CATRIN

Czech Advanced Technology and Research Institute

NEWSLETTER 1/2025

New material enables chemical production using sunlight and water

A unique concept bridging nanotechnology and single-atom engineering

AMULET supports farmers and scientists

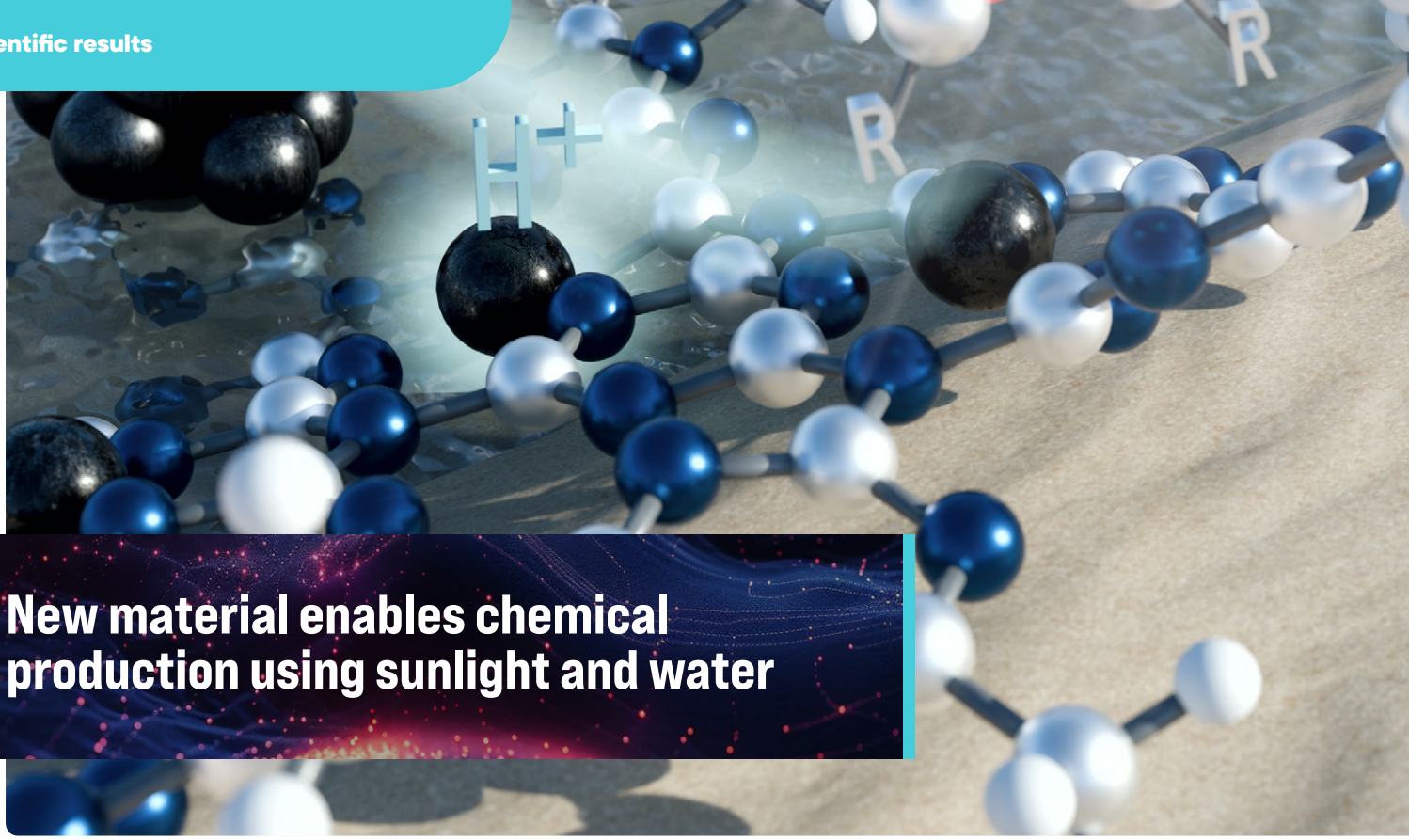
Using AI to predict plant development

Interview with A. Bakandritsos

I want to continue with groundbreaking research

CATRIN is part of the OLIVIE strategy

The goal: A region of healthy living



New material enables chemical production using sunlight and water

An international team of researchers from the Czech Republic, Germany and China has used nanotechnology and atomic engineering to develop a groundbreaking material that can transform a wide range of organic compounds into desired products under ambient conditions, powered solely by solar energy and using water as a proton source. The material's development marks a significant step towards finding alternatives for the environmentally and economically demanding hydrogenation reactions widely used in organic chemistry and pharmaceutical and agrochemical production. The study, which includes contributions from scientists at the Czech Advanced Technology and Research Institute (CATRIN) at Palacký University, was published in the prestigious journal Advanced Materials.

Hydrogenation reactions are integral to hundreds of chemical manufacturing processes across agrochemistry, pharmaceuticals, industrial chemistry and many other sectors, with a combined market worth tens of billions of dollars. However, many photocatalysts currently in use are unable to achieve the yields required for industrial-scale applications and suffer from limited selectivity, meaning they struggle to steer chemical reactions towards the desired products. Moreover, they often require the assistance of additional agents, such as water activation using magnesium, and their applicability is restricted to a narrow range of organic reactions. Finding new solutions that, unlike existing ones, can operate under low temperatures and pressures and without the use of gaseous hydrogen, represents a major scientific and industrial challenge. One promising approach involves using water as a proton source in combination with suitable photocatalysts that enable efficient transformation powered by solar energy.

"In developing a new type of photocatalyst, we combined expertise in nanotechnology and atomic engineering," said corresponding author Radek Zbořil. "Together with our international collaborators, we designed and synthesized a material consisting of palladium nanoparticles anchored within a two-dimensional carbon nitride matrix. Isolated palladium atoms in various oxidation states were incorporated in the vicinity of these nanoparticles. Thanks to the synergistic effect of the components, the new material managed to convert a broad range of organic compounds into desired products with exceptional yields and selectivities, paving the way for industrial applications."

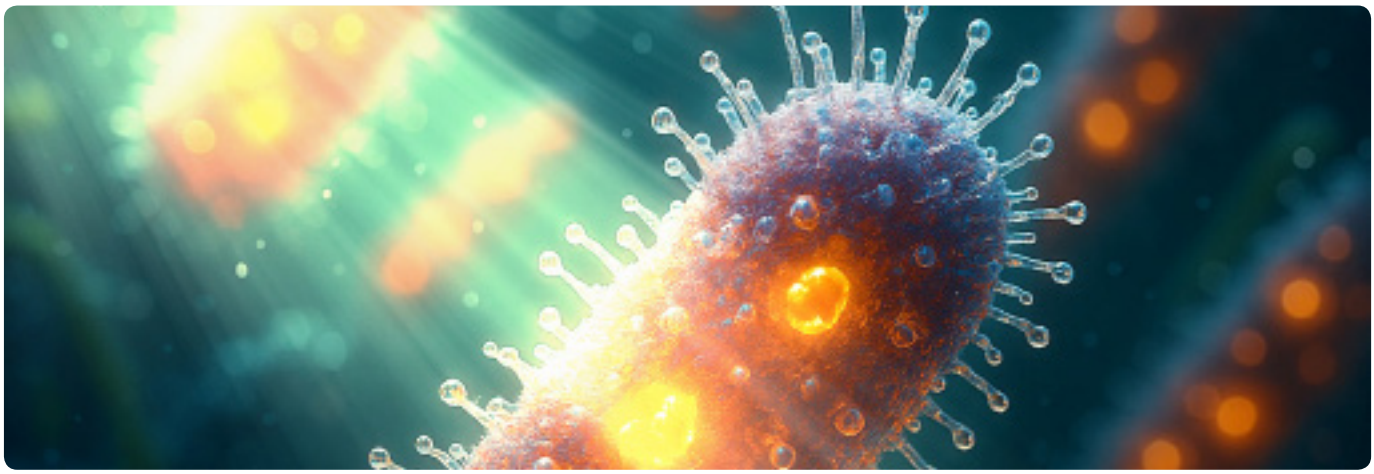
During the research, the team observed that the reaction yields increased dramatically when isolated palladium atoms in varying oxidation states were located near the nanoparticles. "We therefore intentionally designed a composite system in which isolated palladium atoms attracted photogenerated holes to oxidize water, while nanoparticles facilitated the transfer of hydrogen to unsaturated bonds in organic molecules. This is a unique concept that could revolutionize catalytic processes in organic chemistry," explained Giorgio Zoppellaro, who played a key role in elucidating the material's mechanism of action.

> **This is a unique concept that could revolutionize catalytic processes in organic chemistry.**
>
> **Giorgio Zoppellaro**

The research teams from CATRIN and VSB-TUO, in collaboration with colleagues from Germany's Leibniz Institute for Catalysis, have been investigating hydrogenation reactions for years. They have already published several pioneering studies focused on new technologies for synthesizing amine compounds (e.g. Chandrashekhar et al. Nat. Catal. 2022; Cheruvathoor Poulose et al. Nat. Nanotechnol. 2023).

Zhao E., Kong W., Zoppellaro G., Yang Y., Nan B., Li L., Zhang W., Chen Z., Bakandritsos A., Wang Z.-J., Beller M., Zboril R., Chen Z.: Atomic Scale Engineering of Multivalence-State Palladium Photocatalyst for Transfer Hydrogenation with Water as a Proton Source. Advanced Materials 2025. in press. IF = 26.8

A new material that can eliminate bacteria and viruses — all it needs is light



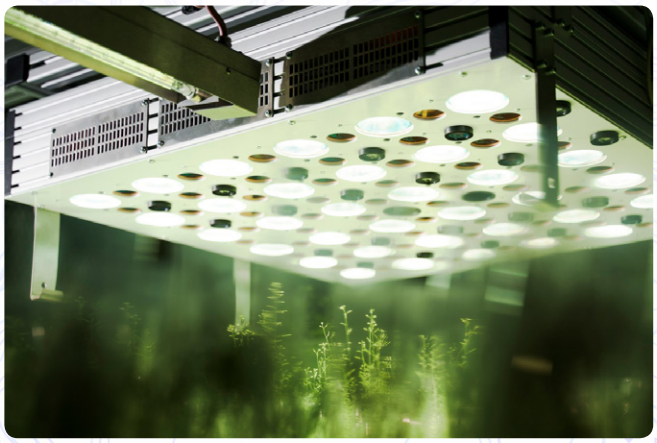
Killing bacteria using light. That's how simple surface disinfection could become in the future. Scientists from EMPA (Swiss Federal Laboratories for Materials Science and Technology), CATRIN at Palacký University and the Centre for Energy and Environmental Technologies (CEET) at VSB–TUO have begun developing a special coating with antimicrobial properties that can be activated by infrared light. This material is also gentle on the skin and environmentally friendly, and it could become a new weapon in the fight against antibiotic-resistant bacteria. Its first practical use is currently being prepared in the field of dentistry.

A novel material that is eco-friendly, biocompatible and metal-free has been designed to rapidly and locally eliminate microorganisms. It is based on polyvinyl alcohol, a biocompatible plastic commonly used for a range of applications, including in the food industry. "A specially synthesized, nitrogen-enriched graphene acid has been incorporated into this matrix. Thanks to its chemical properties, it has significant antimicrobial potential. Its full effect is unleashed when exposed to near-infrared light. The material then employs a dual strategy: it converts light energy into heat, which kills bacteria, and at the same time generates oxygen radicals that disrupt the membranes of pathogens," explained Radek Zbořil from CATRIN and CEET, a corresponding author of the article published in the journal EcoMAt.

The advantage of this approach is that it works entirely differently from conventional antibiotics. Thus, the material protects against a wide spectrum of microorganisms without contributing to the development of resistance. The first practical use of the new coating is being developed for dental medicine. EMPA is collaborating with the Center for Dental Medicine at the University of Zurich to develop a dental splint with firmly embedded graphene acid.

Reina G., Panacek D., Rathammer K., Altenried S., Meier P., Navascues P., Badura Z., Burgisser P., Kissling V., Ren Q., Zboril R., Wick P.: Light irradiation of N-doped graphene acid: metal-free strategy toward antibacterial and antiviral coatings with dual modes of action. EcoMat 2025. 7(4), e70009. IF = 12.6

AMULET model uses artificial intelligence to predict plant development, aiding farmers and scientists



AMULET enables efficient and accurate measurement of morphological and physiological characteristics of plants. Plant research experts and computer scientists from CATRIN at Palacký University, VSB-Technical University Ostrava and Imperial College London collaborated in its development and presented the results in the journal Computers and Electronics in Agriculture. By combining a range of imaging methods with advanced machine learning algorithms, the system can predict the future development and condition of plants based on the data acquired, providing crucial information for farmers and crop breeders.

"In this study, it´s been shown that AMULET can significantly improve the process of phenotyping data, i.e. monitoring and evaluating plant traits in relation to the environment. This is crucial for plant breeding and agricultural research. This approach allows faster and more accurate analysis of plant traits, which can contribute to the development of more resistant and profitable crops," said Nuria De Diego, one of the authors.

The AMULET model processes images acquired using an affordable RGB camera. The researchers have trained it on more than 30,000 images of the model plant Arabidopsis thaliana but have shown that it can also be used on agricultural crops, such as potatoes. "The system includes plant detection, estimation of future development, sorting and data analysis. It improves phenotyping by using an advanced artificial intelligence model that can predict the evolution of image data with high accuracy. This capability could benefit a wide range of users, from scientists to farmers, e.g. by shortening the duration of experiments, enabling early detection of plant stress or faster identification of unhealthy individuals," explained the paper's first author Jan Zdražil from CATRIN and a PhD student at the Faculty of Electrical Engineering and Computer Science at VSB-TUO.

AMULET was developed with the support of the European project

PATAFEST from the Horizon Europe RIA programme. Although experts say the system's functionality needs to be further tested on a wide range of conditions and different plant species, it is already being seen as a breakthrough tool that can fundamentally improve phenotyping — from detection to data analysis. If data can be obtained from the field to validate the model, its use in breeding programmes and agriculture may soon help to achieve higher crop vigour and yield.

Zdražil J., Kong L., Klimeš P., Jasso-Robles F.I., Saiz-Fernández I., Güder F., Spíchal L., Snášel V., De Diego N.: Next-generation high-throughput phenotyping with trait prediction through adaptable multi-task computational intelligence. Computers and Electronics in Agriculture 2025. 235, 110390. IF = 8.9

Scientists develop perovskites with unique properties for solar energy conversion

Researchers from CATRIN, in collaboration with colleagues from VSB–Technical University of Ostrava, the University of Turin and City University of Hong Kong, have developed a new type of nanocrystal based on double halide perovskites. These materials represent a promising alternative to conventional lead-based perovskites commonly used in photovoltaics. The results were published in Journal of Materials Chemistry A.

Perovskites are known for their high stability and compositional flexibility. However, their broader application has so far been limited by their wide band gap, resulting in low activity under solar light illumination. By controlled doping of $Cs_2NaInCl_6$ perovskite nanocrystals with iron, the research team successfully extended their light absorption from 330 nm to 505 nm, reaching into the visible spectrum. Further co-doping with silver significantly reduced the band gap energy and allowed fine-tuning of the electronic structure.

"By modifying the composition, we achieved photocatalytic properties that are extremely rare in lead-free perovskites," said Štěpán Kment, a corresponding author of the study. Density functional theory calculations confirmed that doping with iron introduced new energy states, while co-doping with silver shifted the valence band upward. Thanks to this tailored structure, the material can selectively convert waste carbon dioxide into methane using only sunlight.

Ahmad R., Zhang Y., Navrátil J., Błoński P., Zdražil L., Kalytchuk S., Naldoni A., Rogach A.L., Otyepka M., Zbořil R., Kment Š.: Band engineering in iron and silver co-doped double perovskite nanocrystals for selective photocatalytic CO_2 reduction. Journal of Materials Chemistry A 2024. 12(34), 23035–23048. IF = 9.5

Scientists propose a strategy to tackle climate change in common

Local crop genotypes and organic farming may be crucial in coping with the effects of climate change. This is according to the first ever study investigating the impact of drought on yield and seed quality of different common bean genotypes, published in the European Journal of Agronomy. In this paper, scientists from the Czech Advanced Technology and Research Institute - CATRIN at Palacký University, together with colleagues from Spain and the USA, summarized the results of a pioneering three-year field experiment in both organic and conventional farming. They showed that drought and farming practices significantly affect the yield and quality of beans, with extreme temperatures being a key factor.

"The aim of the study was to evaluate different common bean genotypes — both landraces and commercially available ones — under different environmental conditions, management regimes and irrigation methods to understand how the growing conditions affect their yield and seed quality.

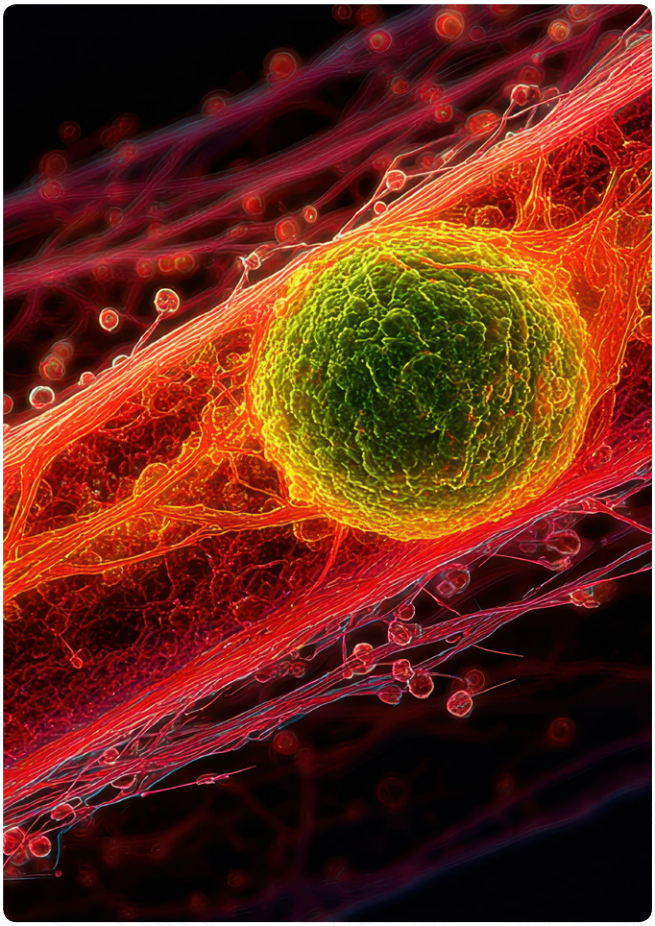
"The research showed that both drought and farming practices significantly affect bean yield and quality, with temperature extremes being a key factor affecting the observed parameters. Under irrigation, organic farming achieved comparable yields to conventional farming and improved seed quality under conditions without artificial irrigation. The landrace Arrocina de Álava was characterized by good drought tolerance and high seed quality when grown without irrigation. This underlines the importance of landraces for the selection of genotypes resistant to climate change," explained Nuria De Diego, CATRIN.

Common bean is an important crop for sustainable food security. Selecting genotypes that are resilient to the effects of climate change, including drought, within different farming systems is a viable strategy to mitigate the impacts of such conditions.

del-Canto A., De Diego N., Sanz-Sáez Á., Štefelová N., Pérez-López U., Mena Petite A., Lacuesta M.: Organic management and local genotypes for elevating yield and seed quality to confront climate change challenges. European Journal of Agronomy 2025. 168, 127613. IF = 5.5

Scientists demonstrate the effect of titanium nitride nanoparticles on anticancer and antibacterial therapy

Researchers at Palacký University's CATRIN together with colleagues from its Faculty of Science and Faculty of Medicine and Dentistry, in collaboration with researchers from VSB-TUO, Charles University and the University of Turin, have demonstrated the promising potential of titanium nitride (TiN) nanocrystals for photothermal anticancer therapy and, for the first time, antibacterial therapy. Their findings were recently published in Applied Surface Science Advances.

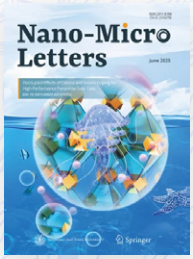


The discovery and development of new, effective cancer treatments and innovative methods to combat antibacterial resistance are among the most pressing scientific challenges of our time. Plasmonic titanium nitride nanoparticles have emerged as a highly efficient, electrocatalytic and environmentally friendly material with good biocompatibility. Their unique physicochemical properties and cost-effectiveness make them highly promising for biomedical applications. However, the influence of TiN morphology on the efficacy of photothermal therapy (PTT) has yet to be explored.

"In this study, we demonstrated that two different TiN morphologies — nanobars and nanospheres — can effectively destroy cancer cells and two key bacterial strains (Staphylococcus aureus and Escherichia coli) using in vitro PTT therapy. We achieved this under milder conditions (lower power and near infrared LED light) compared to other studies. Additionally, we demonstrated the feasibility of in vivo imaging of TiN during treatment," said Kateřina Poláková, the lead author of the study and leader of the BioMed research group at CATRIN.

Polakova K., Rej S., Hradilova S., Belza J., Malina T., Barton Tomankova K., Vecerova R., Matous P., Paral P., Opletalova A., Soukupova J., Pluhacek T., Sefc L., Zboril R., Kment S., Naldoni A.: Morphology-dependent near-infrared photothermal activity of plasmonic TiN nanobars and nanospheres for anticancer, antibacterial therapy and deep in vivo photoacoustic imaging. Applied Surface Science Advances 2025. 26, 100713. IF = 8.7

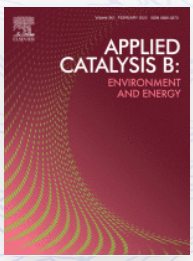
Our latest reviews



M. A. Deshmukh, A. Bakandritsos and R. Zbořil

"Bimetallic Single-Atom Catalysts for Water Splitting"

Nano-Micro Letters 2025, 17(1). IF = 36.3



B. Jaleh, A. Nasri, M. Eslamipanah, M. Nasrollahzadeh, M. Daneshnazar, J. H. Advani, P. Fornasiero, R. Zbořil, M. Antonietti and M. B. Gawande

"State-of-the-art and perspectives of nickel-based single-atom catalysts"

Applied Catalysis B-Environment and Energy 2025, 361, 124590. IF = 21.1

I want to continue pioneering research that addresses urgent global challenges

The chemist Aristeidis Bakandritsos focuses primarily on the development of functional nanomaterials and their applications in energy storage, catalysis and biomedicine. He moved to Olomouc with his family about nine years ago, bringing with him extensive international experience and scientific accomplishments. Over the past two years, he has achieved extraordinary success, as evidenced by successful projects, awards and publications in prestigious journals.

You have been working at RCPTM, now part of CATRIN, since 2016. Although you have achieved excellent results in the past, your success has been exceptional recently, I would say. Would you agree that the last few years have been especially fruitful?

Yes, indeed. The past few years have been particularly productive and fulfilling. This period has marked a phase of significant scientific output and rewarding collaborations, both within my team and across broader networks, leading to substantial contributions in our research fields.

What do you see as the main reasons for this?

The main reasons are a combination of factors. First, there is the supportive and stimulating research environment at CATRIN, which fosters collaboration and innovation, offers access to state-of-the-art facilities and tools for promoting a culture of excellence. Additionally, the dedication, creativity and continuous effort of our research group, along with strong international partnerships, are integral to our success.

Could you highlight some specific achievements that you consider particularly important? How has your research evolved over time?

Among recent accomplishments, I'm particularly proud of our pioneering research on single-molecule and single-atom engineering (particularly on graphene) and their applications in catalysis, environmental sustainability and healthcare, especially our work published in highly regarded journals like Advanced Materials, Nature Nanotechnology and Energy and Environmental Science, among others. Over time, the research focus has progressively moved towards interdisciplinary approaches, effectively integrating nanomaterials science for tackling major challenges in the fields of energy and sustainability.

What are you currently investing most effort in?

Currently, we are intensively working on developing advanced single-atom catalysts and novel nanostructured materials tailored for energy storage solutions, sustainable chemical transformations, valorization of wastes and environmental remediation. These areas hold great promise for addressing critical societal challenges.

You are implementing important international projects. How successful have you and your colleagues been in fulfilling their goals?

I'm pleased to say we are successfully working towards fulfilling all the goals of the projects. Due to the high degree of cooperation, interdisciplinary expertise and effective project management within our team and international partners, we are significantly enhancing our capability of tackling challenges and finding alternatives when we face difficulties.

Science is a team effort and an interdisciplinary endeavour. How would you evaluate the research environment at CATRIN in this regard, and how successful have you been in attracting new talent to your research group?

The research environment at CATRIN strongly emphasizes collaboration and interdisciplinarity, creating ideal conditions for innovation. We have successfully attracted exceptional young researchers and highly qualified international talent to our team, which have been pivotal in achieving excellent results.

This year, you received the CATRIN Award for Outstanding Scientific Output and were also ranked 24th in the Research.com national ranking in the field of Materials Science. How important are these individual recognitions to you?

These recognitions are very important. They are gratifying acknowledgments not just of individual effort but of the collective dedication and hard work of our entire team. Such awards motivate us to continue pushing the boundaries of our research fields.

What challenges lie ahead for you? Do you have any professional dreams or aspirations?

The primary challenge is advancing our research towards practical, real-world applications, particularly in sustainable energy. A key goal is developing highly efficient catalysts based on earth-abundant elements to transform waste into high-value chemicals and fuels. Professionally, I aspire to continue pioneering research that addresses pressing global challenges, while mentoring young scientists and collaborating with experienced researchers in the team and excellent partners from the Czech Republic.

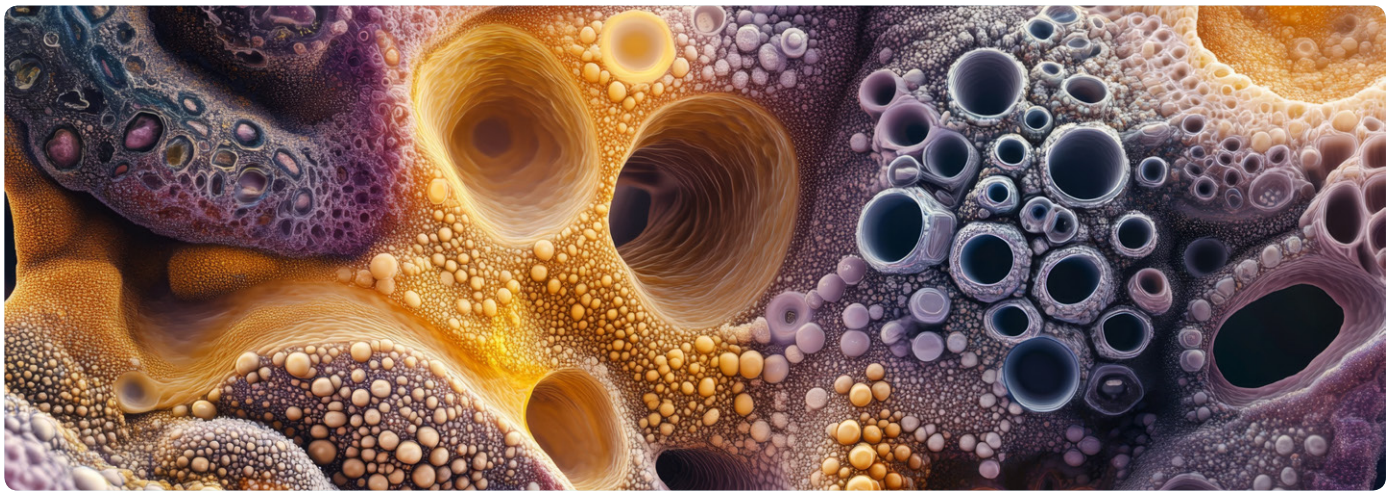
Aristeidis Bakandritsos, Ph.D. (*1977)

Aristeidis began his scientific career as an assistant professor in the Department of Materials Science at the University of Patras in Greece, where he established a laboratory and supervised students towards publications in prestigious journals on the surface functionalization of nanomaterials.

In 2008, he joined the research group of Professor Em. Giannelis at Cornell University. In 2016, he joined RCPTM, now part of CATRIN, where he is now a group leader. Since 2019, he has also been a lead researcher at VSB – Technical University of Ostrava.

His research focuses on the development of functional nanomaterials and their applications in energy storage, catalysis and biomedicine. He has authored more than 155 peer-reviewed publications (h-index of 41), which have received over 7,000 citations (according to the Scopus database).

New GAČR project to devise cutting-edge tools for lipid system simulations



Markéta Paloncýová and her colleague Petra Kührová have embarked on a new three-year project entitled "In-silico Workflow for Lipid-Mediated Active Pharmaceutical Ingredients Delivery Systems". The project aims to develop a validated protocol for molecular dynamics simulations of lipid systems, enabling scientists to study them through computer modelling. The project is funded by the Czech Science Foundation, with an overall budget of 5.1 million Czech koruna.

Lipid systems, such as liposomes and lipid nanoparticles, are highly promising tools in modern medicine. They help minimize the adverse effects of certain drugs and enable the delivery of fragile substances, e.g. mRNA.

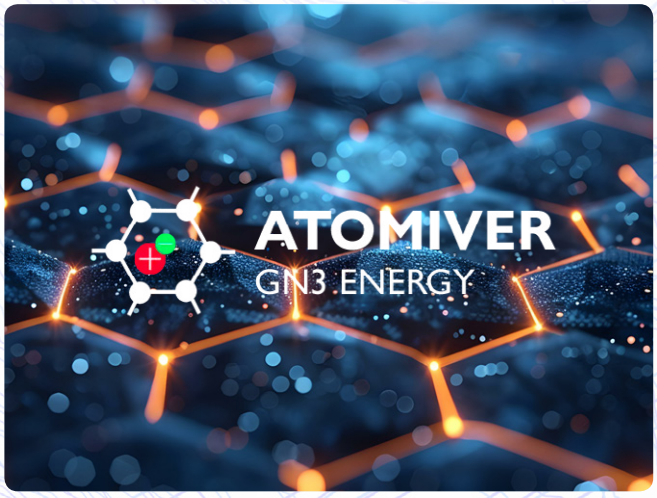
"As part of the project, we are designing tools for the in-silico study of lipids using computer simulations, modelling and data analysis. We will develop lipid libraries as a tool for constructing complex lipid structures containing active pharmaceutical ingredients and test an optimized simulation protocol. Our goal is to provide the scientific community with a reliable set of tools to simulate lipid systems and predict their properties computationally," explained Paloncýová.

Since January 2025, the Czech Science Foundation has funded 474 new scientific projects. CATRIN researchers submitted five applications in this call, two of which were successful. In addition to Markéta Paloncýová's project, funding was awarded to Sergi Kalytchuk for his project entitled "Tailored fluorescent carbon dots engineered for targeted biosensing."

Graphene material from Olomouc moves towards market via Atomiver spin-out company

BUSINESS

A graphene material for energy storage in supercapacitors developed by scientists at CATRIN is moving closer to real-world applications. This advancement is thanks to Atomiver, a newly established spin-out company, which aims to refine the carbon material into a market-ready product and explore its commercial potential. The material is already secured by a Japanese patent, with additional patents in progress.



An electrode material based on nitrogen-enriched graphene — a two-dimensional material composed of a single layer of carbon — was created by researchers in Olomouc seven years ago. Over the following years, its significant potential for electrical energy storage, particularly in supercapacitors, was confirmed. Supercapacitors offer a compelling alternative to widely used lithium-ion batteries. CATRIN researchers have recently worked on developing a prototype device with unique properties as part of the prestigious TRANS2DCHEM project funded by the European Innovation Council. This effort involved collaboration with Bar-Ilan University in Israel and the Italian company ITELCOND. Establishing Atomiver was the next logical step in the material's journey towards commercialization.

"Our goal is to produce nitrogen-doped graphene in bulk without compromising its quality and integrate it into supercapacitors designed for the target market. At a time of growing global energy demand and increasing need for efficient and stable energy storage solutions, our electrode material holds great promise," said Michal Otyepka, co-author of the technology and co-owner of Atomiver.

Global Water Nanotechnologies to bring effervescent water purification tablets to market

BUSINESS

A technology for effective purification of contaminated water developed by researchers at CATRIN is moving closer to real-world application thanks to the newly established spin-out company, Global Water Nanotechnologies. The company aims to progress a patented effervescent tablet technology containing iron nanoparticles to its final development phase and make it available for commercial use.

"The tablets contain iron nanoparticles that remain stable within them. However, upon contact with water, they disperse rapidly throughout the aqueous environment. The mixture of acids and hydroxides in the tablets, which causes fizzing, activates the nanoparticles very quickly, enabling an immediate reaction between their surface and the pollutant," explained Eleni Petala from CATRIN, the lead inventor of the patent. The effervescent tablets can rapidly remove hexavalent chromium, arsenic, herbicides, pesticides and other pollutants from water.

The technology won first place in the national Transfera Technology Day competition in 2021 and was successfully tested in the following years in collaboration with another industrial partner. The founding of the Global Water Nanotechnologies spin-out company in 2024 marks completion of this phase of technology transfer and paves the way for the innovative solution to be deployed in regions facing urgent challenges concerning access to safe water.

Research.com rankings bring year-on-year improvement for CATRIN

CONGRATULATIONS

According to this year's edition of international ranking by Research.com, the Czech leader in Materials Science is the physical chemist Radek Zbořil from CATRIN at Palacký University. Michal Otyepka placed fifth in the same discipline. Thanks in part to these results, the oldest Moravian university has defended its top national position in the field. The university also earned second place in Earth Sciences and Chemistry, with the highest number of representatives overall. Of the seven chemists from Palacký University (UP) featured in the ranking, five are affiliated with CATRIN.

"I'm extremely pleased that we not only achieved significant individual improvements, especially in materials science and chemistry, but also increased the total number of our researchers featured in the ranking. Of the 17 representatives from Palacký University, six come from our institute. Congratulations, not only to them but also to our colleagues from other institutions with whom we collaborate, many of whom also ranked highly, including Pavel Hobza, Martin Pumera, Jiří Čejka and many other Czech and international colleagues," said Pavel Banáš, CATRIN's Director.

In materials science, the authors analysed a total of 37,820 scientists. Palacký University is represented by Radek Zbořil and Michal Otyepka, both of whom improved their positions compared to the previous year. While last year Zbořil ranked second nationally and 434th globally, he now leads the Czech rankings and holds 365th place worldwide. Michal Otyepka maintained his fifth-place national ranking but improved globally from 2,106th to 1,723rd place.

In the field of chemistry, 121,518 scientists were evaluated. Like last year, the Czech leader is Pavel Hobza from the IOCB. Just behind his scientific mentor is Radek Zbořil. Michal Otyepka took 9th place on the list of domestic chemists, with Alexander Dömling 26th, Pavel Banáš 71st and Giorgio Zoppellaro 89th. CATRIN also has a representative in the category of Ecology and Evolution, where Ladislav Bocák ranked 46th nationally and 7,241st globally.

The top scientist associated with Palacký University is Radek Zbořil, with a h-index of 122. Also in the top five are Michal Otyepka (h-index 88) and Alexander Dömling (h-index 70) from CATRIN.

CATRIN leadership honours Markéta Paloncýová and Aristeidis Bakandritsos

CONGRATULATIONS

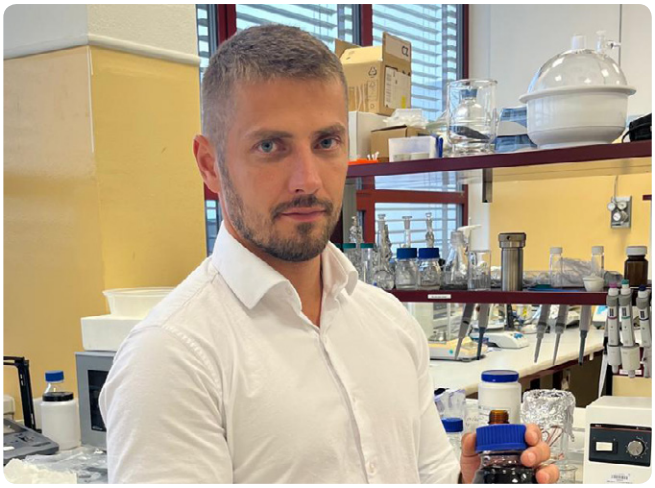
The chemist Aristeidis Bakandritsos, leader of the Magnetic Nanostructures research group, received the Outstanding Scientific Output Award at this year's CATRIN Annual Conference. For the first time ever, CATRIN General Director Pavel Banáš also presented the Jan Belza Award for Inspiring Spirit, which went to the computational chemist Markéta Paloncýová from the Carbon Nanostructures, Biomacromolecules and Simulations research group.

Aristeidis Bakandritsos was recognized for his long-standing contributions to the development of new materials for energy storage, as well as chemical and biomedical applications. Last year, he played a key role in developing organic nanomaterials that improve the performance of lithium batteries.

Markéta Paloncýová received the Jan Belza Award for her outstanding work in computational chemistry, where she exceptionally and inspiringly integrates theoretical modelling with experimental approaches. Her research provides innovative connections between physical and computational chemistry, biochemistry and materials science, thereby significantly contributing to the interdisciplinary understanding of complex chemical and biological systems. The award also reflects her important role in promoting diversity and involvement of women in science, where she serves as an inspiring role model for young female researchers across the scientific community. The award is named after a late colleague whose passion for science and enthusiasm for research continue to inspire many. His wife, Františka Belzová Konvalinková, attended the award ceremony.

David Panáček gains experience at Imperial College London

CONGRATULATIONS



Since February, the physical chemist David Panáček from CATRIN has been conducting research at the prestigious Imperial College London (ICL). Owing to his success in the Marie Skłodowska-Curie Actions (MSCA) – CZ grant call, he joined the research group led by Firat Güder, a leading expert in the development of sensors for plant monitoring and research.

Over the course of 14 months at the Department of Bioengineering, Faculty of Engineering at ICL, he will apply his expertise in graphene chemistry to develop highly efficient and sensitive sensors. "In this case, the sensors are designed to detect physiological changes in plants caused by various types of stress, including diseases. Collaborating with world-class experts in this field is a tremendous opportunity for me to learn from the best," said David Panáček.

The sensors developed during his stay will be tested at the Czech spin-off company AgroBioChem.

CATRIN helps to set up the OLIVIE strategy

COLLABORATION

To leverage the existing cutting-edge facilities of companies and institutions in the Olomouc Region in the fields of modern medicine, research, and development, while at the same time fostering innovations that promote health, a healthy lifestyle and life balance — not only for the region's residents but for society as a whole. This is the goal of the OLIVIE strategy, which CATRIN helped to establish. Radek Zbořil is one of the authors of the concept.

"OLIVIE brings together politicians, doctors, scientists, entrepreneurs and citizens to collaboratively transform their region, making the concept unique on a pan-European scale. The shared commitment to investing time, energy and resources into projects that support a healthy society makes perfect sense to me," said Zbořil.

OLIVIE is an open platform where not only companies, public institutions and associations can take part, but also the people of the Olomouc Region. The platform's goal is to ensure a high quality of life for the region's population. It is built on four pillars: preventive care with an emphasis on healthy lifestyle and screening programmes; creation of a healthy environment, including sustainable agriculture, local food production, spa and rehabilitation services. A key component of the comprehensive strategy is the advancement and application of cutting-edge technologies in medical diagnostics and treatment. More information is available at https://strategieolivie.cz

CATRIN again supports Academia Film Olomouc

COLLABORATION

As in previous years, CATRIN once again supported the international festival of popular science documentary films, Academia Film Olomouc (AFO). Its involvement was reflected in the programme of the festival's 60th anniversary edition, where participants had the opportunity to explore scientific comics, learn about the TECHSCALE and Trans2Dchem projects, as well as the OLIVIE strategy, and engage in discussions with scientists on how scientific results can help address some of today's pressing issues.

"As George E. Brown Jr. once said, research isn't complete until its results are clearly communicated to the public. At CATRIN, we see science communication as an integral part of our mission, and we strive to make our research understandable and beneficial to society as a whole. We consider AFO an exceptional platform for this purpose," explained CATRIN Director Pavel Banáš, outlining the reasons for the collaboration.

Throughout the festival, an exhibition of comics by Patrick Trouillas was on display in the foyer of the Central cinema. TECHSCALE project leader and head of CATRIN-RCPTM Michal Otyepka joined fellow experts in a discussion on how to build public trust in new technologies. The Scientific Director of CATRIN-RCPTM Radek Zbořil participated in a panel discussion on the mission and core pillars of the OLIVIE strategy. Veronika Šedajová, a physical chemist, represented the Trans2Dchem project at the Project Marketplace. CATRIN also had a representative on the international jury — plant phenotyping expert and head of CATRIN-CRH Lukáš Spíchal.

CATRIN scientists contribute to an exhibition on artificial intelligence

Scientists from CATRIN contributed to the creation of the traveling exhibition Futurum Ex Machina: Artificial Intelligence & Civilization, which opened in mid-May at Prague's Kampa. Michal Otyepka and Lukáš Spíchal helped prepare the content for the panels "Revolution in Laboratories" and "Smart Agriculture and Data". Other contributors from Palacký University included Kamil Kopecký and Dominik Voráč from the Faculty of Education.

"I'm very pleased to be involved in exhibitions, organized by Miroslav Bárta, which connect science, society and contemporary topics. Collaborating on these projects is always inspiring for me, just like any encounter with this inspiring person, who is a leading Egyptologist and scientist fascinated by the development and behaviour of civilizations. I'm especially glad to take part in the latest exhibition on artificial intelligence, where I had the opportunity to present how AI is bringing a fundamental revolution to the field of materials research," said Otyepka.

The exhibition, told through 40 stories, explores what artificial intelligence is, how and why it came into being, how it influences us today, and how it may shape the future of civilization. From Prague, it will travel to other cities across the Czech Republic.

Radek Zbořil participated in a discussion on economic strategy

The aim of the "Česko na křižovatce" conference was to highlight the long-term issues hindering the Czech economy and identify both risks and opportunities. The event took place on 16 April in Prague, with participation by politicians, business leaders and employers' organizations. The physical chemist Radek Zbořil from CATRIN, Palacký University, contributed to a programme block focused on research, development and innovation. In addition to evaluating the current situation, he proposed possible solutions.

In the discussion panel, which also featured the Deputy Minister for Science, Research and Innovation Pavel Doleček, the Member of the Board of Directors of the Confederation of Industry of the Czech Republic Petr Jonák and the Chairwoman of the Health and Social Services Section of the Chamber of Commerce of the Czech Republic Eva Karásková, Professor Zbořil referred to the so-called European paradox: namely, although the EU is a global leader in scientific output, producing nearly a quarter of all high-quality scientific publications, it lags behind in valorizing these results and transferring them into practice. The Scientific Director of CATRIN-RCPTM presented three key tools that could help improve the current situation. These included the creation of a platform to support disruptive innovation within the Czech corporate and research environment, with planned simultaneous investment from the state and companies into research and development, support for the establishment of professional companies focused on the commercialization of science and development, and a system of tax relief and incentives for companies conducting research and development.

Photo exhibition of OP JAK projects launched in Olomouc

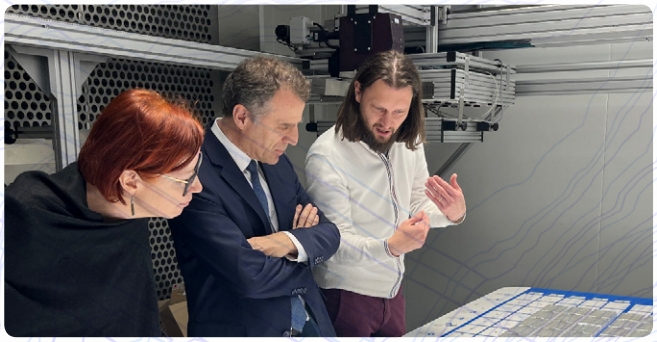
The TECHSCALE project (Technology Beyond the Nanoscale) is among those featured in the travelling photo exhibition organized by the Ministry of Education, Youth and Sports to showcase successful projects from the Johannes Amos Comenius Operational Programme (OP JAK). The first stop was Olomouc's Horní Náměstí in May.

"I greatly appreciate the idea of presenting at least some of the projects to the public, which is why we at CATRIN were happy to cooperate in preparing the exhibition. It's important to help people understand how European Union funds are transforming Czech education and research," said Michal Otyepka, who leads the TECHSCALE project.

Information about the exhibition and the supported projects is available on the OP JAK Project Labyrinth website, which also provides additional articles, interviews and videos about the work of Czech scientists and teachers, as well as improvements to the educational environment for pupils, students and youth. Visitors to the exhibition can participate in a contest held in conjunction with the event.

French Ambassador to the Czech Republic visits CATRIN

During his visit, the French Ambassador to the Czech Republic, Stéphane Crouzat, showed interest not only in research results but also their potential applications and interdisciplinary collaboration.



"I'm pleased that we were able to present the Ambassador with concrete examples of active collaboration between CATRIN scientists and their French colleagues— for example, within the Barande Bioscience Meetings. He was also very interested in their recent successes in the Jean-Marie Lehn Prize competition, which is organized by the French Embassy in cooperation with the company Solvay," said the CATRIN Director Pavel Banáš, commenting on the visit.

Sagar Sanjay Arya

I'm fascinated by how materials science is changing the way we perceive biology

Sagar Sanjaye Aryi´s research is a superb example of interdisciplinary science. As a holder of a MSCA Postdoctoral Fellowship, his research at Palacký University's CATRIN bridges biology and materials science to help solve global challenges, such as the impact of climate change on agricultural crops and antimicrobial resistance.

"My research focuses on bioengineering, nanomaterials, biosensors and plant-environment interactions. At CATRIN, I particularly want to continue to use plant cells and plant parts to understand how plants respond to climate and nutritional changes through electrical signals. I also want to develop new nature-inspired sensors for environmental monitoring — both on Earth and in extraterrestrial environments," said the Indian-born researcher, who has also worked in Australia and the United Arab Emirates and has experience in both academic and commercial spheres.

He has worked in Olomouc since the end of last year. "I chose CATRIN because of its reputation for cutting-edge research in bioengineering, nanotechnology and plant phenotyping. Another big attraction was the opportunity to work with scientists such as Lukáš Spíchal and Radek Zbořil, whose work in plant phenotyping and nanomaterial-based catalysis I have long admired. CATRIN is a very supportive and collaborative environment with an interdisciplinary background and cutting-edge equipment, which fits perfectly with my plans and ambitions," he added. He would like to build on previous work and link laboratory results to global needs, whether it is the use of biohybrid nanomaterials to fight bacterial infections, the development of platforms for testing antimicrobial activity or the development of nanomaterials that can trigger plant defence mechanisms.

"It is amazing that we can use biocompatible materials, nanotechnology and 3D printing to interact with complex biological systems and do so with incredible precision. Nanomaterials can penetrate cells, deliver drugs or monitor molecular events, allowing us to better understand cellular processes. Thanks to advanced imaging technologies, we can see biological structures down to the atomic level. It is amazing how deeply we can penetrate into the very essence of life," said the young researcher of the benefits of current science.

While studying cyber security at Tomas Bata University in Zlín, Jan Zdražil realized he was drawn to science. This led him to pursue a PhD at VSB–TUO, during which he began collaborating with CATRIN on research. He supports colleagues in both plant and materials research with data acquisition, processing and analysis. Their common goal is to contribute to the development of technologies with real-world applications.

Jan Zdražil

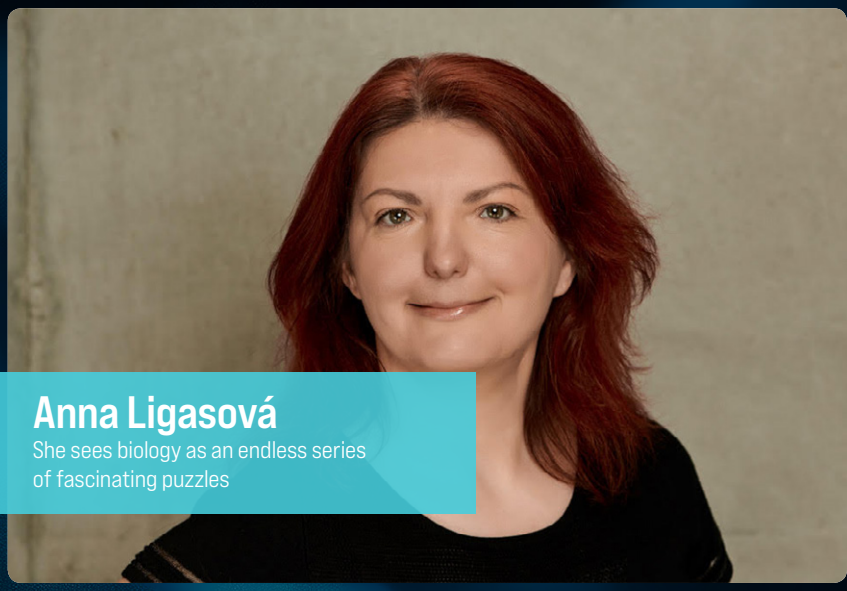
If our research helps someone in the future, that's a bonus

"Theory is great, but I'm more of a practical person and prefer when our results have a tangible outcome. If they also end up helping someone in the future, that's a bonus that brings me joy. That's why I'm grateful that, thanks to my supervisor Václav Snášel and the interest from CATRIN, I get to work on this kind of science," says the data specialist.

The first concrete outcome of his cross-disciplinary and inter-university collaboration is the modular AMULET system, which enables faster and more accurate analysis of plant traits based on plant imaging. This could help farmers and breeders develop more resilient and higher-yielding crops. Collaborations are also beginning with chemists and materials scientists on the development of sensitive sensors for plants, another area where a solid grasp of large datasets will be essential.

Although he enjoys interdisciplinarity as a team player, he admits that communication across fields isn't always easy. "We IT people have our own language, and colleagues from other fields see things from their own perspective, so it took a while before we really started understanding each other. But you can't do quality research without that. So, it's great that we're making the effort," he adds.

At CATRIN, he also has the chance to collaborate with his brother Lukáš and several friends. He admits that this was one of the reasons he joined CATRIN. "Our parents didn't raise us to become scientists, but they did teach us that family comes first. That's why I'm happy to share research and an office with my brother," says the Olomouc native with a smile — someone who considers his hometown a great place to live.



Anna Ligasová

She sees biology as an endless series of fascinating puzzles

Anna Ligasová is trying to decipher some of those puzzles – especially the behaviour of cancer cells – at the Institute of Molecular and Translational Medicine (IMTM). She has helped develop a method that allows rapid analysis of how different substances affect cells, which is crucial, for example, for the development of new drugs and testing their safety. She considers it very important that the research she and her colleagues conduct have real benefits for patients. That is why she would like to see a world where there are smarter "bridges" between academic research and practice.

Anna is a cell biology graduate from Comenius University in Bratislava and has a doctorate from Charles University. She is currently engaged in research that could improve the treatment of blood cancers, such as leukaemia. She specifically focuses on one of the key drugs in chemotherapy, cytarabine. "To put it very simply, I am trying to understand how cancer cells process this drug and how they defend against it, so that we can find a way to break through their defences and increase the effectiveness of the therapy," she explained.

Her second research topic is related to repairing damaged DNA. Chemotherapy often works by massively damaging the DNA of cancer cells so that they cannot multiply further. However, cells are able to call on their own "repair teams" to attempt to repair this damage and survive the treatment.

"And here comes a fascinating paradox. Behind the formation of a tumour lies a defect in the repair mechanisms that allows the cell to multiply uncontrollably. When we then try to destroy it with chemotherapy, the same repair mechanisms can become its key advantage, helping it survive the treatment. I am trying to understand these processes in detail so that we can influence them cleverly in the future, e.g. by temporarily "turning them off" at the right time, and thereby significantly increasing the impact of treatment on tumour cells," added the cell biologist, who is also involved in the development of analytical methods and technologies that can improve, accelerate and reduce the cost of knowledge.

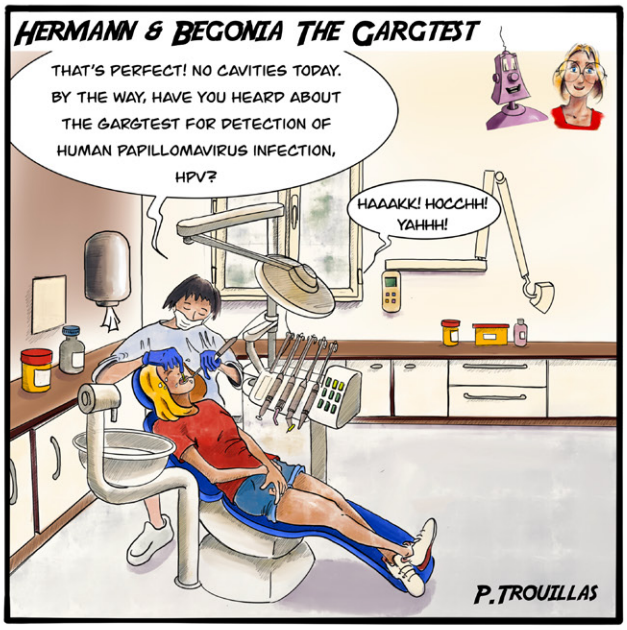
She believes that the path from discovery to the patient should not be as lengthy and rocky as it is today, when many great findings remain "locked in laboratories" because they run into a wall of practical and commercial obstacles. "This is not a dream of less bureaucracy but of greater imagination and courage throughout the system, so that scientific progress is translated into real improvements in our lives as quickly as possible," she concluded.

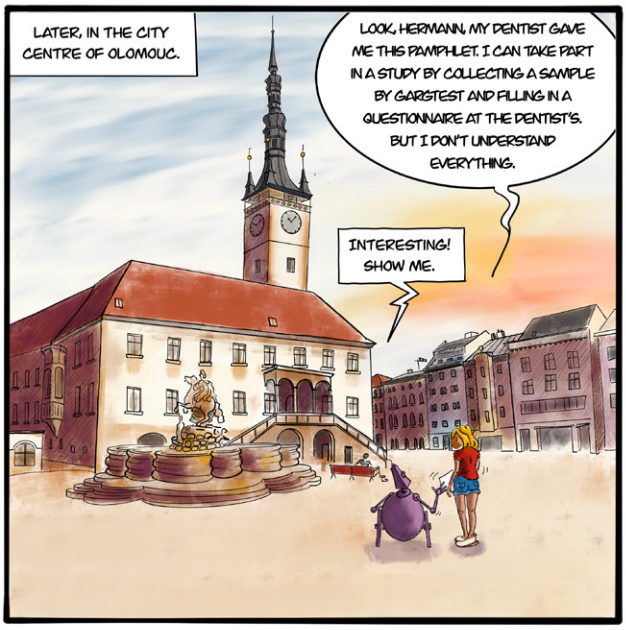
International Spring School targets young scientists focused on biosensors

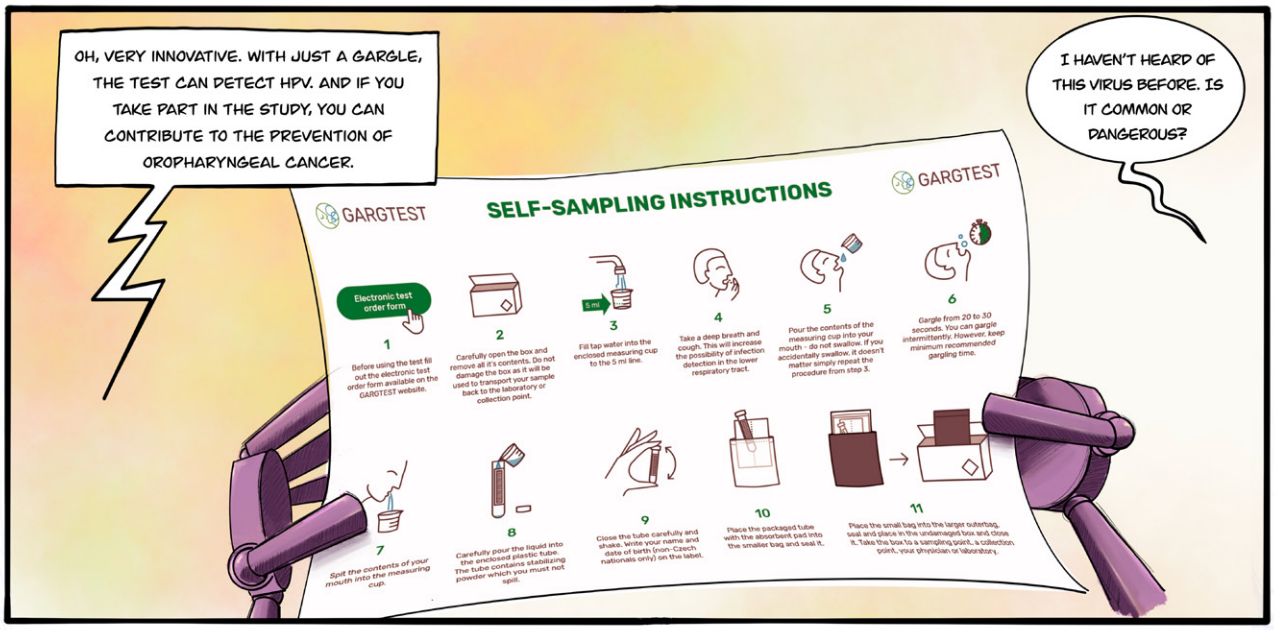
Presenting the latest insights into the development and application of advanced (nano)sensor technologies was the aim of the Spring School on Nanobiosensors and Printed Biosensors, organized in Olomouc by CATRIN as part of the TECHSCALE and SUSNANO projects in cooperation with the University of Tirana and ICN2 in Barcelona. The event brought together 55 scientists.

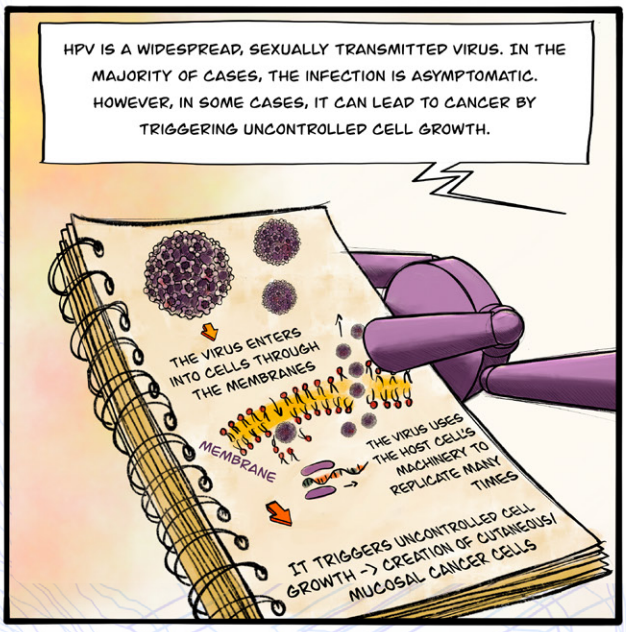
The main goal was to provide master's and doctoral students, as well as early-career researchers, with the latest knowledge in the field of nanobiosensor and printed biosensor development. Over the course of three days, participants gained both theoretical and practical knowledge on the development and application of advanced biosensor technologies, established valuable connections with experts from academia and industry, and found inspiration for their own research and professional growth.

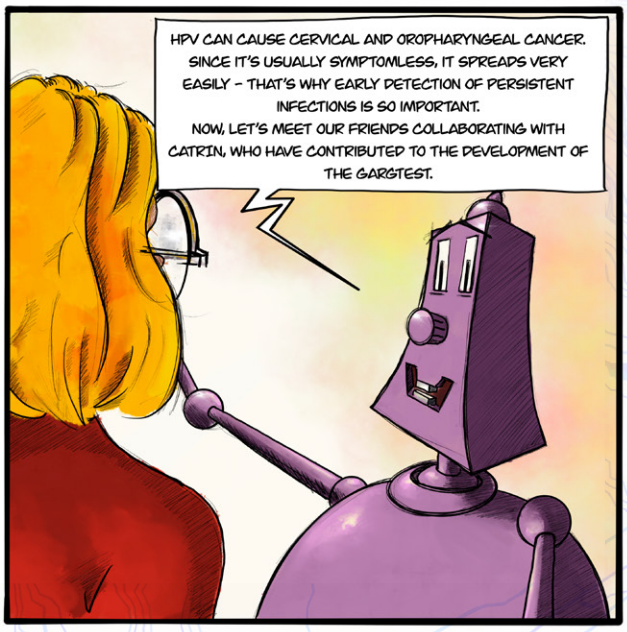
The importance of the event was highlighted by Arben Merkoçi from the top-tier research institute ICN2 in Barcelona. "The Spring School introduced new ideas in the development and production of nanobiosensors, which benefits not only the SUSNANO project but also the broader scientific community focused on designing, constructing and applying a new generation of these devices," stated Merkoçi.

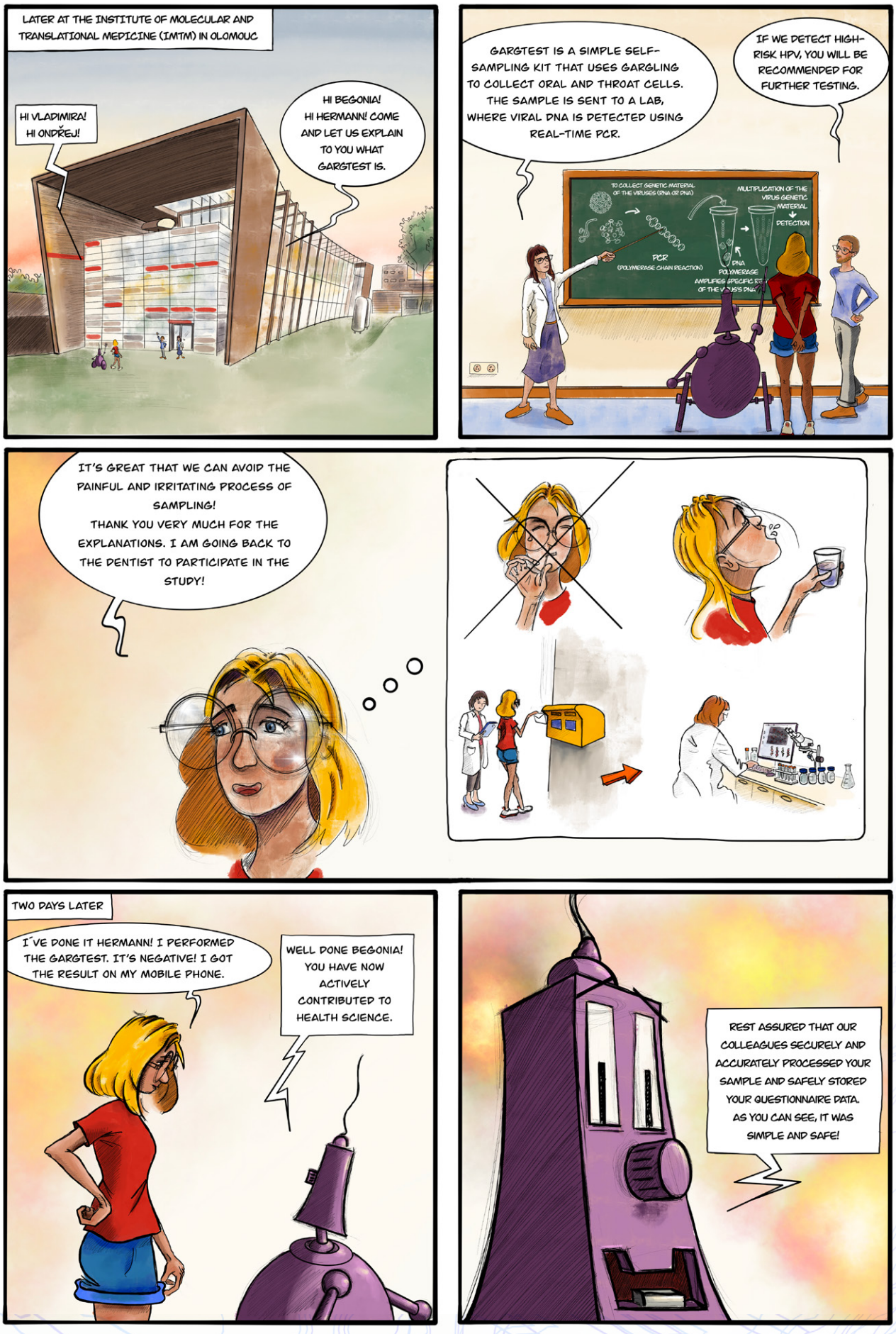

HERMANN & BEGONIA THE GARGTEST
THAT'S PERFECT! NO CAVITIES TODAY. BY THE WAY, HAVE YOU HEARD ABOUT THE GARGTEST FOR DETECTION OF HUMAN PAPILLOMAVIRUS INFECTION, HPV?
HAAAKK! HOCCHH! YAHHH!
P.TROUILLAS


LATER, IN THE CITY CENTRE OF OLOMOUC.
LOOK, HERMANN, MY DENTIST GAVE ME THIS PAMPHLET. I CAN TAKE PART IN A STUDY BY COLLECTING A SAMPLE BY GARGTEST AND FILLING IN A QUESTIONNAIRE AT THE DENTIST'S. BUT I DON'T UNDERSTAND EVERYTHING.
INTERESTING! SHOW ME.


OH, VERY INNOVATIVE. WITH JUST A GARGLE, THE TEST CAN DETECT HPV. AND IF YOU TAKE PART IN THE STUDY, YOU CAN CONTRIBUTE TO THE PREVENTION OF OROPHARYNGEAL CANCER.
I HAVEN'T HEARD OF THIS VIRUS BEFORE. IS IT COMMON OR DANGEROUS?
GARGTEST
SELF-SAMPLING INSTRUCTIONS
GARGTEST
Electronic test order form
1
Before using the test fill out the electronic test order form available on the GARGTEST website.
2
Carefully open the box and remove all it's contents. Do not damage the box as it will be used to transport your sample back to the laboratory or collection point.
3
5 ml
Fill tap water into the enclosed measuring cup to the 5 ml line.
4
Take a deep breath and cough. This will increase the possibility of infection detection in the lower respiratory tract.
5
Pour the contents of the measuring cup into your mouth – do not swallow. If you accidentally swallow, it doesn't matter simply repeat the procedure from step 3.
6
Gargle from 20 to 30 seconds. You can gargle intermittently. However, keep minimum recommended gargling time.
7
Spit the contents of your mouth into the measuring cup.
8
Carefully pour the liquid into the enclosed plastic tube. The tube contains stabilizing powder which you must not spill.
9
Close the tube carefully and shake. Write your name and date of birth (non-Czech nationals only) on the label.
10
Place the packaged tube with the absorbent pad into the smaller bag and seal it.
11
Place the small bag into the larger outerbag, seal and place in the undamaged box and close it. Take the box to a sampling point, a collection point, your physician or laboratory.


HPV IS A WIDESPREAD, SEXUALLY TRANSMITTED VIRUS. IN THE MAJORITY OF CASES, THE INFECTION IS ASYMPTOMATIC. HOWEVER, IN SOME CASES, IT CAN LEAD TO CANCER BY TRIGGERING UNCONTROLLED CELL GROWTH.
THE VIRUS ENTERS INTO CELLS THROUGH THE MEMBRANES
MEMBRANE
THE VIRUS USES THE HOST CELLS MACHINERY TO REPLICATE MANY TIMES
IT TRIGGERS UNCONTROLLED CELL GROWTH -> CREATION OF CUTANEOUS/ MUCOSAL CANCER CELLS


HPV CAN CAUSE CERVICAL AND OROPHARYNGEAL CANCER. SINCE IT'S USUALLY SYMPTOMLESS, IT SPREADS VERY EASILY – THAT'S WHY EARLY DETECTION OF PERSISTENT INFECTIONS IS SO IMPORTANT.
NOW, LET'S MEET OUR FRIENDS COLLABORATING WITH CATRIN, WHO HAVE CONTRIBUTED TO THE DEVELOPMENT OF THE GARGTEST.


LATER AT THE INSTITUTE OF MOLECULAR AND TRANSLATIONAL MEDICINE (IMTM) IN OLOMOUC
HI VLADIMIRA! HI ONDŘEJ!
HI BEGONIA! HI HERMANN! COME AND LET US EXPLAIN TO YOU WHAT GARGTEST IS.
GARGTEST IS A SIMPLE SELF-SAMPLING KIT THAT USES GARGLING TO COLLECT ORAL AND THROAT CELLS. THE SAMPLE IS SENT TO A LAB, WHERE VIRAL DNA IS DETECTED USING REAL-TIME PCR.
IF WE DETECT HIGH-RISK HPV, YOU WILL BE RECOMMENDED FOR FURTHER TESTING.
TO COLLECT GENETIC MATERIAL OF THE VIRUSES (RNA OR DNA)
MULTIPLICATION OF THE VIRUS GENETIC MATERIAL
DETECTION
PCR (POLYMERASE CHAIN REACTION)
DNA POLYMERASE
IT'S GREAT THAT WE CAN AVOID THE PAINFUL AND IRRITATING PROCESS OF SAMPLING!
THANK YOU VERY MUCH FOR THE EXPLANATIONS. I AM GOING BACK TO THE DENTIST TO PARTICIPATE IN THE STUDY!
TWO DAYS LATER
I´VE DONE IT HERMANN! I PERFORMED THE GARGTEST. IT'S NEGATIVE! I GOT THE RESULT ON MY MOBILE PHONE.
WELL DONE BEGONIA! YOU HAVE NOW ACTIVELY CONTRIBUTED TO HEALTH SCIENCE.
REST ASSURED THAT OUR COLLEAGUES SECURELY AND ACCURATELY PROCESSED YOUR SAMPLE AND SAFELY STORED YOUR QUESTIONNAIRE DATA. AS YOU CAN SEE, IT WAS SIMPLE AND SAFE!

Univerzita Palackého
v Olomouci

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