimilate New Nutrient Sensors into the mTORC1 Pathway. *Nat. Commun.* **2024**, *15* (1), 2517.

Keywords: mTOR, growth, metabolism, lysosomes, CRISPR, physiology

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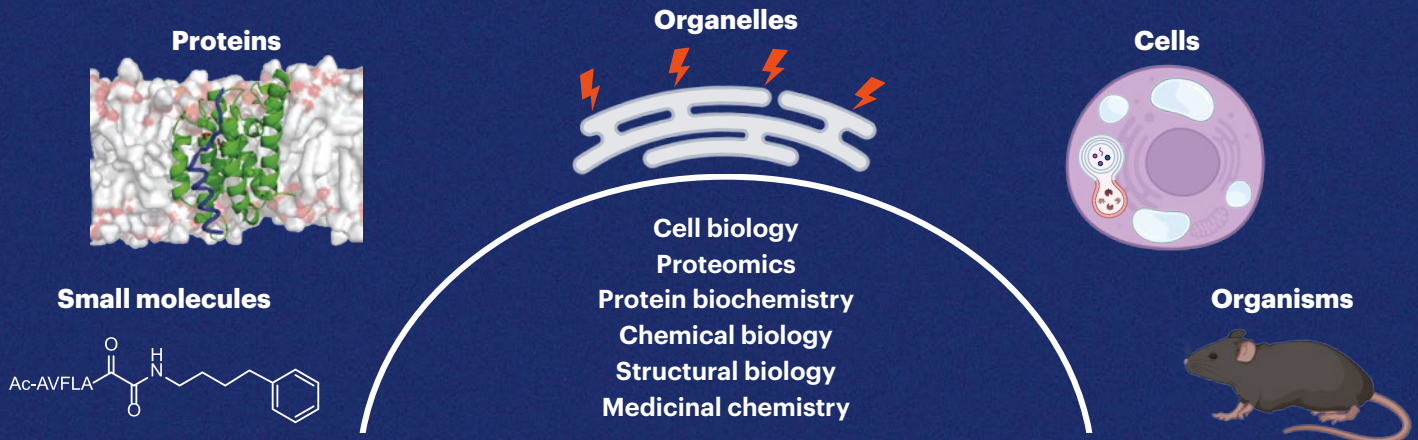
Intramembrane Proteolysis and Biological Regulation

Mechanisms of membrane proteostasis in health and disease: principles and perturbations



Began J, *et al.* et Strisovsky K (2020), *EMBO J* **39**: e102935

Lemberg MK, Strisovsky K (2021), *Mol. Cell* **81**: 2507–2519

Polachova E, *et al.* et Strisovsky K (2023), *J. Med. Chem.* **66**: 251–265

Abramsson ML, *et al.* et, Strisovsky K, *et al.* et Landreh M (2025) *eLife* **14**

We investigate the complexity of biological membranes and the fundamental chemical processes they host. Our research focuses on elucidating the mechanisms that regulate the biogenesis and proteostasis of transmembrane proteins involved in signaling. Intramembrane proteases, which recognize and cleave other membrane proteins within the hydrophobic lipid environment, form a central part of this investigation due to their implications in numerous human diseases, including Alzheimer's and Parkinson's.

We primarily examine the rhomboid superfamily of proteins, known to influence growth factor signaling, mitochondrial homeostasis, malaria parasite pathogenicity, membrane protein trafficking, and inflammatory signaling in mammals. Through our collaborative efforts, we utilize membrane biochemistry, enzymology, structural biology, computational chemistry, and machine learning to determine how substrate recognition, selection, and the lipid environment influence rhomboid proteins.

Proteomics, cell biology, genetics, and medicinal chemistry methods help us uncover membrane-centered molecular mechanisms underlying biological signaling and membrane proteostasis. In selected cases, we then apply these insights to develop small molecules with therapeutic potential.

Poláchová, E.; Bach, K.; Heuten, E. *et al.* Chemical Blockage of the Mitochondrial Rhomboid Protease PARL by Novel Ketoamide Inhibitors Reveals Its Role in PINK1/Parkin-Dependent Mitophagy. *J. Med. Chem.* **2023**, *66* (1), 251–265.

Began, J.; Cordier, B.; Březinová, J. *et al.* Rhomboid Intramembrane Protease YqgP Licenses Bacterial Membrane Protein Quality Control as an Adaptor of FtsH AAA Protease. *EMBO J.* **2020**, *39*, e102935.

Keywords: lipid membrane, membrane protein, proteostasis, signaling, intramembrane proteolysis, protein structure

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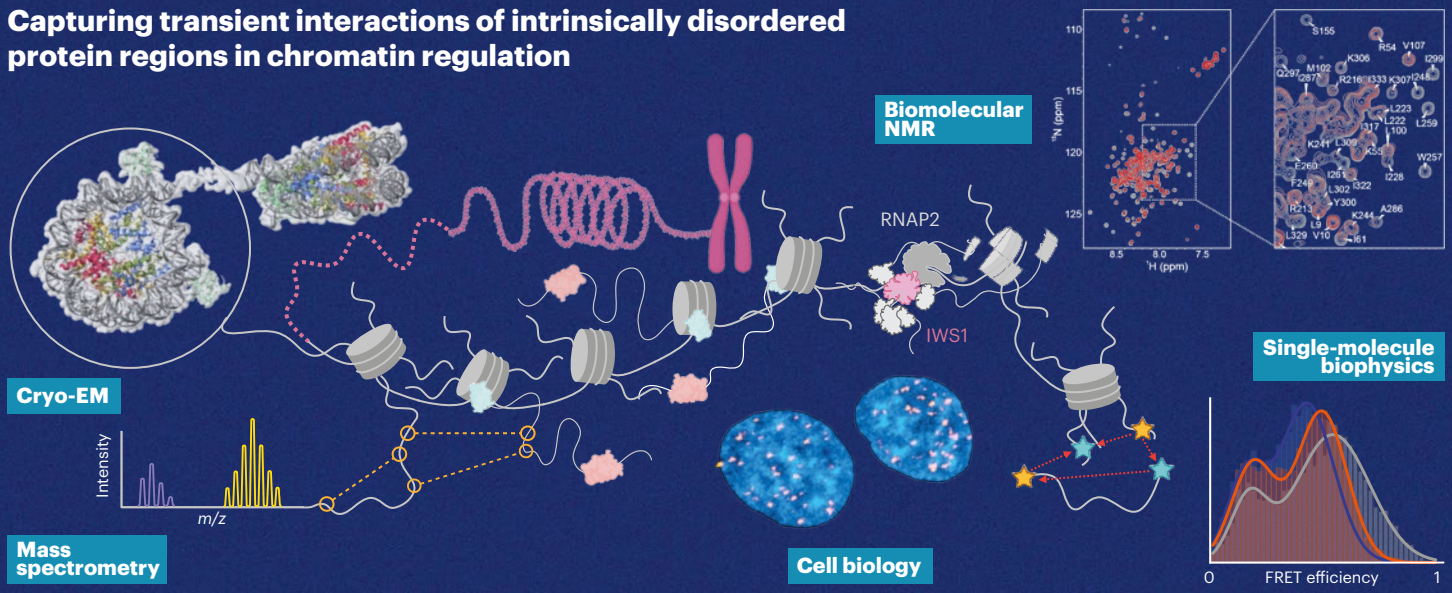
Chromatin Structural Biology

Capturing transient interactions of intrinsically disordered protein regions in chromatin regulation



Intrinsically disordered regions are especially common in the nuclear proteome. They play a variety of roles, such as connecting specific effector domains into large multi-subunit complexes or facilitating frequent, short-lived interactions with DNA and other chromatin-associated factors. Our research aims to gain a thorough understanding of how these disordered regions help form biomolecular complexes linked to transcription. We explore their roles in various nuclear assemblies, nucleosome remodeling and management of chromatin epigenetic states. Our ultimate goal is to shed light on how these dynamic elements contribute to the regulation of eukaryotic gene expression.

Despite its unparalleled versatility, cryo-electron microscopy often fails to visualize these dynamic regions. Therefore, we use this technique in combination with nuclear magnetic resonance spectroscopy, structural mass spectrometry and other single-molecule techniques to achieve a comprehensive grasp of underlying biological processes at the atomic resolution.

Our hypothesis-driven research is primarily focused on protein interaction networks implicated in the regulation of gene transcription. Through a number of excellent collaborations with geneticists and cell biologists, we seek to place our findings in a broader biological context and to fill major knowledge gaps in the field.

Koutná, E.; Lux, V.; Kouba, T. *et al.* Multivalency of Nucleosome Recognition by LEDGF. *Nucleic Acids Res.* **2023**, *51* (18), 10011–10025.

Warner, J. L.; Lux, V.; Veverka, V. *et al.* The Histone Chaperone Spt6 Controls Chromatin Structure through Its Conserved N-Terminal Domain. *Mol. Cell* **2025**, *85* (18), 3407–3424.e8.

Keywords: gene expression, epigenetics, intrinsically disordered proteins, transient interactions, NMR, single-molecule fluorescence microscopy

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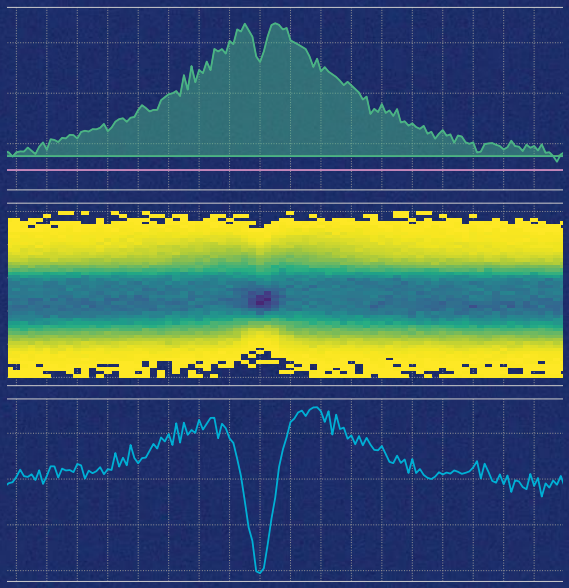
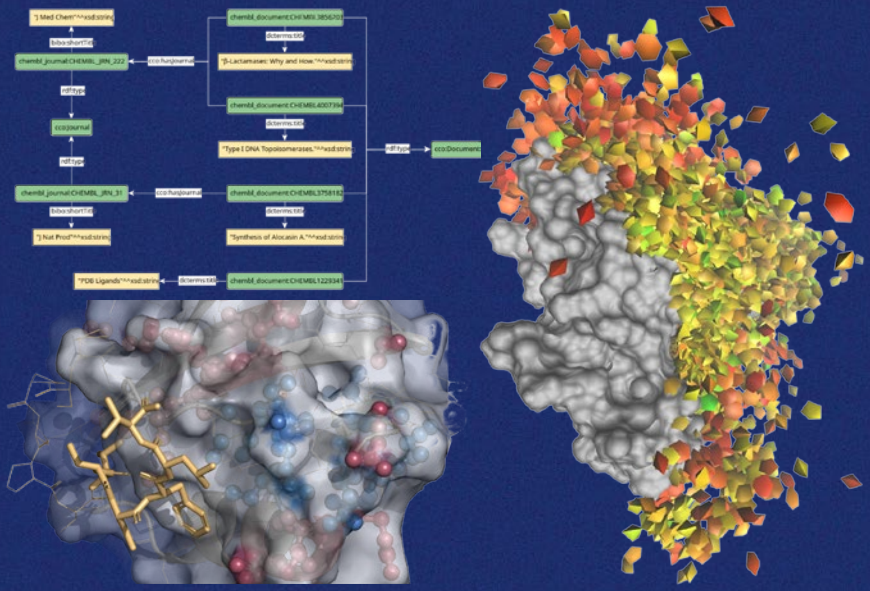
Bioinformatics





Our group studies the sequences, evolution, structures, interactions, and complexes of biomolecules. We investigate the sequence–structure–function paradigm, examining how evolution shapes biomolecular architectures and optimizes function. Combining molecular biology, bioinformatics, and computational tools, we aim to uncover the principles of biomolecular behavior. This information supports our efforts in designing tailored biomolecules for biotechnology, drug discovery, and synthetic biology.

We work across diverse biological systems – from intrinsically disordered proteins and multidomain proteins, through fusion protein design and dynamics, to DNA transcription and DNA-binding proteins. Integrating molecular modeling, simulations, computational chemistry, bioinformatics, and statistics, we seek to develop methods that address the key questions of structural biology.

Beyond research, we offer computational support for protein sequence analysis, structure modeling, protein–protein interaction predictions, and advanced bioinformatics. We also apply Semantic Web technologies to chemical biology. Our Integrated Database of Small Molecules (IDSM) ensures compatibility with major bio/chem databases like Rhea and UniProt. As part of the European Strategy Forum on Research and Innovation (ESFRI) ELIXIR project, we coordinate ELIXIR-CZ, serving as its national management and communication hub.

Vymětal, J.; Jakubec, D.; Galgonek, J. *et al.* Amino Acid Interactions (INTAA) Web Server v2.0: A Single Service for Computation of Energetics and Conservation in Biomolecular 3D Structures. *Nucleic Acids Res.* **2021**, *49* (W1), W15–W20.

Galgonek, J.; Vondrášek, J. IDSM ChemWebRDF: SPARQLing Small-Molecule Datasets. *J. Cheminf.* **2021**, *13* (1), 38.

Keywords: molecular biology, proteins, computational chemistry, advanced bioinformatics

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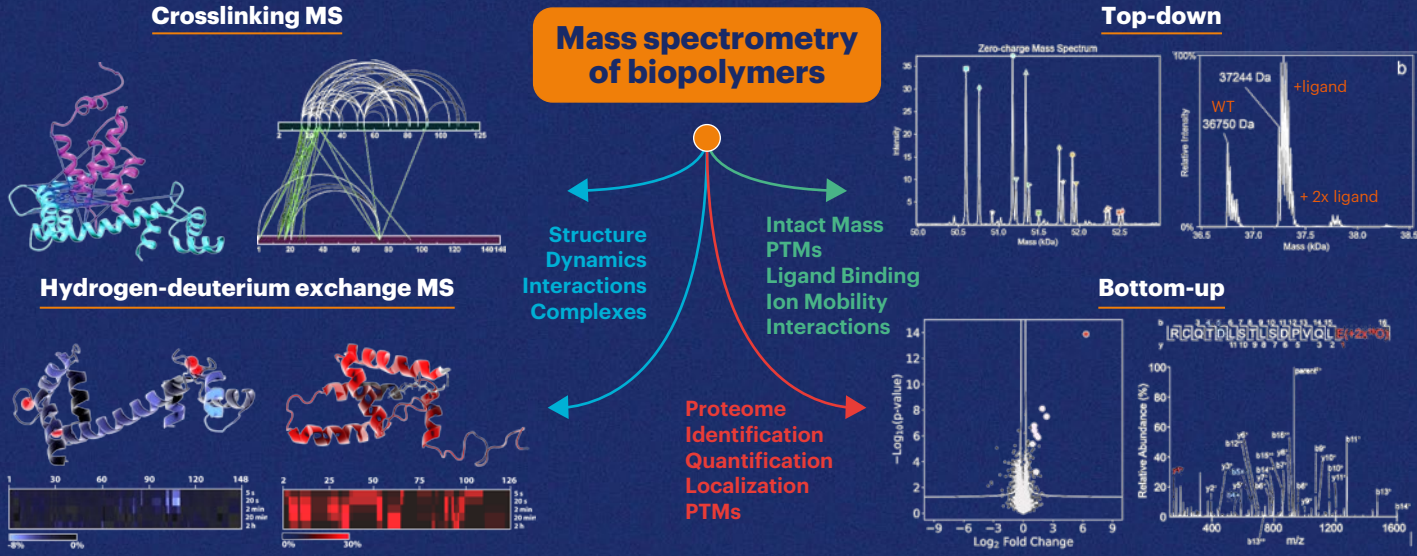
Mass Spectrometry of Biopolymers



Our service facility provides a comprehensive range of techniques for bottom-up, top-down, and structural analysis of proteins and other biomolecules.

We offer identification and quantification of proteins from various biological samples, including cell and tissue lysates, immunoprecipitates (IPs), and SDS-PAGE bands. We perform protein quantification using both label-free approaches and labeling strategies like tandem mass tag (TMT). We also perform post-translational modification analysis, including phosphoproteomics.

Additional services include: denaturing intact mass analysis for protein mass confirmation and the study of covalent modifications or complexes; native mass spectrometry for exploring protein and protein–ligand noncovalent interactions and assemblies; crosslinking mass spectrometry for mapping protein interfaces and topologies; and hydrogen–deuterium exchange mass spectrometry for investigating conformational dynamics and protein–ligand binding sites. We also offer ion mobility measurements to analyze shape differences between populations of isobaric molecules.

We provide consultation, protocol optimization, and data analysis, as well as research support for data deposition in public repositories, figure creation, and general manuscript preparation.

Keywords: proteomics, PTM analysis, structural analysis, top-down proteomics, oligonucleotide mass spectrometry

Tomáš Kouba
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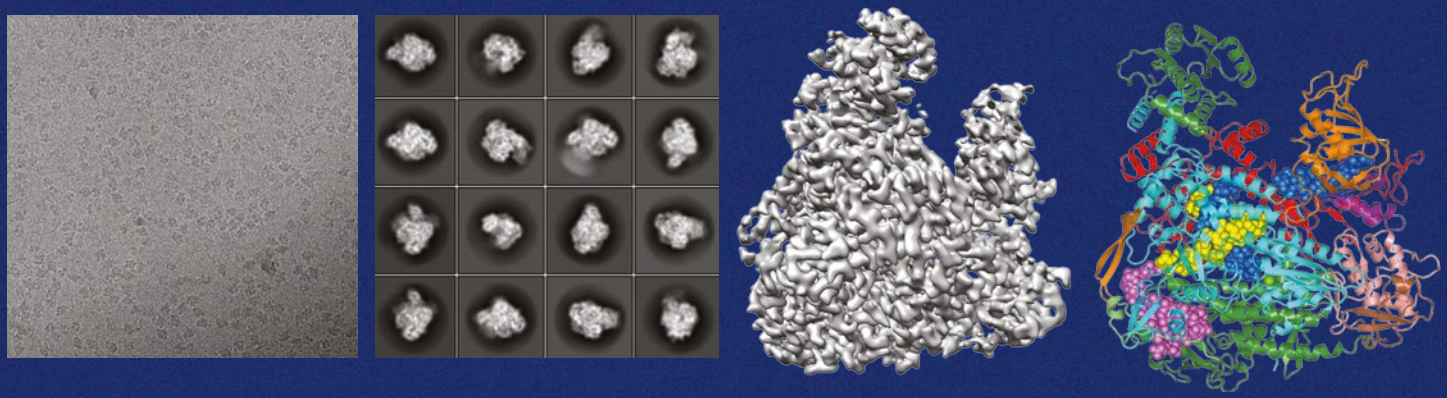
Cryogenic Electron Microscopy

Visualizing the molecules of life at atomic detail



Cryo-EM micrograph → **2D class averages** → **3D density map** → **Atomic model**

Our facility provides 3D structural analysis of biomolecules like proteins, nucleic acids, and their complexes. Cryo-EM allows biomolecules to be observed in their near-native state, flash-freezing them in a thin layer of vitreous, noncrystalline ice. This process preserves their natural conformation for subsequent imaging by transmission electron microscope. By collecting and then analyzing thousands of 2D images, we can reconstruct 3D models of molecules at near-atomic resolution. This detailed structural information is crucial for understanding fundamental biological processes, mechanisms of disease, and structure-based drug design.

Our specialized team offers a full suite of services, guiding projects from initial sample preparation and characterization through to data collection and the final 3D analysis. The facility has established a world-class infrastructure to serve both IOCB researchers and external collaborators. Our new building houses state-of-the-art instrumentation, including the 300kV Krios G4 and 200kV Glacios cryo-transmission electron microscopes, ensuring the highest quality data collection. In collaboration with the High-Performance Computing (HPC) Group, cryo-EM data are processed on a HPC cluster. Our expertise also extends to 3D electron diffraction, a technique that can resolve the 3D structures of small molecules such as drugs.

Koutná, E.; Lux, V.; Kouba, T. *et al*. Multivalency of Nucleosome Recognition by LEDGF. *Nucleic Acids Res*. **2023**, *51* (18), 10011–10025.

Bulvas, O.; Knejzlík, Z.; Sýs, J. *et al*. Deciphering the Allosteric Regulation of Mycobacterial Inosine-5′-Monophosphate Dehydrogenase. *Nat. Commun*. **2024**, *15*, 6673.

Keywords: cryo-EM, structural biology, cryo-electron tomography, high-resolution imaging, atomic model building

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Biochemical Pharmacology

Central cell culture lab

- Mycoplasma testing
- Cytotoxicity

ADME/tox profiling

- Solubility
- Metabolic stability
- Permeability
- *In vivo* PK

Assay development & biological screening

- Oncology
- Anti-infectives
- Neuropharmacology

LC-MS
ECHO-MS

Flow cytometry platform

- 2 analyzers
- High-precision sorter
- Multiparametric panel
- Single-cell sorting

Assay miniaturization | Automation | Data-rich formats

Our group supports IOCB researchers in early-stage drug discovery, combining scientific expertise with cutting-edge instrumentation. We specialize in assay development, biological screening, and target validation, with active projects spanning oncology, anti-infectives, and neuropharmacology.

A key focus area is in vitro ADME/Tox profiling, where we assess solubility, metabolic stability, permeability, and cytotoxicity. These studies are powered by two high-end mass spectrometry platforms: LC-MS for sensitive quantification and ECHO-MS for high-throughput screening. Our in-house animal facility supports early pharmacokinetics studies in rodents for promising compounds.

We also run the central cell culture lab, providing reliable, mycoplasma-free cells, routine cytotoxicity testing, and technical support. Our flow cytometry platform includes two analyzers and a high-precision cell sorter, with services such as multiparametric panel design and single-cell sorting into plates.

With expanding capabilities in assay miniaturization, automation, and data-rich formats, we aim to stay responsive to evolving research needs and help bridge the gap between synthetic chemistry and biological insight.

Břehová, P.; Řezníčková, E.; Škach, K. *et al.* Inhibition of FLT3-ITD Kinase in Acute Myeloid Leukemia by New Imidazo[1,2-*b*]pyridazine Derivatives Identified by Scaffold Hopping. *J. Med. Chem.* **2023**, *66* (16), 11133–11157.

Misehe, M.; Šála, M.; Matoušová, M. *et al.* Design, Synthesis and Evaluation of Novel Thieno[2,3-*d*]pyrimidine Derivatives as Potent and Specific RIPK2 Inhibitors. *Bioorg. Med. Chem. Lett.* **2024**, *97*, 129567.

Keywords: FACS, assay development, screening, ADME, automation, customization

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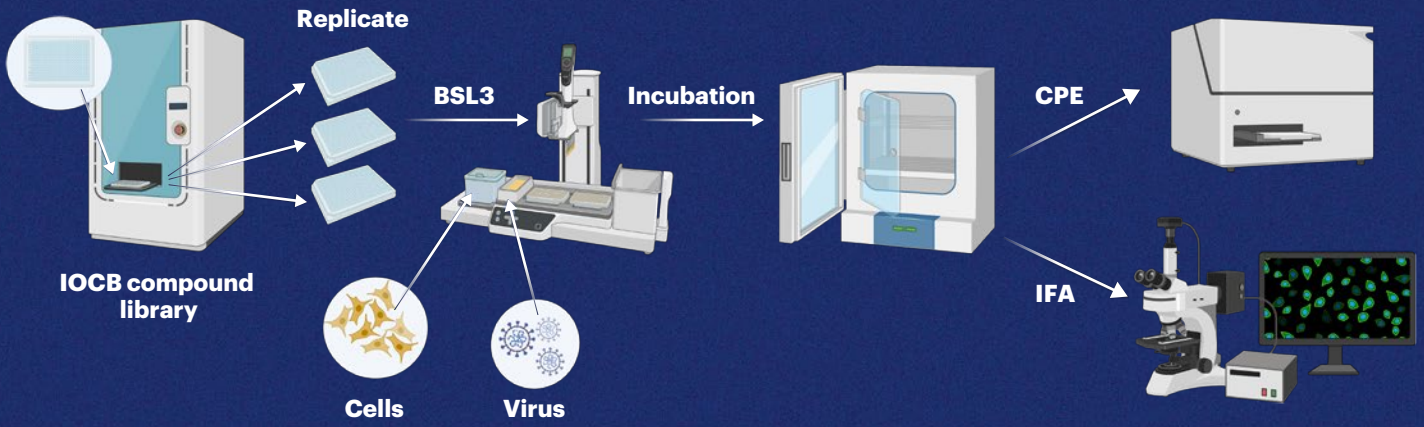
Virology



The virology research service team assists in the IOCB drug discovery program by providing an in-house BSL3 facility for the screening of antiviral compounds against a variety of viruses and collaborates with other IOCB groups on projects involving viruses. Antiviral drug screening is currently performed against the human immunodeficiency virus, the influenza virus, the dengue virus, the Zika virus, the herpes simplex virus, the coxsackievirus, SARS-CoV-2, the hepatitis B virus and the monkeypox virus. Besides screening, we perform immunofluorescence assays, ELISA, large-scale preparation of viruses and infected cells, isolation and amplification of viral genetic material, transfection and silencing experiments.

We cooperate with other groups in the search for improved tenofovir prodrugs, inhibitors of viral methyltransferases, and compounds inhibiting SARS-CoV-2 RNA polymerase and exoribonuclease repair activity.

The services we provide include consultation on virus-related work, biosafety training and initial supervision of new BSL3 users.

We are a state-of-the-art virology laboratory certified for the handling of hazardous pathogens up to level 3. BSL3 users have at their disposal six biohazard boxes, eight CO_2 incubators, a high-performance centrifuge, an ultracentrifuge, a multilabel plate reader, a FACS sorter, a scanR high-content screening microscope and a confocal microscope.

Kocek, H.; Chalupská, D.; Dejmek, M. *et al.* Discovery of Highly Potent SARS-CoV-2 nsp14 Methyltransferase Inhibitors Based on Adenosine 5′-Carboxamides. *RSC Med. Chem.* **2024**, *15*, 3469–3476.

Novotný, P.; Humpolíčková, J.; Nováková, V.; *et al.* The Zymogenic Form of SARS-CoV-2 Main Protease: A Discrete Target for Drug Discovery. *J. Biol. Chem.* **2025**, *301* (1), 108079.

Keywords: antiviral screening, drug discovery, HIV-1, HBV, SARS-CoV-2, influenza virus

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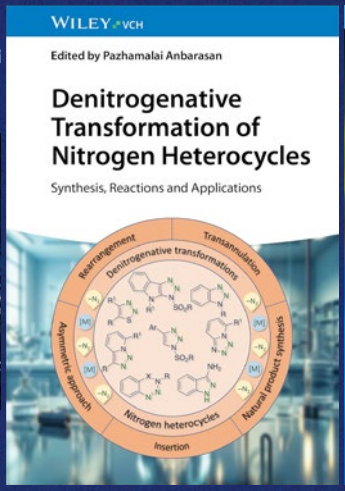
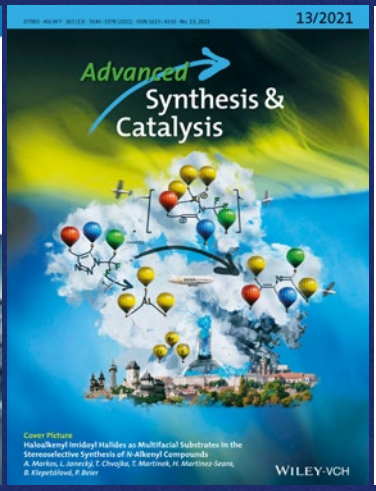
Organic Chemistry of Fluorine and Main Group Elements





We are interested in the development of novel, selective and convenient synthetic reagents and methods towards novel classes of organic molecules, for which there may be applications in crop protection, drug design and material engineering.

We study new reactions and their mechanisms, with a particular focus on the organic chemistry of main-group elements such as fluorine, phosphorus, silicon, sulfur and iodine. We use unusual reactive intermediates such as carbocations, carbanions, radicals, nitrenes and carbenes.

Baris, N.; Dračínský, M.; Tarábek, J. *et al.* Photocatalytic Generation of Trifluoromethyl Nitrene for Alkene Aziridination. *Angew. Chem., Int. Ed.* **2024**, *63*, e202315162.

Motornov, V.; Procházka, M.; Alpuente, N. *et al.* Introducing Weakly Ligated Tris(trifluoromethyl)copper(III). *ChemistryEurope* **2024**, *2*, e202400004.

Keywords: fluorine, sulfur, silicon, iodine, phosphorus, azides, fluoroalkylation, bioconjugation, heterocycles

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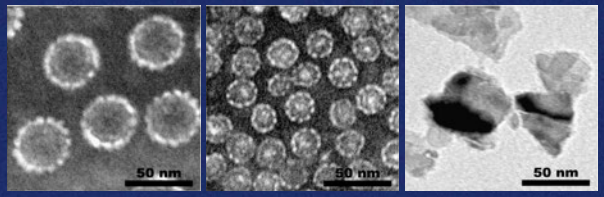
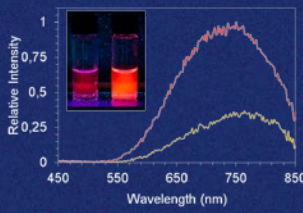
Synthetic Nanochemistry

Nanoparticles for bioimaging, diagnostics and therapy

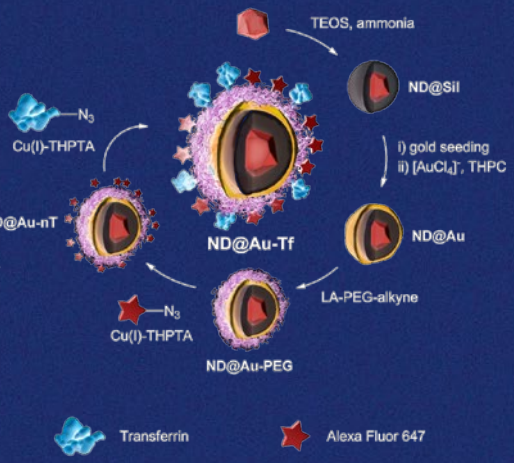
Inorganic and bioorganic nanoparticles



Near-infrared nanoprobes

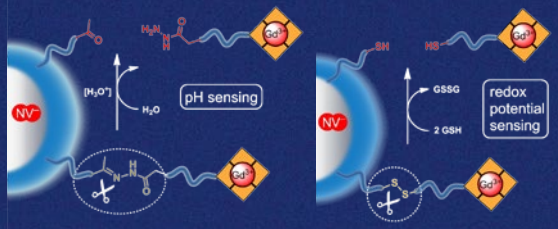


Advanced synthetic protocols



Creation of luminescent centers

New sensing schemes – quantum detection



We investigate interactions of nanoparticles with biological systems and seek new approaches to their synthesis. Currently, we are working on both inorganic or bioorganic structures. Using nanoparticles, we construct targeted multimodal imaging nanoprobes and particles for the diagnostics and treatment of diseases.

Our principal core material structure is fluorescent nanodiamond, a material with a unique electronic structure enabling the optical readout of magnetic and electric fields. It is a non-photobleachable near-infrared-emitting fluorophore. Using a comprehensive synthetic approach, we build up new molecular architectures on the surface of its particles, enabling their use as fluorescent nanolabels and multimodal nanosensors. In collaboration with other teams, we develop novel quantum detection technologies based on nanodiamonds.

We also study near-infrared-emitting gold nanoclusters, plasmonic gold nanoshells, virus-like capsides, gene delivery systems and other nano-sized systems. For all our projects, we design and synthesize novel linkers, fluorescent dyes, ligands, polymers and chemically modified proteins.

Kindermann, M.; Neburkova, J.; Neuhoferova, E. *et al.* Design Rules for the Nano-Bio Interface of Nanodiamonds: Implications for siRNA Vectorization. *Adv. Funct. Mater.* **2024**, *34*, 2314088.

Pavelka, O.; Kvakova, K.; Vesely, J. *et al.* Optically Coupled Gold Nanostructures: Plasmon-Enhanced Luminescence from Gold Nanorod–Nanocluster Hybrids. *Nanoscale* **2022**, *14*, 3166–3178.

Keywords: nanoparticles, bioimaging, sensing, fluorescence, nanodiamond, theranostics, plasmonics

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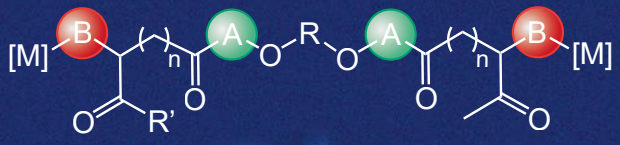
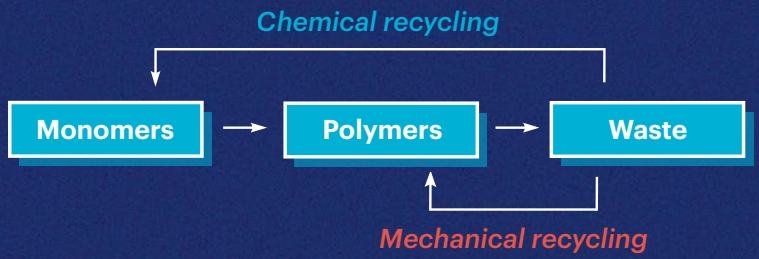
Chemical Recycling of Plastic Waste and Sustainable Polymers

Biodegradable polymers



- Tissue engineering
- Drug delivery
- Daily-use products

Chemical recycling and upcycling



- End of single-use plastics
- New materials from plastic waste

The fate of the ever-increasing amount of plastic waste on our planet is a major global concern. In the Gonsales Lab we are excited to work towards ways of addressing it, for example, through chemical recycling and upcycling, as well as through the synthesis of new biodegradable polymers. Envisioning chemical recycling processes, we aim to explore highly active catalysts and develop efficient systems to break down polymers back into their monomeric form or into added-value compounds. We do this using organometallic chemistry and mechanistic investigations. Similarly, our projects are aimed towards the synthesis of biodegradable and functional polyolefins. With the intention of mainly using cheap sources of metal elements, we are developing catalysts to enable the copolymerization of polar and non-polar monomers yielding polymers with *in-chain* polar units, which will bring about progress towards more degradable and functional materials. The design of new bi- and tridentate ligand scaffolds for catalysts with balanced reactivity and stability may lead to improved catalytic efficiency, better structure control and higher activities than traditional methods, offering new alternatives to fossil fuel-based materials. Biodegradable polymers are also crucial for recent medical advances, for example, in tissue engineering and drug delivery systems.

Publications prior to the author's appointment at IOCB Prague:

Gonsales, S. A.; Kubo, T.; Flint, M. K. *et al.* Highly Tactic Cyclic Polynorbornene: Stereoselective Ring Expansion Metathesis Polymerization of Norbornene Catalyzed by a New Tethered Tungsten–Alkylidene Catalyst. *J. Am. Chem. Soc.* **2016**, *138* (15), 4996–4999.

Gonsales, S. A.; Mueller, Z. C.; Zhao, F. *et al.* Cross-Metathesis of Allenes: Mechanistic Analysis and Identification of a Ru–CAAC as the Most Effective Catalyst. *J. Am. Chem. Soc.* **2021**, *143* (49), 20640–20644.

Keywords: biodegradable polymers, chemical recycling, sustainability, circular economy, catalysis

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Distinguished Chair
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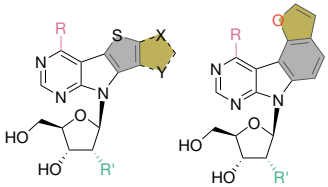
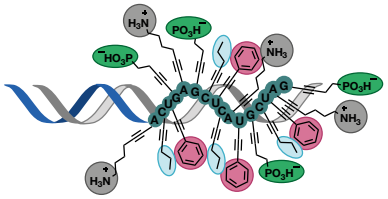
Bioorganic and Medicinal Chemistry of Nucleic Acids

Fused deazapurine nucleosides



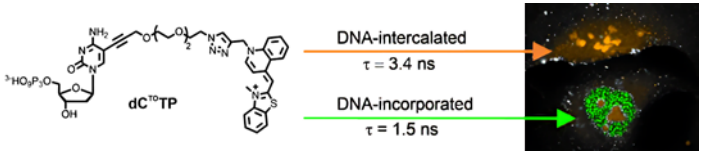
J. Am. Chem. Soc. **2022**, *144*, 19437

Hypermodified DNA



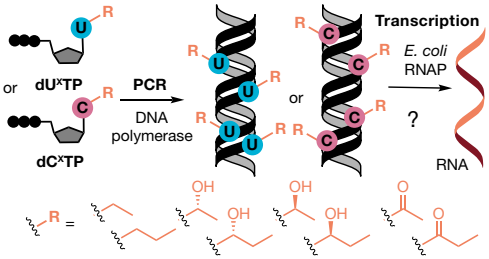
Chem. Commun. **2022**, *58*, 11248 | *Nucleic Acids Res.* **2023**, *51*, 11428
Chem. Eur. J. **2024**, *30*, e202402318

Fluorescent nucleotides for sensing and metabolic labelling



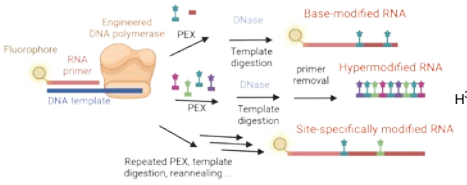
Angew. Chem. Int. Ed. **2023**, *62*, e202307548
Bioconjugate Chem. **2023**, *34*, 772

Chemical epigenetics



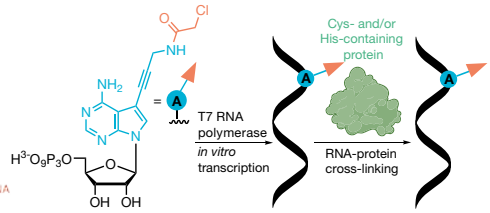
RSC Chem. Biol. **2022**, *3*, 1069 | *Commun. Chem.* **2024**, *7*, 256

Enzymatic synthesis of modified RNA with engineered DNA polymerases



Nat. Commun. **2024**, *15*, 3054

Reactive RNA or DNA probes for cross-linking with proteins



Chem. Eur. J. **2024**, *30*, e202402151
Angew. Chem. Int. Ed. **2023**, *62*, e202213764

Our group designs and prepares novel types of modified derivatives and analogues of nucleobases, nucleosides, nucleotides and nucleic acids for applications in all areas of biomedical sciences. In medicinal chemistry, rational drug design and the systematic biological activity screening of libraries of modified nucleobases, nucleosides and nucleotides have led to the discovery of several new types of potent nucleoside antivirals and cytostatics, kinase inhibitors or receptor ligands.

In bioorganic chemistry, we develop methods of the enzymatic construction of functionalized nucleic acids bearing diverse useful substituents and explore their applications in bioanalysis (e.g., redox labeling for electrochemical detection in the diagnostics of DNA mutations or environment-sensitive fluorescent labeling for sensing protein–DNA interactions, metabolic labeling of DNA, etc.) and in chemical biology (reactive labeling for bioconjugation and cross-linking with proteins, chemical epigenetics for the regulation of gene expression).

Recently, we have developed ways to enzymatically synthesize hypermodified DNA bearing four different functional groups and to select base-modified aptamers against target proteins. Enzymatic synthesis of modified RNA using engineered DNA polymerases has enabled the site-specific modification of mRNA and the development of potential RNA therapeutics.

Brunderová, M.; Havlíček, V.; Matyašovský, J. *et al.* Expedient Production of Site-Specifically Nucleobase-Labelled or Hypermodified RNA with Engineered Thermophilic DNA Polymerases. *Nat. Commun.* **2024**, *15*, 3054.

Kuprikova, N.; Ondruš, M.; Bednárová, L. *et al.* Zwitterionic DNA: Enzymatic Synthesis of Hypermodified DNA Bearing Four Different Cationic Substituents at All Four Nucleobases. *Nucleic Acids Res.* **2025**, *53* (5), gkaf155.

Keywords: nucleosides, nucleotides, oligonucleotides, nucleic acids, DNA, RNA, polymerases

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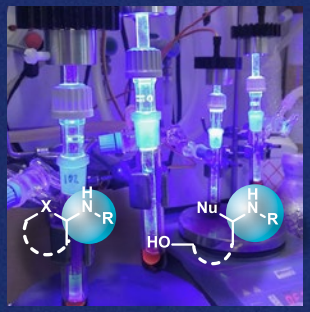
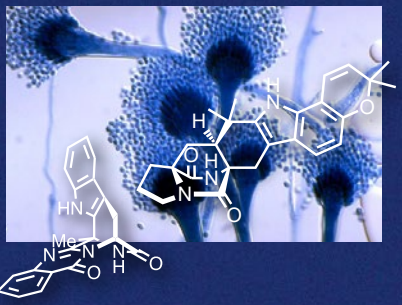
Chemistry of Natural Products

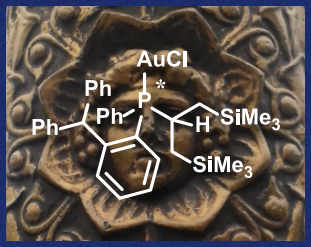
Photocatalysis C(sp³)-H & C(sp²)-H amination reactions



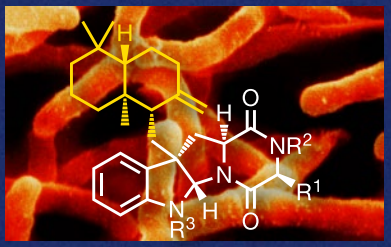
Fungal alkaloids



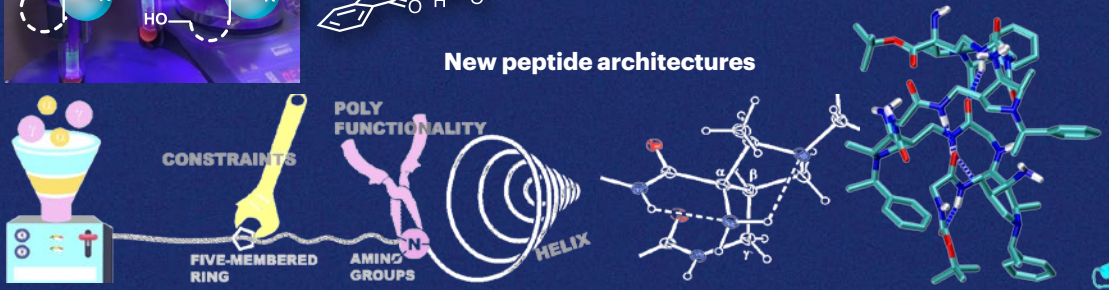
P-chiral gold catalysts



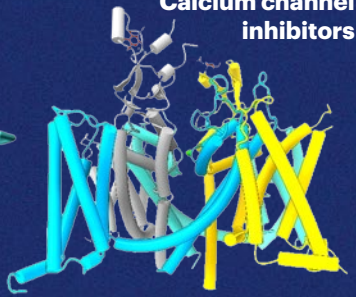
Terpenoid alkaloids



New peptide architectures



Calcium channel inhibitors



Our group's interests primarily cover the total synthesis of natural products and their biological investigation. We are working to elucidate and confirm the structures of natural products and the development of innovative approaches to secure them in amounts sufficient for biological studies. Our focus is centered on streamlining total synthesis by learning to apply nature's blueprints in the most sustainable way possible.

Our research spans from complex indole and bridged diketopiperazine alkaloids to hybrid alkaloid–terpenoid natural products and terpenoids as biomarkers in the study of ancient societies. More recently, our group has started to explore new avenues in peptide chemistry, using unconventional amino acids to generate function through novel structural features and to introduce new functionality.

An equally important area is curiosity-driven research where we explore new pathways in transition metal catalysis using unconventional ligand architectures, photocatalysis, radical reactions, the chemistry of reactive intermediates, and electron transfer chemistry. Our group also provides expertise on selected topics of medicinal chemistry such as the design of antiviral compounds and new approaches to chronic pain research.

Klychnikov, M. K.; Pohl, R.; Císařová, I. *et al.* Concise Total Syntheses of (+)-Brefeldin A, Diastereomers and Analogs and Their Biological Activity. *ChemistryEurope* **2023**, *1*, e202300030.

Just, D.; Palivec, V.; Bártová, K. *et al.* Foldamers Controlled by Functional Triamino Acids: Structural Investigation of α/γ-Hybrid Oligopeptides. *Commun. Chem.* **2024**, *7*, 114.

Keywords: total synthesis, natural products, radicals, electron transfer, alkaloids, lipids, peptides

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Medicinal Chemistry of Nucleotide Analogues

We specialize in the design, development and synthesis of potent inhibitors targeting enzymes involved in nucleoside and nucleotide metabolism. Our target enzymes include adenylate cyclases (ACs), ectonucleotidase CD73, S-methyl-5′-thioadenosine phosphorylase (MTAP), purine nucleoside phosphorylases (PNPs), purine phosphoribosyltransferases (PRTs) and viral polymerases. Utilizing structural biology and computational modeling, we design novel inhibitors and develop efficient synthetic methods to produce target molecules and evaluate their biological properties. Selective inhibitors of specific human ACs hold promises for treating neuropathic pain and neurodegenerative disorders, while inhibitors of human PNP show potential for treating T-cell acute lymphoblastic leukemia. Similarly, inhibitors targeting CD73, MTAP and human PRTs are being investigated as potential anticancer therapies. Acyclic nucleoside phosphonates (ANPs) and bisphosphonates are being studied as potent inhibitors of PRTs in various parasites and bacteria, including *P. falciparum*, *T. brucei* and *M. tuberculosis*. Additionally, we are developing novel prodrugs of ANPs to enhance their pharmacological properties. We also design and investigate the physicochemical and biological properties of molecular photoswitches based on azo compounds, exploring their potential applications in materials chemistry and photopharmacology.

Kalčic, F.; Zgarbová, M.; Hodek, J. *et al.* Discovery of Modified Amidate (ProTide) Prodrugs of Tenofovir with Enhanced Antiviral Properties. *J. Med. Chem.* **2021**, *64* (22), 16425–16449.

Skácel, J.; Djukic, S.; Baszczyński, O. *et al.* Design, Synthesis, Biological Evaluation, and Crystallographic Study of Novel Purine Nucleoside Phosphorylase Inhibitors. *J. Med. Chem.* **2023**, *66* (10), 6652–6681.

Keywords: organic synthesis, drug discovery and delivery, enzyme inhibitors, molecular photoswitches, photopharmacology

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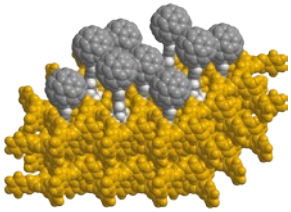
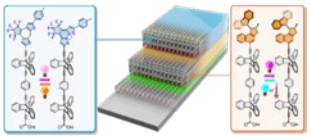
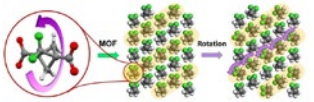
Molecular Devices



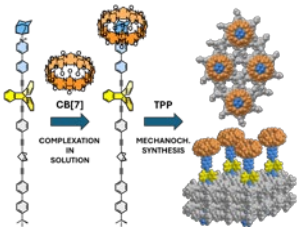
Chem. Commun. **2024**, *60*, 960-963



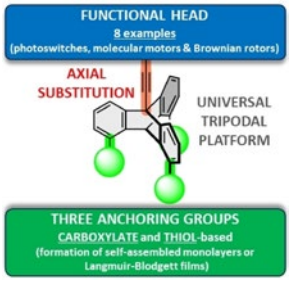
Chem. Eur. J. **2024**, *30*, e2023028



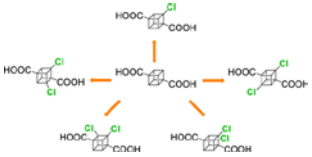
Angew. Chem., Int. Ed. **2023**, *62*, e202215893



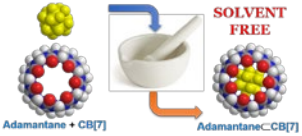
Chem. Sci. **2025**, 10.1039/d5sc03152d



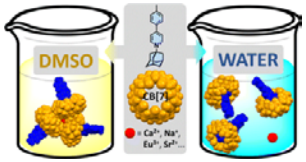
Chem. Eur. J. **2024**, *30*, e202401889



J. Org. Chem. **2024**, *89*, 11100-11108



Chem. Comm. **2021**, *57*, 2132-2135



Chem. Sci. **2023**, *14*, 9258-9266

Our group develops light- and heat-responsive molecular devices such as switches, rotors, and motors, assembling them into well-defined 2D and 3D architectures with controllable mechanical functions. We focus on surface-mounted systems, exploring their organization, activation, and dynamics using Langmuir–Blodgett deposition, self-assembly on gold, and porous matrices.

Our molecular design strategy leverages triptycene-based platforms to control spacing, tilt, and orientation of photoactive units, enabling reversible and selective switching even in densely packed films. We then investigate these modular assemblies using advanced surface characterization and vibrational spectroscopy to probe functions at solid–gas and solid–metal interfaces.

We also specialize in the synthesis of strained hydrocarbons and custom-building blocks, including cubanes, bicyclo[1.1.1]pentanes, and molecular rotors, for integration into molecular machines. Supramolecular strategies using cucurbit[n]uril (CB[n]) macrocycles further expand our toolkit for constructing responsive, layered systems with potential applications in nanomechanics, data storage, and energy transfer.

Santos Hurtado, C.; Bastien, G.; Lončarić, D. *et al.* Surface Inclusion and Dynamics of Cucurbit[7]uril-Based Supramolecular Complexes. *Chem. Sci.* **2025**, *16*, 14081–14087.

Santos Hurtado, C.; Bastien, G.; Rončević, I. *et al.* Regular Arrays of C_{60}-Based Molecular Rotors Mounted on the Surface of Tris(o-phenylenedioxy)cyclotriphosphazene Nanocrystals. *Chem. Commun.* **2024**, *60* (8), 960–963.

Keywords: molecular-level devices, molecular switches, molecular motors, smart materials, photochemistry, reaction mechanisms, triptycenes

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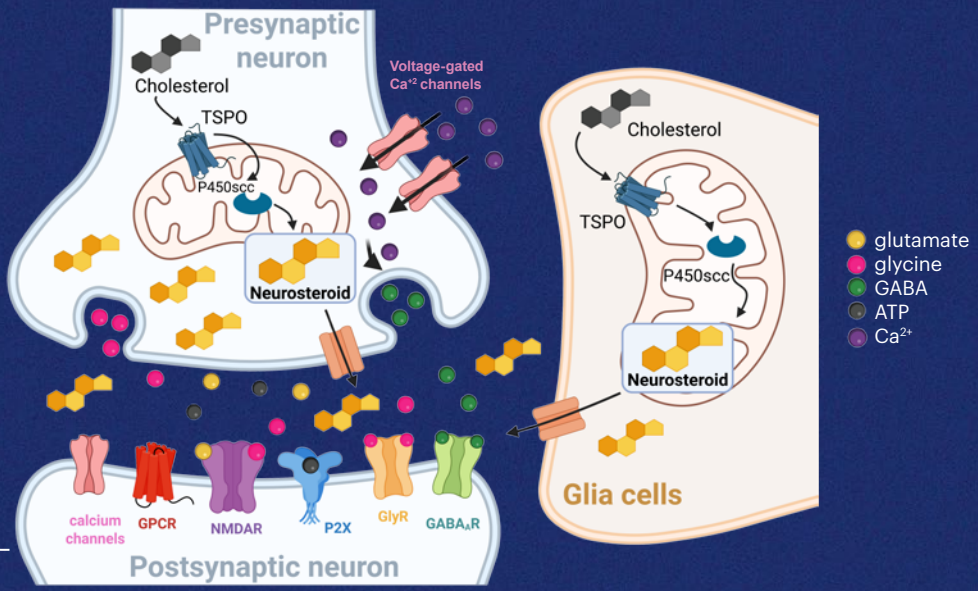
Neurosteroids

Modulation of these receptors is related to physiology and pathology of:

Epilepsy
Pain
Autism
Depression
Ataxia
Huntington's disease
ALS
Stress
Dementia
Alzheimer's disease
Schizophrenia
Multiple Sclerosis
Fragile X-syndrome
Migraine
Insomnia
Parkinson's disease



Our group investigates neurosteroids – endogenous steroids synthesized from cholesterol that rapidly influence neuronal excitability and synaptic function. These effects are mediated through interactions with ligand-gated ion channels, including glutamate, $GABA_A$, glycine, nicotinic acetylcholine receptors, and many others. We explore how neurosteroids modulate these receptors to regulate key neurological processes such as learning, memory, mood, and pain perception, as well as their potential roles in neurodevelopment, stress responses, and the progression of neurodegenerative diseases.

Our research focuses on identifying novel neuroactive compounds with neuroprotective and therapeutic potential, with the aim of developing safer and more effective treatments for conditions such as epilepsy, neuropathic pain, ischemia, and neuropsychiatric disorders. We also explore their broader applications in mitigating neuroinflammation, enhancing cognitive function, and preventing neurodegeneration in aging and disease.

By combining organic chemistry, molecular pharmacology, and neuroscience, we seek to uncover the mechanisms underlying neurosteroid action and translate these findings into innovative strategies for treating neurological and neuropsychiatric diseases.

Kysilov, B.; Kuchtiak, V.; Hrcka Krausova, B. *et al.* Disease-Associated Nonsense and Frame-Shift Variants Resulting in Truncation of the GluN2A or GluN2B C-Terminal Domain Decrease NMDAR Surface Expression and Reduce Potentiating Effects of Neurosteroids. *Cell. Mol. Life Sci.* **2024**, *81* (1), 36.

Chvíla, S.; Kubová, H.; Mareš, P. *et al.* A Zuranolone Nanocrystal Formulation Enables Solubility-Independent *In Vivo* Study of Pentylenetetrazol-Induced Seizures in a Rat Model. *RSC Pharmaceutics* **2024**, *1* (1), 37–46.

Keywords: $GABA_A$ receptors, glycine receptors, nicotinic acetylcholine receptors, glutamate receptors, epilepsy, neuroscience

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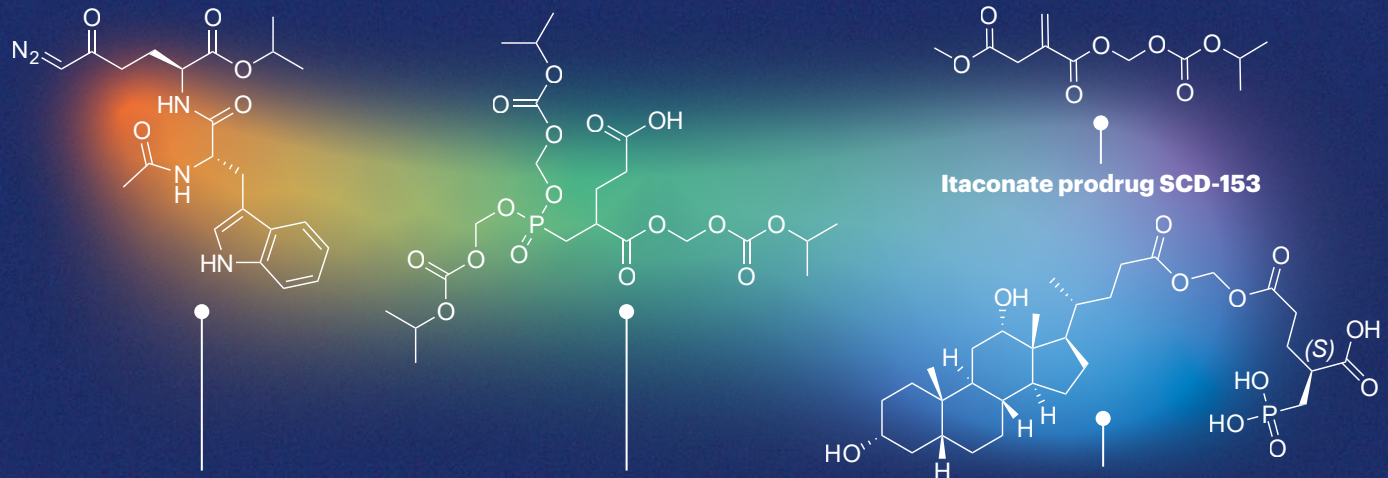
Drug Discovery



Our group focuses on the design and synthesis of biologically active compounds and their prodrugs. In collaboration with Johns Hopkins University in Baltimore, USA, we develop prodrugs of glutamine antimetabolite 6-diazo-5-oxo-L-norleucine (DON), inhibitors of glutamate carboxypeptidase II (GCPII), itaconic acid, decitabine and mebendazole. These compounds may find use as novel therapeutics against cancer or neurodegenerative and autoimmune diseases. Our DON prodrug DRP-104 (Sirpiglenastat) is currently being tested by Dracen Pharmaceuticals in a phase 1/2a clinical trial testing its efficacy against several types of cancer. Other compounds that have progressed to clinical trials are: GCPII inhibitor tris-POC-2-PMPA, investigated as a nephroprotective agent in PSMA-targeted prostate cancer radiotherapy (Bayer AG), and itaconic acid ester SCD-153, investigated as a topical drug candidate for the treatment of alopecia areata (Sun Pharma Advanced Research Company). Further promising compounds have been identified among GCPII inhibitors modified with secondary bile acids investigated in models of acute and chronic colitis ((*S*)-IBD 3540).

We collaborate widely within the IOCB and provide our colleagues with small biologically active molecules and chemical probes. The service part of our work includes solid phase synthesis of peptides, labeled peptides and small molecules, such as enzyme inhibitors with various “warheads”, and amino acid and peptide analysis.

Peters, D. E.; Norris, L. D.; Tenora, L. *et al.* A Gut-Restricted Glutamate Carboxypeptidase II Inhibitor Reduces Monocytic Inflammation and Improves Preclinical Colitis. *Sci. Transl. Med.* **2023**, *15* (708), eabo6571.

Lee, C. B.; Šnajdr, I.; Tenora, L. *et al.* Discovery of Orally Available Prodrugs of Itaconate and Derivatives. *J. Med. Chem.* **2025**, *68* (3), 3433–3444.

Keywords: prodrug design and synthesis, cancer therapy, cancer cell targeting, itaconate, custom synthesis of peptides and small molecules, amino acid analysis

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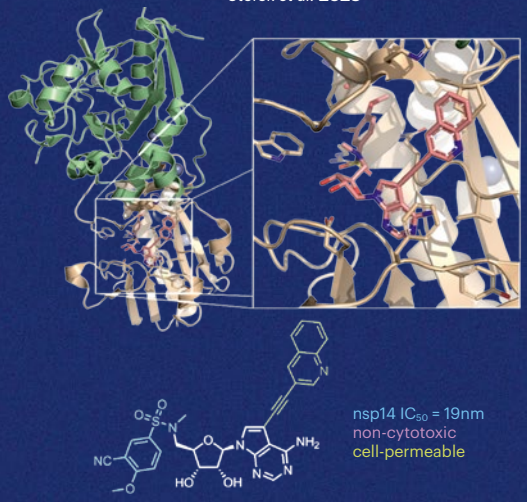
Drug Design and Medicinal Chemistry

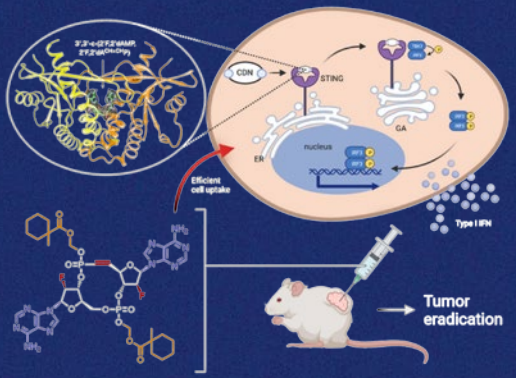
Structure-based design of antiviral compounds

Štefek *et al.* **2023**



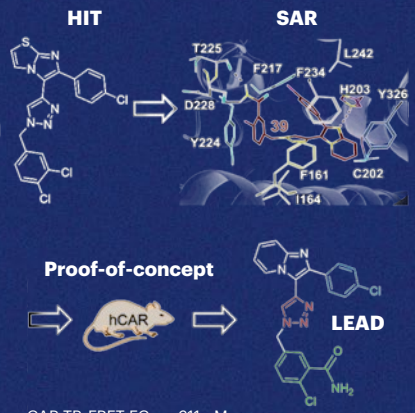
Rational design of immunomodulators

Dejmek *et al.* **2023**



Novel ligands for nuclear receptors

Mejdrová *et al.* **2023**



CAR TR-FRET EC_{50} = 611 nM
CAR AA cell.as. EC_{50} = 1.22 μM
No activation of PXR up to 100 μM

Our group primarily focuses on medicinal chemistry and the development of novel chemical tools for the study of diverse biological processes. We specialize in the structure-based design of innovative antiviral agents, with a particular emphasis on less-explored molecular targets and host factors. We are also interested in compounds with potential applications in the treatment of metabolic diseases and in substances that modulate immune system function.

One of our key projects focuses on the structure-based design of methyltransferase inhibitors. We have been investigating viral methyltransferases, which are essential for the viral life cycle because they catalyze key steps in the capping of viral RNA. This capping is crucial for initiating the translation of viral RNA into proteins and for protecting viral RNA from cellular immune responses. Notably, our work on viral methyltransferase inhibitors has naturally led us to also explore potential inhibitors of human methyltransferases.

We further focus on ligands for nuclear receptors. We investigate a diverse group of compounds capable of modulating the functions of nuclear receptors involved in cholesterol and bile acid metabolism, specifically the constitutive androstane receptor (CAR) and the pregnane X receptor (PXR). Notably, our compound MI883 exerts a dual effect on these receptors, significantly lowering blood cholesterol in humanized mice.

Dusek, J.; Mejdrová, I.; Dohnalová, K. *et al.* The Hypolipidemic Effect of MI-883, the Combined CAR Agonist/PXR Antagonist, in a Diet-Induced Hypercholesterolemia Model. *Nat. Commun.* **2025**, *16*, 1418.

Kocek, H.; Chalupská, D.; Dejmek, M. *et al.* Discovery of Highly Potent SARS-CoV-2 nsp14 Methyltransferase Inhibitors Based on Adenosine 5'-Carboxamides. *RSC Med. Chem.* **2024**, *15*, 3469–3476.

Keywords: structure-based design, methyltransferase inhibitors, immune response modulation, nuclear receptors, constitutive androstane receptor (CAR), cholesterol metabolism

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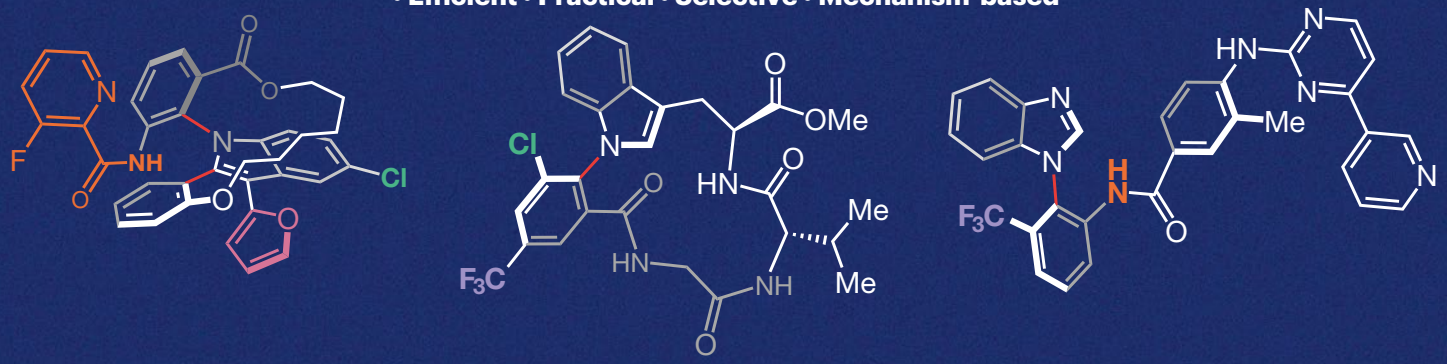
Catalytic Synthesis of Bioactive Molecules

Easy-to-access starting materials and catalysts → **Innovative catalytic reactions and synthesis strategies** → **Creation of molecules for medicinal chemistry**

• Efficient • Practical • Selective • Mechanism-based



Current interests: atropisomeric macrocycles, peptides and analogs of bioactive compounds

The goal of our research is to advance catalytic organic synthesis for drug discovery. We address problems in synthesis by designing catalytic methods and strategies based on mechanistic principles, hoping to deliver more efficient, practical and selective reactions. We target difficult-to-access molecules with drug-like features, placing emphasis on compounds for which key pharmacological properties can only be envisioned. In this way, we hope to demonstrate the potential of synthesis in face of unforeseen challenges encountered in chemical and biological research. The practice of organic synthesis, the core of our scientific mission, offers countless possibilities for teaching and learning. We strive to develop concepts and solve problems in chemistry with an eye to matters of sustainability and medicine – two topics of great importance.

Currently, we are developing methods for the synthesis of atropisomers, which are chiral conformational isomers arising from restricted rotation about a single bond. Atropisomers are crucial in modern drug discovery campaigns but continue to pose challenges for synthesis due to their intrinsic steric hindrance. Such unique molecules therefore serve as platforms for development of robust and stereoselective (atroposelective) reactions. Our current targets are atropisomeric macrocycles, peptides and analogs of biologically active compounds.

Šimek, M.; Dey, P.; Blahout, V. *et al.* Nucleophilic Aromatic Substitutions Enable Diversity-Oriented Synthesis of Heterocyclic Atropisomers via Non-Atropisomeric Intermediates. *Nat. Commun.* **2025**, *16*, 4856.

Keywords: catalysis, stereoselectivity, bioactive molecules, atropisomers

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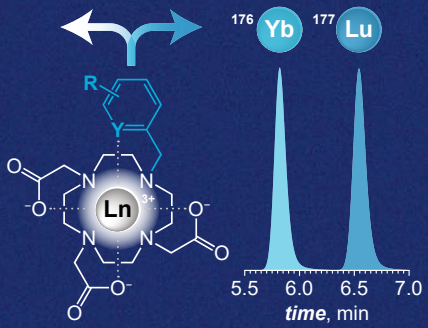
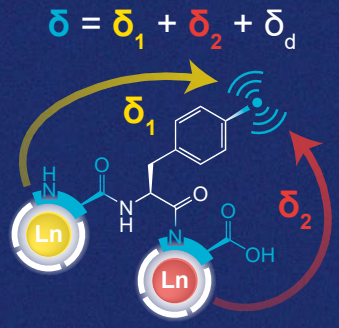
Coordination Chemistry

Radionuclide separation



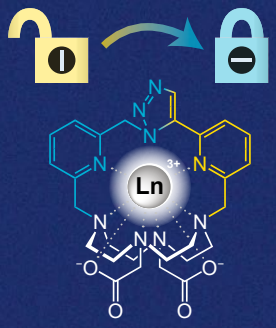
Polasek, M. *licensed* (**2019**).

Paramagnetic encoding



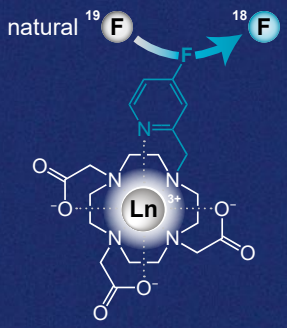
Kretschmer, J. *et al.* **13** (**2022**).

Ultrastable chelation



David, T. *et al.* **15** (**2024**).

^{18}F radiolabeling



Kretschmer, J. *et al.* **63** (**2024**).

Our group designs chelators that expand the applications of lanthanides in medicine, molecular imaging and sustainability. We have developed chelators that selectively separate similar lanthanides, such as Yb and Lu, enabling the efficient production of ^{177}Lu for targeted radiotherapy. This technology, licensed to SHINE Technologies (Janesville, Wisconsin), is used in the commercial production of medical-grade ^{177}Lu, benefiting patients worldwide.

We have introduced paramagnetic encoding, a concept for storing digital information in defined sequences of lanthanide ions, readable by NMR. Addressing a fundamental challenge in lanthanide chemistry, we have developed ClickZip, a synthetic method that increases chelate stability by up to a million times compared to current clinical standards. These ultra-inert chelates can serve as safer MRI agents and reliable molecular tags.

We have also created the first-of-its-kind dual PET/MRI contrast agent combining ^{18}F with gadolinium, merging the anatomical precision of MRI with the molecular sensitivity of PET. Beyond biomedical research, we have designed chelators that recover lanthanides from NdFeB magnets by way of eco-friendly precipitation.

Building on these advances, we continue to explore new chemical strategies for diagnostics, therapy and resource recovery, bridging lanthanide coordination chemistry with real-world needs.

David, T.; Šedinová, M.; Myšková, A. *et al.* Ultra-Inert Lanthanide Chelates as Mass Tags for Multiplexed Bioanalysis. *Nat. Commun.* **2024**, *15* (1), 9836.

Jones, K. G.; David, T.; Loula, M. *et al.* Macrocyclic Chelators for Aqueous Lanthanide Separations via Precipitation: Toward Sustainable Recycling of Rare-Earths from NdFeB Magnets. *J. Am. Chem. Soc.* **2025**, *147* (26), 22666–22676.

Keywords: lanthanides, chelators, molecular imaging, MRI contrast agents, radiopharmaceuticals, metal separation, recycling

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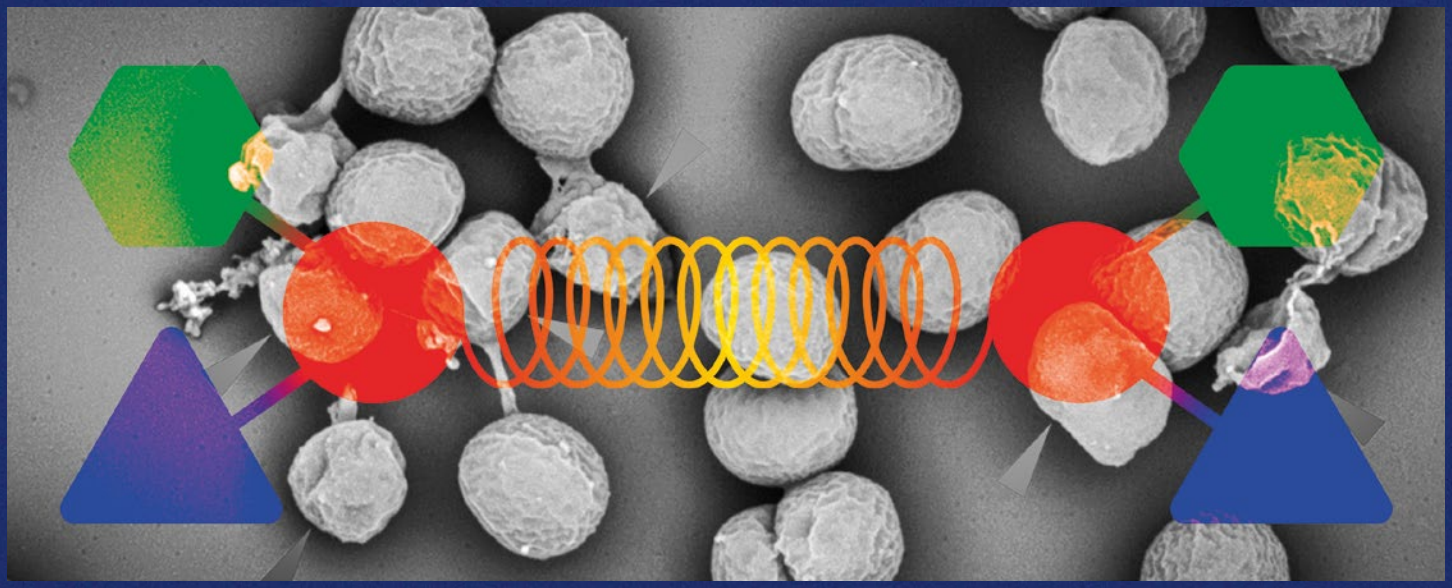
Antimicrobial Compounds



The increasing number of bacterial strains resistant to existing antibiotics, combined with the decline in new antibiotics entering clinical practice, is alarming. Our group is working to address this pressing challenge through several major projects.

We develop novel molecular probes to investigate antibiotic resistance and bacterial regulatory pathways, such as the stringent response, which could serve as potential drug targets. These probes are already being applied by our partners worldwide.

In parallel, we design inhibitors of hypoxanthine–guanine phosphoribosyltransferase, a promising target in malaria, tuberculosis, and trypanosomiasis, and have recently discovered new inhibitors of β-lactamases, the enzymes responsible for resistance to β-lactam antibiotics.

We also develop lipophosphonoxins (LPPOs), a class of novel antibacterial compounds that disrupt bacterial cell membranes. Our research focuses on designing derivatives with enhanced antibacterial and safety properties. Recent advances include LEGO-LPPO, a highly tunable variant with superior activity, and NANO-LPPO, a composite material of LPPOs and nanofibers for antibacterial wound dressings, which has been successfully tested in a mouse model. We are currently evaluating the application of machine learning to structure–activity relationship studies and researching the solid-phase synthesis of new LEGO-LPPO molecules.

Pham, D. D. D.; Mojr, V.; Helusová, M. *et al.* LEGO-Lipophosphonoxins: A Novel Approach in Designing Membrane Targeting Antimicrobials. *J. Med. Chem.* **2022**, *65* (14), 10045–10078.

Keough, D. T.; Petrová, M.; King, G. *et al.* Development of Prolinol Containing Inhibitors of Hypoxanthine–Guanine–Xanthine Phosphoribosyltransferase: Rational Structure-Based Drug Design. *J. Med. Chem.* **2024**, *67* (9), 7158–7175.

Keywords: antimicrobial, antibiotic, inhibitor, bacterial stringent response, nucleotide biosynthesis, salvage pathway

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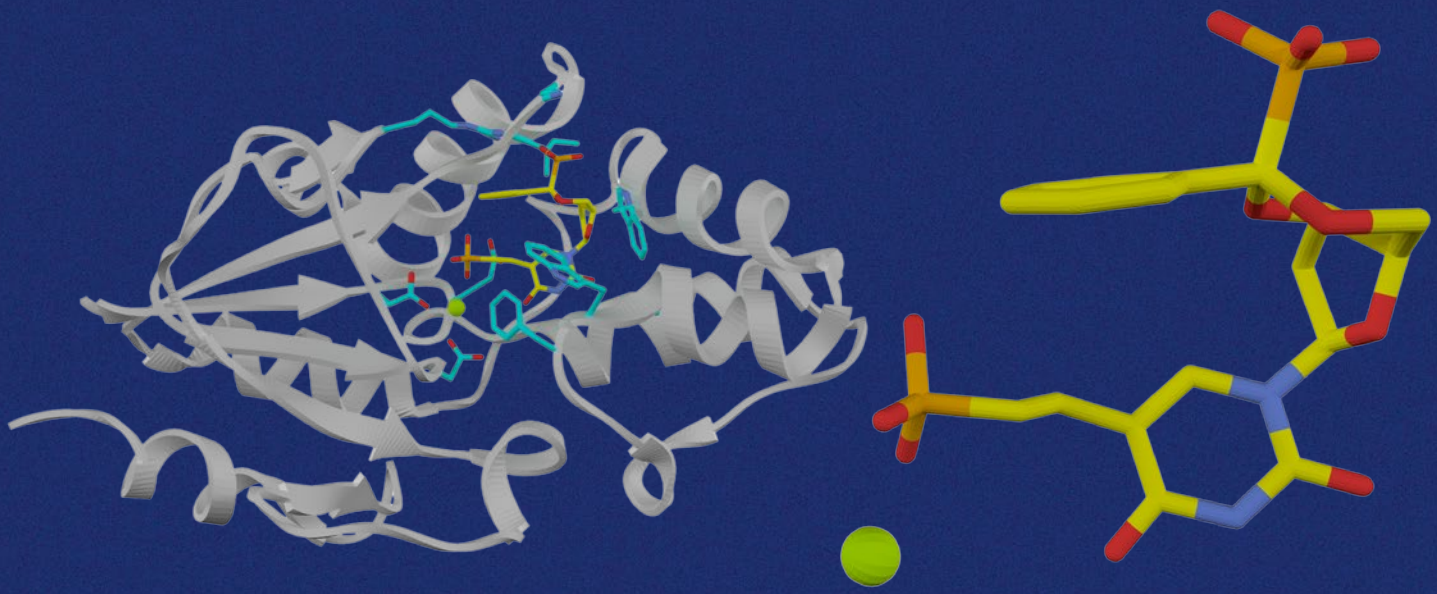
Nucleotides and Oligonucleotides



We design and synthesize nucleoside phosphonic and H-phosphinic acids (NPAs) as building blocks for solid-phase synthesis of chimeric antisense oligonucleotides, which act via RNase H or steric-block mechanisms. We also study regulatory oligonucleotides, including phosphonate 2′,5′-oligoadenylates and CpG oligonucleotides.

As part of these efforts, our investigation of abasic single-site oligonucleotide cleavage by APEX1 revealed an unusual profile, providing insights into antisense strategies that recruit RNase H for RNA cleavage or block translation.

Our NPA chemistry experiments have yielded diverse monomers, featuring furanose or nonoxygen heterocycles bearing a phosphonate, for solid-phase oligonucleotide synthesis. The resulting backbone O–P–C linkages, conferring superior nuclease stability, permit tuning of properties for biological applications.

We also synthesize oligonucleotides in which NPAs replace selected natural units. These compounds exhibit greater nuclease resistance, stronger hybridization, and RNase H stimulation, supporting antisense-mediated gene regulation. Pyrrolidine nucleoside phosphonates and 4′-alkoxynucleosides have shown particular promise, as they boost duplex stability and RNA/DNA selectivity, improving target discrimination.

Zivkovic, M.; Gajarský, M.; Bekova, K. *et al.* Insight into Formation Propensity of Pseudocircular DNA G-Hairpins. *Nucleic Acids Res.* **2021**, *49* (4), 2317–2332.

Lášek, T.; Petrová, M.; Markusová Kóšiová, I. *et al.* 5′-Phosphonate-Modified Oligoadenylates as Potent Activators of Human RNase L. *Bioorg. Med. Chem.* **2022**, *56*, 116632.

Keywords: oligonucleotides, RNase H, phosphonates, solid-phase synthesis

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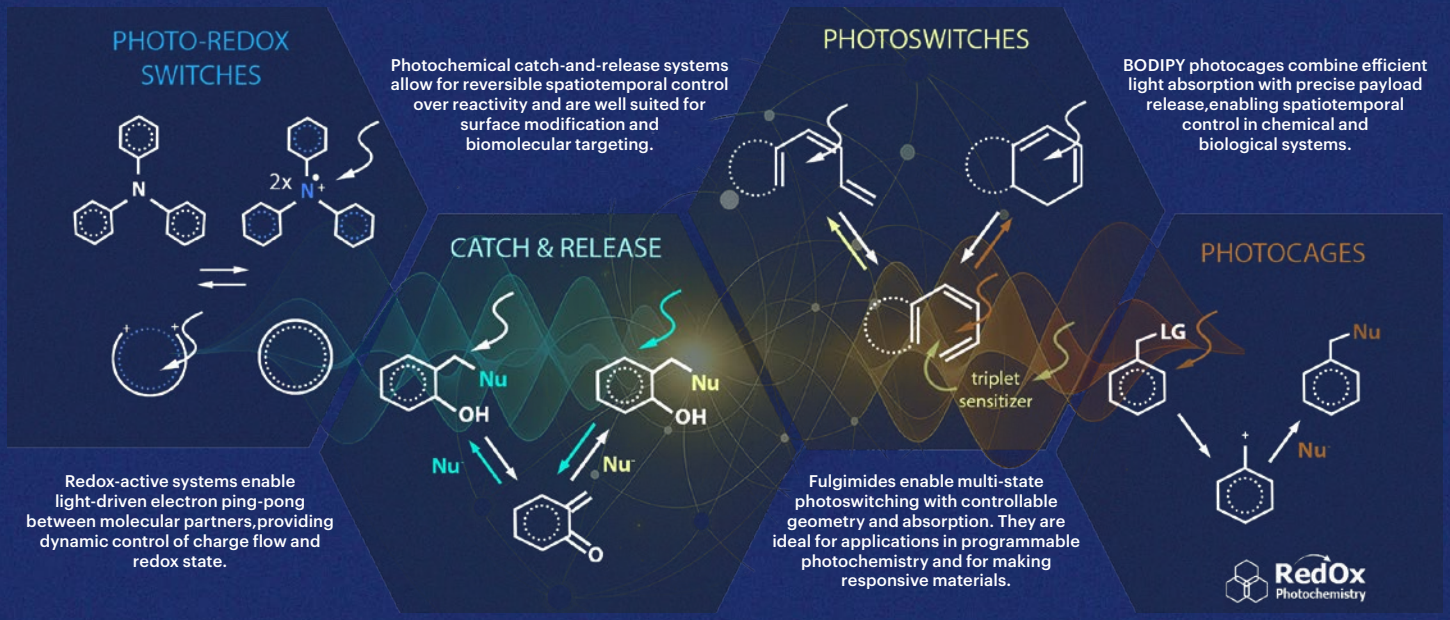
Redox Photochemistry



Reversible electron transfer
Using external stimuli, we control electron transfer in tailored donor–acceptor systems. The aim is to guide redox reactions and stabilize charge-transfer states, which are key in designing redox-active materials with features such as tunable wettability, ion binding and electrostatic charging.

Molecular redox switches
We develop molecular switches, which are compounds that respond to light, pH, solvent characteristics or temperature by toggling between stable states with distinct properties. Redox switches, in particular, shift their structure upon electron transfer. We design and study these systems and incorporate them into surfaces and materials for charge storage, electrostatic bending, ion control and reversible molecular devices.

Stabilization of radicals
We investigate stable organic radicals and radical ions, focusing on their generation, stabilization and reactivity. Our strategies include stabilizing agents, steric protection and macrocyclic confinement. We examine factors that suppress electron back-transfer after redox reactions.

Photoactivatable and multimodal compounds
We design photoactive molecules that undergo controlled transformations (i.e., cleavage, bond formation and rearrangement) upon excitation. Our work includes reversible photoreactions, fluorescent sensors, multimodal systems responsive to light and excited-state multiplicity, and bioorthogonal photo-click chemistry.

Poryvai, A.; Galkin, M.; Shvadchak, V. *et al.* Red-Shifted Water-Soluble BODIPY Photocages for Visualisation and Controllable Cellular Delivery of Signaling Lipids. *Angew. Chem., Int. Ed.* **2022**, *61*, e202205855.

Dunlop, D.; Ludvíková, L.; Banerjee, A. *et al.* Excited-State (Anti)Aromaticity Explains Why Azulene Disobeys Kasha's Rule. *J. Am. Chem. Soc.* **2023**, *145* (39), 21569–21575.

Keywords: electron transfer, radical ions, redox switches, stabilization of radical species, photochemical switches, photoremovable protecting groups

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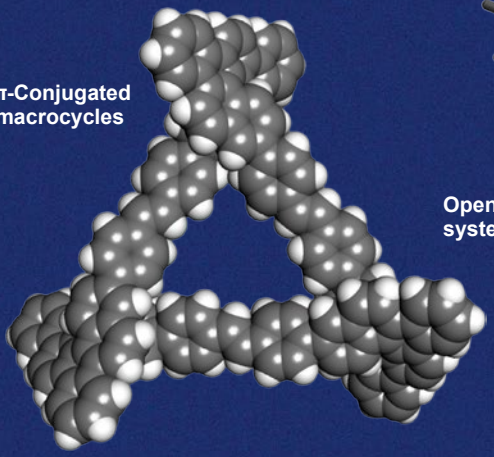
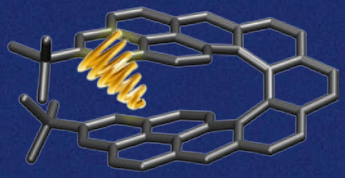
Chemistry of Functional Molecules

Manifold expression of chirality

π-Conjugated macrocycles

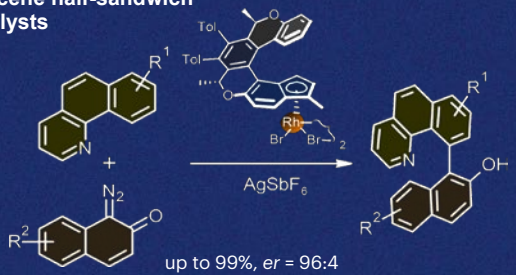


Molecular CPL emitters



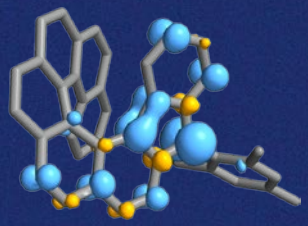
$|g_{lum}|$ up to 7.5×10^{-2}

Helicene half-sandwich catalysts

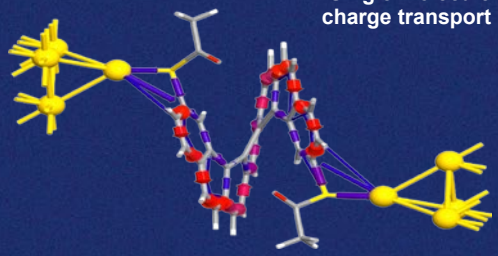


up to 99%, *er* = 96:4

Open-shell systems



Single molecule charge transport



Our research focuses on the development of nontrivial π-electron architectures with significant potential for applications in chemistry, physics, and biology. The central theme of our work is the expression of chirality in the molecular and material domains. Specifically, we focus on the synthesis of helically chiral aromatic compounds (helicenes) that are enantiopure, appropriately functionalized, and suitable for use as building blocks in more complex structures such as π-conjugated macrocycles and open-shell systems.

We systematically investigate related (chir)optical properties, aromaticity, and self-assembly both in crystals and at interfaces, along with charge and spin transport and reactivity at the nanoscale. In addition, we explore the development of novel synthetic methodologies and enantioselective catalysis. Our ultimate goal is to design smart molecular probes and devices with enhanced functionality.

Our experimental techniques are complemented by computational approaches, providing deep insights into the reactivity and physicochemical properties of target π-electron systems in vacuum, solution, and on solid surfaces. Our interdisciplinary research is conducted in close collaboration with experts in scanning probe microscopy, ensuring a comprehensive understanding of the systems under investigation.

Edlová, T.; Rybáček, J.; Cattey, H. *et al.* Stereocontrolled Synthesis of Chiral Helicene-Indenido *ansa*- and Half-Sandwich Metal Complexes and Their Use in Catalysis. *Angew. Chem. Int. Ed.* **2025**, *64*, e202414698.

Houska, V.; Ukraintsev, E.; Vacek, J. *et al.* Helicene-Based π-Conjugated Macrocycles: Their Synthesis, Properties, Chirality, and Self-Assembly into Molecular Stripes on a Graphite Surface. *Nanoscale* **2023**, *15*, 1542–1553.

Keywords: chirality, helical aromatics, 2D self-assembly, on-surface chemistry, enantioselective catalysis, molecular devices

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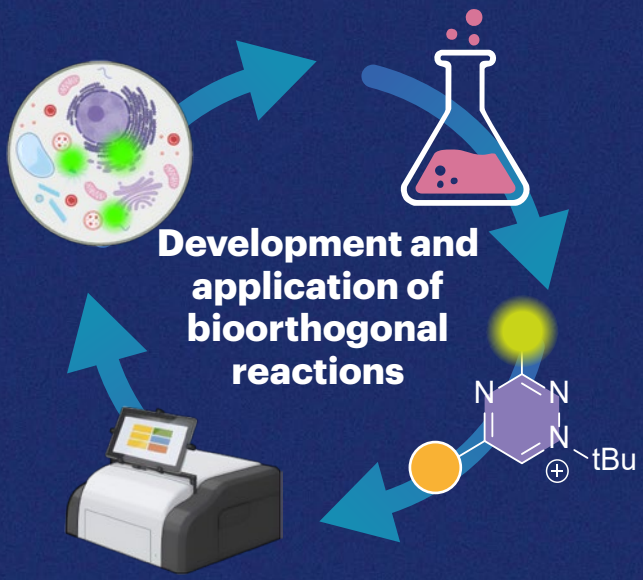
Chemistry of Bioconjugates



Our lab focuses on advancing bioorthogonal chemistry to improve molecular labeling and cellular investigations. We develop novel bioorthogonal reagents and reactions by integrating synthetic organic chemistry with biological methodologies. Following synthesis, we evaluate the reactivity of products using HPLC and UV/Vis spectroscopy and optimize their stability and selectivity under physiological conditions. Fluorogenic probes enable us to track reactivity in live cells by fluorescence microscopy.

We apply our reagents to label and study small molecules and biomolecules in various cellular systems, with a particular focus on tracking drug distribution and identifying molecular targets. Using fluorogenic bioorthogonal reactions, photocrosslinking and proteomics, we aim to provide medicinal chemists with insights into subcellular localization and molecular interactions.

In immunotherapy, we aim to develop novel therapeutic strategies and enhance existing cell therapies using bioorthogonal chemistry. For example, by chemically modifying the surfaces of immune cells with specific targeting moieties, we enhance their ability to eradicate cancer cells. We are also developing new conjugation methods to functionalize antibodies, expanding the potential of bioorthogonal approaches in immunotherapy.

Šlachtová, V.; Bellová, S.; La-Venia, A. *et al.* Triazinium Ligation: Bioorthogonal Reaction of *N*1-Alkyl 1,2,4-Triazinium Salts. *Angew. Chem., Int. Ed.* **2023**, *62*, e202306828.

Rahm, M.; Keppel, P.; Šlachtová, V. *et al.* Sulfonated Hydroxyaryl-Tetrazines with Increased pK_a for Accelerated Bioorthogonal Click-to-Release Reactions in Cells. *Angew. Chem., Int. Ed.* **2025**, *64*, e202411713.

Keywords: bioorthogonal reactions, click chemistry, fluorogenic bioimaging, immunotherapy

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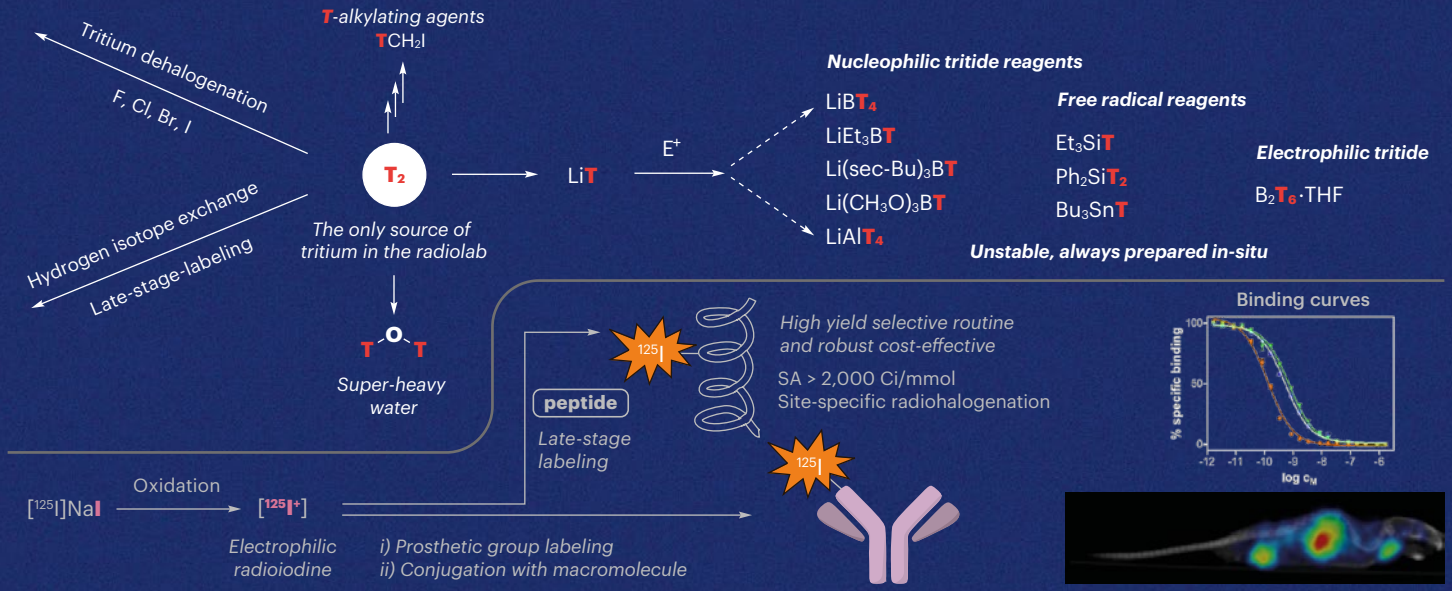
Synthesis of Radiolabeled Compounds



Radioactive labeling is a technique that provides tools for a myriad of applications. Its principle lies in combining target molecules with radioisotopes. The subsequent analysis of radiolabeled molecules is then quantitative, based on the emission of gamma or beta rays. From *in vitro* analyses to *in vivo* studies, taking measurements remains straightforward because it is direct and independent of the matrix. Radioactive labeling remains by far the most competitive method throughout the numerous stages of the process of selecting and validating candidate drug molecules.

Our isotope service includes consultation on label position, synthetic route design, storage and repurification. We supervise radiation safety rules within the institute, oversee radioactive waste management and provide radiometric services.

We radiolabel both small molecules and biomolecules such as peptides, oligonucleotides, proteins and mAbs.

Our state-of-the-art radiosynthetic lab is certified for the handling of ionizing radiation. Its equipment includes a deuterium and tritium manifold operated in a glovebox, analytical / semiprep radio-HPLC, ^{3}H NMR, GC–MS, LC–MS, radio-TLC, a cell harvester, a MicroBeta^{2} plate reader, a scintillation counter (TriCarb), γ-counters, autoradiography equipment (Typhoon imager), and a –196 °C storage facility.

Marek, A.; Brož, B.; Kriegelstein, M. *et al.* Late-Stage Labeling of Diverse Peptides and Proteins with Iodine-125. *J. Pharm. Anal.* **2025**, *15* (7), 101198.

Pimková Polidarová, M.; Břehová, P.; Kaiser, M. M. *et al.* Synthesis and Biological Evaluation of Phosphoester and Phosphorothioate Prodrugs of STING Agonist 3′,3′-c-Di(2′F,2′dAMP). *J. Med. Chem.* **2021**, *64* (11), 7596–7616.

Keywords: ^{3}H and ^{125}I labeling, radiation protection and safety training, radioactive waste management, stable ^{13}C, ^{2}H and ^{15}N labeling

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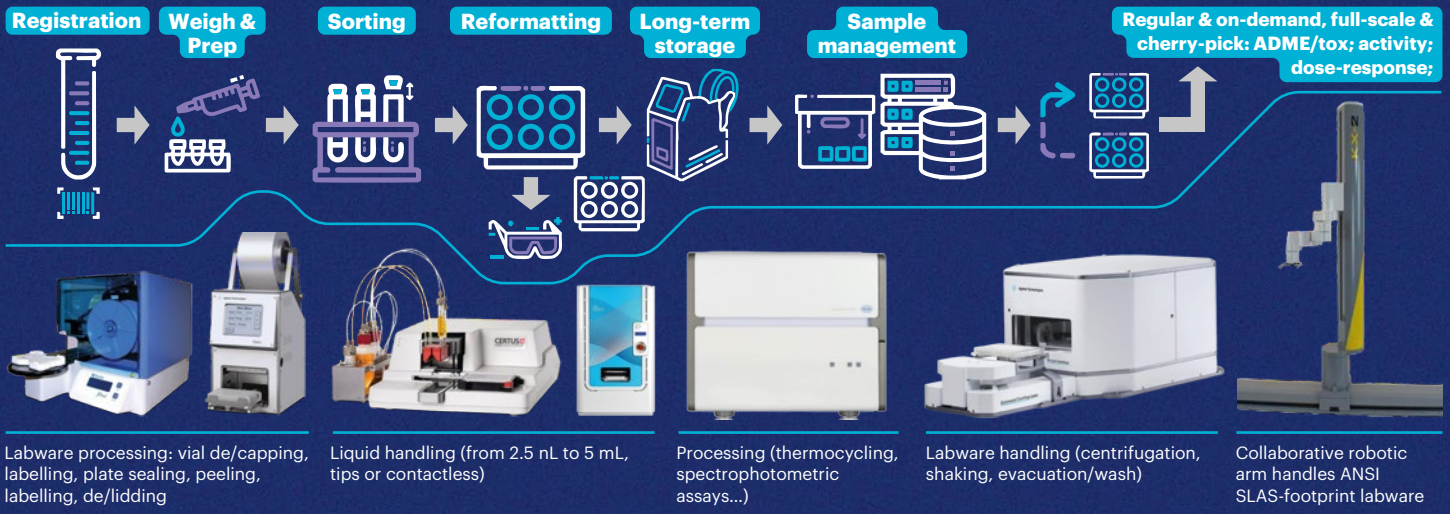
IOCB Compound Library



Labware processing: vial de/capping, labelling, plate sealing, peeling, labelling, de/lidding

Liquid handling (from 2.5 nL to 5 mL, tips or contactless)

Processing (thermocycling, spectrophotometric assays...)

Labware handling (centrifugation, shaking, evacuation/wash)

Collaborative robotic arm handles ANSI SLAS-footprint labware

The IOCB Compound Library encompasses almost all IOCB medicinal chemistry outputs, featuring diverse chemical scaffolds often absent from commercial collections. These include natural products, steroids, peptides, peptidomimetics, and in particular nucleoside and nucleotide analogues. As part of our expanding capabilities, we also synthesize peptide-based inhibitors in 96-well and 384-well plate formats to support rapid, parallelized structure–activity exploration.

As an IOCB core facility, our library drives the transition to data-driven research. Our collection and selected commercial libraries for high-throughput screening can be accessed by both IOCB staff and our external partners. We provide ready-to-use compounds in high-density plate formats for efficient screening, saving researchers time and resources. Our team catalogs and automates the handling of thousands of compounds, including a dedicated steroid collection. We also offer support with troubleshooting, bulk data management, and assistance with preparations for retesting or collaborative projects.

High-quality, data-driven management depends on advanced automation. The Compound Library uses a new automated workcell for handling ANSI/SLAS-compatible labware, equipped with dispensers, pipetting robots, centrifuges, incubators, barcode labelers, sealers, peelers, and more. This setup enables efficient compound processing and streamlines complex luminescence, qPCR, and fluorescence polarization assays.

Šímová, M.; Ormsby, T.; Šinkevičiūtė, U. *et al.* Identification of 6-Aryl-7-Deazapurine Ribonucleoside Phosphonates as Inhibitors of Ecto-5′-Nucleotidase (CD73). *ACS Pharmacol. Transl. Sci.* **2025**, *8* (8), 2575–2585.

Smith, J. D.; Tvrdoňová Stillerová, V.; Dračínský, M. *et al.* Discovery and Isolation of Novel Capsaicinoids and Their TRPV1-Related Activity. *Eur. J. Pharmacol.* **2025**, *999*, 177700.

Keywords: compound management, high-throughput screening, contactless liquid transfer, custom compound access

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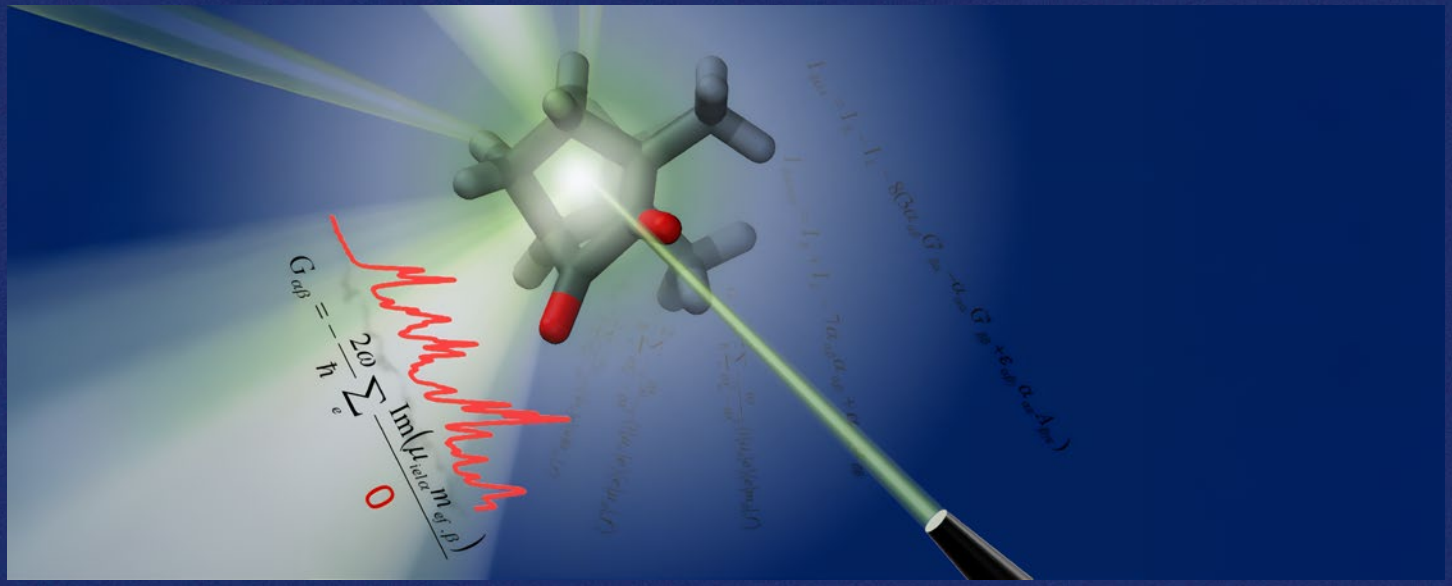
Biomolecular Spectroscopy



We develop and apply theoretical and experimental methods to further the understanding of molecular properties. By employing the techniques of optical spectroscopy, we study the structure, interactions and functions of biomolecules in living cells. The methodologies we create have potential to be used in exploring new functional compounds and materials. In the long term, computational modeling saves money on development and reduces the need for testing drug on animals.

In particular, we develop methods of chiral spectroscopy based on the use of circularly polarized light. These methods are highly sensitive to variations in molecular structure. Among them, analysis of vibrational optical activity reveals especially valuable information. To interpret chiroptical spectra, we have upgraded and extended the combined computational and spectroscopic approach to handle large proteins consisting of thousands of atoms. Lately, we have developed a highly sensitive method for detecting circularly polarized luminescence, which is useful in chemical imaging.

Our group also employs advanced organic synthesis to prepare model systems relevant to studying biological activity, for example, of functionalized proteins with modified folding properties, which have been implicated in Alzheimer's and other neurodegenerative diseases.

Schrenková, V.; Kapitán, J.; Bouř, P. *et al.* Sofosbuvir Polymorphs Distinguished by Linearly and Circularly Polarized Raman Microscopy. *Anal. Chem.* **2024**, *96*, 18983–18993.

Das, M.; Gangopadhyay, D.; Andrushchenko, V. *et al.* Bisignate Surface-Enhanced Raman Optical Activity with Analyte-Capped Colloids. *ACS Nano* **2025**, *19* (10), 10412–10420.

Keywords: optical spectroscopy, quantum chemistry, molecular modeling, organic synthesis, optical activity, method development

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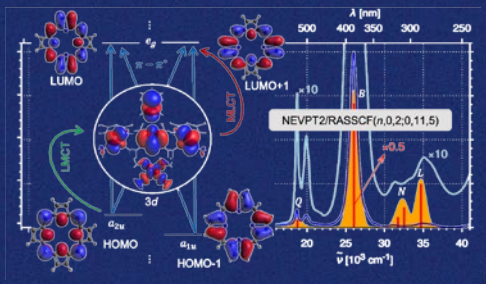
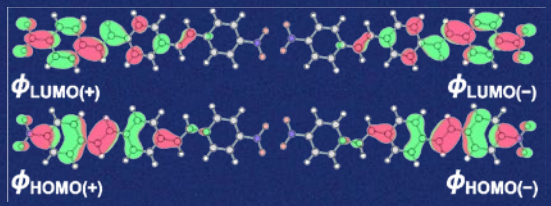
Computational Chemistry

Multireference excited states



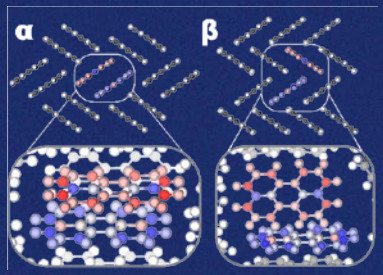
2¹A states as stepping stones in SF?



Metalloporphyrins:
A MR perturbation theory study

Molecular dynamics

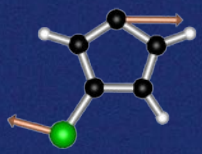
Charge separation and excimers



Spin-orbit coupling

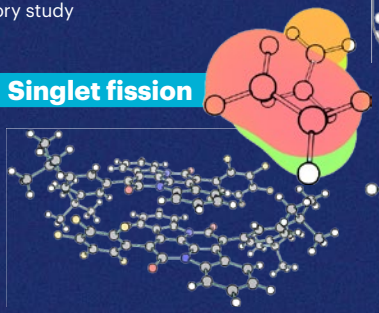
Is parity violation detectable in chiral molecules?

Inverse heavy-atom effect S_0-T_1

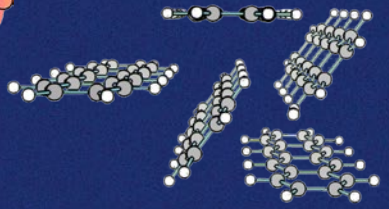


Normal heavy-atom effect S_1-T_2

Singlet fission



$S_0+S_1 \rightleftarrows {}^1(T_1T_1) \rightleftarrows T_1+T_1$



Our group focuses on theoretical studies of organic compounds with complex electronic structures, such as biradicals, dyes and transition metal complexes. We explore the photophysical properties of these molecules, which often differ significantly from closed-shell systems. Such compounds are promising candidates for processes like singlet fission, potentially enhancing organic solar cell efficiency. We seek new chromophores and their arrangements for singlet fission. Another area of focus is the rational design of triplet photosensitizers, useful in organic synthesis or photodynamic therapy, based on halogenated BODIPY and aza-BODIPY systems, where spin–orbit coupling plays a key role.

Spin–orbit coupling, a relativistic effect, sometimes aided by spin–spin coupling, enables spin-forbidden processes and influences high-resolution spectroscopy. We study its impact on intersystem crossing rates, zero-field splitting and the search for a chiral molecule with a measurable parity-violating shift in excitation energy, possibly linked to differences between enantiomers. In transition metal chemistry, we investigate the spectroscopic properties of metal complexes. Our results are based on advanced electronic structure methods, and we actively develop methodologies and scientific software. Strong collaboration with experimental and synthetic groups is a hallmark of our work.

Mencaroni, L.; Zaykov, A.; Carlotti, B. *et al.* Uncovering Intramolecular Singlet Fission at the Root of the Dual Fluorescence of 1,4-bis(p-nitro-β-styryl)benzene in Solution. *Chem. Sci.* **2025**, *16* (33), 15129–15140.

Wasif Baig, M.; Pederzoli, M.; Kývala, M. *et al.* Quantum Chemical and Trajectory Surface Hopping Molecular Dynamics Study of Iodine-Based BODIPY Photosensitizer. *J. Comput. Chem.* **2025**, *46*, e70026.

Keywords: excited states, molecular properties, spectroscopy, relativistic effects, parity violation, singlet fission, software development

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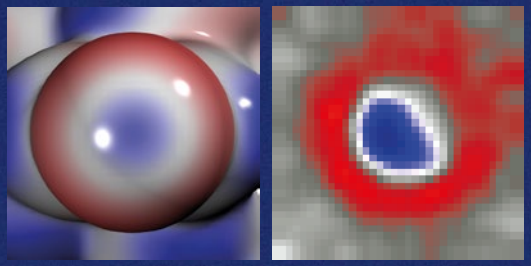
Non-Covalent Interactions

σ-hole

Tetrakis(4-bromophenyl)methane

Theory **Experiment**

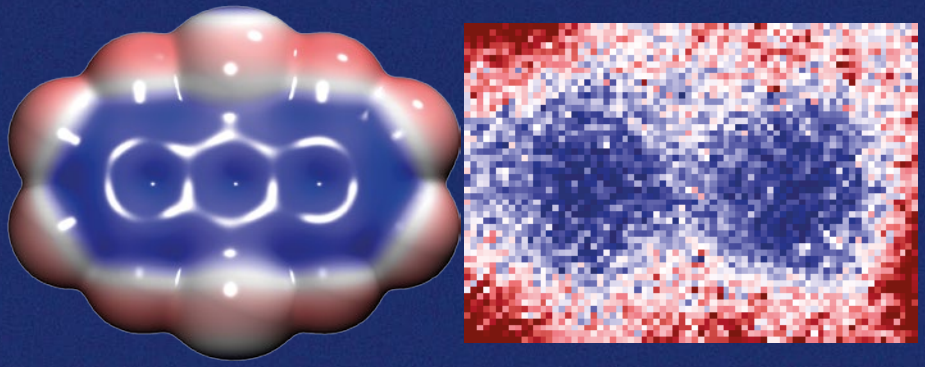


Science, 2021, **374**, 863.

π-hole

9,10-dichlorooctafluoroanthracene

Theory **Experiment**



Nature Communications, 2023, **14**, 4956.

The main research theme of our group is the computational description of non-covalent interactions and covalent and dative covalent bonds in the gas phase as well as in solvents. We use advanced quantum chemical and statistical thermodynamic methods to describe the structure, properties and reactivity of classical and non-classical systems controlled by non-covalent interactions and dative covalent bonds. Where applicable, we attempt to corroborate our computational findings with experimental NMR and IR spectroscopy data.

We have studied the stability of hydrogen-bonded complexes in polar solvents and demonstrated that it increases with solvent polarity, particularly when significant charge transfer occurs between the interacting subsystems.

Our studies on hydrogen bonding have extended to unusual hydridic hydrogen bonding where hydrogen bears a partial negative charge. Despite the opposite charge transfer, we found the spectral features of the bonding, such as red-shifts and IR intensity changes, to be remarkably similar.

We also focus on describing systems with radical characteristics in their ground and excited states or characterizing the mechanisms of reactions that involve organic molecules and are induced by UV light.

Our ongoing research focuses on the development of copper-based catalysts for hydrogenation and dehydrogenation reactions, particularly in CO_2 hydrogenation and ethanol dehydrogenation.

Mallada, B.; Gallardo, A.; Lamanec, M. *et al.* Real-Space Imaging of Anisotropic Charge of σ-Hole by Means of Kelvin Probe Force Microscopy. *Science* **2021**, *374* (6569), 863–867.

Mallada, B.; Ondráček, M.; Lamanec, M. *et al.* Visualization of π-Hole in Molecules by Means of Kelvin Probe Force Microscopy. *Nat. Commun.* **2023**, *14*, 4954.

Keywords: covalent and covalent-dative bonds, ground and exited states, role of solvents, quantum chemistry, molecular dynamics, catalysis

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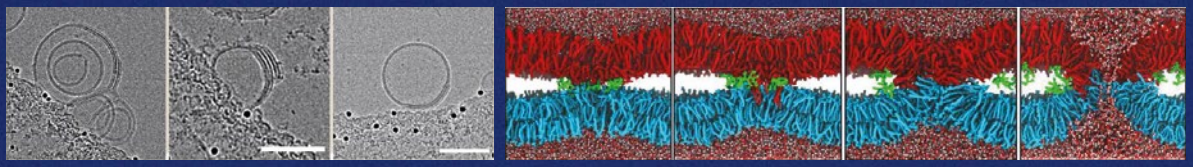
Molecular Modeling

1 Mechanisms of cell-penetrating peptides



2 Charge scaling for biomolecular simulations

$$V_{Coulomb} = q_1 q_2 / 4\pi r \varepsilon_0 \varepsilon_r^e$$

$$q_1 \rightarrow q_1 / \sqrt{\varepsilon_r^e}$$

$$q_2 \rightarrow q_2 / \sqrt{\varepsilon_r^e}$$

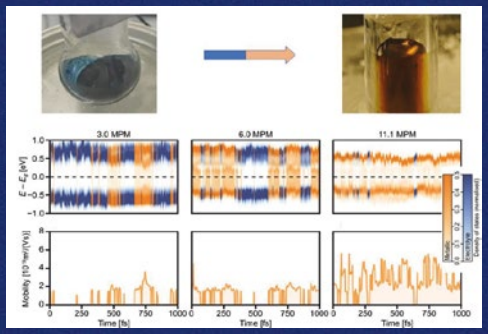
1 *Langmuir* **38** (2022) 11284–11295, *J. Phys. Chem. B* **127** (2023) 4523.

2 *Commun. Biol.* **4** (2021) 440, *Hear. Res.* **440** (2023) 108900.

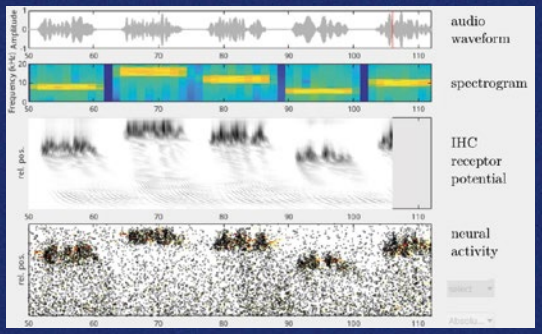
3 *J. Am. Chem. Soc.* **146** (2024) 8043, *Nature Communications* **16** (2025) 4302.

4 *J. Chem. Theory Comput.* **20** (2024) 7546, *J. Phys. Chem.* **25** (2024) 2922.

3 Solvated electrons: electrolytes to metals



4 Modeling of the ear, sweet taste of D_2O, and more...



In our group, we aim at gaining a molecular-level understanding of biological processes involving ions, using computer simulations performed in close contact with spectroscopic experiments. By employing molecular dynamics simulations and quantum chemical methods, we are working to establish the mechanisms of ion–protein and ion–membrane interactions. The applications of the results achieved by our research range from influencing protein aggregation, precipitation or denaturation and controlling enzymatic activity to establishing the properties of phospholipid bilayers in the presence of ions. One of the key aims within the latter subject is to establish the molecular principles governing the action of calcium ions involved in membrane fusion and cationic cell-penetrating peptides, which play an important role in novel methods of drug delivery to cells. To this end, we are also developing improved force fields for molecular dynamics simulations, which effectively include electronic polarization via charge scaling.

Our related research activities concern electron solvation pertinent to Birch reduction processes and the electrolyte-to-metal transitions in solutions of alkali metals in liquid ammonia and water. Additionally, in our free time, we entertain ourselves with "balcony experiments" involving, for example, explosions of alkali metals in water, which also helps us to connect to the general public and popularize science.

Nemirovich, T.; Young, B.; Březina, K. *et al.* Stability and Reactivity of Aromatic Radical Anions in Solution with Relevance to Birch Reduction. *J. Am. Chem. Soc.* **2024**, *146* (12), 8043–8057.

Cruces Chamorro, V.; Jungwirth, P.; Martinez-Seara, H. Building Water Models Compatible with Charge Scaling Molecular Dynamics. *J. Phys. Chem. Lett.* **2024**, *15* (10), 2922–2928.

Keywords: molecular simulations, water, ions, proteins, membranes, solvated electrons, Hofmeister series

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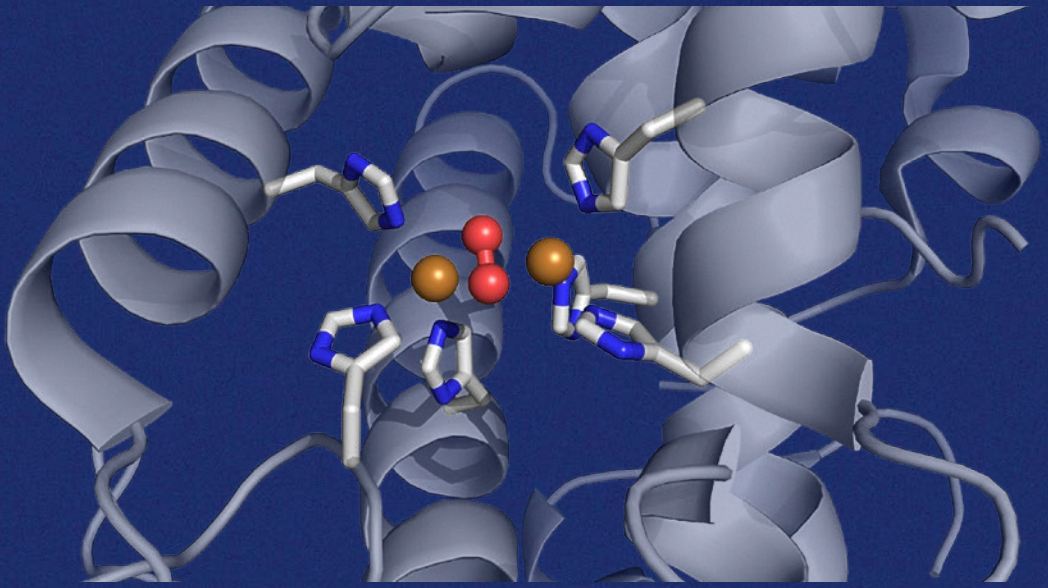
Theoretical Bioinorganic Chemistry



Our group researches several interconnected topics ranging from theoretical bioinorganic chemistry through *ab initio* protein structure predictions and computational (xeno)biology to molecular electronics, chemical bonding, and relativistic effects in chemistry.

Other research topics include the development of quantum mechanics/molecular mechanics (QM/MM) methods, organic reactivity, computational homogeneous catalysis, protein–ligand interactions, computational electrochemistry, theoretical spectroscopy, and the design of novel fullerenes that can act as molecular switches, transistors, and memristors.

Computational (bio)chemistry has become an integral part of chemical and biological systems and processes. Advances in the application of modern quantum mechanics methods to realistic systems along with the availability of accurate solvation models, QM/MM-like coupling schemes, bioinformatics, AI-driven approaches, and structural search engines are steadily enhancing the predictive power required for the design of novel molecules and materials.

Kipouros, I.; Stańczak, A.; Ginsbach, J. W. *et al*. Elucidation of the Tyrosinase/O_2/Monophenol Ternary Intermediate That Dictates the Monooxygenation Mechanism in Melanin Biosynthesis. *Proc. Natl. Acad. Sci. U.S.A.* **2022**, *119* (33), e2205619119.

Osifová, Z.; Kalvoda, T.; Galgonek, J. *et al*. What Are the Minimal Folding Seeds in Proteins? Experimental and Theoretical Assessment of Secondary Structure Propensities of Small Peptide Fragments. *Chem. Sci.* **2024**, *15*, 594–608.

Keywords: metalloenzymes, protein–ligand interactions, structure–function correlations, principles of protein folding, relativistic effects in chemistry, theoretical spectroscopy

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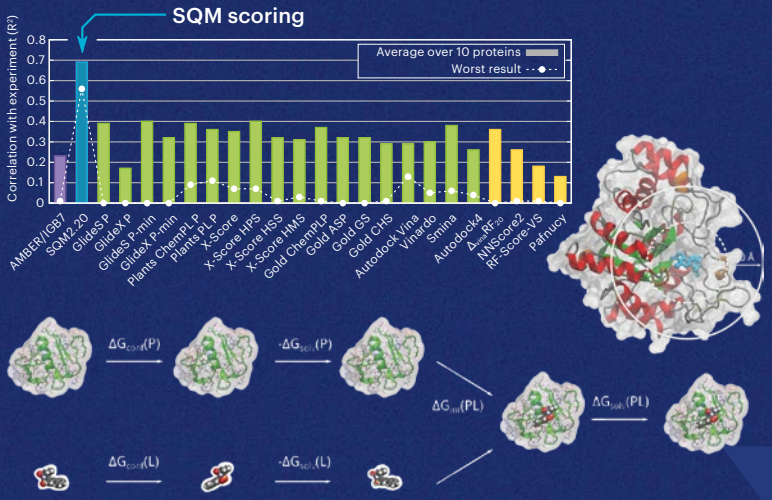
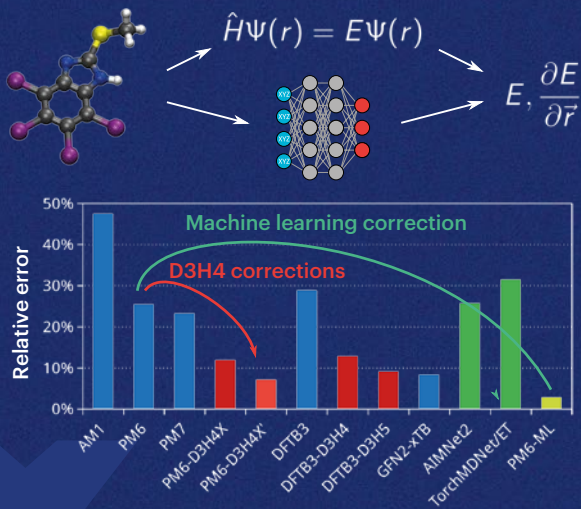
Computational Chemistry for Drug Design

Computer-aided drug design



Semiempirical QM method development



The development of novel drugs is one of the areas where computational chemistry can deliver high practical value. We focus on calculating the binding affinity of protein–ligand complexes, a crucial parameter that describes how strongly a potential drug binds to its target within a cell.

We address this issue by employing uncommon yet highly promising semiempirical quantum chemistry methods. Our group has extensive experience investigating noncovalent interactions and developing efficient computational methods to describe them accurately. Recently, we combined semiempirical quantum chemical calculations with machine learning techniques, allowing us to compute large systems containing thousands of atoms with unparalleled precision. This work is supported by accurate benchmark calculations and analysis of fundamental mechanisms of noncovalent interactions.

To solve practical problems in computer-aided drug design, we combine these state-of-the-art methods with our expertise in biomolecular modeling. Superior to conventional approaches, our computational workflow for predicting protein–ligand binding affinity is currently being applied to real-world problems in collaboration with biochemists and medicinal chemists at IOCB as well as leading pharmaceutical companies.

Pecina, A.; Fanfrlík, J.; Lepšík, M.; Řezáč, J. SQM2.20: Semiempirical Quantum-Mechanical Scoring Function Yields DFT-Quality Protein–Ligand Binding Affinity Predictions in Minutes. *Nat. Commun.* **2024**, *15*, 1127.

Nováček, M.; Řezáč, J. PM6-ML: The Synergy of Semiempirical Quantum Chemistry and Machine Learning Transformed into a Practical Computational Method. *J. Chem. Theory Comput.* **2025**, *21* (2), 678–690.

Keywords: semiempirical quantum chemistry, noncovalent interactions, computer-aided drug design, protein–ligand interactions

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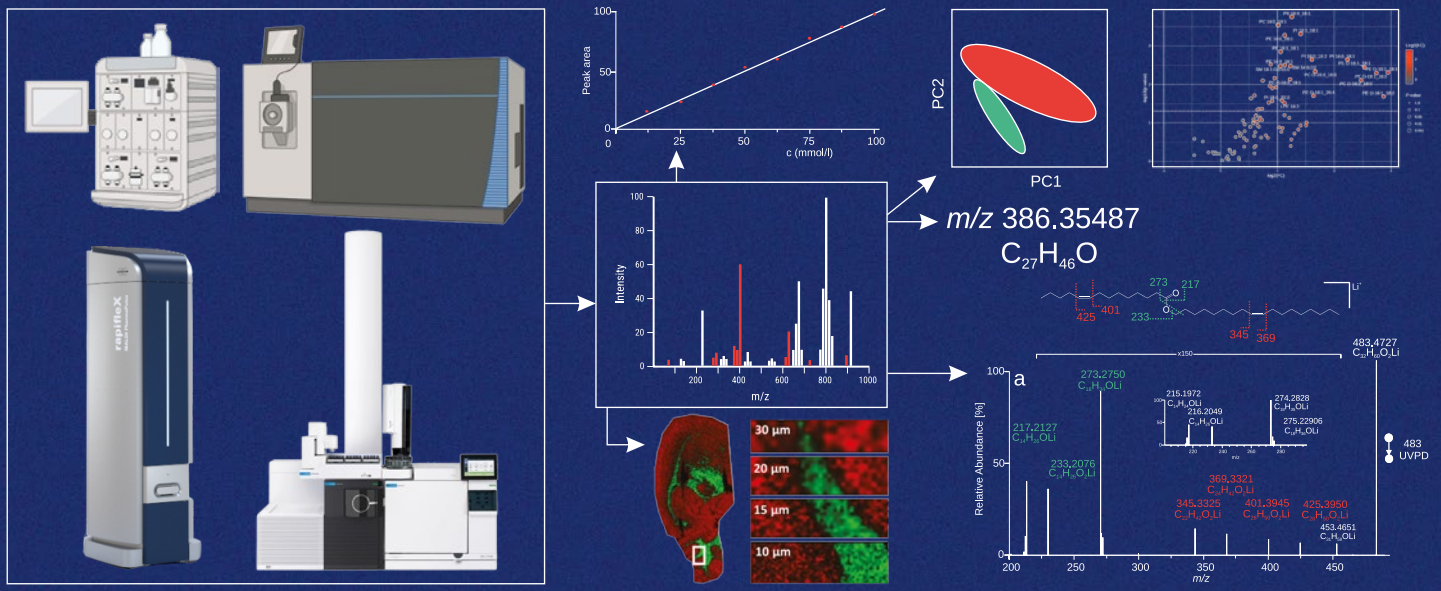
Mass Spectrometry



The Mass Spectrometry Core Facility provides comprehensive analytical support for diverse research projects conducted at IOCB. Our services include the acquisition and interpretation of mass spectra for a wide range of molecules, as well as quantitative analyses of small molecules within complex samples. Customized, on-demand mass spectrometry services are available to address specific research requirements.

We also specialize in mass spectrometry imaging for mapping molecular distributions in biological tissues and lipidomic analyses critical for studying cellular metabolism. Additionally, we offer open-access GC-MS instrumentation accessible to IOCB students and researchers.

Equipped with advanced instrumentation, our facility provides high-quality data that enhances the institute's research projects and reputation of scientific excellence. Our state-of-the-art equipment includes the Bruker rapifleX MALDI-TOF/TOF and Thermo Scientific Orbitrap IQ-X Tribrid mass spectrometers and the Agilent 7250 GC/Q-TOF hybrid system.

Strnad, Š.; Vrkoslav, V.; Mengr, A. *et al.* Thermal Evaporation as Sample Preparation for Silver-Assisted Laser Desorption/Ionization Mass Spectrometry Imaging of Cholesterol in Amyloid Tissues. *Analyst* **2024**, *149* (11), 3152–3160.

Sedláčková, S.; Hieta, J.-P.; Blechová, M. *et al.* Peptide Analysis by Soft X-ray Atmospheric Pressure Photoionization Mass Spectrometry. *J. Am. Soc. Mass Spectrom.* **2025**, *36* (6), 1286–1295.

Keywords: HPLC-MS, GC-MS, MALDI-MS, MALDI-MSI, MS^n, fragmentation technique, lipidomics

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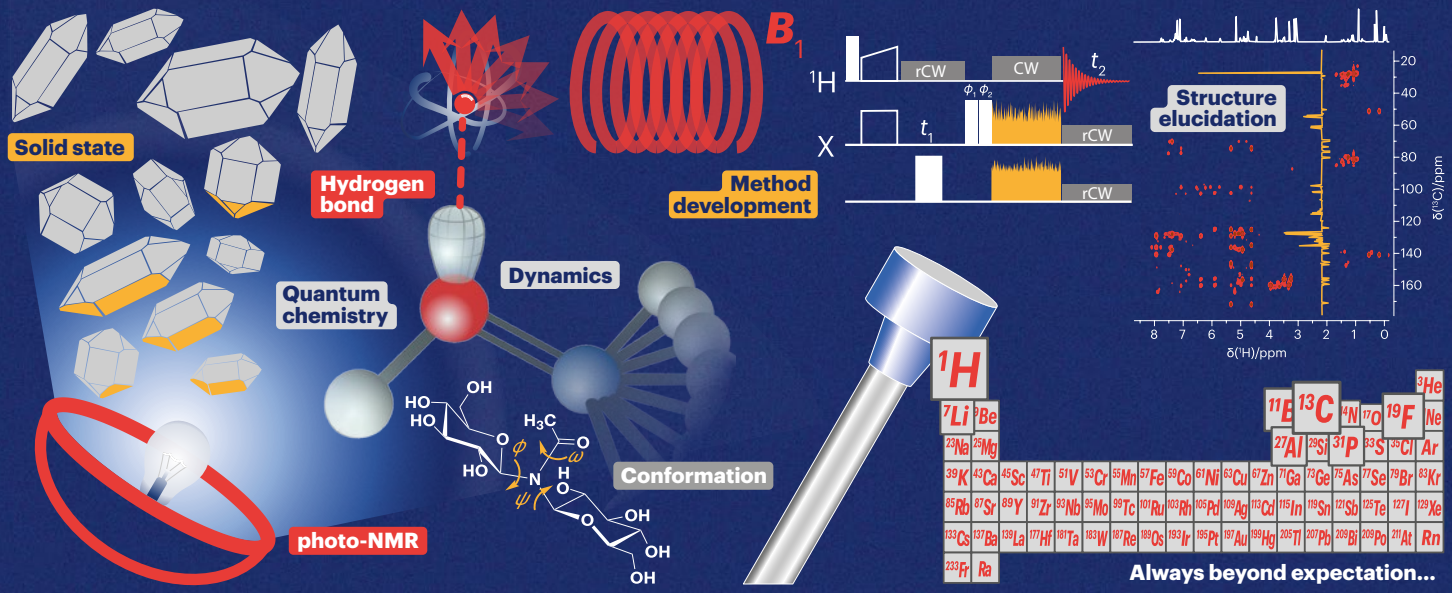
NMR Spectroscopy



Our research deals with many aspects of experimental NMR/EPR spectroscopy in solutions and solids, molecular modeling, and theoretical calculations of spectroscopic parameters and molecular properties. We apply both experimental and theoretical methods in studies of the structure and properties of biologically active compounds, of intra- and inter-molecular interactions, and of reaction mechanisms. In addition, we provide NMR and EPR services to other IOCB researchers.

We utilize modern one- and two-dimensional NMR techniques for the structure elucidation of compounds synthesized in laboratories of the IOCB or isolated from natural sources. We work to determine the configurations of chiral molecules and conduct studies on conformational dynamics in flexible molecules as well as on noncovalent interactions, particularly hydrogen bonding (both intra- and inter-molecular). We have implemented a methodology for continuous UV or visible light irradiation during NMR and EPR experiments, which makes it possible to investigate photochemical processes in real time. We also develop new methods of NMR crystallography that combine experimental solid-state NMR data with theoretical calculations for gaining new insights into the structure and dynamics of solids. We apply EPR spectroscopy together with quantum chemical calculations to solve the structures of paramagnetic molecules in organic and nanomaterial chemistry.

Hruzíková, A.; Barati, V.; Ešnerová, A. *et al.* ^{31}P NMR Study of P-Chirogenic Phosphaphenanthrenes with Molecular Flexibility Tuned by Amino Acid Substituents. *Chem. Eur. J.* **2025**, *31*, e202500330.

Štoček, J. R.; Blahut, J.; Chalupná, S. *et al.* The Hydrogen-Bond Continuum in the Salt/Cocrystal Systems of Quinoline and Chloro-Nitrobenzoic Acids. *Chem. Eur. J.* **2024**, *30*, e202402946.

Keywords: NMR and EPR spectroscopy, structural analysis, theoretical calculations

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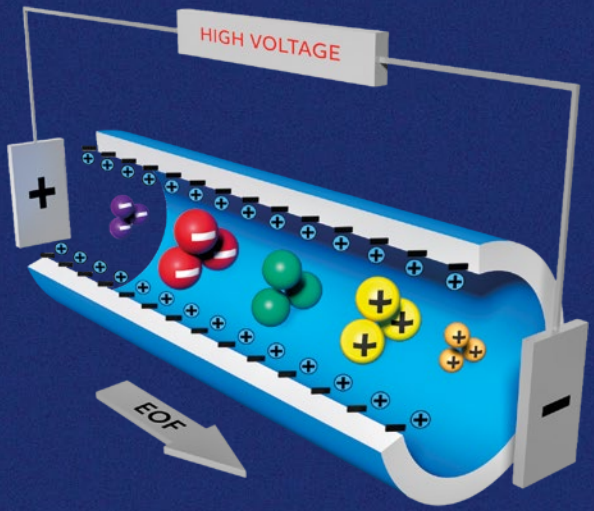
Electromigration Methods



Štěpánová, S. *et al. Electrophoresis* **2024**, *45*, 1000–1009.

Our group is engaged in the research and development of capillary electromigration (CE) methods, specifically their application to the separation, analysis, micropreparation, and characterization of (bio) molecules and (bio)particles. Our laboratory is equipped with four fully automated CE analyzers with UV–vis spectrophotometric, conductometric, and fluorescent detection systems, as well as a semiautomated CE device coupled with a high-resolution Orbitrap Exploris 240 mass spectrometer.

For (bio)molecules and (bio)particles (bio)synthesized, isolated, or investigated at IOCB, the following services are provided:

1. **High-sensitivity qualitative and quantitative analyses, including purity assessment and detection in complex matrices;**
2. **Monitoring of (bio)synthesis, purification, interactions, and reactions;**
3. **Mass spectrometry analysis and structure elucidation;**
4. **Separation of various types of isomers;**
5. **Microscale isolation;**
6. **Physicochemical and biochemical characterization, including determination of electrophoretic mobilities, actual and limiting ionic mobilities, effective charges, acidity constants, Stokes hydrodynamic radii, isoelectric points, relative molecular masses, diffusion coefficients, association and dissociation constants of complexes, rate constants, changes in Gibbs free energy, and enthalpy and entropy of interactions and reactions.**

Šolínová, V.; Koval, D.; Kašička, V. Determination of the Effective Charge Numbers and Ionic Mobilities of Single-Isomer and Randomly Highly Sulfated Cyclodextrins by Capillary Isotachophoresis and Zone Electrophoresis. *Electrophoresis* **2025**, *46*, 820–828.

Konášová, R.; Koval, D.; Tůma, P.; Vaculín, Š.; Kašička, V. Study of Metabolic Pathways of Racemic Ketamine and Its (S)-Enantiomer in Rat Blood Plasma Using CE-ESI/MS with Partial Filling of Dual Chiral Selector System. *Talanta* **2025**, *293*, 128129.

Keywords: capillary electrophoresis, affinity electrophoresis, isotachophoresis, isoelectric focusing, electrokinetic chromatography, electrochromatography

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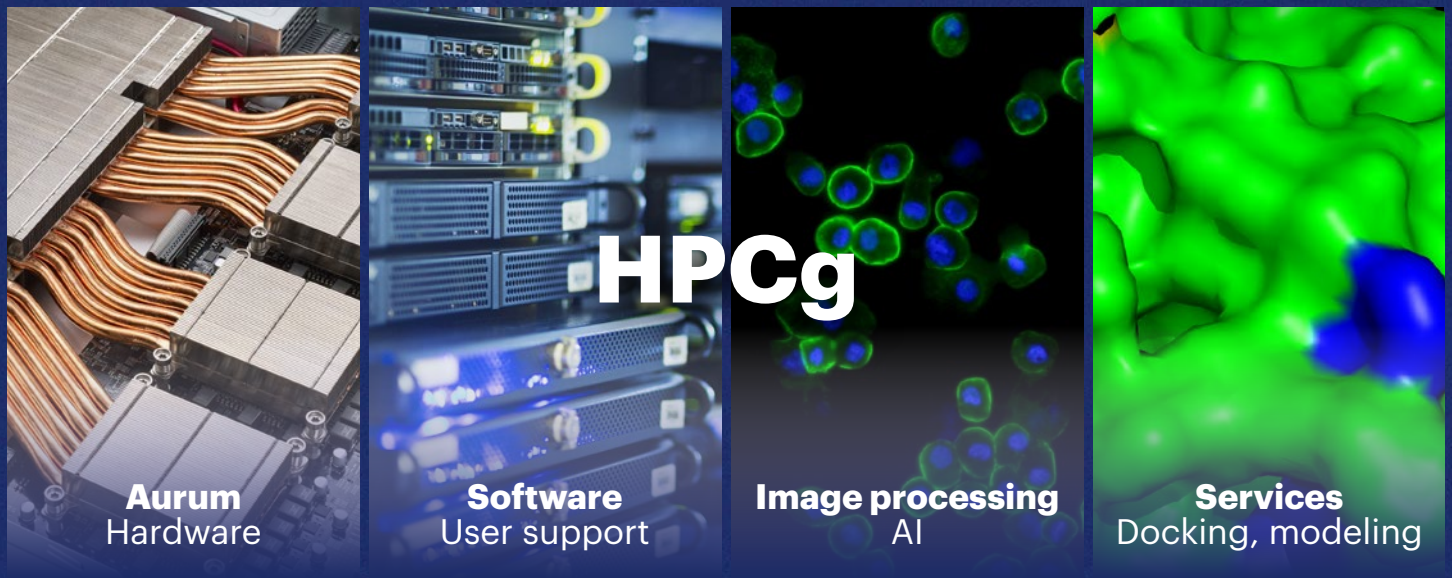
High Performance Computing



The High Performance Computing Service Group (HPCg) provides IOCB scientists with access to advanced computational power and expertise at every stage of their research workflow. Our facility is equipped with an in-house Aurum supercomputer, over 390 CPU/GPU nodes managed by a low latency Omni Path fabric, petabyte scale storage, and a modern Slurm environment – soon to be expanded with a dedicated AI/LLM partition.

We couple this infrastructure with end to end support: system setup and scientific software deployment; interactive user help desk and ticketing; bespoke bioinformatics, molecular modeling, machine learning, and image analysis projects; and a year round training program.

Our services include protein/ligand docking, MD simulations, virtual screening, QM/MM calculations, deep learning image segmentation, statistical modeling and pipeline engineering for NGS, cryo-EM, and imaging core facilities. Our system typically runs at over 93% of its cluster occupancy, registering approximately 120 active users from over 25 groups, more than 200 support tickets, and roughly 50 consultation visits each year.

Supported by a clear data management framework and a planned six-year renewal cycle, our facility delivers scalable and responsive computational capabilities, swiftly transforming complex ideas into publishable results.

Keywords: high-performance computing, molecular modeling, computer simulations, AI, computer cluster, image processing

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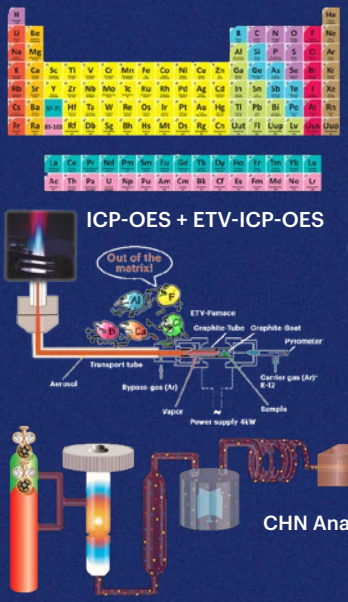
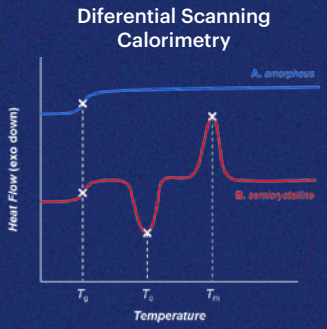
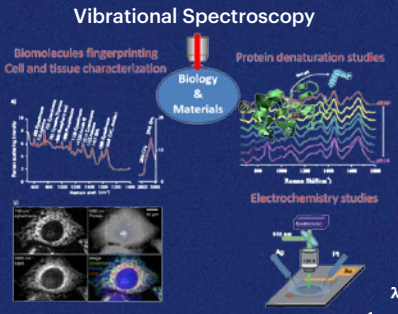
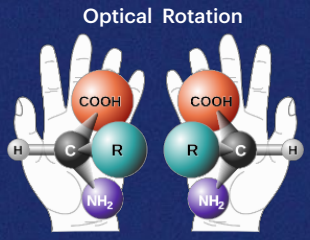
Analytical Laboratory

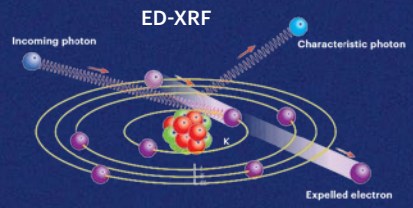
Elemental Analysis + Molecular Spectroscopic Methods

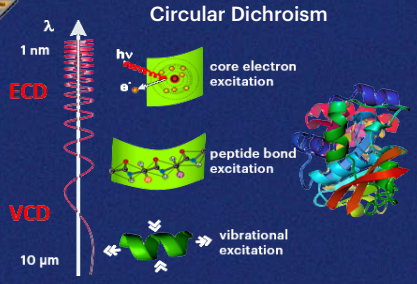












We provide comprehensive elemental analysis of a wide range of samples using minimal materials, enabling fundamental characterization. Combined with structural insights, these data help explain and even predict the properties of many substances. For chemical professionals, accurate elemental composition is vital for assessing purity.

We determine C, H, and N, and can identify or quantitatively analyze almost every other element in the periodic table using X-ray fluorescence spectroscopy and inductively coupled plasma optical emission spectrometry, with the option of electrothermal vaporization. F content is measured with an ion-selective electrode. Titration methods are available for determining S, P, Cl, Br, and I.

To characterize and explore the dynamics of molecular structures, we employ a range of molecular spectroscopy techniques. These include infrared spectroscopy (combined with gas chromatography) and Raman microscopy, allowing us to analyze many different types of materials. Chiral samples are characterized using chiroptical spectroscopy – including electronic circular dichroism (ECD), vibrational circular dichroism (VCD), and Raman optical activity (ROA) – as well as optical rotation.

Thermal transitions are assessed using differential scanning calorimetry. We also perform solubility screening, precise weighing of small samples, and water content analysis in organic solvents.

Kretschmer, J.; Chiaffarelli, R.; Vuozzo, M. *et al.* A Macrocyclic Hybrid PET/MRI Probe for Quantitative Perfusion Imaging *In Vivo*. *Angew. Chem., Int. Ed.* **2024**, *63*, e202409520.

Dostálková, A.; Křížová, I.; Junková, P. *et al.* Unveiling the DHX15–G-Patch Interplay in Retroviral RNA Packaging. *Proc. Natl. Acad. Sci. U.S.A.* **2024**, *121* (40), e2407990121.

Keywords: elemental analysis, chiroptical spectroscopy, ECD, VCD, ROA

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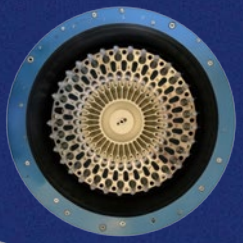
Development Center

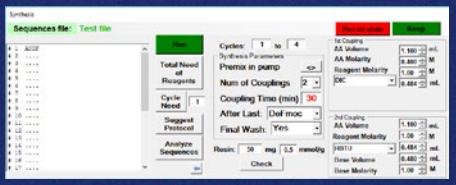
Examples

Tantalum is a metal known for its exceptional resistance to corrosion and excellent performance in high-radiation environments such as inside cyclotrons or nuclear reactors. However, besides these advantageous properties, tantalum is difficult to machine. Our team has, nevertheless, successfully designed and manufactured a custom tantalum reactor tailored for use in the KATRIN project, which focuses on detecting neutrinos. (J. Ráliš, D. Vénos)

NANOFUSION mRNA nanoparticle generator
The generator can work in high-throughput mode with standard well dishes. (K. Šašková, P. Cígler, F. Sedlák)



TRITON peptide synthesizer
This peptide synthesizer uses the centrifugal principle because of the high yield and purity of each step of the synthesis. It can run up to 32 syntheses in parallel. (M. Lebl)



The Development Center supports scientific research at IOCB by designing and producing specialized laboratory instruments, particularly those that are not commercially available. Our mission is to deliver custom technical solutions tailored to the needs of advanced research.

Our core activities include maintaining and repairing instruments, fabricating novel laboratory equipment and, most importantly, developing unique scientific devices in close collaboration with researchers. These services range from initial design through mechanical or electronic engineering to software integration and final manufacturing.

Equipped with modern technologies such as computer numerical control (CNC) machining, laser cutting, 3D printing, and manual glassblowing, our center provides comprehensive in-house production capabilities for rapid prototyping and precise fabrication of complex components.

Serving both IOCB researchers and external clients, the Development Center handles up to 1,000 services requests each year. Its combination of creativity, technical expertise, and scientific collaboration makes it a vital part of the institute's innovation infrastructure.

Keywords: development, laboratory instrumentation, service

IOCB Most Significant Publications 2023

The most significant publications in the CHEM, BIO, and PHYS clusters are selected annually from more than 250 publications by an external international panel of reviewers, the International Advisory Board, and the IOCB Director.

The awarded publications are listed within their clusters alphabetically by title:

CHEM cluster

Civiš, S.; Lamanec, M.; Špirko, V.; Kubišta, J.; Špeťko, M.; Hobza, P. Hydrogen Bonding with Hydridic Hydrogen—Experimental Low-Temperature IR and Computational Study: Is a Revised Definition of Hydrogen Bonding Appropriate? *J. Am. Chem. Soc.* **2023**, *145* (15), 8550–8559.

Schmid, R.; Heuckeroth, S.; Korf, A.; Smirnov, A.; Myers, O.; Dyrlund, T. S.; Bushuiev, R.; Murray, K. J.; Hoffmann, N.; Lu, M.; Sarvepalli, A.; Zhang, Z.; Fleischauer, M.; Dührkop, K.; Wesner, M.; Hoogstra, S. J.; Rudt, E.; Mokshyna, O.; Brungs, C.; Ponomarov, K.; Mutabdžija, L.; Damiani, T.; Pudney, C. J.; Earll, M.; Helmer, P. O.; Fallon, T. R.; Schulze, T.; Rivas-Ubach, A.; Bilbao, A.; Richter, H.; Pluskal, T. Integrative Analysis of Multimodal Mass Spectrometry Data in MZmine 3. *Nat. Biotechnol.* **2023**, *41* (4), 447–449.

Socha, O.; Osifová, Z.; Dračínský, M. NMR-Challenge.com: An Interactive Website with Exercises in Solving Structures from NMR Spectra. *J. Chem. Educ.* **2023**, *100* (2), 962–968.

Magnera, T. F.; Dron, P. I.; Bozzone, J. P.; Jovanovic, M.; Rončević, I.; Tortorici, E.; Bu, W.; Miller, E. M.; Rogers, C. T.; Michl, J. Porphene and Porphite as Porphyrin Analogs of Graphene and Graphite. *Nat. Commun.* **2023**, *14* (1), 6308.

Šlachtová, V.; Bellová, S.; La-Venia, A.; Galeta, J.; Dračínský, M.; Chalupský, K.; Dvořáková, A.; Mertlíková-Kaiserová, H.; Rukovanský, P.; Dzijak, R.; Vrábel, M. Triazinium Ligation: Bioorthogonal Reaction of N1-Alkyl-1,2,4-Triazinium Salts. *Angew. Chem., Int. Ed.* **2023**, *62* (36), e202306828.

BIO cluster

Šilhán, J.; Klíma, M.; Otava, T.; Škvára, P.; Chalupská, D.; Chalupský, K.; Kozic, J.; Nencka, R.; Bouřa, E. Discovery and Structural Characterization of Monkeypox Virus Methyltransferase VP39 Inhibitors Reveal Similarities to SARS-CoV-2 nsp14 Methyltransferase. *Nat. Commun.* **2023**, *14* (1), 2259.

Ticháček, O.; Mistrík, P.; Jungwirth, P. From the Outer Ear to the Nerve: A Complete Computer Model of the Peripheral Auditory System. *Hear. Res.* **2023**, *440*, 108900.

Koutná, E.; Lux, V.; Kouba, T.; Škerlová, J.; Nováček, J.; Srb, P.; Hexnerová, R.; Šváchová, H.; Kukačka, Z.; Novák, P.; Fábry, M.; Poepsel, S.; Veverka, V. Multivalency of Nucleosome Recognition by LEDGF. *Nucleic Acids Res.* **2023**, *51* (18), 10011–10025.

Kuba, M.; Khoroshyy, P.; Lepšík, M.; Kužmová, E.; Kodr, D.; Kraus, T.; Hocek, M. Real-Time Imaging of Nascent DNA in Live Cells by Monitoring the Fluorescence Lifetime of DNA-Incorporated Thiazole Orange-Modified Nucleotides. *Angew. Chem., Int. Ed.* **2023**, *62* (38), e202307548.

PHYS cluster

Yang, Q.; Bloino, J.; Šestáková, H.; Šebestík, J.; Kessler, J.; Hudecová, J.; Kapitán, J.; Bouř, P. Combination of Resonance and Non-Resonance Chiral Raman Scattering in a Cobalt(III) Complex. *Angew. Chem., Int. Ed.* **2023**, *62* (45), e202312521.

Tempra, C.; Cruces Chamorro, V.; Jungwirth, P. Effects of Water Deuteration on Thermodynamic and Structural Properties of Proteins and Biomembranes. *J. Phys. Chem. B* **2023**, *127* (5), 1138–1143.

Dunlop, D.; Ludvíková, L.; Banerjee, A.; Ottosson, H.; Slanina, T. Excited-State (Anti)Aromaticity Explains Why Azulene Disobeys Kasha's Rule. *J. Am. Chem. Soc.* **2023**, *145* (39), 21569–21575.

IOCB Most Significant Publications 2024

CHEM cluster

Baris, N.; Dračínský, M.; Tarábek, J.; Filgas, J.; Slavíček, P.; Ludvíková, L.; Boháčová, S.; Slanina, T.; Klepetářová, B.; Beier, P. Photocatalytic Generation of Trifluoromethyl Nitrene for Alkene Aziridination. *Angew. Chem., Int. Ed.* **2024**, *63* (2), e202315162.

Brunderová, M.; Havlíček, V.; Matyašovský, J.; Pohl, R.; Poštová Slavětínská, L.; Krömer, M.; Hocek, M. Expedient Production of Site-Specifically Nucleobase-Labelled or Hypermodified RNA with Engineered Thermophilic DNA Polymerases. *Nat. Commun.* **2024**, *15*, 3054.

Kretschmer, J.; Chiaffarelli, R.; Vuozzo, M.; Cotton, J.; Blahut, J.; Páliš, J.; Dračínský, M.; Matějková, S.; Seeling, U.; Schmid, A. M.; Martins, A. F.; Polášek, M. A Macrocyclic Hybrid PET/MRI Probe for Quantitative Perfusion Imaging *In Vivo*. *Angew. Chem., Int. Ed.* **2024**, *63* (48), e202409520.

Director's Award

Heuckeroth, S.; Damiani, T.; Smirnov, A.; Mokshyna, O.; Brungs, C.; Korf, A.; Smith, J. D.; Stincone, P.; Dreolin, N.; Nothias, L.; Hyötyläinen, T.; Orešič, M.; Karst, U.; Dorrestein, P.; Petras, D.; Du, X.; van der Hooft, J.; Schmid, R.; Pluskal, T. Reproducible Mass Spectrometry Data Processing and Compound Annotation in MZmine 3. *Nat. Protoc.* **2024**, *19*, 2597–2641.

BIO cluster

Bulvas, O.; Knejzlík, Z.; Sýs, J.; Filimoněnko, A.; Čížková, M.; Clarová, K.; Rejman, D.; Kouba, T.; Pichová, I. Deciphering the Allosteric Regulation of Mycobacterial Inosine-5′-Monophosphate Dehydrogenase. *Nat. Commun.* **2024**, *15*, 6673.

Hadzima, M.; Faucher, F.; Blažková, K.; Yim, J.; Guerra, M.; Chen, S.; Woods, E.; Park, K.; Šácha, P.; Šubr, V.; Kostka, L.; Etrych, T.; Majer, P.; Konvalinka, J.; Bogyo, M. Polymer-Tethered Quenched Fluorescent Probes for Enhanced Imaging of Tumor-Associated Proteases. *ACS Sens.* **2024**, *9*, 3720–3729.

Potužník, J. F.; Nešuta, O.; Škríba, A.; Voleníková, B.; Mititelu, M. B.; Mancini, F.; Serianni, V.; Fernandez, H.; Spustová, K.; Trylčová, J.; Vopálenský, P.; Cahová, H. Diadenosine Tetraphosphate (Ap_4A) Serves as a 5′ RNA Cap in Mammalian Cells. *Angew. Chem., Int. Ed.* **2024**, *63* (6), e202314951.

Šoltysová, M.; Škerlová, J.; Pachl, P.; Škubník, K.; Fábry, M.; Sieglová, I.; Farolfi, M.; Grishkovskaya, I.; Babiak, M.; Nováček, J.; Krásný, L.; Řezáčová, P. Structural Characterization of Two Prototypical Repressors of SorC Family Reveals Tetrameric Assemblies on DNA and Mechanism of Function. *Nucleic Acids Res.* **2024**, *52* (12), 7305–7320.

PHYS cluster

Pecina, A.; Fanfrlík, J.; Lepšík, M.; Řezáč, J. SQM2.20: Semiempirical Quantum-Mechanical Scoring Function Yields DFT-Quality Protein–Ligand Binding Affinity Predictions in Minutes. *Nat. Commun.* **2024**, *15*, 1127.

Manna, D.; Lo, R.; Vacek, J.; Miriyala, V. M.; Bouř, P.; Wu, T.; Osifová, Z.; Nachtigallová, D.; Dračínský, M.; Hobza, P. The Stability of Hydrogen-Bonded Ion-Pair Complex Unexpectedly Increases with Increasing Solvent Polarity. *Angew. Chem., Int. Ed.* **2024**, *63* (20), e202403218.

Nemirovich, T.; Young, B.; Březina, K.; Mason, P. E.; Seidel, R.; Stemer, D.; Winter, B.; Jungwirth, P.; Bradforth, S.; Schewe, H. C. Stability and Reactivity of Aromatic Radical Anions in Solution with Relevance to Birch Reduction. *J. Am. Chem. Soc.* **2024**, *146* (12), 8043–8057.

Leadership

Institute Director

Prof. Jan Konvalinka, PhD (since 2022)

Vice-Directors

Vice-Director for Research
Assoc. Prof. Pavlína Maloy Řezáčová, PhD

Vice-Director for International
Zdeněk Hostomský, PhD

Vice-Director for Strategy and Translational Research
Jiří Polman, PhD

Vice-Director for Economics
Jiří Cairola, MSc

IOCB Board

The IOCB Board, together with the Director, decides on essential scientific and organizational matters of the institute.

Chairman
Prof. Pavel Jungwirth, PhD, DSc.

Vice-Chairman
Prof. Michal Hocek, PhD, DSc.

Internal members
Assoc. Prof. Martin Dračínský, PhD
Pavel Majer, PhD
Assoc. Prof. Pavlína Maloy Řezáčová, PhD
Kvido Stříšovský, PhD

External members
Prof. Radek Cibulka, PhD (UCT Prague)
Prof. Jan Černý, PhD (Charles University, Prague)
Prof. Petr Slavíček, PhD (UCT Prague)

Secretary
Prof. Irena Valterová, PhD

Supervisory Board

The main task of the Supervisory Board is to monitor financial and legal matters concerning the institute's administration.

Chairman
Martin Bilej, PhD, DSc. (Academy Council of the CAS, Institute of Microbiology of the CAS)

Vice-Chairman
Zlatko Janeba, PhD (IOCB Prague)

Members
Prof. Libor Grubhoffer, PhD (Biology Centre of the CAS)
Mgr. Matěj Kliman
Jiří Krechl, PhD (CzechInvest)
Prof. Josef Lazar, PhD (Institute of Scientific Instruments of the CAS)
JUDr. Michal Strouhal (Sedláček, Vaca & spol., Law Office)

International Advisory Board

The main task of the International Advisory Board is to evaluate the research groups at IOCB, provide constructive feedback, and suggest future goals and strategies.

Chairman
Prof. Burkhard König, PhD (University of Regensburg, Germany)

Members
Prof. Karl-Heinz Altmann, PhD (ETH Zürich, Switzerland)
Prof. Wilhelm Boland, PhD (MPI for Chemical Ecology, Jena, Germany)
Prof. M. G. Finn (Georgia Institute of Technology, USA)
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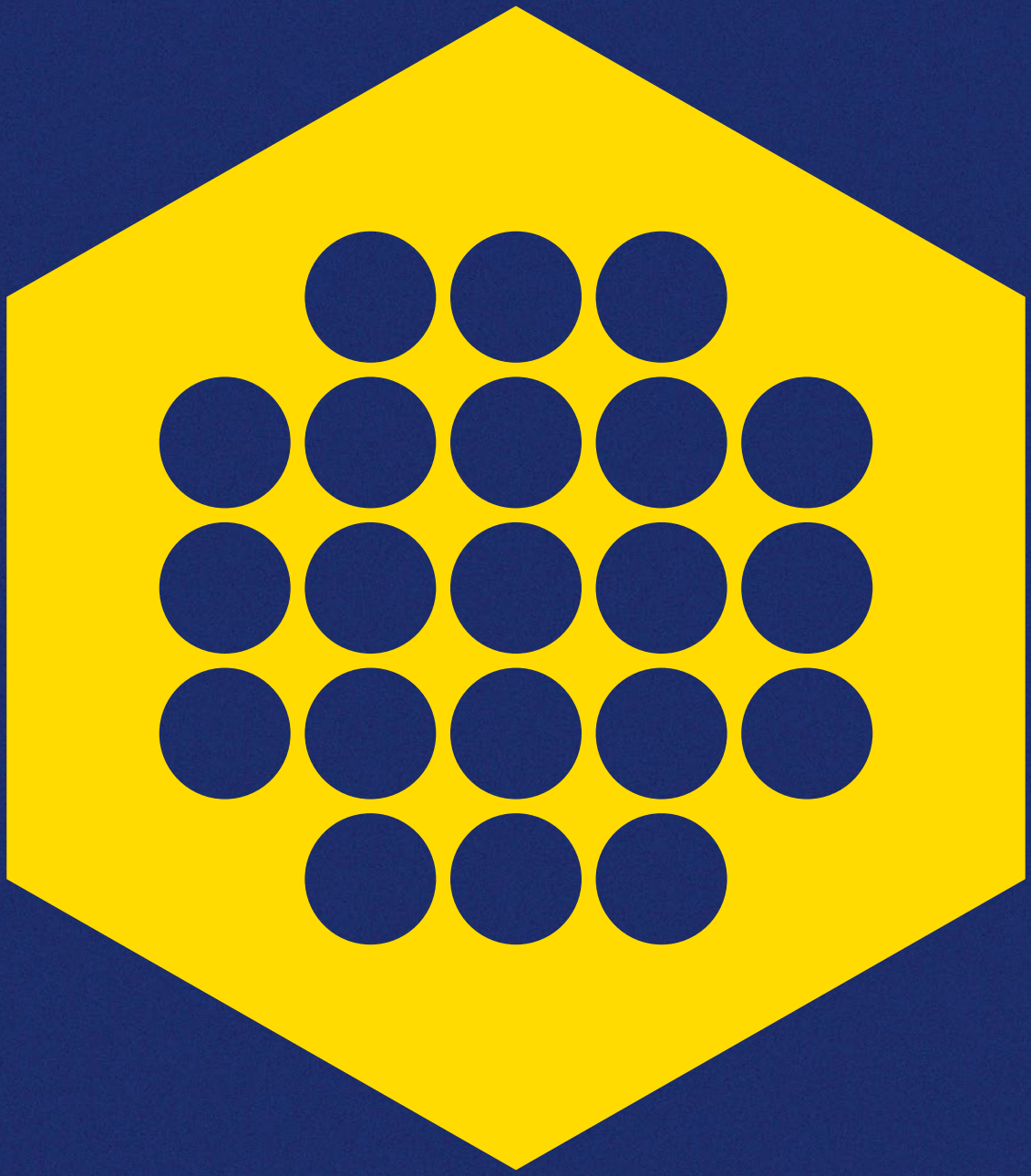

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