CEITEC

# PHD RETREAT 2022

## Book of Abstracts

19.– 20.9. 2022

University centre Telč

# Book of Abstracts

## CEITEC PhD Retreat

19. - 20.9.2022

University Centre in Telč, Czech Republic

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Lenka Dostálová
Jorge Navarro
Kateřina Linhartová
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# Content

# Welcome Address

**Dear attendees!**

After two years of not meeting in person, we are pleased to welcome you to the **sixth edition of the CEITEC PhD Retreat**, a conference organized by PhD students of the Central European Institute of Technology -CEITEC- for fellow PhD students. Since its first edition in 2015, the CEITEC PhD Retreat brings together students and young researchers from different scientific fields and gives them a chance to present and discuss their research, get mutually inspired, and make new contacts in a friendly and motivating environment.

In this edition, you can look forward to six invited lectures given by established CEITEC researchers and forty student contributions in the form of talks and posters, divided into the areas of **life sciences, physics, chemistry, and materials sciences**.

We hope that you find the event an inspiring and useful opportunity to present your work, enrich your knowledge, meet new colleagues and friends, and possibly, make new collaborations useful for your research.

Finally, we would like to thank you for making the CEITEC PhD Retreat possible.

**Your organizing committee,**
Bilal Bawab
Lenka Dostálová
Jana Juráková
Adriana Ladungová
Kateřina Linhartová
Jorge Navarro
Katarina Novčić
Ketty Sinigaglia

# Funding and sponsors

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We are **grateful** to our sponsors who kindly supported this event.

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# About the organizers, the CEITEC Student Committee

The CEITEC Student Committee is a group of PhD students belonging to the six CEITEC research institutes. It was established to improve interdisciplinary cooperation, advance doctoral education and scientific advancements, and nourish academic harmony.

The Committee objectives include:

- Acting as a cooperation between the students and the CEITEC management.
- Student support and orientation.
- Organizing social events (retreats, hiking trips, science mixers, …) to build cohesiveness within CEITEC.
- CEITEC social networking and outreach activities in coordination with the CEITEC PR team.
- Coordinating scientific workshops and training to prepare graduate students for their future careers in collaboration with the CEITEC administration.

**Are you interested in joining us? Write us an email at ceitecstudentcommittee@gmail.com, we look forward to hearing from you**!

# Programme

| MONDAY 19.9. | |
|---|---|
| **9:30** | *Registration* |
| **10:30** | Welcome address |
| **10:45** | **ERIC GLOWACKI: Advances in neural interface technology – minimalistic recording and stimulation** |
| **11:35** | **Katarína Rovenská**: Introducing tunability into structural color filters using vanadium dioxide |
| **11:50** | **Ondřej Wojewoda**: Dielectric nanoparticle enhanced Brillouin light scattering spectroscopy of spin waves |
| **12:05** | **Xia Peng**: Shape-controlled self-assembly of light-powered microrobots into ordered microchains for cells transport and water remediation |
| **12:20** | **Cagatay M. Oral**: Enzyme-immobilized microrobots for degradation of organic contaminants |
| **12:40** | *Lunch Break* |
| **14:00** | **GABRIEL DEMO: Translation machinery captured in motion** |
| **14:50** | **Sponsor talk - MERCK**: Greener solutions for the first green generation |
| **15:00** | **Věra Doseděllová**: Analysis of bile acids in saliva for non-invasive diagnosis of Barrett's esophagus |
| **15:15** | **Kamila Říhová**: Efficacy of combined therapy of disulfiram and 5-fluorouracil in organotypic cultures |
| **15:30** | **Kaushik Baishya**: Investigation of $TiO_2$ nanotubes intercations with cells by Bio-AFM |
| **15:45** | *Coffee Break* |
| **16:20** | **JIŘÍ SEDMÍK: Cerebral organoids in disease modeling** |
| **17:10** | **Ankit Yadav**: Inelastic deformation of nanocrystalline free standing films |
| **17:25** | **Aparna Vasudevan Kandathil**: 2D material based field effect transistor for sensing application |
| **17:40** | **Jan Dubský**: Development of a 500 MHz DNP-NMR system |
| **18:00** | Poster Session |

## TUESDAY 20.9.

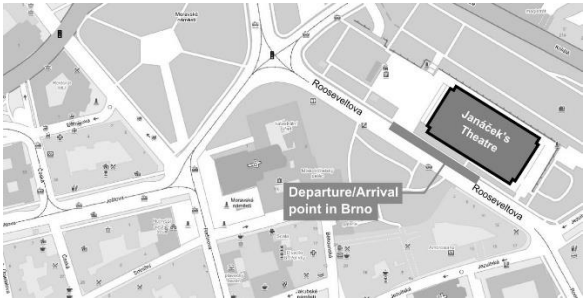
| | |
|---|---|
| **9:00** | Second day address |
| **9:05** | **ANDREW MILLER: Progress in aligning nanomaterials with precision therapeutic approaches for the treatment of chronic diseases** |
| **9:50** | **Sanam Garehbaghi**: Electrochemical detection of miRNA-21 using integrated $MnFe_2O_4$ nanozyme-aptamer |
| **10:05** | **Polina Shpet**: In vitro assessment of the effects of secondary plant metabolites on intercellular communication |
| **10:20** | **Lenka Dostálová**: CRISPR/Cas9 knockout screening revealed genes involved in CD20 regulation |
| **10:35** | *Coffee Break* |
| **11:05** | **JAN MACÁK: Anodic $TiO_2$ Nanotube Layers: synthesis, properties and applications** |
| **11:55** | **Bilal Bawab**: $Cu_2O$: a photoanodic functional material and its stabilization against oxidation |
| **12:10** | **Mahnaz Alijani**: $TiO_2$ nanotube Integrated microwave resonator UV sensor |
| **12:25** | **Michela Sanna**: Fluorinated MAX phases for photoelectrochemical hydrogen evolution |
| **12:40** | *Lunch Break* |
| **14:00** | **LENKA ZAJÍČKOVÁ: Nanoengineered carbon-based materials for biomedical applications** |
| **14:50** | **Radhika Nittoor Veedu**: Polydopamine-derived iron-doped hollow carbon nanorods as an efficient bifunctional electrocatalyst for simultaneous generation of hydrogen and electricity |
| **15:05** | **Shaista Nouseen**: 2D-material integrated filament for 3D printing for energy conversion and storage application |
| **15:20** | **Shidhin Mappoli**: MXene-based 3D printed electrodes for flexible asymmetric supercapacitor |
| **15:40** | *Coffee Break* |
| **16:15** | Closing address and prizes |

# Practical information

**Transportation**

The conference organizers provide a possibility to choose the transportation from Brno to Telč (and from Telč to Brno) by bus. The schedule of the transportation is as follows:

| | Brno → Telč<br>19th September | Telč→ Brno<br>20th September |
|---|---|---|
| Departure point | Roosveltova street, Brno<br>(next to Janáček's Theatre) | parking lot Na Sádkách |
| Departure time: | 7:30<br>(arrive 10 min in advance) | 18:00 |
| Arrival point: | parking lot Na Sádkách | Roosveltova street, Brno |




**Venue**

The University Centre Telč (UCT) (www.uct.muni.cz), owned and run by Masaryk University Brno, is a modern venue for education purposes such as seminars, conferences, summer courses, teambuilding etc. It is located in the historical heart of Telč, which is famous for its unique renaissance and baroque architecture. Since 1992, Telč has been a part of UNESCO World Heritage.

**Accommodation and meals**

Accommodation for the participants will be provided on the upper floors of the UCT, which is also the conference venue (room options: 2 beds, 3 beds, 4 beds). The invited speakers will be accommodated in the hotel U Hraběnky (www.hotel-uhrabenky.cz). The hotel is just a five-minute walk from the

conference venue. The student participants are kindly requested to check in at the reception desk of UCT during the registration after their arrival. For the invited speakers, check-in in the hotel U Hraběnky starts at 14:00. (check-in is possible during the whole afternoon/evening. Reception is working 24/7).The latest checkout time from the UCT is 9:00 on the 20th September. A storage room for luggage will be provided.

Breakfast, lunch, and dinner will be served in the dining room of UC Telč. Coffee breaks will be served in front of P1 conference room. Dinner will be served in a form of banquet during the poster session. Invited speakers staying in the hotel U Hraběnky will have breakfast at the hotel, and the rest of the meals in the UC Telč.

**Invited and student presentations**

The main program will start at 10:30 in the P1 conference room. The allocated time for a student talk is 10 minutes. The talks from the invited speakers are 40-45 minutes long with a space for discussion. The equipment for the presentation (a PC, microphones and a laser pointer) will be provided. All speakers will be asked to send us their presentations in a pdf format prior to the start of the conference. The authors of the best student talk and poster will be awarded a valuable prize.

**Poster session**

The student poster session will take place on Monday evening in the corridor next to the dining room, social evening will continue after. The participants are encouraged to place their posters during a lunch break or one of the coffee breaks. The latest before 18:00. Participants with odd numbers should be present next to their poster in the first half of the poster session, and participants with even numbers in the second half of the poster session.

**Contact information**

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**Emergency phone number: 112**

# Invited Speakers

## Eric Daniel Glowacki

Research group leader | Bioelectronics Materials and Devices |CEITEC BUT

### Biography

Eric Glowacki completed his PhD in chemistry in 2013 at the Johannes Kepler University in Linz, Austria, specializing in bioelectronic and flexible electronic devices. He continued as a postdoc in Linz (2013-2016), with research interest moving into the field of electrophysiology and especially optoelectronic stimulation of excitable cells. In 2016, he was awarded a Wallenberg Molecular Medicine Fellowship, which allowed him to start an independent research group at Linköping University in Sweden. His group has worked on *devices for stimulation of the nervous system, as well as reactive oxygen species generation*.

# Advances in neural interface technology – minimalistic recording and stimulation

Eric Daniel Głowacki

Bioelectronics Materials and Devices Lab, CEITEC Central European Institute of Technology, Brno University of Technology, Brno, Czech Republic
glowacki@vutbr.cz

A great demand exists for minimally-invasive neuromodulation technologies to enable next-generation bioelectronic medicine. This field involves using artificial electrical impulses to achieve a therapeutic outcome, and is successfully deployed in a growing range of clinical applications. Examples include Parkinson's disease, where implanted deep brain stimulators can essentially eliminate symptoms of this condition; epilepsy, where closed-loop stimulators record pathological activity and deliver therapeutic impulses; and various spinal cord and peripheral nerve conditions. The list of applications expands constantly, as patient outcomes often are superior to what can be achieved with pharmaceutical interventions. In this presentation, I will introduce examples of bioelectronic medicine and the newest technologies that are pushing the current limits. A major focus will be minimalistic neural interface technology for selective stimulation of the nervous system. Creating minimally-invasive neuromodulation implants relies on solving advanced materials science and engineering problems. Wireless power delivery will be discussed as one of the major technical challenges in such implanted devices. I will summarize our research team's efforts in using wireless optoelectronic technology for small and conformable nerve and brain stimulation, as well as recent advances in noninvasive stimulation using high-frequency interfering electrical fields.

# Gabriel Demo

Junior research group leader | Structural Biology of Coupled Transcription-Translation | CEITEC MU

## Biography

Gabriel Demo currently established his research group at the Central European Institute of Technology (CEITEC), Masaryk University, in Brno. In 2014 he obtained his PhD in biomolecular chemistry at National Centre of Biomolecular Research (NCBR), Faculty of Science, Masaryk University. As a post-doctoral associate he joined Dr. Andrei Korostelev at the University of Massachusetts Medical School, RNA Therapeutics Institute, Worcester, MA, USA. His main research interest lies in transcription-translation coupling. He applies the state-of-the-art time-resolved cryo-EM to reveal the fundamental mechanisms and capture transient structural intermediates of the transcription and translation in bacteria.

# Translation machinery captured in motion

Gabriel Demo

Central European Institute of Technology, Masaryk University, Czech Republic

During protein synthesis, transfer RNAs (tRNAs) and messenger RNA (mRNA) codons are delivered and translocated within the ribosome from the A to P to E sites, respectively. The tRNA delivery, tRNA proof-reading and translocation of the tRNA anticodons and mRNA are catalyzed by conserved GTPases, elongation factor Tu and G (EF-Tu, EF-G) in bacteria. The structural mechanisms how the ribosome and elongation factors maintain the open reading frame has not been visualized because the rapid GTP hydrolysis step has prevented the capture of authentic EF-G-bound structural intermediates.

The lecture will be aimed on the usage of time-resolved cryo-EM to characterize tRNA delivery/proof-reading and translocation in time dependent manner. We will report newly described intermediate structural states, which visualized the delivery and transition of the tRNAs from the A and P to P and E sites during GTP hydrolysis on EF-Tu and EF-G.

## Jiří Sedmík

Research Specialist | Department of Histology and Embryology | Masaryk University

### Biography

Jiri Sedmik completed his doctoral studies in the Irish scientist Mary O'Connell research group at CEITEC Masaryk University, where he investigated the role of RNA modification/editing in the brain and studied mutations in a specific gene called ADAR2 that cause epilepsy, mental retardation, and microcephaly. Currently, he is a postdoctoral scientist in the group of Dáša Bohačiaková from the Department of Histology and Embryology at the Medical Faculty of Masaryk University. His main research focuses on neuronal cells and cerebral organoids - a new and very promising research model for the study of Alzheimer's disease.

# Cerebral organoids in disease modeling

Jiri Sedmik[1]*, Tereza Vanova[1,2], Jan Raska[1], Katerina Amruz Cerna[1], Veronika Pospisilova[1], Veronika Fedorova[1], Petr Fojtik[1], Simona Vochyanova[1], Hana Klimova[1], Klara Plesingrova[1], Petr Taus[3], Karla Plevova[3,4], Marketa Nezvedova[5], Zdenek Spacil[5], Michaela Capandova[1], Petra Orviska[1], Zuzana Benesova[6], Pavel Abafy[6], Lukas Valihrach[6], Jana Houserova[7], Zdenek Hodny[7], Hana Hribkova[1], Dasa Bohaciakova[1,2]#

[1] Department of Histology and Embryology, Faculty of Medicine, Masaryk University, Brno, Czech Republic.
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[6] Laboratory of Gene Expression, Institute of Biotechnology CAS, BIOCEV, Vestec, Czech Republic.
[7] Department of Genome Integrity, Institute of Molecular Genetics of the Czech Academy of Sciences, Prague, Czech Republic.
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Significant advances in human brain physiology and pathophysiology research have been hindered by the relative lack of adequate study models. For example, the conventional 2D neuronal cell cultures do not reflect the complexity and cellular heterogeneity of the brain tissue, while mouse models lack the primate-specific features of brain development and gene expression. Recently developed protocols for the production of so-called cerebral organoids (COs) have brought new opportunities for human brain study.

COs are self-organized 3D cellular structures that recapitulate brain tissue architecture and function in vitro. They are derived from induced pluripotent stem cells, which can be produced from cells easily obtained directly from patients and healthy controls. Thus, COs allow us to perform studies on relevant cell types that precisely match the patient's genotype while omitting the problems with the inaccessibility of the brain tissue for studies.

The laboratory of Dáša Bohačiaková has been using COs to study various aspects of human brain physiology and disease development. We have successfully employed this 3D cellular model to uncover new insight into molecular mechanisms behind Alzheimer's disease. We also used them to investigate the hypothesis that infectious agents might be the initial triggers for Alzheimer's disease development. Finally, we managed to set up a co-culture model to study glioblastoma cell migration in COs. Glioblastoma is an aggressive type of brain tumor that is otherwise difficult to maintain in cell culture without losing the features of the original tumor tissue. Collectively, the results from our laboratory demonstrate the utility of this complex cell culture model.

# Jan Macák

Group Leader | Advanced Low-Dimensional Nanomaterials | Advanced Materials Research Area Coordinator | CEITEC BUT

## Biography

Jan Macák, an ERC starting grant awardee (2015), built his career as a material scientist exploring the methods of material preparation using electrochemistry with a particular interest in low-dimensional nanomaterials (nanotubes, nanofibers, nanowires and nanoparticles) and their application in biology, power engineering and catalysis. The main objectives of his research rely on the synthesis of new low-dimensional structures by various means and the necessary investigation of the structure-property relationship of these materials.

# Anodic $TiO_2$ Nanotube Layers: synthesis, properties and applications

Jan M. Macak

Brno University of Technology, Czech Republic
University of Pardubice, Czech Republic

Over the past 15 years, self-organized $TiO_2$ nanotube layers have attracted considerable scientific and technological interest due to their wide possible range of applications including (photo-) catalysis, hydrogen generation and biomedical uses [1,2]. The synthesis of the 1D $TiO_2$ nanotube layers is usually carried out by electrochemical anodization of valve Ti metal sheets in various electrolytes. The advantage of anodic $TiO_2$ nanotube layers compared to $TiO_2$ nanotubes prepared by other methods (e.g. hydrothermal) are the tunability of dimensions, their directionality, ability to absorb significant amount of incident light and the possibility to utilize nanotube interiors and exteriors for decoration-coating of secondary materials [2].

The presentation will focus on the recent progress in the TiO2 nanotube layer synthesis. We will discuss an upscaling of the nanotube layers towards areas of dozens of cm2 [3, 4] and the preparation of high aspect ratio layers in a short time [5], considering the control of the anodization parameters. The selective etching of anodic $TiO_2$ nanotube layers towards single-wall nanotube layers [6] and single nanotubes [7], where nanotubes are separated from one another into tube powders will be also discussed. Examples of magnetically guidable nanotube photocatalysts will be demonstrated [7].

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# Lenka Zajíčková

Research group leader | Plasma Technologies for Materials | CEITEC BUT

## Biography

Lenka Zajickova has received a PhDin plasma physics from Masaryk University in Brno (Czechia). Her current research activities broadened to all dry thin-film depositions (chemical or physical vapor deposition, atomic layer deposition), synthesis of carbon nanomaterials, and modification of polymer nanofibers. She develops the deposition and synthesis protocol for mainly biomedical applications (tissue engineering, drug delivery, wound dressing) and investigates the processes to understand them better. She is Assoc. Prof. at the Faculty of Science, Masaryk University, and leads the research group at CEITEC. Before, she gained research experience at Ruhr University Bochum (Germany), Comenius University in Bratislava (Slovakia), and the University of Minnesota (Minneapolis, USA). She is a specially appointed professor at Osaka University (Japan). She chairs the Technology Advisory Committees (TAC) for Atomic Layer Processing and co-chairs Plasma Processing TAC at the Society of Vacuum Coaters. She is a Czech representative at the Int. Union of Pure and Applied Physics (IUPAP) Commission for Plasma Physics.

# Nanoengineered carbon-based materials for biomedical applications

Lenka Zajíčková

Department of Condensed Matter Physics, Faculty of Science, Masaryk University, Brno, Czech Republic
Central European Institute of Technology - CEITEC, Brno University of Technology, Brno, Czech Republic
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Surface reactivity and free energy play an essential role in the interactions of molecules and cells with the surfaces, especially if we think about nanomaterials that typically have huge surface area compared to their volume. In this talk, I want to discuss two types of nanomaterials that surface we tuned towards biomedical applications. The first one is a mat made of polymer nanofibers. It has tremendous application potential for constructing artificial tissues or wound dressings, among others. However, these applications require a surface modification of nanofibers, preferentially with biocompatible and bioactive coating. It was accomplished using plasma enhanced chemical vapor deposition of layers containing amine or carboxyl groups. The second example of nanoengineered materials is the microwave-assisted hydrothermal synthesis of carbon nanoparticles (carbon dots) doped with nitrogen. We established a fast one-step synthesis from glucose and ethylenediamine. The as-prepared nanoparticles exhibit multicolor excitation-dependent fluorescence in a broad spectral range from near UV to near-infrared. Cell viability assays proved their high biocompatibility. The functional groups at the nanoparticle surface enable their coupling with drugs, photosensitizers, or other nanoparticles that are not water-soluble, making them excellent carriers besides being in vitro bioimaging agents.

# Andrew David Miller

Professor of Organic Chemistry and Chemical Biology | Mendel University

## Biography

Prof Miller is Professor of Organic Chemistry & Chemical Biology and is well known as a leading chemist expert in the understanding and exploitation of molecular mechanisms in biology. The overall aim of his academic research work has been and continues to be the design and creation of advanced therapeutics and diagnostics that address unmet medical need in the treatment of chronic diseases (such as cancer, diabetes, pain and some infectious diseases), through the application of chemistry and chemical biology approaches to the fields of nanomedicine and gene therapy. From 1990-2010, Prof Miller was a member of academic staff in the Chemistry Department of Imperial College London (UK) where he founded the Imperial College Genetic Therapies Centre (GTC) in 1998, and became full Professor in 2002. From 2010-2017, Prof Miller was a Professor (visiting) at King's College London (UK) from where he developed his career as an academic entrepreneur. In addition, he held a number of other professorial positions in leading universities around the World including Shanghai Jiaotong University (SJTU) (Shanghai, China), and Nagoya University (MeiDai) (Nagoya, Japan).

Since the beginning of 2017, he joined part-time the Veterinary Research Institute in Brno (Czech Republic), where he has been Director and Key Foreign Scientist (KFS) for OPVVV Project FIT. Nowadays, Prof Miller is focused on his latest position as Professor in the Department of Chemistry and Biochemistry at Mendel University in Brno (Czech Republic). Accordingly, he currently divides his time between working in the Czech Republic and working in the UK, or elsewhere in the world, depending upon the varying demands of his research, teaching and/or commercialization activities.

Prof Miller has so far published well over 250 papers, book chapters and alike, including at least 28 patents and patent applications. He is also principal writer of the first textbook of chemical biology ("Essentials of Chemical Biology") published in August 2008 by John Wiley & Sons. The second edition of this textbook is expected to be published during 2023. In 2020, Prof Miller cofounded KP Therapeutics (Europe) s.r.o. with a pipeline of Precision Therapeutic Approaches (PTAs) in discovery & development for the diagnosis and treatment of chronic diseases. These PTAs all derive from the best of Prof Miller's personal and collaborative academic research work over the past two decades, involving a research spend of at least £30 million.The overall aim of Andrew D Miller's academic research work has been and continues to be the design and creation of advanced

therapeutics and diagnostics in the treatment of chronic diseases (such as cancer, diabetes, pain and some infectious diseases), through the application of chemistry and chemical biology approaches to the fields of nanomedicine and gene therapy. He founded the Imperial College Genetic Therapies Centre (GTC) in 1998, developed his career as an academic entrepreneur at King's College London (UK), and held a number of other professorial positions in leading universities around the World including Shanghai Jiaotong University (SJTU) (Shanghai, China), and Nagoya University (MeiDai) (Nagoya, Japan). Since the beginning of 2017, he joined part-time the Veterinary Research Institute in Brno (Czech Republic), where he has been Director and Key Foreign Scientist (KFS) for OPVVV Project FIT. Nowadays, Prof Miller is focused on his latest position as a Professor in the Department of Chemistry and Biochemistry at Mendel University in Brno.

# Progress in Aligning Nanomaterials with Precision Therapeutic Approaches for the Treatment of Chronic Diseases

Andrew D. Miller[1,2,3]

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Precision Medicine is considered by many to be a necessary future for the treatment for all diseases. Fundamentally, this can be divided into two subsections, namely personalized medicine and precision therapeutics. With personalized medicine, the aim is to understand the genetic, immunological and/or metabolic individuality of patients in order to match individual patients with the most appropriate active pharmaceutical ingredients (APIs) for treatment of their particular disease(s). With precision therapeutics, the aim is to take control of the delivery of APIs to disease target tissue, by means of nanomedicine, and/or make use of select APIs that have extreme target specificity. For several years now, my research teams have been researching into the use of lipid-based nanoparticle (LNP) technologies with the main aim of realizing precision therapeutic approaches (PTAs) for the treatment of chronic diseases. Our approach is three-fold:

1. To devise stable, triggerable RNA-delivery LNPs for the enhanced functional delivery of RNAs (siRNAs, miRNAs, sgRNAs or mRNAs) to target cells in vivo – with a particular focus on PTAs (or vaccinations) for the treatment of hepatitis B virus (HBV) infections, liver cancer and other liver disorders

2. To devise stable theranostic drug-delivery LNPs that can be used in magnetic resonance-guided focused ultrasound (MRgFUS)-based PTAs for the treatment of glioblastoma multiforme (GBM) and breast cancers
3. To devise LNP related technologies for the functional delivery of hydrophobic drugs that can be used in PTAs for the treatment of virus infections, including SARS-CoV-2, and for the treatment of liver disorders such as diabetes

Implementation of these PTAs in the clinic could radically improve patient outcomes whilst reducing both required drug doses and side effects to an unprecedented degree. Such potential step changes in disease treatment explain why precision therapeutics should be an indispensable part of future medicine.

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# SPONSOR TALK: **Greener solutions for the first green generation**

Stanislav Kukla
Merck Life Science spol. s r.o.
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At Merck, sustainability is more than just a trendy word... it's a mindset. A growing portfolio of greener products and solutions and a variety of innovative programs uniquely enables us to act as sustainability multiplier for you, our customers. Our greener products combine enhanced sustainability with exceptional and long-trusted Merck quality, so they not only help you practice responsible science by minimizing environmental and health impacts, but also make your work more efficient by improved product performance.

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# Student Talks

# T1: Introducing tunability into structural color filters using vanadium dioxide

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Holey structural color filters are well-known as a demonstration of the extraordinary optical transmission [1]. For a given illumination, the optical response of such color filters is fixed and depends mostly on the depth and size of the holes, on their lateral arrangement and on the materials used for both the substrate and the thin filtering layer. By introducing externally tunable material into the structural color filters, we can alter their optical response even after they were fabricated. We demonstrate this possibility by taking advantage of the thermally inducible phase transition of vanadium dioxide ($VO_2$) occurring at an easily reachable temperature of ca. 67°C. $VO_2$, despite being mostly known for its applications in near- and mid-infrared regions, can be used in metasurfaces working also at visible wavelengths [2, 3]. The experimentally obtained refractive index values of a $VO_2$ layer below (30°C) and above (80°C) its transition temperature exhibit significant differences also at the visible wavelengths. In this work, we implement $VO_2$ elements into structural color filters in various geometries and analyze their influences on the optical responses of holey structural color filters.

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# T2: Dielectric nanoparticle enhanced Brillouin light scattering spectroscopy of spin waves

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Advances in Brillouin light scattering (BLS) spectroscopy allowed us to study and develop first generation of magnon devices and is one of the main reasons why magnonics became one of the most promising candidates for "beyond CMOS" technology. However, further development and especially miniaturization is needed to bring spin-wave devices to real application. Here, BLS is limited with its fundamental limit in probing short wavelength magnons. This limit is given (for the Stokes process) by the momentum conservation condition: $k_i=k_r+k_m$, where $k_i$ ($k_r$ ) is wavevector of the incident (reflected) light and k_m is wavevector of the magnon [1]. Thus, in the back-scattering geometry, the maximal wavenumber of spin waves, which can be detected, equals twice the incident light wavenumber. Most BLS experiments utilize light from visible spectra, thus restricting state-of-the-art experiments to the approx. 300 nm wavelengths of spin waves.

To tackle this limitation, we propose a novel way of detecting short-wavelength spin waves beyond the fundamental limitation of the BLS. We employ Mie resonance-based dielectric nano-resonators to localize and amplify the incident electric wave [2]. We were able to increase the maximal detectable wavevector approx. three times. The coherent excitation using the microstrip antenna verified the results obtained by measuring and fitting the thermal spin wave signal.

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# T3: Shape-controlled self-assembly of light-powered microrobots into ordered microchains for cells transport and water remediation

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Nature presents collective behavior of living organisms aiming to accomplish complex tasks, inspiring the development of cooperative micro/nanorobots. Herein, the spontaneous assembly of hematite-based microrobots is presented. Autonomous motile light-driven hematite/Pt microrobots with cubic shapes are prepared by hydrothermal synthesis. Microrobots show a fuel-free motion ability on the basic of photocatalysis.

Because of the asymmetric orientation of the dipolar moment in the crystal, cubic hematite/Pt microrobots can self-assemble into ordered microchains. The microchains exhibit different synchronized motions under light irradiation depending on the mutual orientation of the individual microrobots during the assembly, which allow them to accomplish multiple tasks, including capturing, picking up and transporting microscale objects, such as yeast cells and suspended matter in water extracted from personal care products, as well as degrading polymeric materials. Such light-powered self-assembled microchains hold great potential toward cargo capture, transport and delivery, and wastewater remediation.

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# T4: Enzyme-immobilized microrobots for degradation of organic contaminants

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Nano/microrobots are small-scale machines that are able to convert external stimuli or chemical energy into motion for performing useful actions [1]. The active motion features of nano/microrobots in water bodies provide the possibility to effectively remove harmful contaminants by capture or degradation without needing external agitation [2]. In this context, this work explores light-driven zinc oxide (ZnO) microrobots for the autonomous removal of organic contaminants. Specifically, morphology of the microrobots is programmed by single-element doping, leading to light-controlled motion having on/off switching capabilities. The microrobots are further modified to immobilize an enzyme on their surfaces for providing an additional removal capability by oxidizing organic contaminants. This novel concept of utilizing enzyme-immobilized light-driven microrobots has the potential to lead an autonomous and efficient remediation strategy to clean contaminated water bodies without the need for human interference.

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# T5: Analysis of bile acids in saliva for non-invasive diagnosis of Barrett's esophagus

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Saliva is a clear biofluid composed of a variety of compounds including electrolytes, organic acids or proteins that contribute to salivary biological functions such as protection, lubrication, and buffering. The rich metabolome and simple, repeatable, and non-invasive collection make saliva appealing for clinical research because levels of certain biomarkers could reflect the disease state. In this work, bile acids in saliva are investigated in diagnostics of Barrett's esophagus that is characterized by pathological changes of the esophageal tissue.

We present methodology for saliva collection and preparation by solid-phase extraction and subsequent analysis of unconjugated and glycine-conjugated bile acids by ultra-high-performance liquid chromatography-mass spectrometry. Eleven bile acids were quantified in saliva by tandem mass spectrometry. Bile acid levels were significantly elevated in saliva from patients with Barret's esophagus (n = 10) in comparison to healthy volunteers (n = 10). Moreover, taurine-conjugated bile acids and a sulfate conjugate were identified in saliva by high resolution mass spectrometry. In summary, analysis of salivary bile acids including taurine conjugates might be applicable in diagnosis of Barret's esophagus, however it is necessary to conduct a larger clinical study.

This work was supported by the institutional support RVO: 68081715.

# T6: Efficacy of combined therapy of disulfiram and 5-fluorouracil in organotypic cultures

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Drugs efficient in preclinical testing often fail when transferred to clinical practice. The main reason is probably using of oversimplified 2D models which do not include the effect of the tumor microenvironment and the presence of various cell types participating in the formation of tumors in vivo.

In our study, we used three-dimensional tumor models, spheroids and organotypic cultures. Spheroids were grown from colon cancer cell lines and organotypic cultures were prepared from the tumor tissue of patients with diagnosed colorectal cancer. We tested the efficacy of 5-fluorouracil, a commonly used antimetabolite in the treatment of colorectal carcinoma, and disulfiram/copper, an old drug with novel anti-cancer effects, both as a single treatment and in combination. We developed a multi-modal approach combining brightfield and fluorescence microscopy for evaluating drug effects on cell-type heterogeneous organotypic cultures. Combined treatment with

5-fluorouracil and disulfiram/copper efficiently decreased the presence of cancer cells in these models. Moreover, disulfiram/copper down-regulated the expression of markers associated with 5-fluorouracil resistance.

Thus, we propose combined therapy of 5-fluorouracil and disulfiram/ copper for further testing as a treatment for colorectal carcinoma. In addition, we show that organotypic cultures are suitable models for anti-cancer drug testing.

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# T7: Investigation of $TiO_2$ nanotubes intercations with cells by Bio-AFM

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$TiO_2$ nanotube (TNT) layers produced by anodization of Titanium have been recognized as excellent biocompatible material owing to their low cytotoxicity, high stability, and antibacterial properties. As they possess also good hemocompatibility and anticoagulation characteristics, TNT layers are promising for vascular implants and biomedical mapplications due to excellent osteoblast cell adhesion and proliferation [1] and effective growth of hydroxyapatite [2]. These properties make them excellent as final surfaces for medical and dental implants based on Ti alloys.

In the present work investigates $TiO_2$ nanotube (TNT) layers and their surface modifications by Atomic Layer Deposition (ALD) for the proliferation of Human Gingival Fibroblast cells. The key technique used in this study is bio-atomic force microscopy (bio-AMF). To study these cells, TNT layers (prepared via electrochemical anodization) with a distinct inner diameter of 12 nm, 15 nm and 100nm were used as substrates, as they appear to be the most suitable for the cell growth in general [3,4]. Additionally, TNT layers were coated by thin TiO2 coatings using ALD. An increase in cell growth and adhesion of the cells for all materials coated by 5 ALD cycles compared to their uncoated counterparts. The additional ALD $TiO_2$ coatings changed the surface composition of all materials, while preserving the original structure and protected them from unwanted crystallization and shape changes. The presented approach of mild surface modification by ALD has a significant effect on the materials' biocompatibility and is promising toward application in implant materials. In the presented work, we investigated the matrix elasticity (Young's modulus, stiffness, adhesive force, and roughness) and nanotopography using the bio-AFM (atomic force microscopy) method.

**Keywords:** Ti sheets, $TiO_2$ nanotube, Anodization, Bio-AFM, Cell behavior.

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# T8: Inelastic deformation of nanocrystalline free standing films

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We propose a two phase model to explain the inverse Hall-Petch effect, i.e. decrease of the strength with decreasing grain size in nanocrystalline materials with very small grains. We assume that a nanocrystalline material consists of the grain-boundary and the perfect grain-interior with different mechanical properties. The strength of nanocrystalline aluminum is simulated by Molecular Dynamics. In this work, we show the dependency of the elastic modulus, ultimate tensile stress and engineering yield strength on the grain size. The experimental values of modulus and strength are much lower, approximately 6 times. Probably the real sample is porous, which in turn leads to low experimental values of mechanical properties. We come up with an approach to introduce the porosity in the grain boundaries as well as in the grain interior in order to reduce the discrepancy in the experimental and simulated values of deformed nanocrystalline aluminum. Our modeled value of modulus is still 3 times higher and the value of strength about 2 times higher than the experimental one.

# T9: 2D material based field effect transistors for sensing applications

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Sensors of high sensitivity and selectivity are highly desirable in the fields of medicine, food, environmental studies, and many more. The introduction of ultrathin 2D materials has tremendously improved the sensing and biosensing capabilities of Field effect transistors (FETs) [1]. Attaining high sensitivity includes (i) increasing the number of sites of analyte interaction at the sensing material and (ii) improving the transduction of this interaction into the electrical response of the device. The large surface area to volume ratio and unique structural and electronic properties of 2D materials make them a perfect candidate for sensing material [2]. FETs provide high sensitivity, label-free, real-time, fast response sensor platforms [3]. The electrolyte-gated field effect transistors (EGFET) open the possibility to operate in water or buffered media at low voltages [4]. Here we combine the high sensitivity of 2D material with EGFET to achieve sensors with high sensitivity and selectivity.

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# T10: Development of a 500 MHz DNP-NMR system

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Nuclear Magnetic Resonance (NMR) is an important analytical method, which has found many applications in biology and medicine. However, many important biological molecular systems and processes in organisms, to which NMR could potentially be applied, exhibit so extremely high complexity that investigation of these systems with NMR reaches its limit despite tremendous progress, which was made in the development of magnetic resonance technique over the decades. Hence, a further increase in NMR sensitivity is a very important task for many research areas. Recently, the method of Dynamic Nuclear Polarization (DNP), which is linked to Electron Paramagnetic Resonance (EPR), has drawn the attention of many scientists as a very promising and effective approach to enhancing NMR signal. In this context, we aim to build a working prototype of a combined high-field EPR/NMR system operating at the magnetic field of 11.75 T, which corresponds to EPR and proton NMR at frequencies of 329 GHz and 500 MHz, respectively. Such a system will allow us to perform liquid state DNP NMR experiments on biological samples and to observe physiological processes almost in real-time.

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# T11: Electrochemical detection of miRNA-21 using integrated $MnFe_2O_4$ nanozyme-aptamer

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Non-small cell lung cancer (NSCLC) is among the highest rated cause of death incidents. However, early-stage treatments of NSCLC have efficient medication in preventing the death of patient. For this purpose, quantification of miRNA-21, which has 68 % specificity in detection of lung cancer, as a biomarker helps in the early-stage diagnostics of NSCLC. The concentration of miRNA-21 in plasma, in diagnosed population has been previously detected to be 7 times higher in comparison to healthy population.

In this study, an electrochemical sensing approach based on Nanozyme-Aptamer system has been developed for quick and simple determination of miRNA-21. Herein, $MnFe_2O_4$ Nanoparticles (NPs) as nanozymes have been prepared with inherent oxidase activity towards TMB (3,3′,5,5′-Tetramethylbenzidine) electroactive molecule as substrate. When the electrode surface is modified by the nanozymes, the TMB oxidation is increased leading to a decrease in the oxidation current and an increase in the reduction current in cyclic voltammetry measurements.

$MnFe_2O_4$ DNA modification passivates its enzymatic activity of towards TMB. The presence of miRNA in the media hybridizes with DNA and detach it from the surface of $MnFe_2O_4$. The hybridization process reactivates the nanozymatic activity increasing the reduction response, which is directly related to the concentration of miRNA. Electrochemical measurements like cyclic voltammetry, Amperometry and differential pulse voltammetry have been investigated to prove this fact.

The developed method shows sufficient sensitivity for precise detection of miRNA in blood plasma with good reproducibility. Hence, it can be used in clinical analysis for the preliminary testing.

# T12: In vitro assessment of the effects of secondary plant metabolites on intercellular communication

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**Introduction**: Prenylated phenolics are secondary plant metabolites with many impressive properties, such as strong antioxidative and anti-inflammatory activity. Moreover, the chemopreventive effects have been documented for several plant phenols. One of their possible modes of action can be via renewal gap-junctional intercellular communication (GJIC). GJIC plays a significant role in the maintenance of tissue homeostasis. Consequently, dysregulation of GJIC has been linked to various pathophysiological conditions and diseases, including carcinogenesis. Recently, a variety of structurally different prenylated phenolics from plant species *Paulownia tomentosa*, *Morus alba*, and *Morus nigra* were successfully isolated at the Department of Natural Drugs, MU, Brno. Certain compounds were found to show potent bioactivities, such as restoration of GJIC. Nevertheless, the chemopreventive properties of plant phenolics have not been fully explored.

**Methods:** The research is focusing on the effects of prenylated phenolics on tumorigenic and cancer-derived liver cell lines (WBras and HepG2). For *in vitro* assessment of GJIC, multiparametric scalpel loading-dye transfer assay (mSLDT) has been chosen, followed by fluorescence microscopy with automated image analysis. The cell-based screening will be conducted on 2D (monolayer) and 3D (tumor spheroids) in vitro models.

**Aims**: The research should (1) expand the current knowledge about antiproliferative effects via renewal GJIC and (2) investigate in more detail the ability of plant compounds to attenuate cell proliferation, migration, or tumor formation. Thereby, *in vitro* assessment of GJIC could (3) be effectively utilized in drug discovery and (4) propose appropriate drugs containing plant-derived chemicals to individuals with a high risk of cancer.

# T13: CRISPR/Cas9 knockout screening revealed genes involved in CD20 regulation

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CD20 is a surface antigen expressed almost exclusively on the surface of B cells. As such, it is the main target of monoclonal antibodies (mAb) like rituximab which are used as first-line treatment in the immunotherapy of B-cell malignancies. Unfortunately, malignant B cells often develop resistance to the monoclonal antibodies which leads to therapy failure and disease relapse. Downregulation of CD20 on the surface of the malignant cells was described as one of the mechanisms responsible for the resistance development. We aim to identify genes that regulate CD20 surface expression as targeting proteins coded by these genes can potentially enhance anti-CD20 mAbs efficiency.

We performed CRISPR/Cas9 screening on CD20-low Ramos cells that were resistant to the rituximab. Rituximab-resistant cells were transduced by genome-wide CRISPR knockout library to obtain a population of cells with single-gene knockouts. After 3-week cultivation, the top 5% of cells with the highest CD20 levels were sorted out. The abundance of each gRNA was evaluated using NGS and a bioinformatical tool MAGeCK, and gRNAs that were significantly enriched in the sorted population were selected.

We identified several genes whose disruption led to upregulation of CD20 on the surface of cells and successfully validated the results in polyclonal knockout populations. These genes will further be validated in monoclonal cell lines and molecular mechanisms underlying their function will be studied.

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# T14: $Cu_2O$: a photoanodic functional material and its stabilization against oxidation

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The self-organized 1D $TiO_2$ nanotubular layers have attracted considerable scientific and technological interest over the past two decades, all motivated by a great performance in the range of applications including photo-catalysis, solar cells, hydrogen generation and biomedical uses. The synthesis of these nanotubular layers has been carried out by a conventional electrochemical anodization of Ti sheets. Except the 1D character, these nanotubes possess unique features such as tunable dimensionality, structural flexibility, unidirectional electron transport through nanotube walls, chemical and mechanical stability and biocompatibility.

One of the major application targets of $TiO_2$ nanotubes has been their utilization as scaffolds or templates for deposition of secondary materials towards new applications. In particular, for the photoelectrochemical applications (e.g. photovoltaics) ordered nanostructures, such as self-organized $TiO_2$ nanotubes, offer the advantage of directed charge transport and controlled phase separation between the donor and acceptor materials, unlike within randomly ordered mesoporous $TiO_2$ supports.

Numerous techniques were utilized for this purpose, such as hydrothermal routes, electrodeposition or Atomic Layer Deposition (ALD) techniques. Electrodeposition is very powerful technique to deposit metals [4], oxides [5] or other rather complex materials (such as $CuInSe_2$ [6]) within the nanotubes various by means of complete filling or decoration with. On the other hand, ALD can deposit the widest range of secondary materials within $TiO_2$ nanotubes by means of homogenous coatings.

The presentation will focus on the electrodeposition of cuprous oxide ($Cu_2O$) as a p-type semiconductor within $TiO_2$ nanotube layers as n-type semiconductor substrates. The as-deposited $Cu_2O$ nanoparticles were subsequently passivated by ultrathin barrier ALD layers with the aim to protect $Cu_2O$ against electrochemical dissolution and to act as electron transport layer at the solid-liquid interface. Experimental details and some very recent photo-electrochemical and structural characterizations of a new type of hetero-structured material will be presented and discussed.

# T15: $TiO_2$ nanotube integrated microwave resonator uv sensor

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Ultraviolet (UV) irradiation is extensively utilized in numerous applications such as outer space communication, biological disinfection, memory storage, optoelectronic circuits, and biological analysis [1]. Excessive exposure to UV irradiation is deleterious and causes adverse health effects, for instance, premature aging and skin cancer. A rapid and highly sensitive device for the detection of UV is in great demand in various applications. Recently, planar microwave resonator sensors have demonstrated attractive and robust performance providing high sensitivity, real-time response, and low-cost fabrication process [2]. The planar microwave resonators can easily be integrated with nanostructured materials to make them sensitive to UV radiation via absorption and subsequent charge generation [3]. Among various wide bandgap metal oxides such as $TiO_2$, ZnO, $SnO_2$, one-dimensional $TiO_2$ nanotubes (TNTs) are favorable in UV photodetectors as they possess, except intrinsic $TiO_2$ properties high active surface area and their unique hollow geometry enables increased charge trapping and, a direct pathway for rapid transport of photogenerated carriers [4,5]. Therefore, the use of high aspect ratio (HAR) TNTs might offers superior sensing performance in the UV region.

In this presentation, the impact of TNT thicknesses on the UV sensitivity of the planar microwave resonator's response will be investigated. We will demonstrate the use of a high frequency microwave resonator integrated with different thicknesses (50, 80, 100 µm) of TNT membranes. The presented work will aid in selecting an optimized thickness of TNT membranes with a large active surface-to-volume ratio to provide the highest sensitivity to UV irradiation.

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# T16: Fluorinated MAX phases for photoelectrochemical hydrogen evolution

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The study of affordable materials with high energy conversion efficiencies for the photoelectrochemical generation of hydrogen from water is currently a crucial objective for the scientific community[1]. MAX phases are a class of layered ternary compounds that is well known for their interesting physical properties, but still underexplored as photoelectrocatalyst for energy conversion[2]. The chemical modification of layered materials can play a decisive role in tuning the properties for energy-related applications. In this work, a set of MAX phases, namely $Ta_2AlC$, $Cr_2AlC$, $Ti_2AlC$, $Ti_3AlC_2$, were exposed to fluorine gas and their photoelectrocatalytic properties were tested for the hydrogen evolution reaction. All the mentioned compounds showed good hydrogen evolution performances under illumination, in particular after the fluorination process. Fluorinated $Cr_2AlC$ showed the lowest overpotential and fluorinated $Ti_2AlC$ and $Ti_3AlC_2$ showed the most prominent photoelectrocatalytic enhancement upon fluorination.

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**Acknowledgements**

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# T17: Polydopamine-derived iron-doped hollow carbon nanorods as an efficient bifunctional electrocatalyst for simultaneous generation of hydrogen and electricity

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As a step toward developing robust and highly active electrocatalysts for the hydrogen evolution reaction (HER), we have developed a polydopamine-derived iron-doped hollow carbon nanorod (FeHCNR). It exhibits high electrocatalytic activity toward the HER in acidic media with an overpotential of 29.4 mV at the current density of 50 mA cm−2. To demonstrate the practical feasibility of the HER characteristics, we designed a new type of Zn−$H_2$ hybrid battery for the simultaneous generation of hydrogen and electricity by asymmetric electrolysis with the acid catholyte and alkaline anolyte. The system displayed an open circuit voltage of 1.28 V along with good stability compared to that of the one built using the commercial Pt/C catalyst. This device could generate $H_2$ gas with a Faradaic efficiency of 97% along with the generation of electricity. Thus, the FeHCNR could perform well toward the HER and ORR during the system-level demonstrations, and this advantage is mainly credited to the hollow nanorod structure of the catalyst, which provides better exposure to the active sites along the outer and inner walls of the system to facilitate the concerned reactions. The open-tube structure of the FeHCNR is supportive of the simultaneous diffusion of the electrolyte and reactants along with more facile dissipation of the products.

# T18: 2D- material integrated filament for 3D printing for energy conversion and storage application.

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The limited amount of fossil fuels and incessant growth of the human population along with industrial and modern development of society induced energy crisis and impacted living environmental conditions. To resolve these issues, electrochemical energy conversion and storage devices (EECS) have been emerged as green, environmentally friendly, and inexpensive pathways to develop alternative energy sources. Recently, 3D printing shows a facile fabrication path for electrodes in the electrochemical application. 3D printing via Fused deposition modeling (FDM) technique represents an eco-friendly technology in the fabrication of EECS devices. In FDM process, a filament is printed layer-by-layer to obtain the preferred geometry of the electrode. The commercial conductive filament contains a low amount of conductive substances that give a low electrochemical performance. Besides the activation of the post-printed electrodes and deposition of desired 2D materials on top of it required several steps. Moreover, the filament often inherits impurities such as $TiO_2$, $Fe_3O_4$ that drastically affect the electrochemical properties. To address these concerns, customized filament fabrication is currently focused to achieve desired electrochemical properties. This can be done by increasing the quantity of conductive fillers and incorporating 2D materials into the filament matrix. Among 2D materials, transition metal dichalcogenides (TMDs) and MXene have emerged as promising candidate for EECS devices as they have demonstrated excellent properties such as chemical stability, high electrical conductivity, porosity, and hydrophilicity.

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# T19: MXene-based 3D printed electrodes for flexible asymmetric supercapacitor

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Energy storage devices are a prerequisite for many modern wearable and portable devices. Among advanced energy storage devices, supercapacitors are considered a potential substitute for Li-ion batteries owing to their high power density, cyclic stability, and fast charging-discharging capability. However, inadequate energy density is still a turndown for its applications. To compete with the modern energy demand, cell design, particularly the right material combination and manufacturing techniques, must be addressed. Recently, 3D printing has emerged as a promising additive manufacturing technique. This technology allows rapid prototyping of 3D microstructures to fabricate interdigital electrochemical energy storage devices with highly controllable structures. 3D printing, along with the advancement of synergistic nano-architectures of binary metal oxides with 2D transition metal carbides and nitride (MXene) material, elevated the conductivity and highly reversible redox nature. Recent progress demonstrated that binary transition metal oxides (BTMOs), as well as their hybrids with (Mxene), are potential candidates due to their earth-abundance, large specific surface area, rich redox chemistry, highly electrocatalytic and conductivity properties. However, systematic studies and potential applications on BTMO/MXene composites are not explored to date. From this perspective, the proposed research work aims to design, synthesize, and development of various BTMOs and their Mxene-supported composite electrodes for 3D printed electrochemical energy storage devices.

# Student Posters

# P1: Towards the atomically resolved magnetism: Magnetic imaging in TEM

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Nanoscale analysis of magnetic order in solids is essential for designing novel devices, such as magnetic memories, sensors, or computing devices. During the last decades, transmission electron microscopy (TEM) was at the forefront of atomic-scale analysis due to its ability to analyze structure and chemical properties in solids with atomic precision [1]. Despite that, there is a lack of experimental approaches sensitive to magnetic properties at the sub-nm scale. Here we summarize the state of the art of magnetic imaging using TEM, which has gained significant interest due to recent technological development of the instrumentation as well as the growing interest in exotic magnetic configurations, such as antiferromagnetism [2]. We will cover the recent advances in TEM techniques, such as differential phase contrast (DPC) [3], or electron magnetic dichroism (EMD) [4] that have recently entered the field of atomically resolved magnetic imaging.

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# P2: Anatase-brookite biphasic $TiO_2$ heterojunctions

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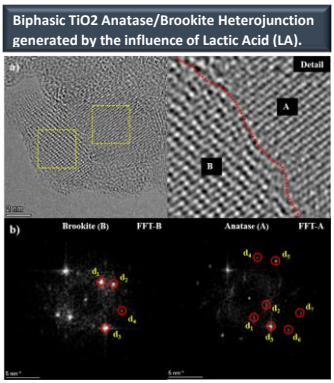
This method constitutes hydrolysis–condensation reactions catalyzed in the presence of an acid, governed by the hydrolysis ratio and the nature of coordinating groups in the titanium precursor. The acid catalysts enhance the transformation of amorphous gels into $TiO_2$ with further hydrolysis-polycondensation reactions, accompanied by structural rearrangements and Heterojunctions generation active sites for photocatalytic applications. Exist limited reports for particulate sol-gel systems, with agents such as carboxylic acids. The present work is performed on the complex synthesis of biphasic $TiO_2$ nanoparticles by the use of Titanium Isopropoxide (TTIP) as a precursor and substitutive acetic acids (SAA) at low-temperature (80°C). The HRTEM, SAED, and the FFT confirmed the formation of the Anatase-brookite $TiO_2$ heterojunction and triple Junction with Pt, identifying the most intense families of planes of A-B {321}, {221}, {211}, applying the SAA. The obtained and characterized materials presented a biphasic composition with anatase (A), about 70-80%, and brookite (B) 20-30%, being an optimal nanostructure for the photocatalytic application.

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# P3: Spectroscopy of thin molecular films

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Single-molecule magnets (SMMs) are coordination complexes that display magnetic characteristics of purely molecular origin, but comparable to those seen in traditional bulk magnets [1]. SMMs have been suggested as viable contenders for various applications in spintronic devices, magnetic qubits, and high-density information storage, requiring controlled thin films and designs to be carefully regulated [2,3]. In this Ph.D. project, we will use a high vacuum chamber for thermal sublimation of thin films of various transition metals and lanthanide complexes. We will work in cooperation with chemists to suggest the best type of ligands suitable for deposition from bulk synthesized nanoparticles to the nanostructured thin films. Our last goal will be to improve the spectrometer sensitivity to detect the deposited molecules and examine the magnetic properties of prepared thin films by using a high-frequency electron spin resonance spectrometer. The theoretical predictions of intrinsic magnetic parameters and surface interactions will be provided on ab-initio and DFT-based calculations. To analyze the surface chemistry of the prepared thin films, we will also perform some other characterizations such as scanning electron microscopy, X-ray photoelectron spectroscopy, and atomic force microscopy. **References:**

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# P4: Layered MAX phase electrocatalyst activity is driven by only a few hot spots

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The constant rise in the global population has inevitably led to an increase in fossil fuel consumption, which is why turning to renewable energy sources and the green hydrogen cycle is becoming of crucial importance. Utilizing electrochemical water splitting via hydrogen evolution reaction (HER) to produce clean hydrogen is a promising alternative to resolve the current energy and environmental crisis.

MAX phases, layered transition metal carbides and/or nitrides, have gained significant interest in the scientific community due to their electrocatalytic and electrochemical performance for the HER [1]. Among various MAX phases, double transition metal phase, $Mo_2TiAlC_2$, showed enhanced electrochemical activity for the HER [2]. Even though the macroscopic electrochemical activity of the MAX phase is known, there is a lack of deeper understanding and knowledge of the distribution and uniformity of the HER activity on different MAX phase microparticles. Therefore, the detailed investigation of the uniformity of the $Mo_2TiAlC_2$ microparticles activity with techniques such as scanning electrochemical microscopy (SECM) is needed.

In this study, the microsocpic HER activity of the $Mo_2TiAlC_2$ microparticles is investigated by SECM and it will shown that their electrocatalysis is driven by a few highly active microparticles (hot spots) with an outstanding catalytic activity towards hydrogen evolution, while the most of the $Mo_2TiAlC_2$ microparticles have lower catalytic activity [3].

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# P5: Synthesis and molecular magnetism in pentacoordinate Co(II) complexes with pendant alkyl chains

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Single molecule magnets (SMMs) are molecules showing the slow relaxation of magnetisation based on purely molecular origin. They illustrate the smallest possible magnetic storage devices, which can maintain information in single molecule. A good SMM exhibits a large effective anisotropy barrier Ueff and high value of relaxation time $\tau_0$ [1].

First, ligands L1 (2,6-bis(1-octyl-1H-benzimidazol-2-yl)pyridine) and L2 (2,6-bis(1-dodecyl-1H-benzimidazol-2-yl)pyridine) were prepared and characterized. The preparation of ligands L1 and L2 was based on N-alkylation of imidazole rings of bzimpy in order to increase the solubility of ligands and complexes in solvents such as $CH_2Cl_2$ or acetone, which is important for further deposition using lithography techniques. Then, four new pentacoordinate complexes expressed by general formula $[Co(L1)X_2]$ (X = Cl- for 1 and Br- for 2) and $[Co(L2)X_2]$ (X = Cl- for 3, Br- 4) were prepared and characterized. The dynamic magnetic investigations of complexes revealed field induced SMM. Complexes 1 – 4 exhibit energy barrier Ueff in the range of 25 to 45 K and relaxation time □0 of the order of $10^{-7}$ s, which are values typical for Co(II) mononuclear complexes.

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# P6: Deposition of a Co(II) paramagnetic molecular compound on graphene: Theory and experiment

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We present the prediction, characterization, stability, magnetic properties, and deposition on graphene of a Co(II) compound with Hsalapi ligands (Hsalapi = 2-Methyl-6-(2'-oxybenzylideneamino)pyridine) (Cambridge Structural Database code MIFWUU). We demonstrate the stability of the molecular compound at temperatures up to 250 C, making it suitable to deposition by drop-cast and thermal sublimation. The integrity of the compound after deposition on graphene was demonstrated by Raman spectroscopy and x-ray photoemission spectroscopy (XPS), and we argue that the presence of pseudo-coordination nitrogen atoms, i.e. which present non-covalent interactions with the Co center and do not belong to its coordination environment, are in part responsible for such stability. The magnetic properties of the Co(II) compound in bulk state, encoded in the axial (D) and rhombic (E) zero-field splitting parameters, were predicted by CASSCF-NEVPT2** calculations, showing good agreement with dc magnetometry and high-frequency electron paramagnetic resonance (HFEPR) spectroscopy experiments, and revealing a magnetization of the easy-axis type (D < 0). Density functional theory (DFT) calculations of the Co(II) molecule on graphene showed electron transfer from molecule to graphene, causing n-doping of graphene and changing the total magnetization of the molecule. The latter result could open the possibility to the tuning of molecular properties by electrostatic gating of graphene.

**complete-active space self-consistent field N-electron valence second-order perturbation theory

**Keywords**: Paramagnetic molecules; graphene; deposition on surfaces; DFT; CASSCF; HFEPR

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# P7: Superchiral bile acid-based metallo macrocycles and supramolecular cages

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Self-assembly, metal coordination and chiral cavities are essential features used by nature. In the past three decades, many supramolecular assemblies were synthesized via coordination-driven self-assembly using di- or tritopic pyridyl ligands and palladium(II) with the largest $Pd_{48}L_{96}$ species. However, majority of these assemblies are made of achiral ligands and do not contain chiral cavity. Therefore, to mimic closer the natural enzyme-like cavities, our group has introduced the "next-generation" metallo-supramolecular assemblies, e.g., $Pd_3L_6$ (Fig. 1) using chiral bile acid-based (ursodeoxycholic acid, UDCA) ditopic ligands.[1]

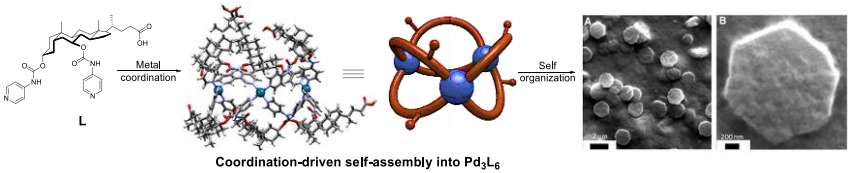


**Figure 1**. Bile acid-based metallo-macrocycle and its self-organization.

Further study showed that similar $Pd_3L_6$ can form hexagonal microparticles (Fig. 1) via Hierarchical Self-Organization.[2] To investigate the effect of ligand's bent angle on coordination self-assembly, chenodeoxycholic acid-based (CDCA, an epimer of UDCA) ditopic ligand was used which results in a mixture of PdnL2n species ranging from $Pd_2L_4$ to a large $Pd_6L_{12}$.[3] Finally, UDCA-based tritopic ligand was synthesized and its self-assembly produced the largest-ever superchiral supramolecular cage $Pd_{12}L_{16}$ containing record 160 chiral centers.[4]

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# P8: Fabrication of folic acid-based supramolecular metallogels

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The challenge of delivering medications to patients efficiently, selectively and with fewer adverse effects motivates the need to develop novel, better drug delivery techniques. Among these new technologies, supramolecular gels have become a research hotspot.[1] Unlike traditional polymer gels, supramoleculpaular gels are driven by weak and reversible non-covalent interactions. The supramolecular gels frequently display poor mechanical characteristics but can easily undergo various structural transformations upon external stimuli. The folate receptor (FR) which is anchored to the cell surface is overexpressed in a vast majority of cancer tissues, whereas its expression is restricted in healthy tissues and organs. As a result the high affinity of folic acid (FA) for FRs offers a unique opportunity for precise targeting at cancer cells.[2] FA itself was proven to be an efficient organo-gelator in the DMSO-water system. The mechanical strength of pure FA gels are rather weak severely limiting their application.[3] We present out ongoing studies on FA-based metallogels, their mechanical properties, morphological features, and structural investigation. These materials form stable supramolecular gels at surprisingly low concentrations with interesting mechanical properties. Our results in the field expand the library of biocompatible renewable organic building blocks to prepare strong gels.

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# P9: Platinum(II) complexes bearing amino-based ligands and their interaction with macrocyclic cavitands

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Platinum-based drugs are pillar of cancer chemotherapy; approximately half of all patients receive a platinum drug as a part of their treatment.[1] Despite great success of these bifunctional drugs numerous disadvantages exist such as their severe side effects due to their low selectivity towards cancer cells and rapid degradation in biological environment. To overcome these challenges, one needs to think out of the box. Previously reported complex phenanthriplatin,[2] a mono-functional cationic platinum complex derived from cisplatin, where a phenanthridine ligand is substituted for one of the chlorides of cisplatin, has potent anticancer activity. This complex has been indicated to form a mono-functional adduct with DNA that does not significantly deviate from the standard duplex topology but efficiently stalls the RNA polymerase II, hence blocking transcription.[3,4]

In this work we focus on synthesizing mono-functional complexes based on cisplatin and transplatin where one of the two chlorides is replaced by bulky hydrophobic amine-based ligand, which is assumed to help in penetrating lipophilic cell membrane and increase cellular uptake of the drug. The hydrophobic amine-based ligand is also used as an anchor for binding with various macrocyclic cavitands. Our efforts on the synthesis, characterization, and host-guest chemistry of the resulting supramolecular assemblies[5] will be demonstrated as a parallel to our recent studies on ruthenium-based systems.

**Acknowledgments**
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# P10: RNA as a therapeutic target

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Majority of drugs available in the market target proteins, but ~80% of proteins are considered undruggable; therefore, selecting another suitable candidate is crucial for treating many systemic and cancer-related pathologies. Around 75 % of the human genome is transcribed into RNA, while only a small fraction (~3%) of it translates to protein. Moreover, the 3'Untranslated regions (3'UTRs) of RNAs, which play a crucial role in the mRNA stability and regulation of gene expression, form distinctive secondary and tertiary structures interacting with proteins inside the cell.

Our goal is to find small drug-like molecules that can target 3'UTR of several non-druggable oncogenes (i.e., MYC, KRAS) and non-oncogene addiction genes (HSF1, CDK12, NRF2, etc). These small drug-like molecules have distinct advantages such as high affinity, specificity, and easy administration and can readily cross the cell membrane to reach intracellular targets.

We screened a library of small molecules that target 120 nucleotide fragments of 3'UTR of MYC mRNA by using an in-vitro fluorescence-based anisotropy assay (FA) in a high-throughput setup. Our approach is based on the change of conformation of the RNA fragment upon binding of small molecules to find lead compounds, optimized to target other mRNAs and mRNA-mRNP complexes. Characterization of specific mRNA-bound proteomes, investigation of possible ways to manipulate the said interactions, and understanding whether such small molecule-RNA interactions disrupt these functional RNA-protein interactions, will help address the challenges of drug Discovery

# P11: Elucidating the effect of ADAR2 mutations on seizures in humans and mice

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Seizures are sudden, uncontrolled electrical disturbances in the brain. It can cause changes in behavior, movement or sensation, and level of consciousness. The pathogenesis is very complex, which mainly related to changes in ion channel neurotransmitters and glial cells. However, the exact pathogenic mechanism remains unclear. Antiepileptic drugs are usually used for treatment, but 30% to 40% of people will continue to have seizures despite treatment due to medication-resistant. Others may require more invasive surgical treatments.

Adenosine deaminases acting on RNA (ADARs) convert adenosine-to-inosine (A-to-I) by hydrolytic deamination in numerous mRNA and pre-mRNA transcripts. Three members of the ADAR family, ADAR1, ADAR2, and ADAR3, have been identified in humans, but only ADAR1 and ADAR2 are enzymatically active. ADAR2 edits especially CNS transcripts; one of its most critical ADAR2 editing events is in the Gria2 transcript encoding an ionotropic glutamate receptor 2 (GluA2) subunit. The GluA2 subunit is the major AMPA receptor subunit in developing cerebral cortex and hippocampal neurons, and it guides receptor assembly. Mutations in ADAR2 have been suggested to contribute to hyperexcitability in specific epilepsy syndromes. But recently, we find that some of the *ADAR2 IE* (Infant Epilepsy) mutant proteins have quite small effects on *GRIA2* Q/R site editing in a co-expressed pre-mRNA substrate that encodes only *GRIA2* exon 11 and the 5′ half of intron 11.

So, elucidating the effect of ADAR2 mutations on seizures in humans and miceis of great significance.

# P12: Protein motif for bacterial affinity

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Antimicrobial resistance is already considered by the World Health Organization as one of the top 10 public health threats that humanity is facing. It is therefore necessary to develop new ways to treat bacterial infections. Antimicrobial peptides (AMPs) are a promising option to tackle this problem. Due to their mechanism of action, which usually disrupts the cell membrane of bacteria, their use is less likely to lead to the development of resistant bacteria. Nevertheless, most AMPs not only are active against bacterial cells but also mammalian cells, so we need to develop AMP sequences with higher selectivity for bacteria and reduced toxicity for human cells.

In this work, we have calculated by all-atom molecular dynamics (MD) simulations the potential of mean force (PMF) of amino acid analogs along two models of membrane which mimic bacterial and human cell membranes. The results from these simulations have then been used to calculate the free energy of 20 amino acid long peptides. Finally, using a genetic algorithm, the peptide sequences have evolved to maximize the selectivity towards bacterial membrane.

# P13: MYC mRNP Complexes as a target for small drug-like molecules

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The MYC oncogene is a significant driver of tumor development in many tissues. Although strictly regulated in normal cells, MYC is dysregulated in more than 50% of all cancers. Myc protein lacks classical binding pockets for small-molecule drugs; so far, no other therapeutic approach has led to a clinically successful drug.[1], [2] RNAs can form distinct tertiary structures, making RNA a potential drug target in numerous diseases; however, there is only one approved RNA-targeted small molecule in human disease treatment, with a few more in clinical trials. Based on its sequence, MYC 3'UTR forms structured motifs predicted to be highly functional. We propose targeting the 3'UTR of MYC mRNA with small drug-like molecules as an alternative path to regulate its activity. [3]–[6]

To investigate this possibility, it is crucial to study the RNA structure and its RNA-protein complexes. Like all mRNA, MYC is associated with RNA-binding proteins (RBPs) in mRNPs throughout its life. [7] We perform biotin-based RNA pulldown in vivo to isolate MYC mRNPs. The enriched bound proteins were analyzed using mass spectrometry proteomics. Built on published protocols, I have established a one-day biotin-based RNA pulldown protocol that is reliable, repeatable, and ready to be used for any other target.

We focus on highly enriched proteins compared to control samples. A preliminary list of candidate proteins was obtained from the gathered data, which is still evolving. However, additional research is needed to locate the binding sites and characterize the biochemical properties of these complexes. We plan to study the regulatory effect of screened drug-like molecules using the dual luciferase assay and analyze the conformational changes using other biophysical methods.

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# P14: The post-translational modifications of ADAR1 and its relevance to innate immunity.

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One of the most common RNA modifications is the deamination of adenosine bases to inosine. This is catalyzed by the adenosine deaminase acting on the RNA (ADAR) family of enzymes. This editing is an essential process that aids in the discrimination between self and viral RNA. ADAR1, has two isoforms; the constitutively expressed p110 isoform, primarily resides in the nucleus, and the interferon-inducible p150 isoform is predominantly cytoplasmic, but can shuttle between the nucleus and the cytoplasm owing to the presence of both a NLS and a NES [1]. The regulation of ADAR1 is of paramount importance to prevent aberrant interferon pathway stimulation, which would have grave consequences on a range of diseases from cancer to the autoimmune disorders; Aicardi Goutières syndrome [2].

There are over 400 post-translational modifications, and each has very context-dependent effects. Being either reversible or irreversible, PTMs can alter a protein's structure, biochemical properties, and function. They are thus a major mechanism that expands the complexities of the proteome. In this study, we investigate the potential modifications of ADAR1 and their role in immunity. We are studying certain modifications: methylation, phosphorylation, ubiquitination, and ISGylation, and have observed changes in protein stability, localization, and editing activity; with potential impacts on dysregulation of ADAR1 in diseases.

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[2] Mannion et al., "The RNA-Editing Enzyme ADAR1 Controls Innate Immune Responses to RNA."

# P15: Distinct p53 phosphorylation patterns in chronic lymphocytic leukemia patients are reflected in circumjacent pathways' activation upon DNA damage

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Background: Protein p53 has a central role in tumor suppression. The p53 level is kept low in the basal state, but after DNA damage, p53 is stabilized and triggers transcription of its target genes. In chronic lymphocytic leukemia (CLL), aberrations in the *TP53* gene are linked to aggressive disease since the function of the p53 protein is impaired. However, the p53 function might also be disrupted by other mechanisms, e.g. altered phosphorylations, even in the wild-type (wt) protein. Thus, we aimed to assess how p53 phosphorylations affect p53 function in CLL.

Results: Electrophoretical screen of *TP53*-wt primary CLL samples after inducing DNA damage revealed two p53 phosphoprofiles: profile I with heavily phosphorylated p53 and profile II with weakly phosphorylated p53. At the transcriptomic level, the profile I samples showed a standard response to DNA damage. In contrast, profile II failed to fully activate p53 targets, which made it similar to *TP53* mutated samples (*TP53*-muts). Next, untreated cells differed in the basal activity of the hypoxia pathway: TP53-muts > profile II > profile I. Finally, DNA sequencing revealed that ATM, a crucial part of the DNA damage-p53 axis, was more frequently mutated in profile II.

Conclusion: In CLL, *TP53*-wt cells with less phosphorylated p53 show *TP53* mutant-like behavior after DNA damage. It is linked to ATM defects and the higher basal activity of the hypoxia pathway. Overall, our study highlights the importance of phosphorylation in regulating p53 function in CLL.

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# P16: Studying the interplay between Drosophila Adar and Dicer-2 in innate immune induction

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Adenosine deaminases acting on RNA (ADARs) are enzymes that deaminate adenosine (A) to inosine (I) in double-stranded RNA (dsRNA) structures; there is only one *Adar* gene in *Drosophila melanogaster*. *Adar*$^{5G1}$ null *Drosophila* mutants show aberrant innate immune induction in terms of expression of antimicrobial peptide (AMP) transcripts through the dsRNA sensor; Dicer-2 [1].

The aim of this project is to suppress innate immune induction of *Adar*$^{5G1}$ null mutants. To achieve this we use the *Uas/Gal4* binary system whereby to knock-down different components of the innate immune pathway with weak ubiquitous (*Arm-GAL4*) drivers. Our preliminary results show rescue of AMPs levels in *Adar*$^{5G1}$ null mutants with *Dcr-2* knock-down.

We are also generating multiple *Adar* and *Dcr-2* knock-outs with the CRISPR/Cas9 gene editing system in *Drosophila Schneider* S2 cells. These mutant cell lines will be used to test resistance of *Adar* mutants to different RNA viruses, and also to test *Dcr-2* activity and immune induction after transfection of edited or modified dsRNAs.

In conclusion, this project aims to elucidate the interplay between *Drosophila* Adar and Dicer-2 and characterize the pathway leading to innate immune induction in which they are involved.

[1] Deng, P., et al., Adar RNA editing-dependent and -independent effects are required for brain and innate immune functions in Drosophila. Nat Commun, 2020. 11(1): p. 1580

# P17: Analysis of mass spectra in multiple myeloma patients using artificial neural networks

Monika Vlachová[1]*, Jana Gregorová[1], Sabina Adamová[1], Lukáš Pečinka[2,3], Lukáš Moráň[1,5], Volodymyr Porokh[1,2], Martin Štork[6], Luděk Pour[6], Josef Havel[2,3], Petr Vaňhara[1,4] , Sabina Ševčíková[1,7]

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Multiple myeloma (MM) is a heterogenous disease in which the bone marrow is infiltrated by plasma cells. If the cells also infiltrate organs or soft tissues, the condition is referred to as extramedullary disease (EMD). Pathogenesis has not yet been satisfactorily elucidated, treatment remains in both cases complicated. We believe that to distinguish between these two diseases, it would be possible to use the data obtained with MALDI-TOF (Matrix-Assisted Laser Desorption/Ionization Time-of Flight Mass Spectrometry), further analysed using artificial neural networks (ANN), principal component analysis and partial least squares discriminant analysis. After evaluation of peripheral blood samples from MM, EMD and healthy donors, we found that these methods reliably discriminate MM and EMD patients from healthy donors and that ANN is able to distinguish the mass spectra of MM patients from those of EMD patients.

Support & Funding: This work was supported by grant of the Czech Ministry of Health NU21-03-00076 and project National Institute for Cancer Research (Programme EXCELES, ID Project No. LX22NPO5102) - Funded by the European Union - Next Generation EU and by internal grant of Masaryk University MUNI/A/1391/2021.

# P18: Single-cell rna sequencing analysis of t helper cell differentiation and heterogeneity

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Single-cell transcriptomics has emerged as a powerful tool to investigate cells' biological landscape and focus on the expression profile of individual cells. The major advantage of this approach is an analysis of highly complex and heterogeneous cell populations, such as specific T helper cell subpopulations known to differentiate into distinct subpopulations. The need for distinguishing the specific expression profile is even more important considering the T cell plasticity. However, the universal pipelines for single-cell analysis are usually insufficient for every cell type. Here, the aims are to analyze the diversity of T cell phenotypes employing classical in vitro cytokine-mediated differentiation of human T cells isolated from human peripheral blood by single cell transcriptomic approach with the support of labeled antibodies and a comprehensive bioinformatics analysis using a combination of *Seurat*, *Nebulosa*, *GGplot*, and others. The results showed high expression similarities between the Th1 and Th17 phenotype and very distinct Th2 expression profiles, including the upregulation of genes such as *PTMA* or *HSPE1* in both Th17 and Th1. In the case of Th2 highly specific marker genes, *SESN2* and *JAML* were expressed. Overall, our results demonstrate how donor difference, Th plasticity, and cell cycle influence the expression profiles of distinct T cell populations. The results could help to better understand the importance of each step of the analysis when working with T-cell single-cell data and observe the results in a more practical way by using our analyzed datasets.

# P19: Elucidating the biological role of ADAR1 in the innate immunity response

Ketty Sinigaglia[1], Janka Melicherová[1], Pavla Linhartova[1], Stanislav Stejskal[1], Katarína Marečková[2], Radek Malik[3], Radislav Sedlacek[4], Petr Svoboda[3], Liam Keegan[1], Mary O'Connell[1]

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ADAR enzymes are responsible for the deamination of adenosine into inosine in cellular dsRNA allowing the cell to distinguish endogenous RNA from exogenous RNA and preventing an aberrant immune response. Accumulation of endogenous unedited ADAR1 RNA substrates within cells triggers type I IFN production through the anti-viral MDA5/MAVS pathway. Three members of the ADAR gene family (ADAR 1-3) have been identified in vertebrates. In addition, two isoforms of ADAR1 are synthesized: an IFN-inducible, cytoplasmic 150-kDa protein and a constitutive, nuclear 110-kDa protein.

Loss of function mutations in the h*ADAR1* gene cause Aicardi-Goutières Syndrome (AGS), a rare human congenital encephalopathy that resembles congenitally acquired viral infection. *Adar1* deficiency in murine models lead to embryonic lethality by E12.5 with aberrant IFN induction, apoptosis and failed hematopoiesis. Concurrent deletion of *Mavs* or *Mda5* rescues the embryonic lethality, allowing the pups to survive till P15. *Adar1,Mavs* mice show an increased apoptosis in the intestine, a mild inflammation, and disrupted spleen morphology. We have shown that the apoptosis detected in the small intestine of *Adar1,Mavs* mice at P14 is absent at embryonic stage and it is spreading from the proximal part along the whole small intestine few days after birth.

*Adar1* KO causes activation of dsRNA-dependent protein kinase *Pkr*, an IFN stimulated gene responsible of translation inhibition by phosphorylating eIF2a and of cell death pathways activation. We have shown that the mortality, the intestinal apoptosis and the minute phenotype present in Adar1,Mavs mutant mice are rescued after *Eif2ak2* deletion.

Our goal at the moment is to investigate at molecular level why *Pkr* KO is able to rescue the *Adar1*, *Mavs* lethality. Preliminary data show that Pkr activation is prevented in the enzymatically inactive Adar1 embryos suggesting that Adar1 and Pkr could compete for the same dsRNA substrate and that the presence of the inactive Adar1 is sufficient to avoid Pkr pathway activation.

# P20: Drug repurposing for venetoclax-resistant acute myeloid leukemia

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**Objectives**: Acute myeloid leukemia (AML) is a malignant disease derived from the bone marrow precursors of myeloid lineage. The treatment options were expanded by introducing venetoclax-based therapies, which transformed the frontline regimen of AML patients unfit for chemotherapy. However, exposure to this treatment inevitably enhances the selection of venetoclax-resistant AML subclones. Combatting this resistance remains a priority to maximize the patients' overall survival by using alternative treatment strategies. Hence, we aim to screen for effective compounds capable of targeting venetoclax-resistant AML phenotype and to link the molecular mechanisms underlying the observed lethality.

**Material and methods:** The library of 859 approved drugs (EMA, FDA) is applied to different models mimicking the venetoclax-resistance selection: 1) AML patient-derived mouse xenograft (PDX) model generated by using AML cells transplanted into an immunodeficient mouse host and treated with different regimens of venetoclax until disease progression; 2) Venetoclax-resistant AML cell lines (MOLM-13, HL-60) generated by chronic administration of venetoclax with gradually increasing doses. Selected top compounds from the drug screen were validated in 10-point dose-response curves.

**Results:** Drug screening in venetoclax-resistant MOLM-13 cell line revealed additional resistance to glucocorticoid receptor agonists while remaining highly sensitive to topoisomerase inhibitors and DNA-damaging agents. Surprisingly, we observed opposite results for the AML-PDX mouse model showing decreased sensitivity to topoisomerase inhibitors and DNA-damaging compounds. Moreover, our data from both models shared hypersensitivity to proteasome and HDAC inhibitors.

**Conclusion:** Approved drug screening substantially contributes to personalized medicine and provides hints to overcoming drug resistance such as to venetoclax.

This project was partly supported by grants MUNI/A/1330/2021, MUNI/A/1419/2021, OPRDE (No.CZ.02.2.69/0.0/0.0/19_073/0016943) and project NICR (EU program EXCELES, No. LX22NPO5102).

# P21: Recognition of RNA Polymerase II C-terminal domain by RPRD2

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The largest subunit of human RNA Polymerase II contains highly flexible C-terminal domain (CTD) that is composed of 52 heptapeptide repeats (first half of repeats with consensus sequence YSPTSPS and second half largely degenerated in sequence). Several CTDs canonical and non-canonical residues can be subjects of post-translational modifications. Tyrosine, threonine, and serine residues undergo dynamic phosphorylation/dephosphorylation resulting in specific phosphorylation patterns throughout different stages of transcription cycle. These phosphorylation patterns are recognized by various transcription and processing factors during the transcription cycle. Therefore, CTD plays an important role in the regulation of transcription and coupling of transcription to post-transcriptional processes such as mRNA processing.

In this study, we show that human transcription factor, RPRD2, recognizes specifically pSer2 or pThr4 phosphorylated forms of CTD via its CTD-interacting domain (CID) in a similar way to its yeast homologue, Rtt103. The interaction of RPRD2 CID with pSer2 phosphorylated CTD is further enhanced by additional phosphorylation on pSer7. To provide mechanistic details of the interaction between RPRD2 CID and pSer2,7 CTD, the solution structure was obtained using NMR spectroscopy. pSer 2 and pTh4 phosphomarks occur mainly during the late elongation and termination. RPRD2s preference for these two phosphomarks suggests possible involvement of RPRD2 in transcription termination.

# List of participants

## Invited Speakers

| | |
|---|---|
| Demo, Gabriel | CEITEC MU |
| Glowacki, Erik Daniel | CEITEC BUT |
| Macák, Jan | CEITEC BUT |
| Miller, Andrew David | Mendel University |
| Sedmík, Jiří | Masaryk University |
| Zajíčková, Lenka | CEITEC BUT |

## Physics, Chemistry, Materials Science

| | | |
|---|---|---|
| Alijani, Mahnaz | CEITEC BUT | T15 |
| Asgharian Marzabad, Mahya | CEITEC MU | P8 |
| Baishya, Kaushik | CEITEC BUT | T7 |
| Chattopadhyay, Subhasis | CEITEC MU | P7 |
| Dubský, Jan | CEITEC BUT | T10 |
| Garehbaghi, Sanam | CEITEC BUT | T11 |
| Hajducek, Jan | CEITEC BUT | P1 |
| Kandathil, Aparna Vasudevan | CEITEC BUT | T9 |
| Mappoli, Shidhin | CEITEC BUT | T19 |
| Nittoor Veedu, Radhika | CEITEC BUT | T17 |
| Nouseen, Shaista | CEITEC MENDELU | T8 |
| Oral, Cagatay M. | CEITEC BUT | T4 |
| Paul, Shib Shankar | CEITEC MU | P9 |

| | | |
|---|---|---|
| Peng, Xia | CEITEC BUT | T3 |
| Rovenská, Katarína | CEITEC BUT | T1 |
| Sanna, Michela | CEITEC BUT | T16 |
| Tahsin, Muhammad | CEITEC BUT | P3 |
| Tinoco Navarro, Lizeth Katherine | CEITEC BUT | P2 |
| Wojewoda, Ondřej | CEITEC BUT | T2 |
| Yadav, Ankit | CEITEC IPM | T8 |

## Life Sciences

| | | |
|---|---|---|
| Amoruso, Damiano | CEITEC MU | P16 |
| Blasco, Sofia | CEITEC MU | P12 |
| Cherian, Anna | CEITEC MU | P14 |
| Dosedělová, Věra | CEITEC MU | T5 |
| Du, Qiupei | CEITEC MU | P11 |
| Isar, Mohd | CEITEC MU | P10 |
| Jaroušek, Radim | CEITEC MU | P18 |
| Mohammadi Koubjari, Sepideh | CEITEC MU | P13 |
| Pešová, Michaela | CEITEC MU | P15 |
| Říhová, Kamila | CEITEC MU | T6 |
| Shpet, Polina | CEITEC MU | T12 |
| Vlachová, Monika | CEITEC MU | P17 |

## Organizers

| | | |
|---|---|---|
| Bawab, Bilal | CEITEC BUT | T14 |
| Dostálová, Lenka | CEITEC MU | T13 |
| Juráková, Jana | CEITEC BUT | P5 |
| Ladungová, Adriana | CEITEC MU | P20 |
| Linhartová, Kateřina | CEITEC MU | P21 |
| Navarro, Jorge | CEITEC BUT | P6 |
| Novčić, Katarina | CEITEC BUT | P4 |
| Sinigaglia, Ketty | CEITEC MU | P1 |