

INSTITUTE OF BIOORGANIC CHEMISTRY
POLISH ACADEMY OF SCIENCES
COMPENDIUM

2023



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2023



INSTITUTE OF BIOORGANIC CHEMISTRY
Polish Academy of Sciences



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Prof. MAREK FIGLEROWICZ

Director

Our mission is to:

- conduct interdisciplinary research on biological systems at various levels of their organization, utilizing advanced approaches applied in the fields of chemical, biological, and computer science,
- undertake efforts to preserve the highest quality and innovation of conducted research, with special emphasis on their relevance to society,
- promote scientific achievements and ensure wide access to reliable knowledge.

A handwritten signature in blue ink, which appears to read 'M. Figlerowicz', written in a cursive style.



**LUIZA HANDSCHUH, PhD, DSc
Assoc. Prof.**

Deputy Director for Scientific Affairs



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Chair of the Scientific Council



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Deputy Chair of the Scientific
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JOANNA BANASIAK, PhD

Secretary of the Scientific Council

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Prof. Paweł Bednarek

Prof. Jacek Błażewicz

Ordinary member of the PAS

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Prof. Marek Figlerowicz

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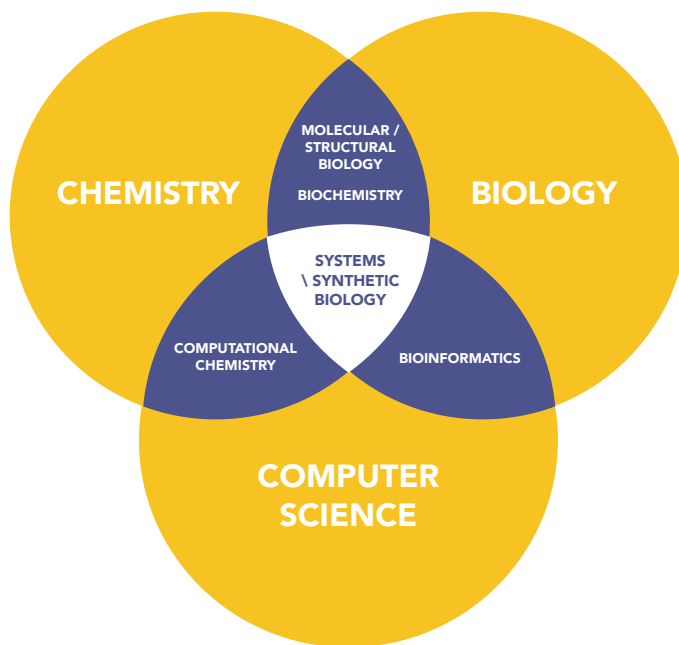
VISION AND DEVELOPMENT STRATEGY

IBCH PAS VISION

In the coming years, the Institute should become one of the leading European scientific centers specializing in interdisciplinary and transdisciplinary research on living organisms at various levels of their organization.

The distinguishing feature of IBCH PAS, compared to other national and international scientific institutions, is and should still be its interdisciplinary nature. Therefore, we should strive to strengthen it and ensure the balanced development of research in the fields of chemistry, biology, and informatics.

Our scientific activity should particularly focus on areas common to these disciplines.



At IBCH PAS, research and development activities are conducted in the fields of chemical, biological, and informatics science.

THE STRATEGIC GOALS OF IBCH PAS ARE THE FOLLOWING:

- maintaining the Institute's leading position in the country in the field of life sciences,
- strengthening the interdisciplinary nature of research as a distinguishing element of the Institute,
- enhancing the international position and competitiveness of IBCH PAS,
- strengthening and further developing the research potential of the institution.



IBCH PAS HISTORY

The origins of the Institute date back to the mid-1950s, when two specialized laboratories of the Polish Academy of Sciences (PAS) operated within the universities in Poznań: the Laboratory of Alkaloids led by Prof. Jerzy Suszko and the Laboratory of Plant Biochemistry headed by Prof. Stefan Barbacki. In 1969, both laboratories merged to form the Department of Stereochemistry of Natural Products PAS (hereinafter referred to as DSNP PAS), affiliated with the Institute of Organic Chemistry PAS in Warsaw. The head of the new department became Prof. Maciej Wiewiórowski.

Initially, the research conducted in the Department focused mainly on various aspects of the structural chemistry of alkaloids. However, shortly after its establishment, Prof. Wiewiórowski decided on a radical change in the research expertise, shifting towards more promising areas involving the chemistry and biology of nucleic acids. This has remained the Institute's

primary research focus to this day. In 1974, the Department was moved from Collegium Chemicum of Adam Mickiewicz University (AMU) to a new location at Z. Noskowskiego Street. A group of doctoral students who gathered around Prof. Wiewiórowski became the stem of the scientific staff. The Department established extensive cooperation with renowned foreign institutions, where its employees undertook long-term scientific internships.

In 1980, DSNP PAS, still headed by Prof. Maciej Wiewiórowski, gained independence and was renamed the Department of Bioorganic Chemistry PAS. The newly formed institution employed 44 individuals, including 19 researchers. In recognition of the outstanding scientific and organizational achievements of the institution, on February 6, 1988, the Prime Minister decided to transform the Department into the Institute of Bioorganic Chemistry, Polish Academy of Sciences (IBCH PAS). At that time, the

scientific staff of the Institute numbered 54, including 10 professors and associate professors, and the Institute employed a total of 121 people. The Institute's structure comprised nine specialized research laboratories. Also in 1988, following Prof. Maciej Wiewiórowski's retirement, Prof. Andrzej B. Legocki was appointed as the Director of IBCH PAS. Prof. Jerzy Pawełkiewicz was elected as the first Chair of the IBCH PAS Scientific Council.

In the following years, the Institute experienced dynamic development. In 1992, a new building for the Poznań Science Center and a modern greenhouse were completed. The first investment was financed by the State Committee for Scientific Research, and the second by the Foundation for Polish-German Cooperation. In 1993, the Poznań Supercomputing and Networking Center (PSNC) was established as an affiliate of the Institute, led by Prof. Jan Węglarz and his deputy, Dr. Maciej Stroiński.



Since 1993, IBCH PAS has been entitled to confer doctoral and habilitation degrees in the field of chemistry, in the discipline of chemistry or biochemistry, which led to the introduction of the Partnership-based Doctoral Program of the IBCH PAS in 1994. By 1995, IBCH PAS employed 150 people, including 78 in scientific positions (among others, 10 professors and 6 associate professors) and 25 PSNC employees. The Doctoral Program enrolled 28 students.

In 2003, Prof. Andrzej B. Legocki was appointed as the President of the Polish Academy of Sciences. Prof. Wojciech T. Markiewicz became the new Director of IBCH PAS, holding this position for two four-year terms until November 30, 2011.

As a result of a joint initiative by IBCH PAS and the Poznań University of Technology, the European Center for Bioinformatics and Genomics was established in 2011. In the same year, Prof. Marek Figlerowicz was appointed as the new Director of IBCH PAS for three consecutive terms.

In 2014, the Ministry of Science and Higher Education awarded IBCH PAS the prestigious status of the Leading National Research Center (KNOW) in biological sciences.

In 2015, the new headquarters of PSNC were established. The Polish Optical Internet Research Center was located in a complex of buildings at Jana Pawła II Street no. 10 in Poznań. Additionally, IBCH PAS acquired a historic townhouse located in the neighborhood of the conference center at Wieniawskiego Street no. 21/23. According to the plan, the building will house the IBCH PAS Center for Innovation and Education (CIES).



In 2016, IBCH PAS received the European “HR Excellence in Research” award, and a year later, as part of the evaluation of scientific units conducted by the Ministry of Science and Higher Education for the years 2013-2016, it obtained the highest category A+.

In 2019, five units signed an agreement to establish the Poznań Doctoral School of the Institutes of the Polish Academy of Sciences (PDS IPAS). IBCH PAS became the leader of the consortium, which also included the Institute of Dendrology PAS, the Institute of Molecular Physics PAS, the Institute of Human Genetics PAS, and the Institute of Plant Genetics PAS. At the same time, recruitment to the Partnership-based Doctoral Program of the IBCH PAS was completed. In the same year, the Central Commission for Academic Degrees and Titles granted IBCH PAS the right to confer doctoral and habilitation degrees in the biological sciences. On July 1, 2019, Cezary Mazurek, PhD, Eng, was appointed as the Director’s Plenipotentiary for PSNC, and Krzysztof Kurowski, PhD, Dsc, Eng, was appointed as his deputy.

In 2020, a few days after the first case of COVID-19 appeared in Poland, the Viral Support Group was convened at IBCH PAS. The group provided comprehensive assistance to the Provincial Sanitary and Epidemiological Station in Poznań in performing diagnostic tests and subsequently began developing its own genetic tests for detecting SARS-CoV-2 infection. Thanks to collaboration with national companies, the production of MediPAN tests was quickly implemented, making our country independent of foreign supplies. The tests developed at IBCH PAS were among the most sensitive, cost-effective, and fastest tests available on the Polish market. All members of the Viral Group were honored with high state decorations bestowed upon them in an extraordinary manner.

In 2022, the Minister of Education and Science announced the results of the categorization of national scientific units for the years 2017–2021. IBCH PAS achieved the category A+ in the disciplines of biological sciences, A+ in the discipline of chemical sciences, and A in the discipline of information and communication technology. In the



same year, IBCH PAS became the owner of the palace-park ensemble in Turew, which will serve as a branch of the IBCH PAS CIES. Additionally, an agreement was signed for PSNC to join the IBM Quantum Network, leading to the establishment of the first Central-Eastern European quantum computing hub in Poznań.

In 2023, PSNC won a competition to install one of the first six European quantum computers in Poznań.

Currently, the IBCH PAS is one of the leading scientific institutions in Poland. Its distinctive feature, unique in Poland and Europe, is its interdisciplinary nature; the Institute is conducting interdisciplinary and transdisciplinary research in the fields of chemistry, biology, bioinformatics, and informatics. IBCH PAS employs almost 900 people, with an additional 70 doctoral students conducting their research as part of the Partnership-based Doctoral Program of IBCH PAS and the Poznań Doctoral School of IPAS. The Institute operates 28 scientific departments and 12 specialized laboratories. In the PSNC structure, there are 16 technical departments organized into 4 divisions. IBCH PAS is one of the national leaders in obtaining national and foreign grants, particularly from European sources. In 2004, 2010, 2016, 2018, and 2020, IBCH PAS was honored with the "Crystal Brussels" award for outstanding achievements in the implementation and promotion of research and innovation programs of the European Union.



SHORT BIOGRAPHY OF IBCH PAS FOUNDER

PROFESSOR MACIEJ WIEWIÓROWSKI

Prof. Maciej Wiewiórowski (1918–2005) was a Polish chemist, an ordinary member of the PAS, one of the most distinguished Polish scientists of the second half of the 20th century. He mentored dozens of master's and thirty-eight doctoral students, most of whom obtained professorial titles.

Born on August 24, 1918, in Bagatelka, near Września, he began his chemical studies at the University of Poznań at the age of 18. World War II interrupted his studies, during which he fought in the ranks of the Home Army (AK). After the war, he completed his studies and began his scientific work at the Higher School of Economics (HSE) in Poznań. In 1950, under the supervision of Prof. Jerzy Suszko, he obtained his doctoral degree, and in 1954, became an assistant professor and took over the leadership of the Department of General Chemistry HSE.

Following his foreign scientific internships, Prof. Wiewiórowski became a pioneer and advocate of modern instrumental analysis methods in Poland. In 1959, he became an associate professor and took over the management of the Department of Ste-

reochemistry and Organic Spectrochemistry at Adam Mickiewicz University (AMU). In 1969, he obtained the title of full professor, and in the same year, was appointed the director of the Institute of Chemistry AMU.

As early as 1955, he began collaborating with the Polish Academy of Sciences, and was entrusted with the management of the Biochemical Laboratory of the Plant Breeding Department (1955–60) and the Laboratory of Biochemistry and Alkaloid Structure at the Institute of Biochemistry and Biophysics PAS (1960–69). In 1969, he became the head of the Department of Stereochemistry of Natural Products PAS (DSNP PAS), and five years later, he relocated the Department to the premises at Z. Noskowskiego Street 12.

Shortly after establishing DSNP PAS, Prof. Wiewiórowski delved into a new area of research: nucleic acid chemistry. Conferences on this topic, organized by him, attracted the most distinguished scientists from around the world, e.g., C.B. Reese, F. Cramer, N.J. Leonard, H. Köster (Kiekrz 1974), H. Vorbrüggen, E. Ohtsuka, W. Sanger, J. Van Boom, and R.L. Letsinger (Dymaczewo 1976). In 1984, he chaired the organizing committee of the IUPAC International Sym-

posium on Natural Products Chemistry in Poznań, and from 1985 to 1988, served as president of the Polish Chemical Society.

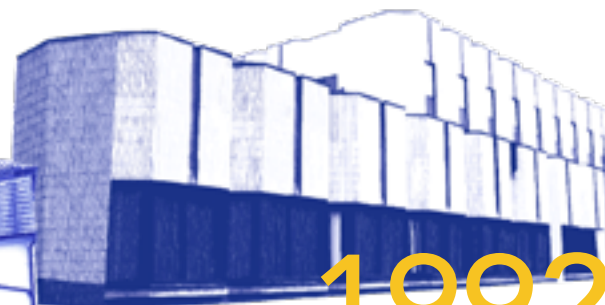
In July 1980, the DSNP PAS gained independence and changed its name to the Department of Bioorganic Chemistry PAS. Prof. Wiewiórowski led this Department until its transformation into the Institute in 1988. Shortly after this event, he retired.

His most important roles included serving as Vice-Rector for Research at AMU (1968–73), Member of the Presidium PAS (1969–83), Vice-President PAS (1981–83), and Chair of the Central Qualification Committee for Scientific Cadres (1973–79). Among numerous decorations and honors, he was awarded the degree of doctor honoris causa from the Poznań Academy of Economics (1986) and the Commander's Cross with Star of the Order of Polonia Restituta (2000).

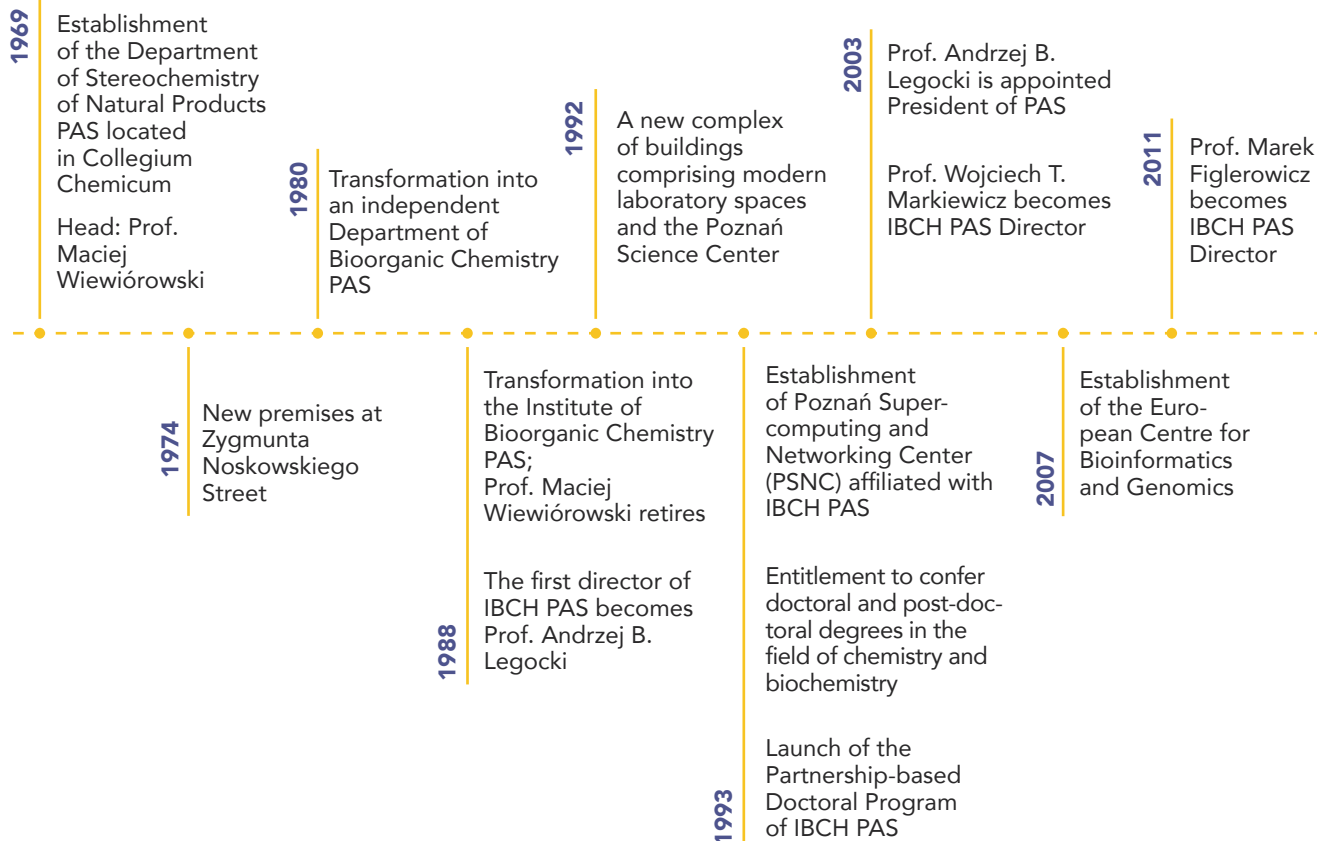
Prof. Wiewiórowski passed away on March 30, 2005, in Poznań. His legacy includes numerous publications but, above all, the school he created and the research techniques he left for his students and subsequent generations of scientists.

TIMELINE

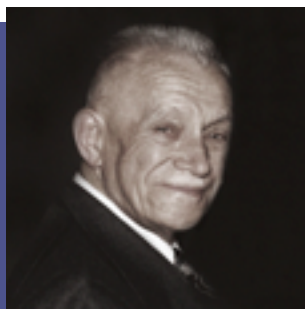
1974



1992



**Prof.
MACIEJ
WIEWIÓROWSKI**
Director
1969-1988



**Prof.
ANDRZEJ B.
LEGOCKI**
Director of the Institute
1988-2003



2015

2022



2014

IBCH PAS receives the status of the Leading National Research Center (KNOW) for the period 2014 - 2018

2016

Granting the HR Excellence in Research logo to the Institute by the European Commission

2018

Joining the EU-OPENSREEN ERIC consortium

2020

Establishment of the Viral Support Group

Elaboration of COVID-19 diagnostic tests

2023

Establishment of the IBCH PAS Center for Innovation and Education

Completion of the Genomic Map of Poland

Development of the MOSAIC Platform
Establishment of the Bioimaging Platform

2015

Acquisition of the townhouse at Henryka Wieniawskiego Street 21/23

Establishment of the new headquarters of PSNC at Jana Pawła II Street

2017

Following the scientific activity evaluation for 2013 - 2016, the Ministry of Science and Higher Education awards the Institute an A+ category

2019

The Poznań Doctoral School of Institutes of the Polish Academy of Sciences (led by IBCH PAS) commences its activities

Entitlement to confer doctoral and post-doctoral degrees in the field of biological sciences

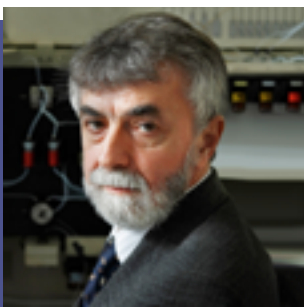
2022

Following the scientific activity evaluation for 2017 - 2021, the Ministry of Education and Science awards the Institute the following categories:
A+ in the field of biological sciences
A+ in the field of chemical sciences
A in the field of information and communication technology

IBCH PAS becomes the owner of the palace park complex in Turew

**Prof.
WOJCIECH T.
MARKIEWICZ**

Director of the Institute
2003-2011



**Prof.
MAREK
FIGLEROWICZ**

Director of the Institute
2011-2023

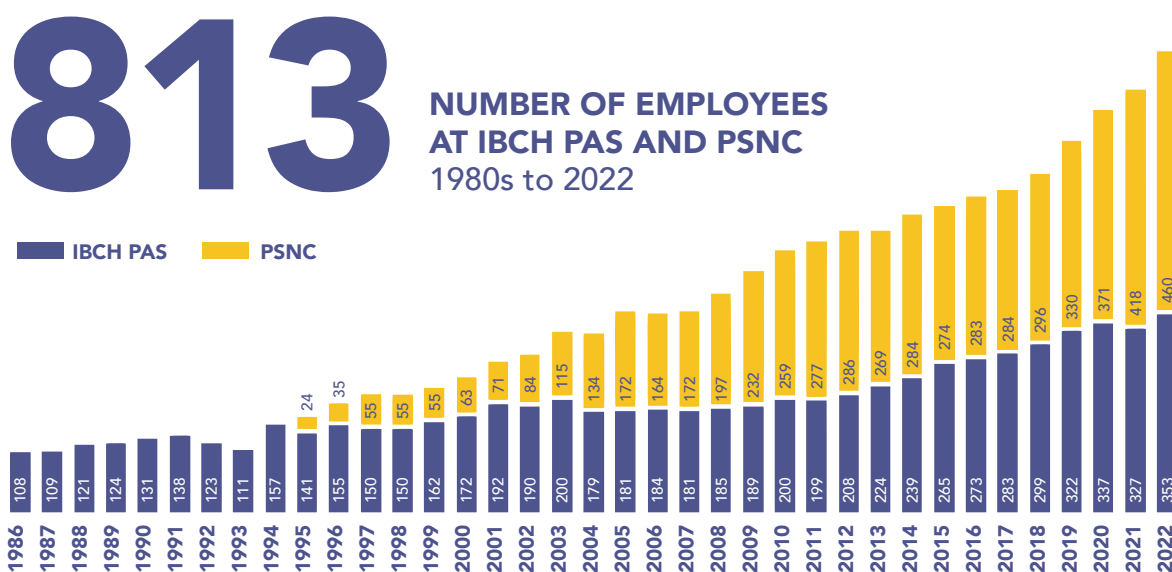


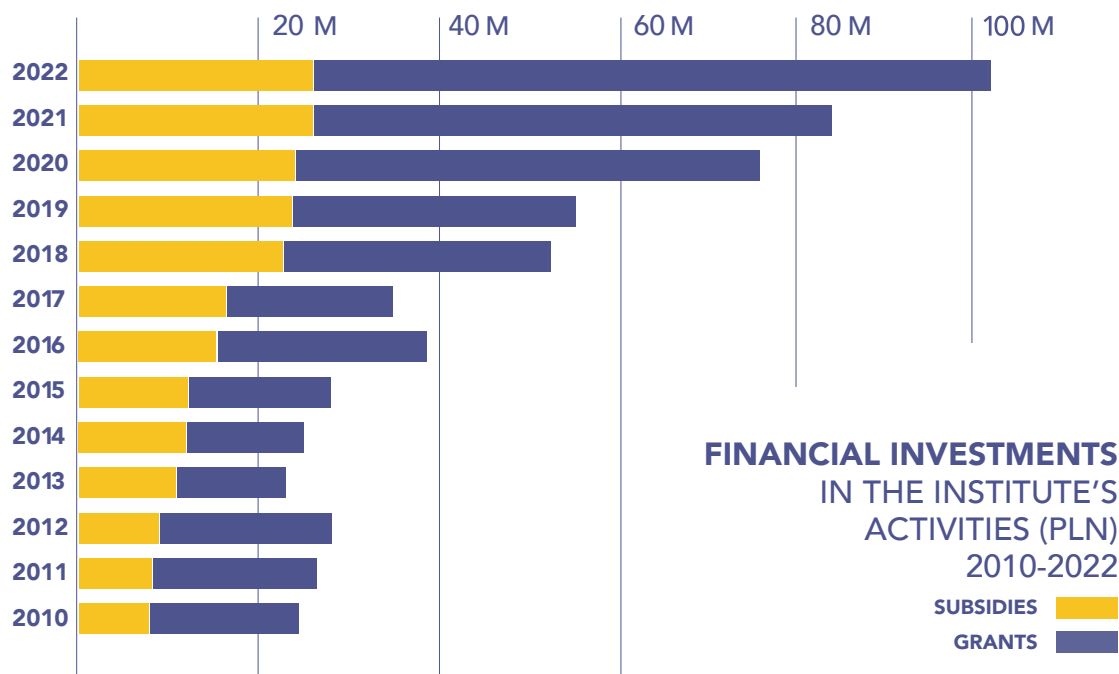


INSTITUTE IN NUMBERS

Currently, IBCH PAS employs almost 900 staff members, with an additional 70 doctoral students conducting their research as part of the Partnership-based Doctoral Program of IBCH PAS and the Poznań Doctoral School of IPAS. Within the Institute, there are 28 scientific departments and 12 specialized laboratories. The PSNC comprises 16 departments organized into 4 divisions.

The Scientific Council of IBCH PAS is entitled to confer doctoral and habilitation degrees in the field of natural sciences, in the disciplines of chemical sciences and biological sciences. Over 40 habilitation degrees (DSc) and over 220 doctoral degrees (PhD) have been awarded so far.





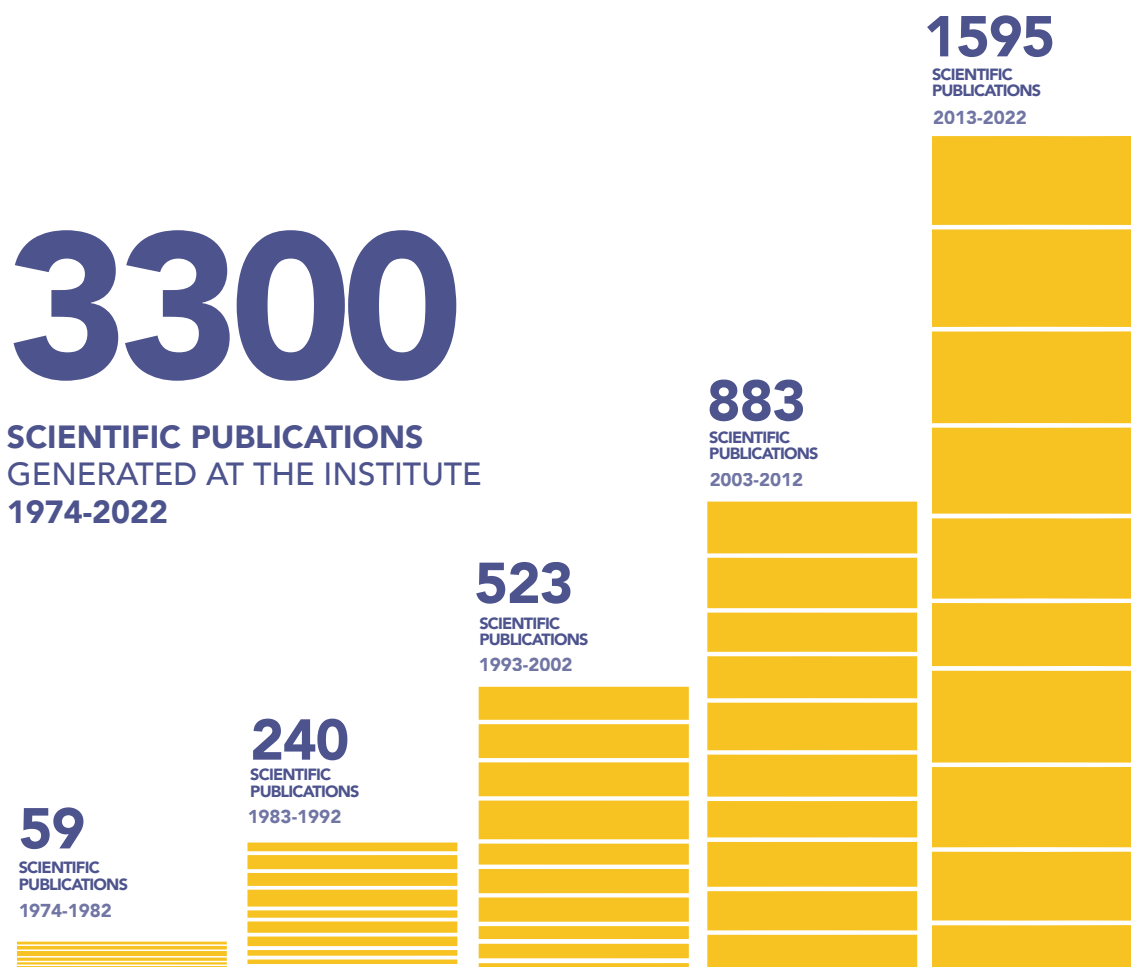
621 760 000 PLN

IBCH PAS is one of the country leaders in obtaining national and international grants. Around 200 scientific projects are implemented annually at IBCH PAS. For outstanding achievements in the implementation and promotion of research and innovation programs of the European Union, IBCH PAS has been awarded the “Crystal Brussels”

prize five times. The result of the implementation of numerous projects is the publication of approximately 200 papers annually. Each year, over 50 students pursuing bachelor’s and master’s degrees undergo internships at IBCH PAS, with some of them conducting their diploma theses under the supervision of the Institute’s employees.

IBCH PAS is the organizer and co-organizer of numerous national and international conferences and scientific meetings. Over 15 such events are organized annually. Among the recurring events, we can mention Science on Vacation (in Jurata), Brain Awareness Week, and Researchers' Night.

The Institute publishes two scientific journals, "BioTechnologia" and "Computational Methods in Science and Technology," as well as books. Over the course of the 30 years of operation of Scientific Publishers OWN, over 500 publications have been released.



COLLABORATION OF IBCH PAS WITH FOREIGN INSTITUTIONS



CANADA	University of British Columbia McGill University	INDIA	University of Calcutta
UNITED STATES	University of Louisville University of Rochester University of Georgia Florida Atlantic University Baylor College of Medicine Harvard Medical School National Cancer Institute, Frederick Argonne National Laboratory New York State University	CHINA	Liaoning University of Technology Institute of Plant Physiology and Ecology, Chinese Academy of Sciences University of Hong Kong
ARMENIA	Yerevan State University	JAPAN	Kyoto University Osaka University
IRAN	Shiraz University	AUSTRALIA	Flinders University, Adelaide University of Sydney University of Melbourne
		NEW ZEALAND	University of Otago



IRELAND	University College Dublin
UNITED KINGDOM	Wellcome Trust Sanger Institute European Bioinformatics Institute University of Edinburgh Scotland's Rural College
SPAIN	Polytechnic University of Madrid University of Valladolid
PORTUGAL	Center for Neuroscience and Cell Biology, University of Coimbra
FRANCE	INSEEC Business School University of Strasbourg Institut Curie National Institute of Health and Medical Research (INSERM) François Jacob Institute of Biology Institute of Genetics and Molecular and Cellular Biology (IGBMC), Ostwald
NORWAY	University of Oslo University Centre in Svalbard
SWEDEN	Swedish University of Agricultural Sciences
FINLAND	University of Helsinki
DENMARK	University of Southern Denmark
NETHERLANDS	Erasmus University Medical Center Rotterdam
AUSTRIA	Wilhelminen Cancer Research Institute

GERMANY	Bergakademie Freiberg University of Technology Albert Ludwig University of Freiburg ElementZero Biolabs, Berlin Mittweida University of Applied Sciences Ruhr University Bochum University of Tübingen Max Planck Institute for Plant Breeding Research Max Delbrück Center for Molecular Medicine Leibniz Institute for Primate Research University of Cologne
ITALY	University of Trento University of Udine University of Milan Sapienza University Neuromed, Venafrò
SWITZERLAND	F. Miescher Institute for Biomedical Research Lausanne University Hospital University of Fribourg University of Zurich Institute of Molecular Plant Biology in Zurich Swiss Federal Institute of Technology in Zurich
UKRAINE	Lviv National Medical University
GREECE	University of Athens



ACTIVITY FOR THE NATIONAL AND INTERNATIONAL COMMUNITY



The Institute's continuous focus on maintaining a high quality of scientific staff and keeping research potential at a high, global level enables not only efficient scientific activity but also rapid response to emerging challenges such as the crisis situation associated with the COVID-19 pandemic. At the onset of the epidemic in Poland, employees and doctoral students of the

Institute, widely known as the “Viral Support Group,” actively engaged (as volunteers) in diagnosing infections with the SARS-CoV-2 virus. The Institute also utilized its scientific potential to create a Polish test for virus detection (MediPAN) and swiftly commercialized it. The test’s effectiveness, comparable to others on the market, and its lower price are excellent confirmation of the Institute’s capabilities in conducting R&D activities and establishing effective cooperation with the business world. The President of the Republic of Poland, upon the Minister of Science and Higher Education’s recommendation, awarded the Members of the “Viral Support Group” the highest state decorations for their merits in scientific research activities. The selection of the Institute as the national node for the European initiative “Covid-19 Portal,” coordinated by the European Bioinformatics Institute within the European Molecular Biology Laboratory, was further evidence of the Institute’s recognition for its efforts in combating the COVID-19 pandemic.



In light of Russia’s aggression against Ukraine, employees of the Institute and PSNC actively engaged in organizing assistance for refugees as well as the scientific community in Ukraine. Here are examples of actions taken:

- technical support for information services for refugees from Ukraine
- employment and internships for scientists from Ukraine
- temporary accommodation with meals for refugees in the PSNC building (Zwierzyniecka)
- collection of donations for individuals accommodated on-site and those staying in Ukraine
- monetary fundraising for refugee needs; financing purchases including school supplies and textbooks for learning Polish
- support by IBCH PAS employees in translating conversations and documents during formalities
- medical duties at medical points in Przemyśl by PSNC employees who were volunteers and rescuers of the Polish Red Cross Rescue Group in Poznań, providing round-the-clock medical and humanitarian assistance to refugees, participating in the preparation and distribution of humanitarian aid by the Polish Red Cross in Poznań
- active assistance in finding employment and accommodation for refugees
- organization of workshops for Ukrainian children, Polish language lessons, and psychological consultations
- conducting free COVID-19 tests for Ukrainian citizens in the PANgen laboratory.





STRATEGIC PROJECTS

EUROPEAN CENTER FOR BIOINFORMATICS AND GENOMICS GENOMIC MAP OF POLAND

The **Genomic Map of Poland (GMP)** is a specialized infrastructure housing databases containing approximately 6,000 genome sequences of Polish inhabitants, along with bioinformatics tools for large-scale genome analysis. The components of GMP include:

Polish Reference Genome – created based on a very detailed analysis of genomes from 30 individuals, including 10 trios in a child-mother-father scheme. This analysis was conducted using several complementary genome sequencing technologies, including those generating short and long reads;

Genetic Variability Map – a collection of data and tools for their analysis, developed based on the sequencing results of over 3,000 genomes of randomly selected Polish inhabitants from across the country;

Phen-Gen – a collection of data and tools for analyzing associations between phenotype and genotype, created for over a thousand individuals whose genome sequences and additional information regarding their physical characteristics and health status were collected (e.g., blood morphology, chest X-rays, body composition analysis, anaerobic capacity tests, exertion tests);



Eth-Gene – a collection of data and tools for analyzing genetic variability in small populations (e.g., ethnic minorities), created based on approximately 1,000 whole-genome DNA sequences from representatives of ethnic and regional minorities residing in Poland: Silesians, Kashubians, Highlanders, Lemkos, and Poznań Barmbers. Additionally, within the Highlanders minority, Podhale, Pieniny, Orawa, Spiš, and Ochotnica Highlanders may be distinguished.

The DNA samples for the research were collected from blood or saliva, either from existing repositories or from volunteers participating in the project. Study participants received reports on their maternal (women and men) and paternal (only men) origin based on determined haplogroups of mitochondrial DNA and Y chromosome.

The project's implementation will contribute to increasing the overall knowledge of human population genetics and enable a deeper understanding of the nature of genetic variability among Polish inhabitants. It will also help create the conditions necessary for the development of personalized medicine and the establishment of new standards in preventive care, diagnostics, and healthcare. The reference databases developed as part of the project can serve as a reference point in all kinds of biological and medical research conducted on the Polish population. The developed tools will facilitate access to data and genomic analysis also for users who are not specialists in this field.



GMP is being developed as part of the project titled "European Center for Bioinformatics and Genomics". The project is co-financed by the European Union from the European Regional Development Fund under the Smart Growth Operational Program. The project, implemented by a consortium consisting of the Institute of Bioorganic Chemistry PAS and Poznań University of Technology, is led by Prof. Marek Figlerowicz.



GENOMIC
MAP OF
POLAND

EUROPEAN CENTER FOR BIOINFORMATICS AND GENOMICS ECBG MOSAIC

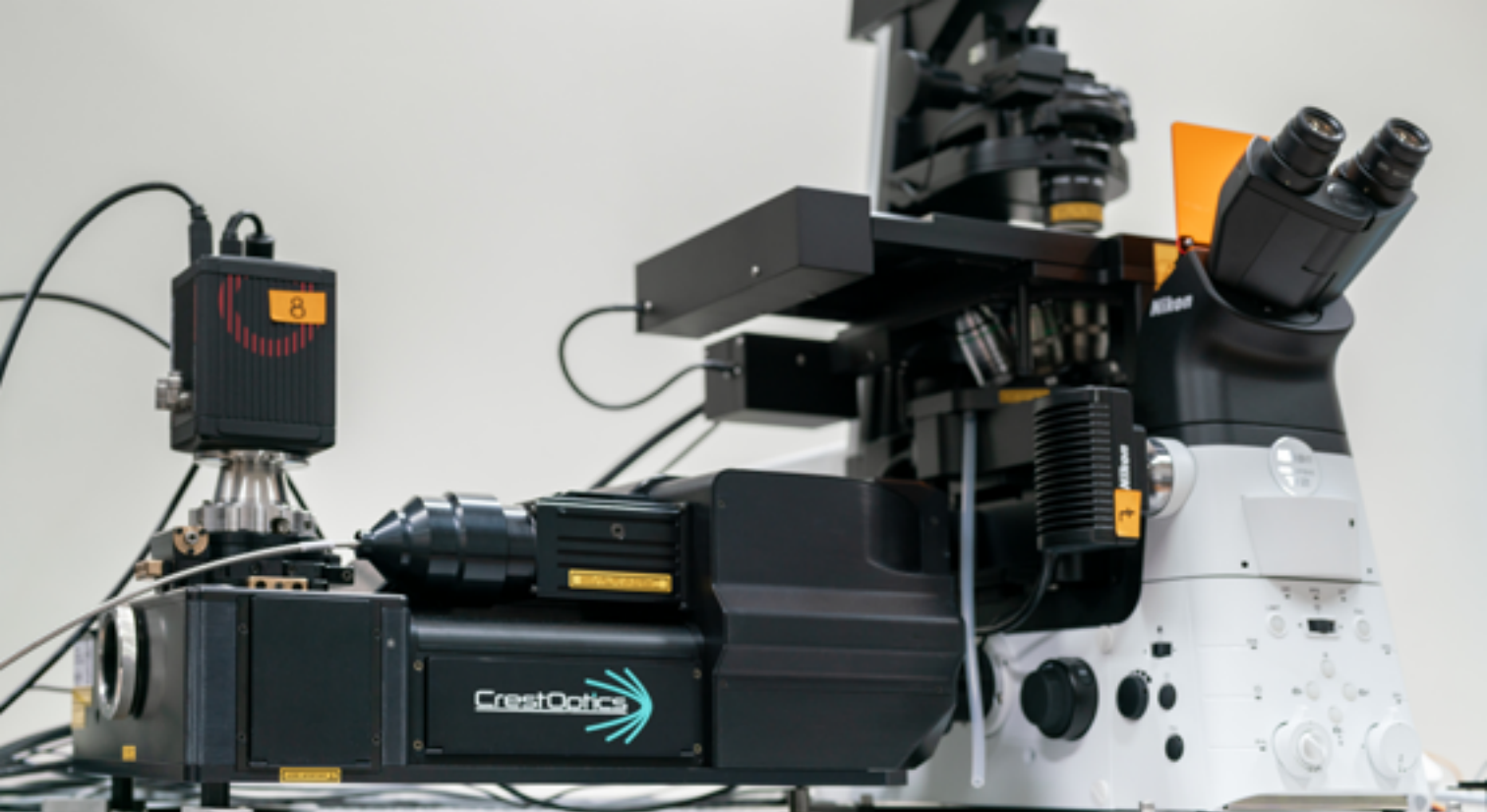
One of the fundamental challenges facing modern medicine is the effective use of information the increasingly abundant biomedical and clinical data. Technological advancements at the turn of the 20th and 21st centuries have introduced numerous new methods and techniques, enabling in-depth, multi-level analysis of the human body and its physiological processes. However, translating these newly engineered technologies into clinical practice is hindered by the lack of comprehensive approaches that can extract the most important elements from large and heterogeneous datasets and subsequently integrate them into one coherent picture.

The ECBG – European Center for Bioinformatics and Genomics – MOSAIC project addresses these challenges. Its strategic goal

is to create an advanced research platform enabling the acquisition of multidimensional biomedical and clinical data, their standardization, integration, and analysis using artificial intelligence algorithms to generate new knowledge and tools for widely accessible, personalized medicine. The English name of the platform, MultiOmicS and Artificial Intelligence for Clinical practice, abbreviated as MOSAIC, reflects the ultimate outcome of its operation – the comprehensive image of the functioning of the biological system (cells, tissues, organs, or the entire organism) composed of many seemingly unrelated data points.

The MOSAIC platform is open and universal, encompassing state-of-the-art scientific research equipment, unique multiomic and clinical databases, as well as advanced tools





for data analysis and visualization. The infrastructure created in this project will provide comprehensive solutions in the field of (epi)genomics, (epi)transcriptomics, and proteomics, as well as the analysis of clinical data, including imaging data, facilitating innovative biomedical research combining high-throughput multiomics and data analysis using artificial intelligence for both domestic and international research groups.

The project was co-financed by the European Union from the European Regional Development Fund. It was implemented by a consortium consisting of partners specializing in key areas for the functioning of the MOSAIC platform: the Institute of Bioorganic Chemistry, Polish Academy of Sciences (leader,

multiomics) and the affiliated Poznan Supercomputing and Networking Center (artificial intelligence, data analysis and sharing), Poznan University of Technology (artificial intelligence, data analysis), National Institute of Oncology Maria Skłodowska-Curie – National Research Institute, Branch in Gliwice (oncology), Stefan Cardinal Wyszyński National Institute of Cardiology – National Research Institute (cardiology). The project, led by Prof. Marek Figlerowicz, concluded in December 2023.



NEBI

NATIONAL RESEARCH CENTER FOR IMAGING IN THE BIOLOGICAL AND BIOMEDICAL SCIENCES

The project NEBI – National Research Center for Imaging in the Biological and Biomedical Sciences is part of an international initiative called Euro-Biolmaging. The main goal of the project is to establish an advanced infrastructure for multidimensional imaging of biological processes as well as collecting, processing, and sharing the acquired data.

As a part of the project, specialized infrastructure was created to enable bioimaging at all levels of organization of living systems, in particular: (i) biological and biomedical imaging using high-throughput techniques; (ii) imaging of cell and tissue structures and functions using high-resolution techniques; and (iii) modeling and visualization of the dynamics of complex processes. At IBCH

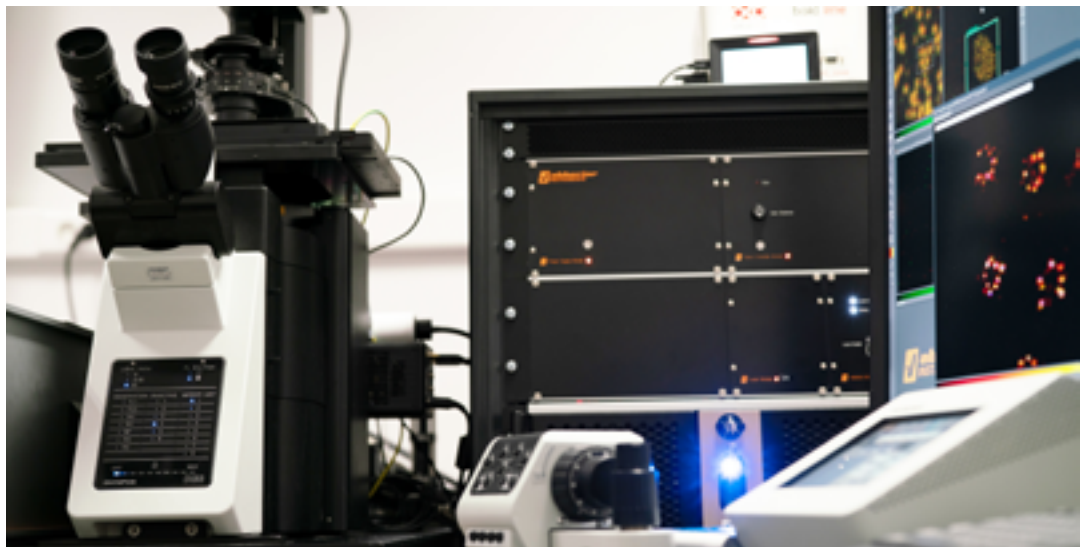
PAS, four specialized research stations have been established, including:

- Ultra-High-Resolution Microscopy
- Preparation of Cells for High-Throughput Parallel Multiomics Analyses
- High-Throughput Parallel Multiomics Analyses
- Mass Analysis of Low-Molecular Compounds

Additionally, the project created or implemented specialized bioinformatics toolkits:

- supporting automation of the process of advanced analysis of imaging data with visualization and semi-automatic interpretation of results;





- facilitating access to reference resources and automatically managed data processing schemes;
- enabling access to shared computing resources (with particular emphasis on new generation graphical hardware accelerators) and virtualization of access to computing resources dedicated to high-performance processing and analysis of image data in the HDA (High end Data Analysis) model;
- supporting the process of accessing and sharing data within research teams and cooperation between teams at the national and international level.

The infrastructure created as part of the project enables the development of a new strategy for imaging the changes that occur at various levels of cell or organism organization (molecular, subcellular, tissue, organ) in biological models of lifestyle diseases and

in material collected from patients. The data obtained and the tools created will allow a better understanding of both the molecular basis of diseases and the development of innovative therapies and diagnostic procedures. The newly established research infrastructure serves as a nationwide reference center for biological imaging, promoting knowledge exchange and providing IT support to other research centers and industrial partners not only in Poland but also abroad.

The project is co-financed by the European Union from the European Regional Development Fund under the Smart Growth Program. The consortium implementing the project includes the Nencki Institute of Experimental Biology, Polish Academy of Sciences; the Institute of Bioorganic Chemistry, Polish Academy of Sciences; and the affiliated Poznań Supercomputing and Networking Center.

CENTER FOR CHEMICAL BIOLOGY IBCH PAS

FORMERLY: CENTER FOR HIGH-THROUGHPUT SCREENING

The project is implemented, among others, as a part of the POL-OPENSREEN initiative, included in the Polish Research Infrastructure Road Map in 2014. Its goal is to create and make available unique infrastructure and expertise in the field of chemical biology, both to the scientific and business communities, in the country and around the world. As a part of this project, IBCH PAS is creating the most advanced system in Poland for identifying biologically active substances through high-throughput analysis of hundreds of thousands of chemical compounds (so-called libraries).



When Poland joined the EU-OPENSREEN ERIC (European Research Infrastructure Consortium) network as a founding member, IBCH PAS met the rigorous requirements set by an international team of experts and obtained the status of a partner (so-called Partner Site) of this consortium as one of three Polish units (along with the Institute of Medical Biology PAS in Łódź, the leader of the POL-OPENSREEN project, and the Institute of Biochemistry and Biophysics PAS in Warsaw). In 2018, the Ministry of Science and Higher Education awarded Polish representatives in EU-OPENSREEN a targeted financial subsidy for the expansion and launch of research infrastructure. The head of the awarded grant on behalf of IBCH PAS was Prof. Marek Figlerowicz.

Thanks to the received subsidy, the Center for Chemical Biology (CCB) was established at IBCH PAS, headed by Jacek Kolanowski, PhD, DSc. The Center possesses specialized and globally unique laboratories and an interdisciplinary team of experts with many years of international experience. One of the elements of the Center's infrastructure is AGAMEDE, a system combining auto-



mation with artificial intelligence, the originator and designer of which is Radosław Pilarski, PhD. The first prototype of the device was created as part of the project EPICELL, headed by Prof. Wojciech T. Markiewicz. The subsidy obtained from the Ministry of Science and Higher Education enabled the expansion of the AGAMEDE platform with additional devices, increasing the throughput and universality of the system. This financing also allowed the Center to expand its competences in the field of optimization of the so-called hits, including the use of medicinal chemistry and synthetic biology methods. As part of its activities, CCB offers access to expertise and infrastructure as well as substantive support in the fields of:

- developing molecular tests and performing high-throughput screening tests on biochemical and cellular models based on luminescence detection and multi-parameter high-throughput imaging;
- medicinal chemistry, including optimization of bioactive compounds using chemoinformatics and synthesis, semi-synthesis, and biosynthesis of dedicated compound libraries;
- development of new technologies as well as testing and preparation of application notes for modern research equipment;
- consulting in developing ideas, research plans, and preparing R&D projects.

The Center's goal in the coming years is to adapt the most modern and reliable tests and technologies to identify and optimize bioactive compounds and to discover the mechanisms of their action. Additionally, we are planning on constantly expanding the portfolio of services in cooperation with academic centers and business partners in Poland and around the world.

STRATEGIC PROJECTS

PLATFORM FOR DESIGNING, SYNTHESIS, AND TESTING OF RNA THERAPEUTICS AND VACCINES

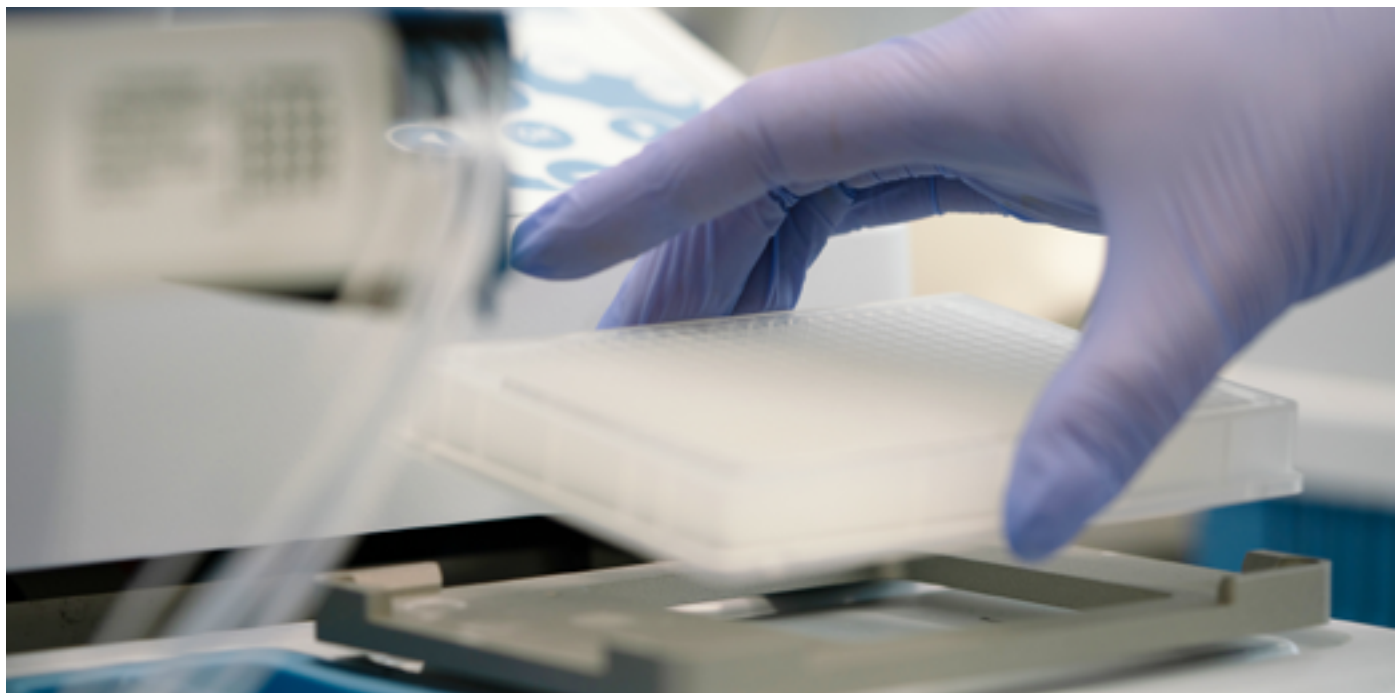
Since the birth of RNA technology, it has been accompanied by enormous expectations related to the practical use of RNA therapeutics and vaccines in medicine. Although the results obtained were very promising, they did not immediately lead to the implementation of a new class of therapeutics. For years, a difficult problem to solve was to ensure the high specificity of RNA activity, develop effective drug delivery methods, and ensure their safe use. For these reasons, only a dozen or so therapeutic RNAs are currently approved for use. RNA technology was used on a large scale only in 2020 to produce vaccines during the COVID-19 pandemic.



This achievement was based on the research of Katalin Karikó and Drew Weissman, Nobel Prize winners in 2023. These scientists developed chemical modifications that ensure the efficiency and safety of RNA vaccines. As a result of their mass use in many countries, including Poland, the COVID-19 pandemic was significantly limited. Next, the further development of RNA technology and its application in both therapy and medical prevention has been widely recognized as one of the priorities of global scientific research.

At the end of 2021, the IBCH PAS began the implementation of a 6-year project awarded under the Medical Research Agency competition for the development of innovative therapeutic solutions using RNA technology. The platform created as part of the project will be used to design, synthesize, and test innovative RNA therapeutics and vaccines.

As part of the work carried out at the Institute, a multifunctional platform is being created to support individual stages of creating various types of RNA molecules that can be used in the therapy and prevention of human diseases. The research will cover a wide range of activities necessary to produce therapeutic/vaccine RNAs, including the development of:



- databases and bioinformatic tools for their design,
- chemical and enzymatic synthesis procedures,
- optimal methods for delivering each type of RNA to cells and organisms,
- methods for assessing activity in cell culture conditions,
- methods for preclinical assessment in studies on animal models.

The final product resulting from the project will therefore be both a unique technological platform for the design and production of therapeutic/vaccine RNAs and a set of potential drugs. The project titled

“Development of a universal fast-response platform, based on RNA technology, ensuring the national drug and epidemiological safety” was created as part of a consortium with Polfa Warszawa S.A. It assumes the practical use of the Institute’s many years of experience in RNA research and the production capabilities of the largest pharmaceutical company in Poland.

The scientific manager of the project is Prof. Marek Figlerowicz. Teams involved in the implementation of the project are led by: Marcin Chmielewski, Maciej Figel, Agnieszka Fiszer, Luiza Handschuh, Marta Olejniczak, Katarzyna Rolle, Marta Szachniuk, Anna Urbanowicz, and Paweł Zmora.





SCIENTIFIC DEPARTMENTS

DEPARTMENT OF STRUCTURAL BIOINFORMATICS

RNA structure prediction and analysis | structural motifs | algorithms for molecular biology | databases and web applications

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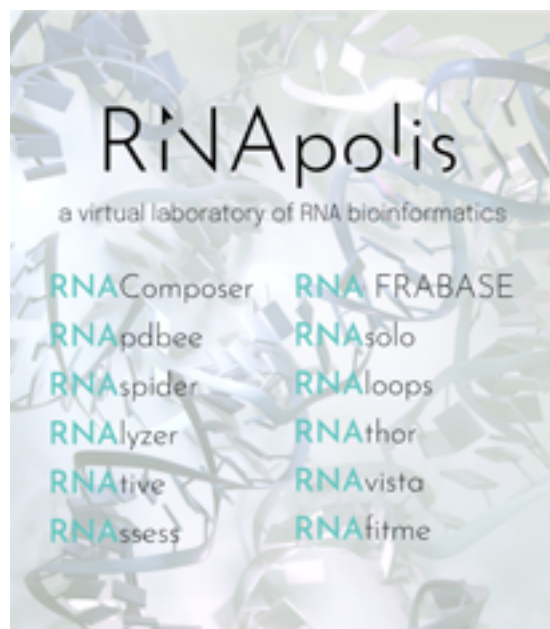
RESEARCH SCOPE

Molecular computational biology and bioinformatics. Ongoing research focuses on issues related to the analysis of biomolecule structures and their interactions, with a strong accent on RNA. This implies the formulation of new bioinformatics challenges, the solution to which is the mainstream of the Department's activities.

Our research aims to model complex problems in structural biology and develop and implement efficient combinatorial algorithms to analyze them. We use the latest methods and computer technologies and conduct *in silico* experiments comple-

mentary to the laboratory ones. The Department's flagship and most important achievement is RNAPolis, a virtual RNA bioinformatics laboratory bringing together more than 20 computational tools dedicated to RNA molecules. We also study quadruplex structures. As part of the SpaceTetrado project, we have developed a G4 database and tools for analyzing, classifying, and visualizing their structures.

As the RNAPolis group, we participate in world-wide blind prediction experiments RNA-Puzzles and CASP, where we predict 3D RNA structures in expert modeling and web server categories.



MAIN RESEARCH TOPICS

- Development of RNAPolis, a virtual RNA bioinformatics laboratory
- Development of computational systems (RNA FRABASE, RNAComposer, RNApdbee, RNAspider, ONQUADRO, WebTetrado, etc.)
- Modeling of 2D and 3D RNA structures
- Comparative analysis of structural data
- Annotation and classification of structure motifs present in RNA, i.e., pseudo-knots and quadruplexes



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RESEARCH PROJECTS

Feature exploration and modelling of quadruplex structures (NSC OPUS, PI: M. Szachniuk)

Predicting 3D RNA structures using Generative Adversarial Networks (NSC Preludium Bis, PI: M. Szachniuk)

Development of a universal fast-response platform, based on RNA technology, ensuring the national drug and epidemiological safety (Medical Research Agency, project implemented in the consortium, project leader: Polfa S.A. Pharmaceutical Works, principal investigator: M. Figlerowicz, task leader: M. Szachniuk)



SELECTED PUBLICATIONS

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Szachniuk M. RNApolis: computational platform for RNA structure analysis. FCDS 2019; 44:241-257

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Kudla M et al. Virxicon: a lexicon of viral sequences, Bioinformatics 2020, 36:5507-5513

Zok T et al. ONQUADRO: a database of experimentally determined quadruplex structures, NAR 2022; 50:D253-D258

Luwanski K et al. RNAspider: a webserver to analyze entanglements in RNA 3D structures, NAR 2022; 50:W663-W669

Schneider B et al. When will RNA get its AlphaFold moment? NAR 2023; 51:9522-9532

DEPARTMENT OF NUCLEIC ACIDS BIOENGINEERING

modified oligonucleotides | thermodynamics of non-canonical DNAs and RNAs | G-quadruplexes | aptamers | alternative splicing | anticancer therapy

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RESEARCH SCOPE

Development, preparation, and characteristics of new molecular tools based on nucleic acids and their analogues.

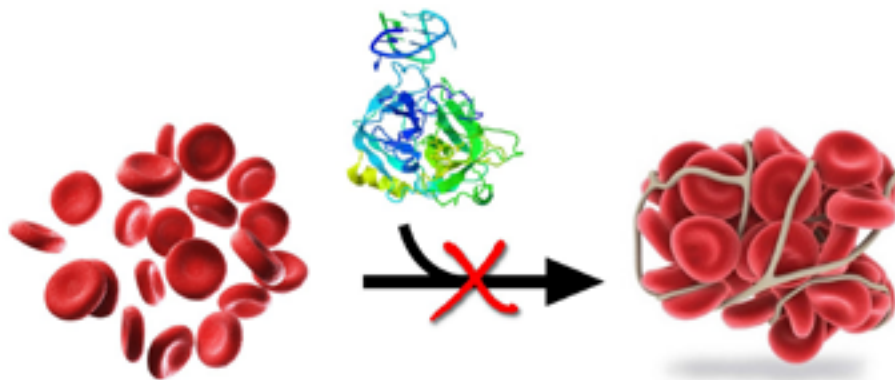
The variety of chemical modifications provides practically unlimited possibilities for controlled modulation of oligonucleotide physicochemical and biological properties, which can be applied as useful and highly specific diagnostic and therapeutic tools.

Our main activity focuses on G-quadruplexes and aptamers with anticancer and anticoagulant potential. In addition, we are developing research on the regulation of alternative splicing in cancer cells and investigating the effect of chemically modified gapmers in terms of their ability to induce targeted mRNA degradation. We are also

developing novel molecular tools that are capable of unfolding G-quadruplexes within biologically relevant therapeutic targets.

MAIN RESEARCH TOPICS

- Physicochemical and biological characteristics of molecular tools based on nucleic acids and their analogues
- Development of sequence-selective oligonucleotides targeted towards interactions with G-quadruplexes
- Regulation of alternative splicing in cancer cell lines
- Development of potent aptamers with improved anticoagulant properties
- *in vitro* studies of chemically modified G-quadruplexes and their antiproliferative properties



Research on G-quadruplexes and aptamers with anticoagulant activity



HEAD

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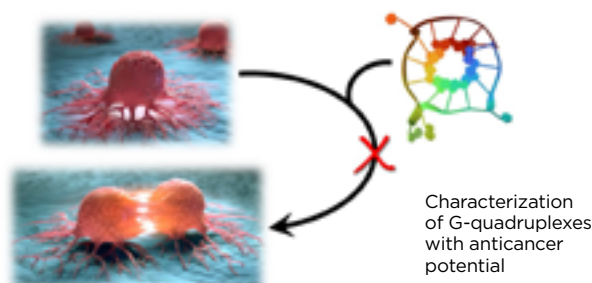
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RESEARCH PROJECTS

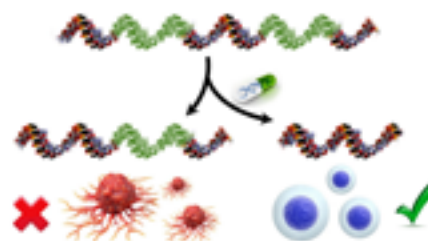
Thrombin binding aptamer with expanded chemical diversity as potential anticoagulant and anticancer agent (NSC, OPUS, PI: W. Kotkowiak)

Novel bispecific G-quadruplex conjugates as potential anticancer agents (NSC, PRELUDIUM, PI: C. Roxo)

Foldback triplex-forming oligonucleotides as novel tools for G-quadruplex unfolding and selective inhibition of c-Myc oncogene transcription (NSC, OPUS, PI: A. Pasternak)



Regulation of alternative splicing in cancer cells



SELECTED PUBLICATIONS

Kotkowiak W et al. Thermodynamic, anticoagulant and antiproliferative properties of thrombin binding aptamer containing novel UNA derivative. *Mol. Ther. Nucl. Acids* 2018; 2;10:304-316

Kotkowiak W et al. Improved RE31 analogues containing modified nucleic acid monomers: thermodynamic, structural and biological effects. *J. Med. Chem.* 2018; 62(5), 2499-2507

Roxo C et al. G-Quadruplex-Forming Aptamers—Characteristics, Applications, and Perspectives. *Molecules* 2019; 24(20):3781

Roxo C et al. G4 Matters—The Influence of G-Quadruplex Structural Elements on the Antiproliferative Properties of G-Rich Oligonucleotides. *Int. J. Mol. Sci.* 2021; 22: 4941

Bartyś N et al. Optimization of Bifunctional Antisense Oligonucleotides for Regulation of Mutually Exclusive Alternative Splicing of PKM Gene. *Molecules* 2022; 27, 5682

Kotkowiak W et al. Physicochemical and antiproliferative characteristics of RNA and DNA sequence-related G-quadruplexes. *ACS Med. Chem. Lett.* 2022; 14(1):35-40

DEPARTMENT OF MOLECULAR AND SYSTEMS BIOLOGY

archaeogenomics | genomics | NGS | cell differentiation | RNA transport | regeneration

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RESEARCH SCOPE

Genomics, particularly population genomics and archaeogenomics; application of genomics in biomedical studies; the role of RNA in cell differentiation and tissue regeneration.

In recent years, our research interests have focused on issues related to the genetic variability and genetic diversity of populations inhabiting the territory of Central-Eastern Europe in the first millennium AD and in contemporary times. Studies on contemporary populations are also aimed at understanding the genetic determinants of human diseases.



Our second leading research area covers a broad spectrum of issues related to the biogenesis, editing, transport, and function of RNA in processes shaping the developmental trajectories of various cell types.

The knowledge and experience gained in both main research areas are utilized to build new systemic approaches that enable precise descriptions of specific physiological and pathological states at the single-cell level. Ultimately, the acquired information is used to create models illustrating higher levels of life organization.

MAIN RESEARCH TOPICS

- Archaeogenomics: the biological history of populations living in Central-Eastern Europe
- Genetic variability of the contemporary population living in Poland
- Genomics in the study of human diseases
- RNA in cell differentiation and tissue regeneration
- RNA editing in the regulation of biological processes
- Understanding and designing cell differentiation trajectories



HEAD

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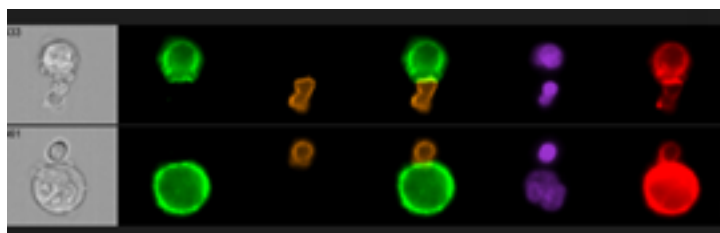
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RESEARCH PROJECTS

European Center for Bioinformatics and Genomics: Genomic Map of Poland (National Information Processing Institute, Smart Growth Operational Programme 2014-2020, a project implemented in a consortium, PI: M. Figlerowicz)

NEBI, National Research Center for Imaging in the Biological and Biomedical Sciences (National Information Processing Institute, Smart Growth Operational Programme 2014-2020, a project implemented in a consortium, project leader: Nencki Institute of Experimental Biology, task coordinator on behalf of IBCH PAS: M. Figlerowicz)

European Center for Bioinformatics and Genomics, MOSAIC (National Information Processing Institute, Smart Growth Operational Programme 2014-2020, a project implemented in a consortium, PI: M. Figlerowicz)



Development of a universal fast-response platform, based on RNA technology, ensuring national drug and epidemiological safety (Medical Research Agency, project implemented in the consortium, project leader: Polfa S.A. Pharmaceutical Works, PI: M. Figlerowicz)

A computational platform for optimizing cell development paths to obtain homogeneous populations (National Centre for Research and Development, LIDER, PI: I. Stolarek)

SELECTED PUBLICATIONS

Stolarek I et al. Genetic history of East-Central Europe in the first millennium CE. *Genome Biology* 2023; 24, 173

Ciecierski L et al. Human AGEs: an interactive spatio-temporal visualization and database of human archeogenomics. *Nucleic Acids Research* 2023; 51, 5, W269–W273

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DEPARTMENT OF BIOMOLECULAR NMR

NMR spectroscopy | nucleic acid structure | G-quadruplexes | duplex-quadruplex hybrids | DNAzymes | aptamers

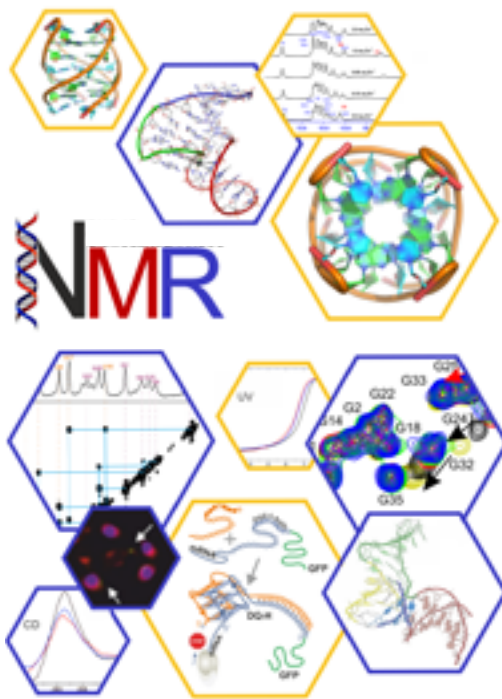
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RESEARCH SCOPE

Structure, function, and dynamics of biomolecules, especially nucleic acids.

In our work, we mainly employ biomolecular NMR methods, complemented by a set of other biophysical and biochemical methods such as UV and CD spectroscopies or electrophoretic methods.

The performed investigations result in the elucidation of atomic-resolution structures of functionally important RNA and DNA molecules that are invaluable for understanding the structure-function relationship for these systems. The main research topics currently tackled in our group include the search for rules governing G-quadruplex folding, the analysis of duplex-quadruplex hybrid structures as potential therapeutic tools, and the elucidation of the molecular modes of action for functional DNA molecules such as DNAzymes and aptamers.



MAIN RESEARCH TOPICS

- Elucidation of the rules governing G-quadruplex folding
- Structural and functional analysis of RNA duplex-quadruplex hybrids
- Structural studies of functional DNA molecules – DNAzymes and aptamers
- Development of paramagnetic NMR methods
- Design and synthesis of small molecule ligands selective for DNA/RNA G-quadruplexes





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RESEARCH PROJECTS

Exploring the sequence-structure relationship as a starting point for the design of DNA G-quadruplexes with a given topology – an integrative approach combining molecular simulations with experimental methods; (NCN OPUS, consortium with Gdańsk University of Technology, PI: J. Czub, Co-Investigator from IBCh PAS: Z Gdaniec)

NMR structural studies of 8-17 and I-R2 DNAzymes; (NCN SONATA, PI: W. Andrałojć)

Lanthanide binding oligonucleotides (LBOs) as paramagnetic tags for NMR spectroscopy of nucleic acids; (NCN OPUS PI: W. Andrałojć)

Synthesis and structural/biophysical studies of model mRNA/mt-tRNA oligomers to evaluate the role of modified nucleosides (m5C, hm5C, f5C, ca5C, m1G) in translation and human diseases; (NCN OPUS, consortium Lodz University of Technology, PI: G. Leszczyńska Co-Investigator from IBCh PAS: W. Andrałojć)

Anti-cancer strategy based on the induced G-quadruplex formation. Structural and biological properties of ligand-RNA/mRNA complexes; (NCN SONATA PI: D. Gudanis)

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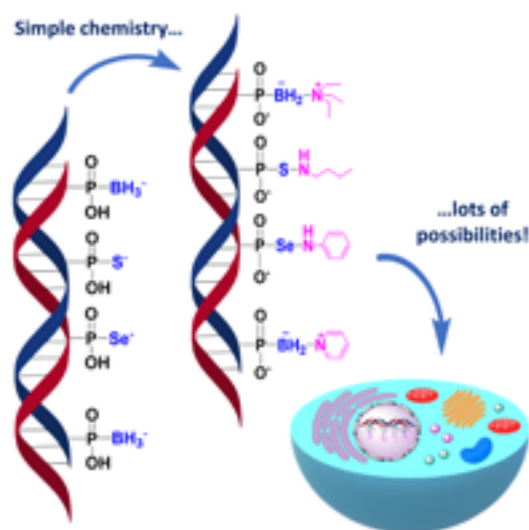
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MAIN RESEARCH TOPICS

- Basic studies on methods of synthesis and the properties of H-phosphonates of nucleosides and their analogues.
- Design and synthesis of new nucleotide compounds (e.g., pronucleotides) with potential antiviral or anticancer activity.
- Studies of the metabolic pathways of pronucleotides in various chemical and physiological environments.
- Chemistry and stereochemistry of P-chiral nucleotide analogues.
- Synthesis and characterization of nucleoside analogs with potential biological activity, e.g., acyclonucleosides, 2'-C-alkylribonucleosides, 2',3'-dideoxynucleosides, and dinucleosides bonded by the 1,2,3-triazole system.



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Romanowska J et al New anti-HIV pronucleotide phosphoramidate diesters containing amino- and hydroxypyridine auxiliaries. *Eur.J.Med.Chem.* 2019, 164, 47-58

Materna M et al. Oxyonium phosphobetaines - unusually stable nucleophilic catalyst-phosphate complexes formed from H-phosphonates and N-oxides, *RSC Adv.* 2016, 6, 14448-14451

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DEPARTMENT OF PLANT MOLECULAR PHYSIOLOGY

ABC transporters | Fabaceae | genetic engineering | phytohormones | phenylpropanoids

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RESEARCH SCOPE

ABC (ATP-binding cassette protein) membrane transporters in the model legume plant *Medicago truncatula*.

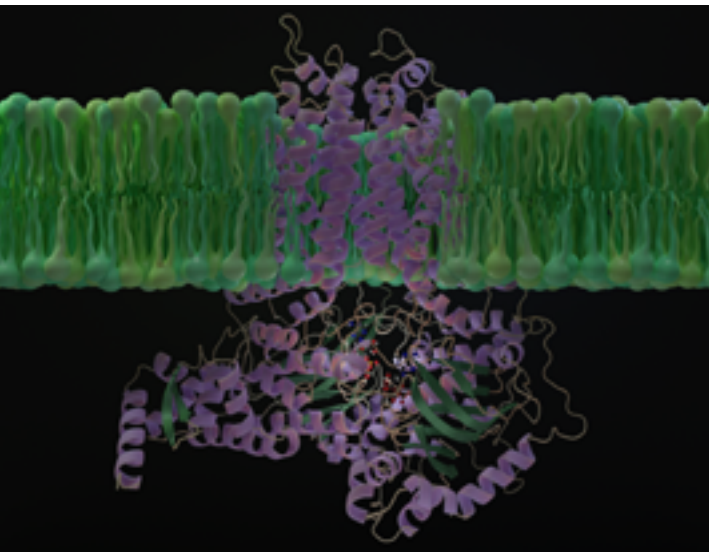
The ABC transporters form one of the most numerous and widely distributed protein families. We study the role of ABC proteins in the distribution of both specialized metabolites and phytohormones. The obtained results contribute to a better understanding of the adaptive evolution of these transporters and the resulting molecular determinants. They also have potential for translational biology and could benefit plant producers.



Medicago truncatula

MAIN RESEARCH TOPICS

- Identification and classification of plant ABC proteins
- Functional characterization of the ABCG subfamily in *Medicago truncatula*
- The role of ABCG proteins in the distribution of phenylpropanoids and interactions between legumes and microorganisms
- Cytokinin transport and its role in Fabaceae morphogenesis
- Membrane protein-mediated transport of phytohormones in response to biotic and abiotic stresses
- Understanding the signaling pathways involved in the process of seed maturation and germination



Structure of the ABCG membrane protein



HEAD

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RESEARCH PROJECTS

Functional characteristics of ABCG transporters in *Medicago truncatula* seeds (NSC, OPUS, PI: M. Jasiński)

New mechanisms determining MFT-mediated sensitivity to abscisic acid during the germination of *Medicago truncatula* seeds (NSC, OPUS, PI: J. Banasiak)

Relationship between ATPase activity stimulation and transport – the case of selective *Medicago truncatula* ABCG transporter (NSC, PRELUDIUM, PI: K. Pakuła)

ABCG driven transport of phenylpropanoids in *Medicago truncatula* – a versatile but adapted scenario (NSC, OPUS, PI: M. Jasiński)



Medicago truncatula
flower,
embryo,
root nodule

SELECTED PUBLICATIONS

Jarzyniak K et al. Early stages of legume–rhizobia symbiosis are controlled by ABCG-mediated transport of active cytokinins. *Nature Plants* 2021; 7:428-436

Banasiak J, Jasiński M. ATP-binding cassette transporters in nonmodel plants. *New Phytologist* 2022; 233:1597-1612

Pakuła K et al. Restriction of access to the central cavity is a major contributor to substrate selectivity in plant ABCG transporters. *Cellular and Molecular Life Sciences* 2023; 80:105

Banasiak J et al. A roadmap of plant membrane transporters in arbuscular mycorrhizal and legume–rhizobium symbioses. *Plant Physiology* 2021; 187:2071-2091

Biała W et al. *Medicago truncatula* ABCG10 is a transporter of 4-coumarate and liquiritigenin in the medicarpin biosynthetic pathway. *Journal of Experimental Botany* 2017; 68:3231-3241

Pawela A et al. MtABCG20 is an ABA exporter influencing root morphology and seed germination of *Medicago truncatula*. *The Plant Journal* 2019; 98: 511-523

DEPARTMENT OF MOLECULAR GENETICS

cancer genetics | MLPA | miRNA | lncRNA | circRNA | noncoding mutations

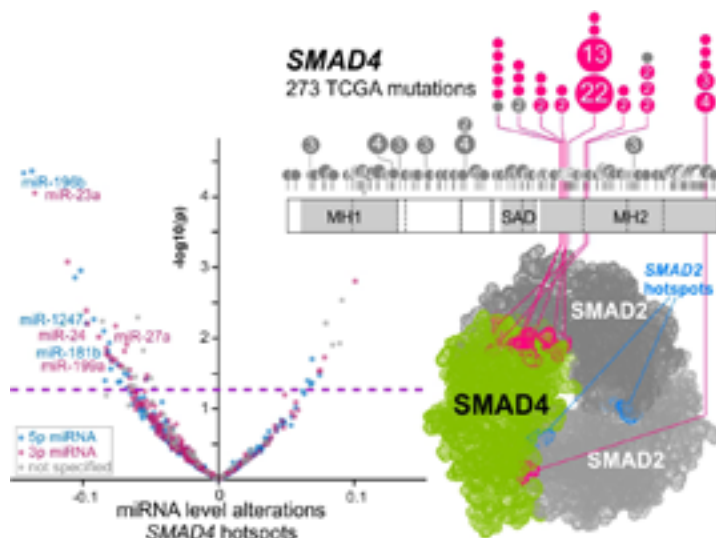
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RESEARCH SCOPE

Identification and analysis of the functional consequences of genetic variants.

Our scope of interest encompasses variants of various types - from single nucleotide substitutions to large chromosomal rearrangements, from heritable germline variants to somatic mutations, from common polymorphisms to private aberrations, and from functional to neutral changes.

At present, we are focused on two main areas of research. First, the identification of new genetic and epigenetic variants and risk genes playing a role in heritable genetic predisposition to cancer, especially breast and ovarian cancers, as well as rare heritable cancer syndromes. Second, the identification and functional characterization of somatic mutations, potential cancer-driving mutations in noncoding genetic elements, particularly miRNA genes and noncoding parts of protein-coding genes.



Localization of somatic cancer mutations in the MH2 domain of the *SMAD4* gene responsible for interaction and heterotrimer formation with *SMAD2*, and their impact on miRNA levels in cancer

MAIN RESEARCH TOPICS

- The study of mutations in the *MIR142* gene in blood cancers.
- Analysis of genetic variants and epigenetic changes (promoter methylation) in selected genes associated with ovarian cancer predisposition.
- Identification and characterization of somatic mutations in miRNA genes and microRNA biogenesis genes.
- Development of new methods for genetic analysis.
- Analysis of somatic mutations in non-coding elements of genes.



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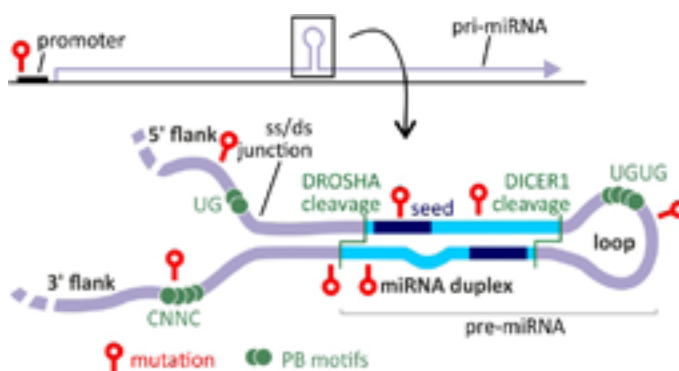
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RESEARCH PROJECTS

Identification of cancer-driver mutations in non-coding parts of protein-coding genes and long non-coding RNA genes (NSC OPUS 20, PI: P. Kozłowski)

The effect of cancer somatic mutations in miRNA genes on the functioning of these genes and their potential role in cancer (NSC SONATA 16, PI: P. Gałka-Marciniak)

Analysis of somatic mutations in miRNA and miRNA-biogenesis genes to identify new therapeutic targets and biomarkers of cancer (NSC MAESTRO 8, PI: P. Kozłowski)



Localization of potentially functional mutations within the functional domains of miRNA genes

SELECTED PUBLICATIONS

Galka-Marciniak P et al. A pan-cancer atlas of somatic mutations in miRNA biogenesis genes. *Nucleic Acids Res.* 2021; 49:601

Urbanek-Trzeciak MO et al. Pan-cancer analysis of somatic mutations in miRNA genes. *EBioMedicine.* 2020; 61:103051

Czubak K et al. Global Increase in Circular RNA Levels in Myotonic Dystrophy. *Front Genet.* 2019; 10:649

Suszynska M et al. BARD1 is a low/moderate breast cancer risk gene: evidence based on an association study of the central European p.Q564X recurrent mutation. *Cancers.* 2019; 11:740

Suszynska M et al. Large-scale meta-analysis of mutations identified in panels of breast/ovarian cancer-related genes – Providing evidence of cancer predisposition genes. *Gynecol Oncol.* 2019; 153:452

Dabrowska M et al. qEva-CRISPR: a method for quantitative evaluation of CRISPR/Cas-mediated genome editing in target and off-target sites. *Nucleic Acids Res.* 2018; 46:e101

DEPARTMENT OF RNA STRUCTURAL GENOMICS

RNA viruses | influenza virus | SARS-CoV-2 | isoenergetic microarrays | thermodynamics of nucleic acids | antisense oligonucleotides | small molecules | RNA structure | pathogenic RNA | RNA modifications

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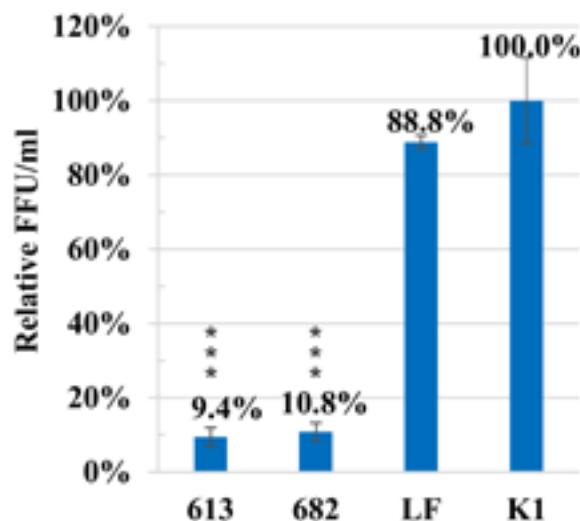
RESEARCH SCOPE

Studies of RNA secondary and tertiary structures as well as complexes of RNA with proteins, other RNA, or small molecules.

The goal of this research is not only to determine RNA structure but also to use this knowledge to modulate RNA function, including pathogenic RNAs involved in human diseases. At the present moment, the Department's research objects are, among others, the influenza virus and SARS-CoV-2. We are interested in the structure of viral RNA and conserved structural motifs with functional importance. The Department's research also includes the design and application of short modified oligonucleotides and their bioconjugates as functional and structural probes. We also develop inhibitory strategies based on oligonucleotides and small molecules.

MAIN RESEARCH TOPICS

- Small molecules binding to RNA
- Modified oligonucleotides - antisense and microarray strategies
- Oligonucleotide carriers and bioconjugates
- CRISPR/Cas systems as strategies for replication inhibitors of RNA viruses
- Thermodynamic and comparison analysis of studied RNA,
- Prediction of RNA secondary structure
- RNA motifs functional studies
- RNA modifications
- RNA structural genomics of viruses, including influenza virus and SARS-CoV-2
- Secondary and tertiary structures of RNA and its complexes
- Modulation of RNA function
- Inhibition and regulation of RNA viruses' proliferation



Antiviral activity of the two most effective unmodified siRNAs in the IFA assay compared with the negative control (K1) and lipofectamine (LF)



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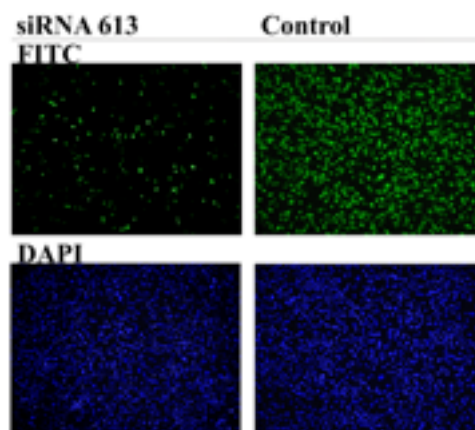
RESEARCH PROJECTS

Input of the structure of influenza A virus RNA in regulation of virus proliferation. High throughput screening of small molecules towards inhibition of influenza virus replication (NSC OPUS, PI: E. Kierzek)

Antiviral strategies targeting RNA: Triplex forming peptide nucleic acids (PNA) and their small molecule conjugates specific to conserved RNA motifs in Influenza A and SARS-CoV-2 (NSC OPUS, PI: E. Kierzek)

Long noncoding RNA - new aim of anti-influenza therapy. UMO-2020/39/D/NZ6/03267, National Science Centre grant (NSC SONATA, PI: M. Soszyńska-Jóźwiak)

The G-rich sequences in the influenza A virus genome – structural features and potential biological function in viral replication cycle (NSC SONATA, PI: M. Szabat)



Exemplary fluorescence microscopy images of the influenza virus-infected MDCK cell culture in the IFA assay and effect of siRNA 613

SELECTED PUBLICATIONS

Michalak P. et al., Conserved Structural Motifs of Two Distant IAV Subtypes in Genomic Segment 5 RNA. *Viruses* 2021, 13, 525

Soszyńska-Jóźwiak M. et al., Universal and strain specific structure features of segment 8 genomic RNA of influenza A virus – application of 4-thiouridine photocrosslinking. *Journal of Biological Chemistry* 2021, 297, 6, 101245

Soszyńska-Jóźwiak M. et al., Secondary Structure of Subgenomic RNA M of SARS-CoV-2. *Viruses* 2022, 14, 322

Mirska B et al., In vivo secondary structural analysis of Influenza A virus genomic RNA. *Cellular and Molecular Life Sciences* 2023, 80, 136

Kierzek E. et al., Secondary Structure Prediction for RNA Sequences Including N6-methyladenosine. *Nature Communications* 2022, 13, 1271

Szabat M. et al., A Test and Refinement of Folding Free Energy Nearest Neighbor Parameters for RNA Including N6-Methyladenosine. *Journal of Molecular Biology* 2022, 167632

DEPARTMENT OF GENOME ENGINEERING

CRISPR-Cas9 | amiRNA | microsatellites | polyglutamine diseases | gene therapy

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RESEARCH SCOPE

Neurodegenerative diseases caused by short tandem repeat (CAG)_n expansion. The mechanisms leading to the instability of expanded repeated sequences and the role of DNA repair in these processes.

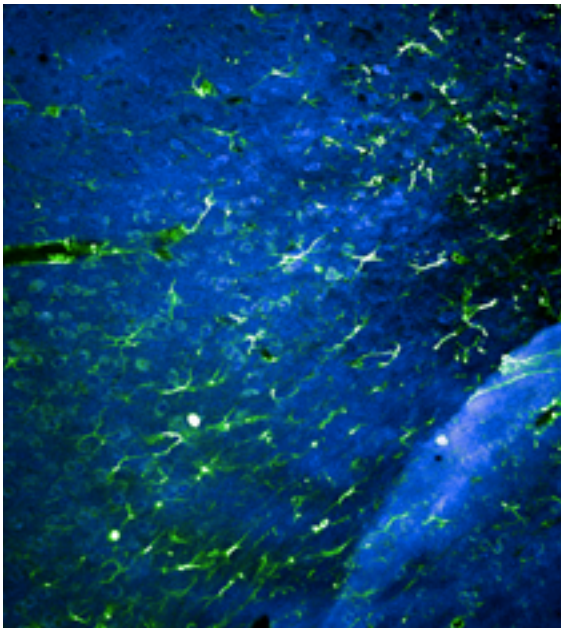
In our research, we use the CRISPR-Cas technology to create new disease models, induce double-stranded DNA breaks, and identify genes associated with CAG repeat instability in large-scale experiments. Our

goal is to develop a therapeutic approach based on the use of DNA repair mechanisms for controlled shortening of mutated CAG repeats or limiting their expansion.

An important goal of our research is also the development of RNA interference technology in the field of artificial microRNAs (amiRNAs) used to silence the expression of target genes in therapeutic approaches.

MAIN RESEARCH TOPICS

- Study of the mechanisms responsible for the instability of microsatellite sequences
- Study of DNA double-strand break repair mechanisms in microsatellite regions
- Development of genome editing technologies and methods for assessing their effectiveness and specificity
- The use of genome editing technology to establish disease models and in therapy of genetic diseases
- The use of artificial miRNA in the therapy of human diseases



Immunofluorescent staining of mouse brain for the presence of GFAP marker after AAV5 vector injection



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RESEARCH PROJECTS

Searching for new therapeutic targets in polyglutamine diseases (NSC, OPUS, PI: M. Olejniczak)

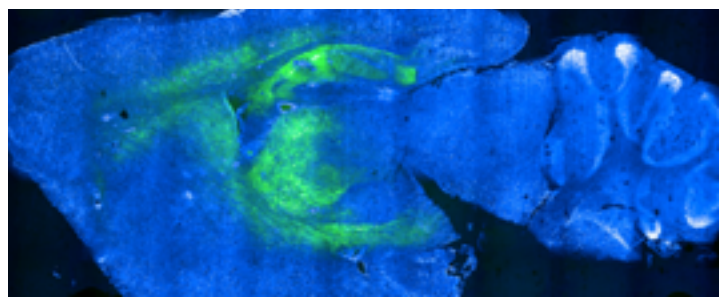
Allele-selective therapy for polyglutamine diseases with the use of RNA interference technology (NSC, PRELUDIUM BIS, PI: M. Olejniczak)

Microscopic identification of proteins involved in DNA repair of CAG repeats regions (NSC, PRELUDIUM, PI: M. Nowaczyk)

Investigation of DNA repair mechanisms in DRPLA model using CRISPR-Cas system (NSC, PRELUDIUM, PI: M. Dąbrowska)

The use of artificial miRNAs in experimental therapy of Huntington's Disease (NSC, PRELUDIUM, PI: A. Kotowska-Zimmer)

The importance of CAG repeat length polymorphism in the pathogenesis of cancer (MEN, PERŁY NAUKI, PI: M. Karwacka)



Distribution of AAV5-GFP viral vector in the mouse brain after injection into the striatum

SELECTED PUBLICATIONS

Dabrowska M et al. qEva-CRISPR: a method for quantitative evaluation of CRISPR/Cas-mediated genome editing in target and off-target sites. *Nucleic Acids Res.* 2018, 46:e101

Dabrowska M et al. Precise excision of the CAG tract from the Huntingtin Gene by Cas9 Nickases, *Front Neurosci.* 2018, 12:75

Sledzinski P et al. Paving the way towards precise and safe CRISPR genome editing. *Biotechnology Adv.* 2021; 49:107737

Kotowska-Zimmer A et al. Artificial miRNAs as therapeutic tools: Challenges and opportunities. *WIREs RNA* 2021; e1640

Kotowska-Zimmer A et al. A CAG repeat-targeting artificial miRNA lowers the mutant huntingtin level in the YAC128 model of Huntington's disease. *Molecular Therapy NA* 2022; 28: 702-715

Kotowska-Zimmer A et al. Universal RNAi triggers for the specific inhibition of mutant huntingtin, atrophin-1, ataxin-3 and ataxin-7 expression. *Molecular Therapy NA* 2020, 19:562-571

DEPARTMENT OF PLANT FUNCTIONAL METABOLOMICS

Specialized metabolism | plant immunity | tryptophan | *Arabidopsis*

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RESEARCH SCOPE

Specialized metabolism of model and crop plants. Particularly, we focus on metabolic pathways with functions in plant-microbe interactions.

One of our main objects of interest is tryptophan metabolism in the model plant *Arabidopsis thaliana* and in related Brassicaceae species. We are also interested in the specialized metabolism of the model grass *Brachypodium distachyon* and of barley. We investigate the profiles of metabolites produced in plants during their response to pathogenic or beneficial microorganisms. In the case of model species, we also analyze the metabolomes of mutant lines defective in selected genes to recognize the function of the corresponding enzymes in metabolic pathways. We also study the phenotypes of selected mutants during their interactions with microorganisms, which enables the identification of the functions of particular metabolites. Finally, we employ synthetic biology tools to engineer tryptophan-specialized metabolism.



MAIN RESEARCH TOPICS

- Tryptophan metabolism in the immunity of the model plant species *Arabidopsis thaliana*.
- Synthetic biology of tryptophan-specialized metabolism in plants.
- Metabolic pathways involved in the resistance of barley towards abiotic and biotic stresses.
- Function of plant secondary metabolites in growth promotion induced by microbial endophytes.



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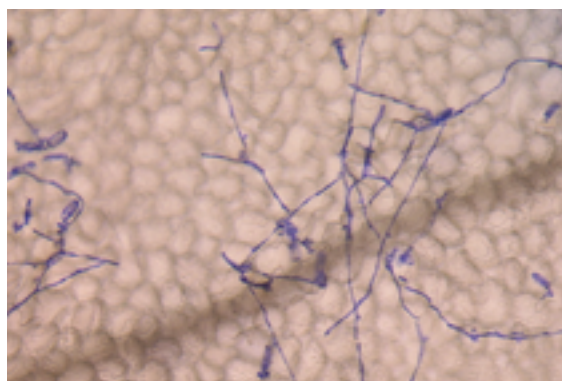
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RESEARCH PROJECTS

Molecular basis of glucosinolate modification and activation in the immunity of Brassicaceae species (NSC OPUS, PI: P. Bednarek)

Interspecies metabolic engineering as a tool to investigate immune functions of plant specialized metabolites (NSC OPUS, PI: P. Bednarek)

Description of the key mechanisms of coordination and prioritization of barley's response to simultaneous biotic and abiotic stresses – a multiomic approach (NSC OPUS, PI: A. Piasicka)



Impact of subcellular localization on the specificity of selected enzymes involved in the biosynthesis and metabolism of bioactive sulfur-containing compounds from Brassicaceae plants (NSC OPUS, PI: P. Bednarek)

SELECTED PUBLICATIONS

Czerniawski P et al. Loss of MYB34 Transcription Factor Supports the Backward Evolution of Indole Glucosinolate Biosynthesis in a Subclade of the Camelineae Tribe and Releases the Feedback Loop in This Pathway in *Arabidopsis*. *Plant & Cell Physiol.* 2023, 64:80-93

Singh G et al. Specialized metabolites as versatile tools in shaping plant-microbe associations. *Mol. Plant*, 2023, 16: 122-144

Pastorczyk M et al. The role of CYP71A12 monooxygenase in pathogen-triggered tryptophan metabolism and *Arabidopsis* immunity. *New Phytol.* 2020, 225: 400-412

Piślewska-Bednarek et al. Glutathione Transferase U13 Functions in Pathogen-Triggered Glucosinolate Metabolism. *Plant Physiol.* 2018, 176:538-551

Sugiyama, R, Bednarek P et al. Retrograde sulfur flow from glucosinolates to cysteine in *Arabidopsis thaliana*. *PNAS* 2022, 118:e2017890118

DEPARTMENT OF STRUCTURE AND FUNCTION OF BIOMOLECULES

biological crystallography | protein structure | RNA structure | chitinase | trinucleotide RNA repeats

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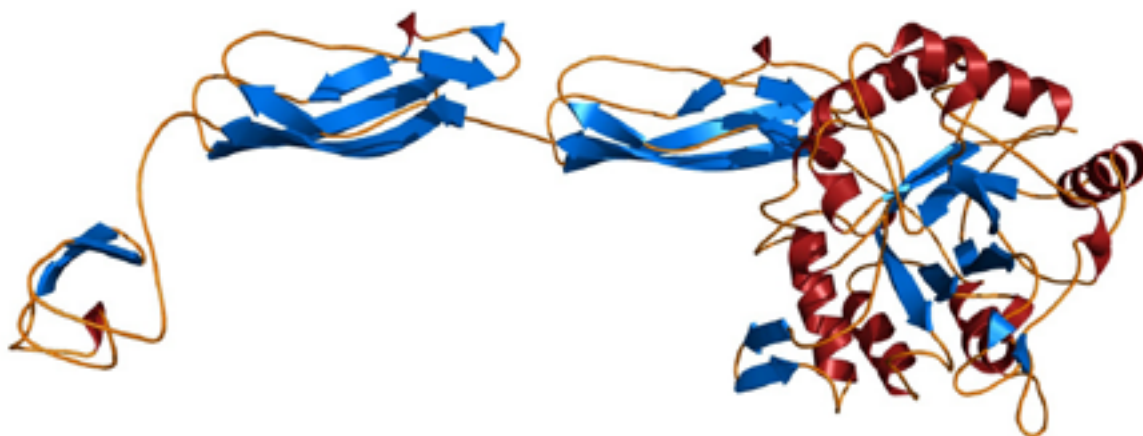
RESEARCH SCOPE

Structural biology of proteins and nucleic acids.

Our research primarily focuses on enzymes from extremophilic organisms. They serve as examples of proteins optimized for stability and catalytic efficiency. Analyzing their structures helps us understand the rules of this optimization. One of our research goals is to construct an artificial “chitinosome” for efficient chitin degradation. We are also interested in RNAs, especially those involved in the pathogenesis of neurodegenerative diseases (TREDs). This includes studying the interactions of such RNAs with synthetic ligands, which may be useful in designing therapeutics.

MAIN RESEARCH TOPICS

- Pathogenic RNA sequences that cause neurodegenerative disorders (TREDs) and interactions of such sequences with potential therapeutics
- Chitinolytic enzymes as a material for constructing an artificial chitinosome
- Proteins from extremophiles as models for investigating the bases of adaptation of organisms to extreme environmental conditions, particularly to identify those structural elements that are responsible for proteins' stability in thermophiles and enzymatic efficiency in psychrophiles



Chitinase Chi60 from a psychrophilic organism *Moritella marina*



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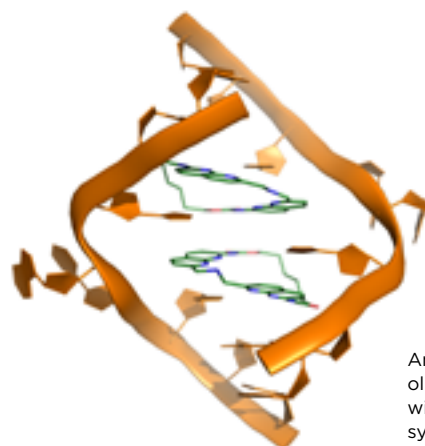
RESEARCH PROJECTS

Life at the limits: diversity, adaptation strategies and bioprospecting of microbes lining in Arctic deep sea habitats (NSC, GRIEG, PI: W. Rypniewski)

Crystallographic analysis of RNA-ligand complexes. Towards rational design of lead compounds for development of therapies against neurodegenerative disorders (NSC, OPUS, PI: A. Kiliszek)

The study of chitinolytic enzymes, aiming at constructing an artificial chitinosome (NSC, OPUS, PI: W. Rypniewski)

Development of methodology for stabilisation of RNA hairpins for crystallographic study (NSC, SONATA BIS, PI: A. Kiliszek)



An RNA oligonucleotide with a bound synthetic ligand

SELECTED PUBLICATIONS

Kiliszek A et al. Broken symmetry between RNA enantiomers in a crystal lattice. *Nucleic Acids Res.* 2021; 49:12535-12539

Kiliszek A et al. Structure and thermodynamics of a UGG motif interacting with Ba²⁺ and other metal ions: accommodating changes in the RNA structure and the presence of a G(syn)-G(syn) pair. *RNA* 2023; 29:44-54

Biniek-Antosiak K et al. Structural, thermodynamic and enzymatic characterization of N,N-diacetylchitinobiose deacetylase from *Pyrococcus chitonophagus*. *Int. J. Mol. Sci.* 2022; 23:15736

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Bejger M et al. A computationally designed β -amino acid-containing miniprotein. *Chem. Commun.* 2021; 57:6015-6018

DEPARTMENT OF RIBONUCLEOPROTEIN BIOCHEMISTRY

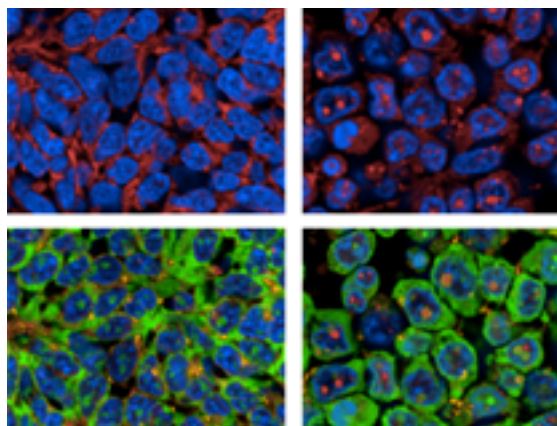
nucleic acid-binding proteins | regulatory RNAs | regulation of gene expression | Dicer-type ribonucleases | SARS-CoV-2 RNA polymerase complex

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RESEARCH SCOPE

Our interests focus on the role of RNA and DNA in the regulation of the activity of nucleic acid-binding proteins and exploring the mechanisms beyond the activity and specific functions of these proteins.

Currently, the main object of our research is Dicer-type ribonucleases. These proteins are mostly known for their important role in the biogenesis of small regulatory RNAs: miRNAs and siRNAs. However, a growing number of reports demonstrate that the activity of Dicer proteins extends beyond the biogenesis of small regulatory RNAs; for example, Dicers may also be involved in apoptosis or DNA damage repair. By identifying the cellular RNAs and DNAs bound by human Dicer, we investigate the role of selected Dicer•RNA and Dicer•DNA complexes in various cellular processes. In addition, by using target-specific inhibitors that selectively interact with individual components of the protein•RNA complexes, we study the specific activity of the protein (on the example of Dicer-type proteins and the RNA polymerase complex of the SARS-CoV-2 virus) and the importance of a given RNA molecule for the functioning of the cell (on the example of Dicer-type proteins).



HEK293 wild-type cells*

HEK293 cells with a mutation in the *DICER1* gene

MAIN RESEARCH TOPICS

- Structural and functional aspects of protein-nucleic acid interactions.
- The role of RNA/DNA in the regulation of the activity and functions of nucleic acid-binding proteins (on the example of Dicer-type proteins).
- Endogenous factors regulating the activity of Dicer-type ribonucleases.
- Designing and testing inhibitors against Dicer-type ribonucleases.
- Model systems for activity studies of the polymerase complexes (on the example of the SARS-CoV-2 RNA polymerase complex).

* The images were acquired using the expertise and infrastructure of the Center of Chemical Biology of the IBCH PAS, on a high-throughput Opera Phenix microscope purchased with funds from the Ministry of Education and Science (decision DIR/WK/2018/06) awarded under the POL-OPENSREEN project - Polish Screening Platform for Chemical Biology



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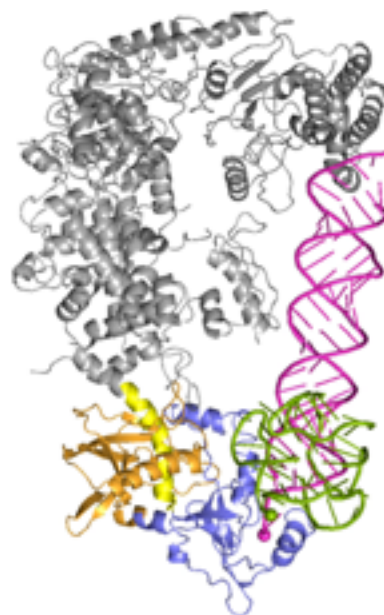
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RESEARCH PROJECTS

Close Encounters of the Third Kind: what happens when ribonuclease Dicer encounters in the cell RNA and DNA adopting G-quadruplex structures (NSC, OPUS, Principal Investigator: A. Kurzyńska-Kokorniak)

The cellular RNA interactome of the human Dicer helicase domain (NSC, PRELUDIUM, Principal Investigator: K. Ciechanowska)

Development of a high-throughput system for rapid assessment of biological activity of compounds targeting the SARS-CoV-2 replication complex, selection of compounds with the highest therapeutic potential and assessment of their cytotoxicity to human cells (NCRD, Smart Growth Operational Programme 2014-2020 'Fast Track', project implemented in the consortium, project leader: ideas4biology Sp. z o. o.; task leader from IBCH PAS: A. Kurzyńska-Kokorniak)



Both pre-miRNAs and G-quadruplexes are anchored in the same region of Dicer

SELECTED PUBLICATIONS

Szpotkowski K et al. Structural studies of protein-nucleic acid complexes: A brief overview of the selected techniques. *Comput Struct Biotechnol J*. 2023; 21:2858-2872

Koralewska N et al. RNA and DNA G-quadruplexes bind to human dicer and inhibit its activity. *Cell Mol Life Sci*. 2021; 78:3709-3724

Wojnicka M et al. Unknown Areas of Activity of Human Ribonuclease Dicer: A Putative Deoxyribonuclease Activity. *Molecules*. 2020; 25(6):1414

Pokornowska M et al. The RNA-RNA base pairing potential of human Dicer and Ago2 proteins. *Cell Mol Life Sci*. 2020; 77:3231-3244

Kurzynska-Kokorniak A et al. The many faces of Dicer: the complexity of the mechanisms regulating Dicer gene expression and enzyme activities. *Nucleic Acids Res*. 2015; 43:4365-80

DEPARTMENT OF STRUCTURAL BIOLOGY OF EUKARYOTES

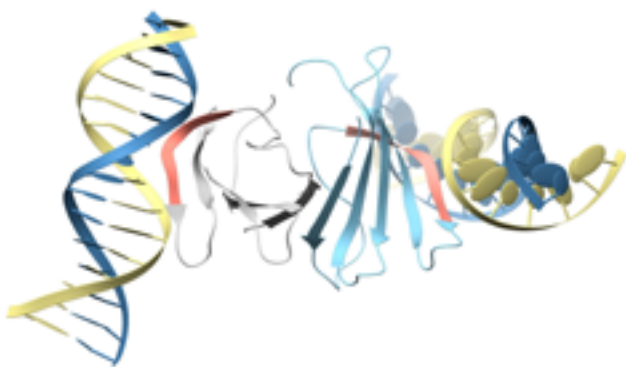
biocrystallography | Cryo-EM | drug design | herbicide design | transcription factors | metabolic pathways

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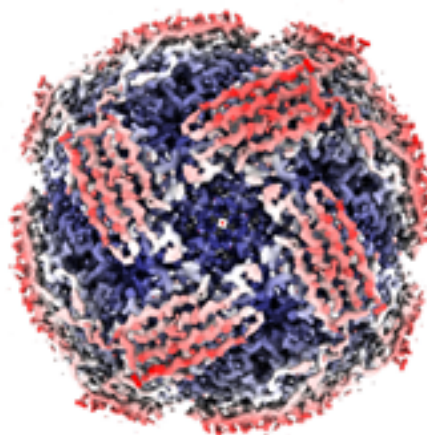
RESEARCH SCOPE

Structural biology, interactions of proteins with small molecules, other proteins, DNA, and RNA.

Apart from deepening our knowledge, the results of our research enable us to rationally design bioactive compounds, such as drugs or herbicides. We have a particular interest in protein targets for anticancer therapies and plant proteins relevant to modern agriculture. Utilizing macromolecular crystallography and cryoelectron microscopy (Cryo-EM), along with biophysical, biochemical, and bioinformatic methods, we gain new insights into the fascinating world of biomolecules.



Crystal structure of WRKY18 transcription factor in complex with DNA



Cryo-EM map of plant HISN5 protein - a molecular target for herbicide design

MAIN RESEARCH TOPICS

- Resolving the structures of proteins and nucleic acids.
- Structure-based design of anticancer drugs targeting mitochondrial metabolism.
- Molecular basis of interactions between proteins and small- and macro-molecular partners, with particular emphasis on research of transcription factors.
- Structure-based design of herbicides that block metabolic pathways.



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RESEARCH PROJECTS

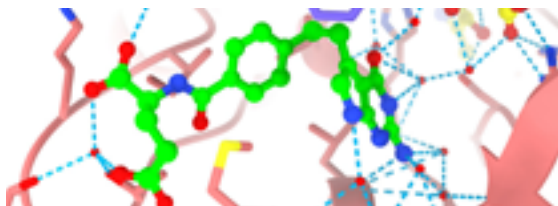
Search for Inhibitors of Human δ 1-Pyrroline-5-Carboxylate Reductase 1 (PYCR1) as Lead Molecules for the Development of Novel Anticancer Drugs (NSC OPUS, PI: M. Ruszkowski)

Novel L-asparaginases as potential therapeutic agents and antimicrobial targets: structural and functional studies of enzymes with dual implications for drug design (NSC OPUS, PI: M. Jaskolski)

Development of an efficient method of production of WRKY group IIa transcription factors from *Arabidopsis thaliana* for further structural studies (NSC MINIATURA PI: M. Grzechowiak)

The puzzling structure of Grainyhead-like human transcription factors involved in tumor growth regulation (NSC SONATINA, PI: M. Rutkiewicz)

Histidine Biosynthetic Pathway in Plants: Structural and Functional Studies as a Framework for the Design of Inhibitors and Activators (NSC SONATA, PI: M. Ruszkowski)



Binding of the pemetrexed chemotherapeutic to the mitochondrial isoform of serine hydroxymethyltransferase

SELECTED PUBLICATIONS

Grzechowiak M et al. New aspects of DNA recognition by group II WRKY transcription factor revealed by structural and functional study of AtWRKY18 DNA binding domain. *International Journal of Biological Macromolecules* 2022; 213:589

Rutkiewicz M et al. Insights into the substrate specificity, structure, and dynamics of plant histidinol-phosphate aminotransferase (HISN6). *Plant Physiology and Biochemistry* 2023; 196:759

Ruszkowski M et al. Cryo-EM reconstructions of BMV-derived virus-like particles reveal assembly defects in the icosahedral lattice structure. *Nanoscale* 2022; 14:3224

Tran LH et al. 3D Domain Swapping Dimerization of the Receiver Domain of Cytokinin Receptor CRE1 From *Arabidopsis thaliana* and *Medicago truncatula*. *Frontiers in Plant Science* 2021; 12: 756341

Witek W et al. Structural and mechanistic insights into the bifunctional HISN2 enzyme catalyzing the second and third steps of histidine biosynthesis in plants. *Scientific Reports* 2021; 11:9647

Loch JI et al. Crystal structures of the elusive *Rhizobium etli* L-asparaginase reveal a peculiar active site. *Nature Communications* 2021; 12:6717

DEPARTMENT OF MEDICAL BIOTECHNOLOGY

RNA biology | CAG repeats | polyQ diseases | RAN translation | iPSC | microRNA

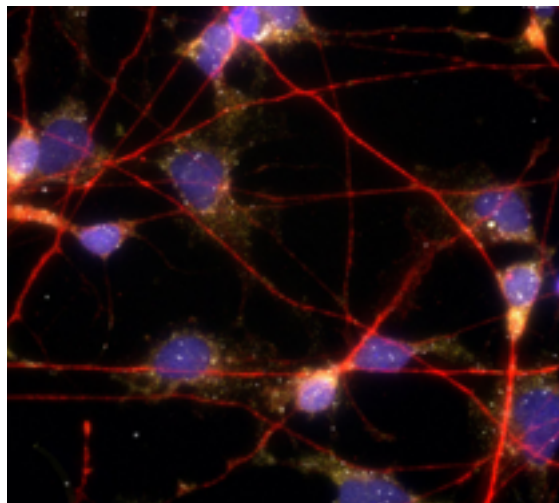
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RESEARCH SCOPE

The diversity of RNA functions and dysfunctions in the context of repeated tracts and neurodegenerative diseases.

Our research focuses on trinucleotide repeat sequences (mainly CAG) and their expansion related to polyglutamine (polyQ) diseases that include Huntington's disease (HD) and spinocerebellar ataxias (SCAs).

We aim to precisely describe new molecular pathogenic pathways for polyQ diseases, with particular emphasis on RNA-dependent pathways and changes in the level of various types of RNA. We investigate the functioning of mutant mRNA containing CAG repeat expansion, as it is a very promising target for oligonucleotide-based tools in therapeutic approaches. We are also interested in determining the function of repeat tracts in wild-type RNAs, including non-coding RNAs.

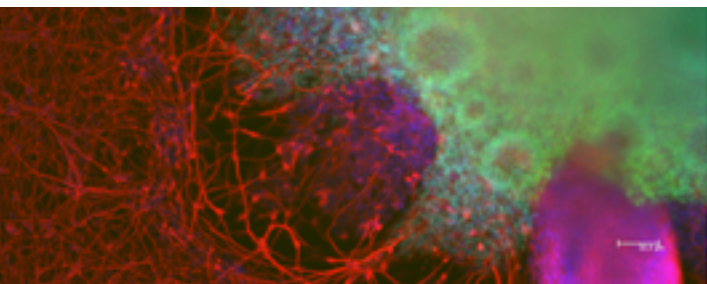


MAP2 DAPI GAPDH mRNA HTT mRNA

mRNA detection in human HD neurons

MAIN RESEARCH TOPICS

- RNA and protein toxicity markers in polyQ diseases
- Establishment and characteristics of new cellular and mouse models
- Investigation of molecular interactions with trinucleotide repeat tracts in RNAs
- Role of non-coding RNAs in the pathogenesis of polyQ diseases
- Investigation of RAN translation and alternative polyadenylation events for transcripts with repeat expansions
- Design and testing of oligonucleotide-based therapeutic strategies



Human neuronal HD cells

TUJ1 PAX6 DAPI



HEAD

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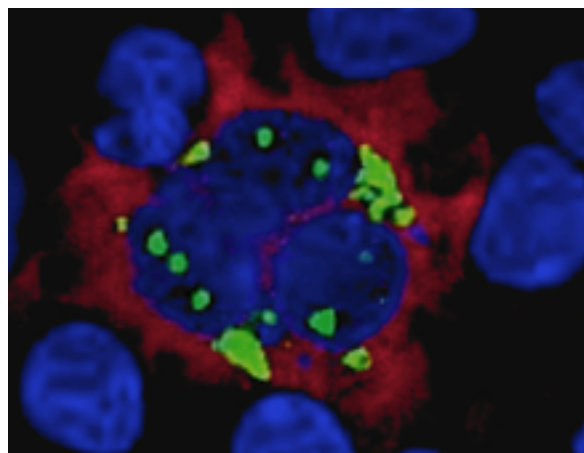
RESEARCH PROJECTS

Function and dysfunction of repeated tracts in non-coding and protein-coding transcripts (NSC, OPUS, PI: A. Fiszer)

RAN translation at CAG repeats in spinocerebellar ataxia type 3 (NSC, SONATA, PI: M. Jazurek-Ciesiołka)

Investigation of initial pathways of DRPLA pathogenesis in human neural precursors (Ministry of Education and Science, Diamantowy Grant, PI: B. Nowak)

Development of a universal fast-response platform, based on RNA technology, ensuring the national drug and epidemiological safety (Medical Research Agency, project implemented in the consortium, project leader: Polfa S.A. Pharmaceutical Works, PI: M. Figlerowicz, task leader: A. Fiszer)



poliQ poliA DAPI RAN proteins in the SCA3 model

SELECTED PUBLICATIONS

Joachimiak P et al. Allele-specific quantitation of ATXN3 and HTT transcripts in polyQ disease models. *BMC Biology* 2023; 21:17.

Ciesiolka A et al. Artificial miRNAs targeting CAG repeat expansion in ORFs cause rapid deadenylation and translation inhibition of mutant transcripts. *Cellular and Molecular Life Sciences* 2021; 78(4):1577-1596.

Jazurek-Ciesiolka M et al. RAN translation of the expanded CAG repeats in the SCA3 disease context. *Journal of Molecular Biology* 2020; 432(24):166699.

Kozłowska E et al. Generation of human iPS cell line IBChi001-A from dentatorubral-pallidoluysian atrophy patient's fibroblasts. *Stem Cell Research* 2019; 39:101512. doi.org/10.1016/j.scr.2019.101512

Joachimiak P et al. Implications of Poly(A) Tail Processing in Repeat Expansion Diseases. *Cells* 2022; 11(4):677.

Witkos TM et al. A potential role of extended simple sequence repeats in competing endogenous RNA crosstalk. *RNA Biology* 2018; 15(11):1399-1409.

DEPARTMENT OF BIOPOLYMER CHEMISTRY

nucleic acids chemical synthesis | thermolabile fluorescent dyes | thermally releasable polymers | biopolymers | triphosphates | functional chitin

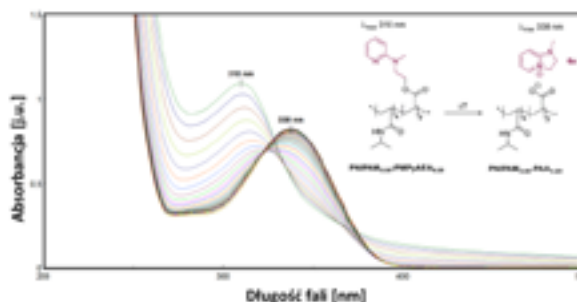
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RESEARCH SCOPE

Chemical synthesis of biopolymers with a particular emphasis on nucleic acids, peptides, carbohydrates, and their modifications.

We create and study new, functional polymer materials with potential applications, such as drug carriers or supports in solid-phase chemical synthesis. All molecules that we obtain are thoroughly characterized using structural and mass analysis methods.

We have extensive experience in the chemical synthesis of modified nucleic acids (RNA and DNA) both in the solid and liquid phases. We undertake research aimed at the synthesis of chemical molecules based on thermo-responsive technology and biological polymers. Among the thermosensitive tools developed by us are molecular thermometers, polymers, and fluorescent tags. An example of functional biopolymers with practical applications can be polyaminosaccharides, such as chitin, where chemical modification transforms them into biocompatible materials.



Thermosensitive polymers

MAIN RESEARCH TOPICS

- Chemical synthesis of biopolymers and their modification, such as nucleic acids, peptides, carbohydrates, and lipids
- Application of thermosensitivity in chemical synthesis
- Thermolability for designing protecting groups, fluorescent dyes, catalysts with thermoactivity, and thermoresponsive polymers
- Qualitative and quantitative instrumental analysis using PVA-type capillary electrophoresis, high-performance HPLC column chromatography with UV-Vis, fluorescent, and Corona detectors, MALDI analysis
- Synthesis of new functional biomaterials, such as chitin modifications



HEAD

Marcin K. Chmielewski, PhD, DSc, Assoc. Prof.

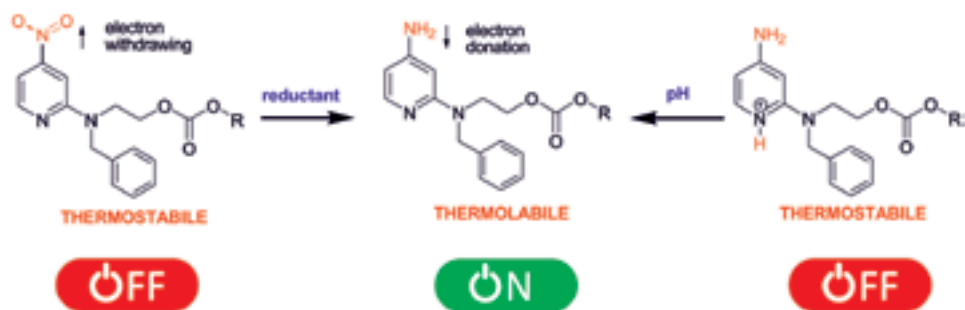
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RESEARCH PROJECTS

Development of large-scale synthesis of nucleic acids using hybrid supports (NCBiR, Smart Growth Operational Programme 2014-2020 'Fast Track', project implemented in the consortium, project leader: FutureSynthesis sp.z o.o.; task leader from IBCH PAS: M.K. Chmielewski)

Implementation of the production method of 5'triphosphorylated nucleic acids (NCBiR, TANGO, PI: M.K. Chmielewski)



Concept of controlling thermolability

SELECTED PUBLICATIONS

Brzezinska, J., Chmielewski, M.K. et al, 2-Pyridinyl-N-(2,4-difluorobenzyl)aminoethyl Group As Thermocontrolled Implement for Protection of Carboxylic Acids Organic Letters 2016, 18, 3230–3233

Paluch M., Chmielewski M.K., et al, Pyridin-2-yl-substituted smart polymers sensitive to thermally triggered side group cyclization European Polymer Journal 2023,186, 111865

Hyjek-Składanowska, M., Chmielewski, M. K., & Nowotny, M. et al, Disulfide bridge cross-linking between protein and the RNA backbone as a tool to study RNase H1.,Bioorganic & Medicinal Chemistry 2020, 115741

Witkowska A., Chmielewski M.K., et al., Fluorescent 2-(Pyridin-2-yl)vinyl Pyridine Dyes and Their Thermocontrolled Release J. Org. Chem. 2019, 84, 13447-13456

Frydrych-Tomczak, E.; Chmielewski, M.K.; et al, Structure and Oligonucleotide Binding Efficiency of Differently Prepared Click Chemistry-Type DNA Microarray Slides Based on 3-Azidopropyltrimethoxysilane, Materials 2021, 14, 2855

Brzezinska J, Chmielewski, M.K., et al, Experimental and computational studies on a protonated 2-pyridinyl moiety and its switchable effect for the design of thermolytic devices. PLoS ONE 2018,13(9), e0203604

DEPARTMENT OF MOLECULAR NEUROBIOLOGY

polyQ disorders | pathogenesis | neurodevelopment | therapy

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RESEARCH SCOPE

Influence of neurodegenerative diseases on the adult and developing brain.

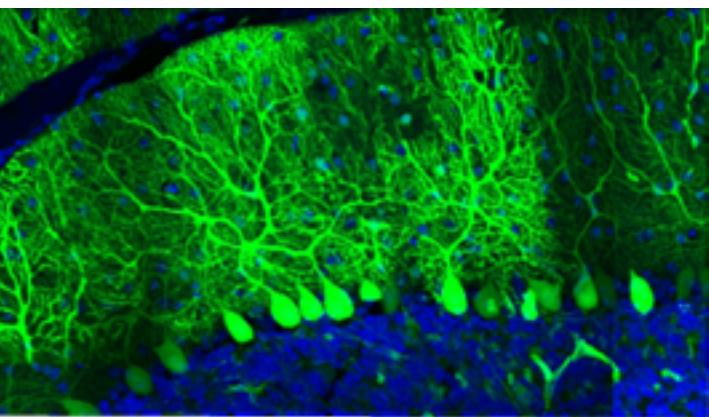
We study the role of various mRNAs and proteins in the development of brain diseases using mouse models, organoids, iPSCs, and neuronal cells. Our primary focus is on understanding the molecular mechanisms underlying neurodegenerative diseases, particularly Huntington's disease and spinocerebellar ataxia type 3, with the goal of developing effective therapeutic interventions.

PolyQ diseases have a unique etiology and are the result of multiple CAG repeats in 9 different genes. These mutant genes pro-

duce toxic proteins with a long polyglutamine domain, which directly cause neuronal death in the brain, similar to what occurs in Alzheimer's disease. Our focus is on studying brain development in Huntington's disease. We investigate processes that occur in cell populations during the early stages of embryonic brain development in organoids and stem cells. We explore the pathogenesis of polyQ diseases to identify new therapeutic options that could be applied to other neurodegenerative disorders. We test potential treatments on animal models of neurodegenerative diseases.

MAIN RESEARCH TOPICS

- Pathogenesis of Huntington's disease and spinocerebellar ataxia type 3 (SCA3)
- Neurodevelopmental mechanisms of Huntington's disease and SCA3
- Mechanism of action of small molecule therapeutics in polyQ diseases
- CAG-targeted therapies in SCA3 and Huntington's disease
- Cholesterol metabolism as a therapeutic target for SCA3
- Ketogenic interventions in neurodegenerative diseases





HEAD

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RESEARCH PROJECTS

Development of a universal fast-response platform, based on RNA technology, ensuring the national drug and epidemiological safety (Medical Research Agency, project implemented in the consortium, project leader: Polfa S.A. Pharmaceutical Works, principal investigator: M. Figlerowicz, task leader: M. Figiel)

Molecular Mechanisms of Dietary Intervention on Neurodegeneration (NSC; The EU Joint Programme – Neurodegenerative Disease Research, PI: M. Figiel)

Investigation of a new therapeutic strategy to reduce mutant protein in SCA3 / MJD (NSC, PI: M. Figiel)

Adaptive multi-tier intelligent data manager for Exascale (NCRD, Horizon 2020; Co-PI: M. Figiel)

Discovering disorders of brain development in Huntington disease as a consequence of putative total huntingtin deficiency in HD, using juvenile HD iPSC and fused brain organoids (NSC, PI: M. Figiel)

SELECTED PUBLICATIONS

Piasecki P et al., Impaired interactions of ataxin-3 with protein complexes reveals their specific structure and functions in SCA3 Ki150 model; *Front. Mol. Neurosci.* 2023. 16:1122308.

Surdyka M et al., Selective transduction of cerebellar Purkinje and granule neurons using delivery of AAV-PHP.eB and AAVrh10 vectors at axonal terminal locations. *Front Mol Neurosci.* 2022 Sep 13; 15:947490.

Wiatr K et al., Broad Influence of Mutant Ataxin-3 on the Proteome of the Adult Brain, Young Neurons, and Axons Reveals Central Molecular Processes and Biomarkers in SCA3/MJD Using Knock-In Mouse Model., *Front Mol Neurosci.* 2021 Jun 17; 14:658339.

Wiatr K et al., Altered Levels of Proteins and Phosphoproteins, in the Absence of Early Causative Transcriptional Changes, Shape the Molecular Pathogenesis in the Brain of Young Presymptomatic Ki91 SCA3/MJD Mouse. *Mol Neurobiol.* 2019 Dec; 56(12):8168-8202.

Światońska K et al., Identification of Altered Developmental Pathways in Human Juvenile HD iPSC with 71Q and 109Q Using Transcriptome Profiling. *Front Cell Neurosci.* 2019; 12:528. [PMC6345698/](https://doi.org/10.3389/fncl.2019.00528)

DEPARTMENT OF MOLECULAR NEUROONCOLOGY

brain tumors | glioblastoma | cancer stem cells | regulatory RNA | extracellular matrix

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RESEARCH SCOPE

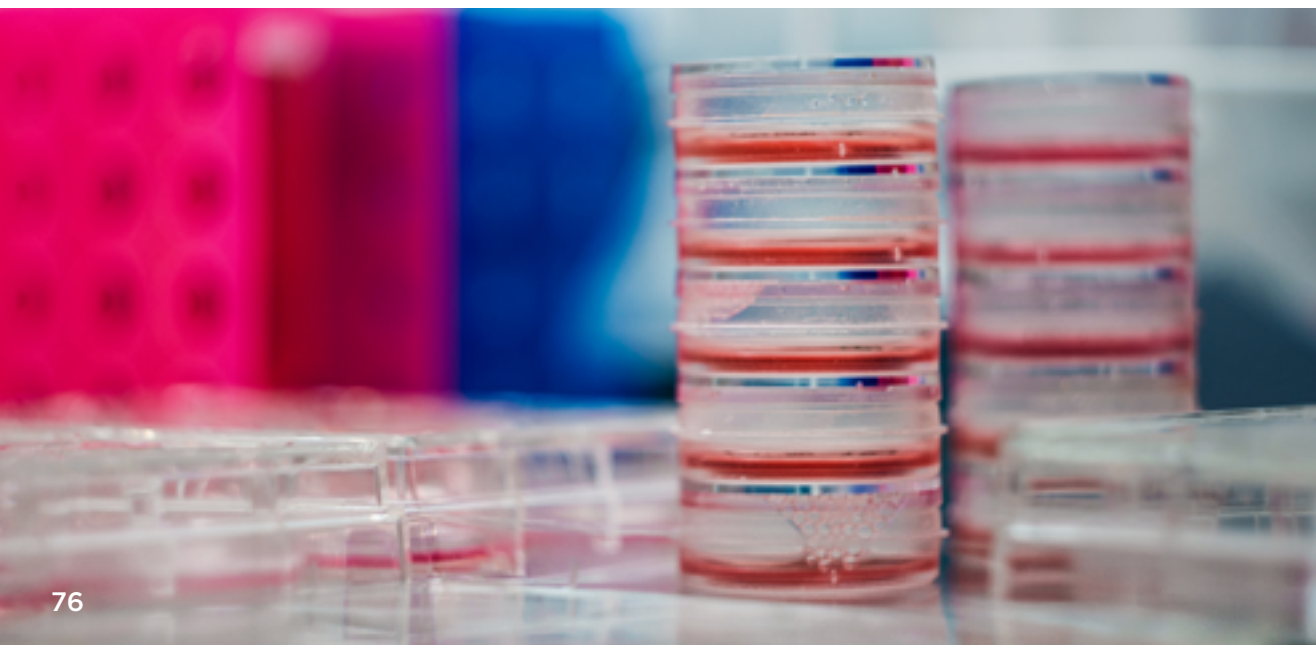
The determination of the importance of RNA in cancer, particularly brain tumors.

We study the impact of the tumor micro-environment on the expression of different RNA classes, e.g., miRNA and circRNA, and their function in development and progression processes. We are particularly interested in the changes within the extracellular matrix and the role of RNAs in the ECM rearrangement. We focus especially on the identification of RNA molecules with special clinical significance (diagnostic markers, therapeutic molecules). We also create innovative models to study tu-

mor progression: organoids and spheroids derived from patients with glioblastoma.

MAIN RESEARCH TOPICS

- The role of ncRNA in the function of cancer stem cells
- Identification of RNA and proteins involved in migration and invasion processes
- Identification of molecules with diagnostic, prognostic, and therapeutic potential
- Development and characterization of new models based on primary cell lines from GBM patients
- Development of new therapeutic strategies utilizing RNA





HEAD

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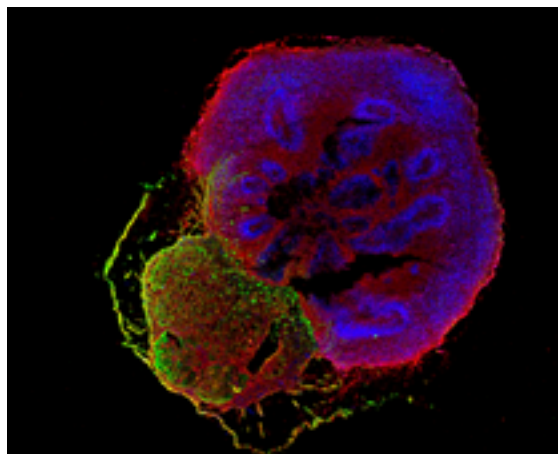
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RESEARCH PROJECTS

The characteristic of the regulatory RNAs landscape in glioblastoma multiforme (GBM). Circular RNAs and micro RNA-like molecules as new players in gliomagenesis and GBM progression and their importance for glioblastoma stem cells. (NSC, SONATA BIS, PI: K. Rolle)

Patient-derived bioprinted organoids for toxicological prediction analysis and new drugs design (NSC, MINATURA, PI: D. Wawrzyniak)

Development of a universal fast-response platform, based on RNA technology, ensuring the national drug and epidemiological safety (Medical Research Agency, project implemented in the consortium, project leader: Polfa S.A. Pharmaceutical Works, principal investigator: M. Figlerowicz, task leader: K. Rolle)



The structure of a hybrid glioma invasion model in immunofluorescent staining

SELECTED PUBLICATIONS

Rolle K et al. Promising human brain tumors therapy with interference RNA intervention (iRNAi). *Cancer Biol Ther.* 2010; 9:396-406.

Głodowicz P et al. Mitochondrial transport of catalytic RNAs and targeting of the organellar transcriptome in human cells. *J Mol Cell Biol.* 2023, mjad051.

Grabowska M et al. miR-218 affects the ECM composition and cell biomechanical properties of glioblastoma cells. *J Cell Mol Med.* 2022; 26:3913-3930.

Latowska J et al. Non-coding RNAs in brain tumors, the contribution of lncRNAs, circRNAs, and snoRNAs to cancer development-their diagnostic and therapeutic potential. *Int J Mol Sci.* 2020; 21:7001.

DEPARTMENT OF BIOMEDICAL PROTEOMICS

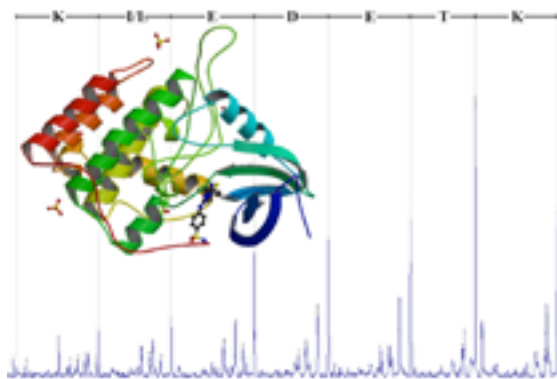
proteomics | mass spectrometry | chronic kidney disease (CKD) | cardiovascular disease (CVD) | hematopoietic cancer

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RESEARCH SCOPE

Proteins involved in the development and progression of various human pathophysiological conditions, with particular attention to chronic kidney disease-related atherosclerosis (CKD-A) and hematological malignancies.

We specialize in the large-scale study of the proteome and its application in the translational studies of human diseases. Mass spectrometry-based quantitative analysis of the proteome leads to the uncovering of disease-affected protein profiles. Analysis of these changes with bioinformatics provides biological insight into the physiological effect, i.e., disease-related signaling pathways and processes altered in a given condition. Complemented by studies on other “omic” levels and functional analyses of cells *in vitro* and *in vivo*, they can contribute to deciphering the molecular pattern of the studied disease and the factors promoting its development and progression. We are also interested in the application of proteomics in precision medicine and understanding the ‘individuals’ characteristics that determine the susceptibility and outcome of treatment.



Protein identification using mass spectrometry methods

MAIN RESEARCH TOPICS

- Investigations of the role of proteins dysregulated during the development of CKD-A and the mechanism underlying the progression of this disease.
- Analysis of the relationship between oxidative stress and chronic inflammation in CKD and CVD.
- Elaboration of screening and targeted proteomic approaches in biomedical research.
- Analysis of the mechanism of cell resistance to proteasome inhibitors in multiple myeloma.
- Identification of protein biomarkers of resistance to chemotherapy.



HEAD

Magdalena Łuczak, PhD, DSc, Assoc. Prof.

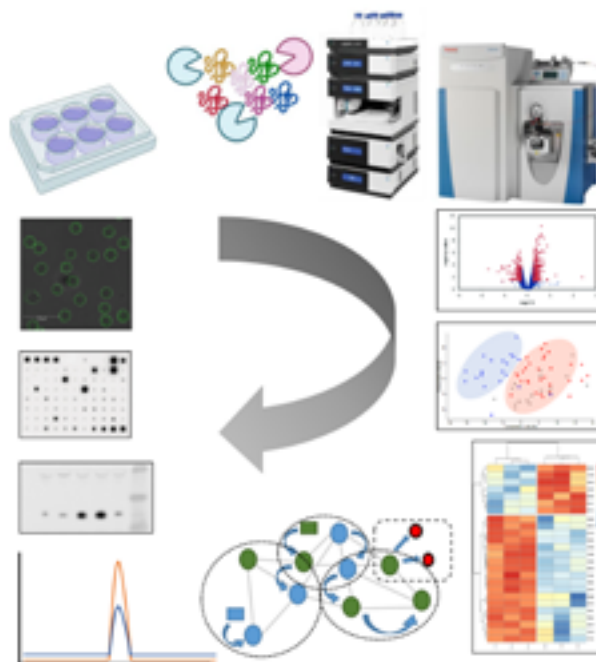
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RESEARCH PROJECTS

Comprehensive phosphoproteomic analysis of NKT cells in the context of the role of phosphorylation mechanisms in progression of atherosclerosis in chronic kidney disease (NSC, OPUS, PI: M. Łuczak)

Proteomic analysis of myeloma plasma cells to determine proteins and pathways involved in acquired resistance to proteasome inhibitors (NSC, OPUS, PI: D. Dytfeld)



Quantitative proteomic analyses

SELECTED PUBLICATIONS

Tracz J. et al. Proteomic Profiling of Leukocytes Reveals Dysregulation of Adhesion and Integrin Proteins in Chronic Kidney Disease-Related Atherosclerosis. *Journal of Proteome Research* 2021; 20, 6, 3053-3067

Ehrlich H. et al. Arrested in Glass: Actin within Sophisticated Architectures of Biosilica in Sponges. *Advanced Science* 2022; e2105059

Łuczak M. et al. Label-Free quantitative proteomics reveals differences in molecular mechanism of atherosclerosis related and non-related to chronic kidney disease. *International Journal of Molecular Sciences* 2016; 17(5). pii: E631

Łuczak M. et al. iTRAQ-based proteomic analysis of plasma reveals abnormalities in lipid metabolism proteins in chronic kidney disease-related atherosclerosis. *Scientific Reports* 2016, 6: 32511

Thompson R.M. et al. Glutaminase inhibitor CB-839 synergizes with carfilzomib in resistant multiple myeloma cells. *Oncotarget* 2017 8; 35863-35876

DEPARTMENT OF RNA STRUCTURE AND FUNCTION

RNA structure *in vivo* | RNA function | RNA binding proteins | retrotransposons | mRNA bioproduction

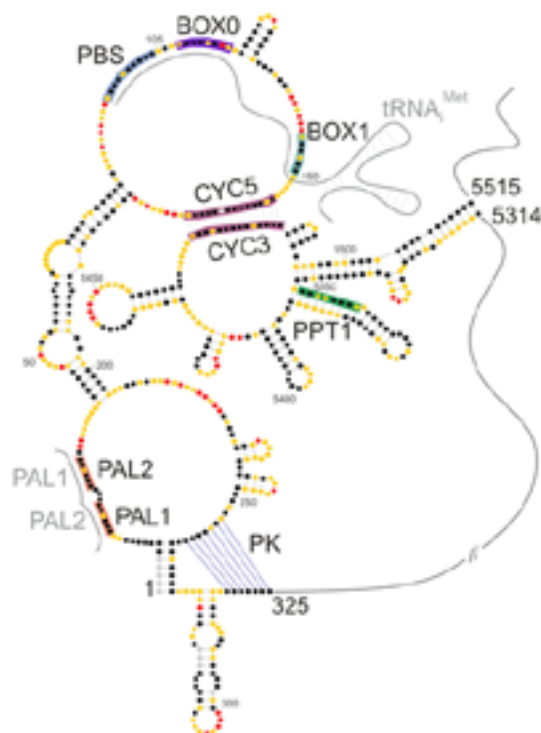
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RESEARCH SCOPE

The correlation between RNA structure and function, replication of RNA viruses, RNA in diseases, and RNA-based therapeutics.

The studies of the Department focus on exploring RNA structural dynamics in complex cellular environments using cutting-edge biochemical and bioinformatics technologies. We aim to precisely describe RNA structure features regulating its trans-

port, translation, and decay in the cell. Our research also contributes to understanding how complex multifunctional RNA genomes fold *in vivo* and how RNA structural elements regulate the replication of endogenous retroelements. In addition, we explore factors that can impact RNA structure, including ribosomes and virus-like proteins. Furthermore, we are also involved in the development of groundbreaking technology for mRNA production in microorganisms.



MAIN RESEARCH TOPICS

- RNA structure mapping and the development of bioinformatics tools for RNA structural data analysis.
- Large-scale structural characteristics of transcriptomes and the creation of an mRNA structure database.
- Evaluation of structure's role in RNA functioning.
- Investigation of Gag-like protein interactions with RNA.
- Structural and functional genomics of LTR-retrotransposons (Ty1, Ty3).
- Developing a platform for the bioproduction of therapeutic mRNA.



HEAD

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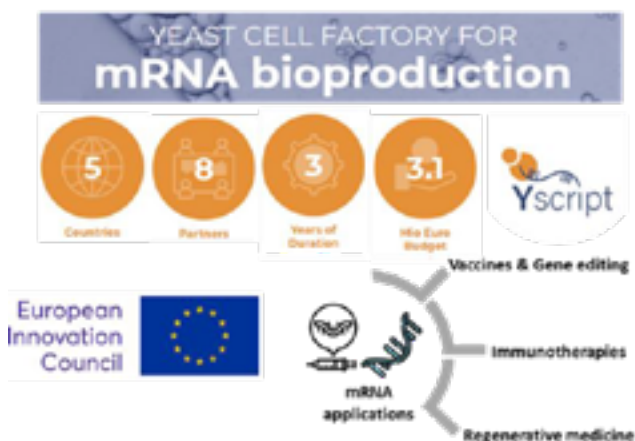
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RESEARCH PROJECTS

Transcriptome-wide analysis of RNA structure in the cell and across cellular compartments, and identification of the impact of cellular factors on RNA structure in *S. cerevisiae* (NSC, OPUS, PI: K. Pachulska-Wieczorek)

Yeast cell factory for mRNA bioproduction. YSCRIPT, EIC (Pathfinder, PI: Ch. Pichon, IBCH PI: K. Pachulska-Wieczorek)

Arc as a neuronal Gag. Exploring the viral properties and functions of a master regulator of synaptic plasticity (NSC, PRELUDIUM, PI: J. Gumna)



Exploring Ty3 genomic RNA structure during retrotransposition in yeast (NSC, PRELUDIUM, PI: A. Andrzejewska-Romanowska)

NAJWAŻNIEJSZE PUBLIKACJE

Andrzejewska A et al. *In vivo* structure of the Ty1 retrotransposon RNA genome. *Nucleic Acids Res.* 2021; 49(5):2878-2893

Zawadzka M et al. Cell Compartment-Specific Folding of Ty1 Long Terminal Repeat Retrotransposon RNA Genome. *Viruses.* 2022; 14(9):2007

Gumna J et al. Retroviral-like determinants and functions required for dimerization of Ty1 retrotransposon RNA. *RNA Biol.* 2019; 16(12):1749-1763

Gumna J et al. RNA Binding Properties of the Ty1 LTR-Retrotransposon Gag Protein. *Int J Mol Sci.* 2021; 22(16):9103

Gumna J et al. RNAtThor - fast, accurate normalization, visualization and statistical analysis of RNA probing data resolved by capillary electrophoresis. *PLoS One.* 2020; 15(10):e0239287

DEPARTMENT OF NEURONAL CELL BIOLOGY

spinocerebellar ataxia | neurodegeneration | Purkinje cells | selective neuronal vulnerability | epigenetics

portal.ichb.pl/departament-of-neuronal-cell-biology/

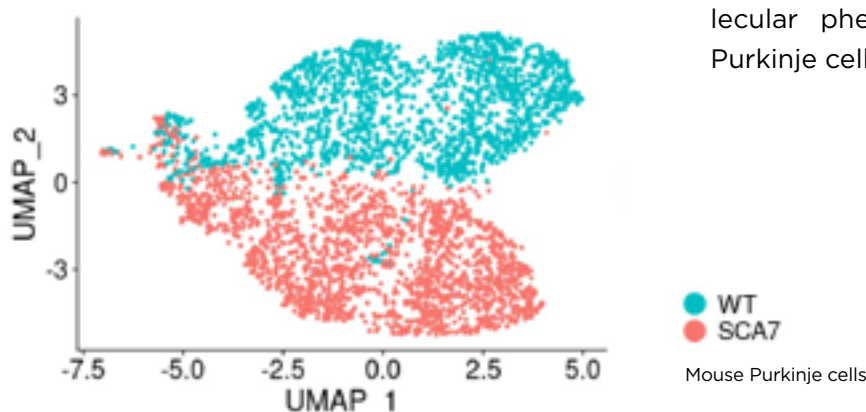
RESEARCH SCOPE

The molecular mechanisms and cellular processes explaining the selective vulnerability of neurons in neurodegenerative diseases and the effective therapies to protect these vulnerable cells.

Our primary research focuses on Purkinje cells, which experience degeneration in spinocerebellar ataxias. By integrating experimental approaches involving animal models with bioinformatics methodologies, we aim to gain a comprehensive understanding of the fundamental aspects of neurodegenerative processes. Specifically, our attention is directed towards unraveling the impact of epigenetic alterations on the selective degeneration of Purkinje cells in the context of spinocerebellar ataxia type 7.

MAIN RESEARCH TOPICS

- Developing and optimizing the protocol for selective isolation of Purkinje cell nuclei
- Analyzing epigenetic changes, including histone modifications, in Purkinje cells derived from mouse models of spinocerebellar ataxia using both bulk and single-cell methods
- Studying chromatin accessibility in ataxia-affected Purkinje cells
- Integrating bioinformatic analysis of transcriptional and epigenetic data to identify molecular differences between healthy and diseased cells
- Creating tools that utilize artificial intelligence for the identification of molecular phenotypes in degenerating Purkinje cells





HEAD

Pawel M. Switonski, PhD

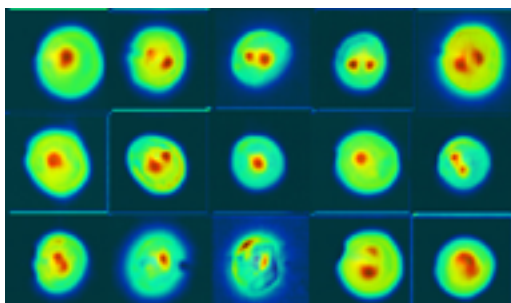
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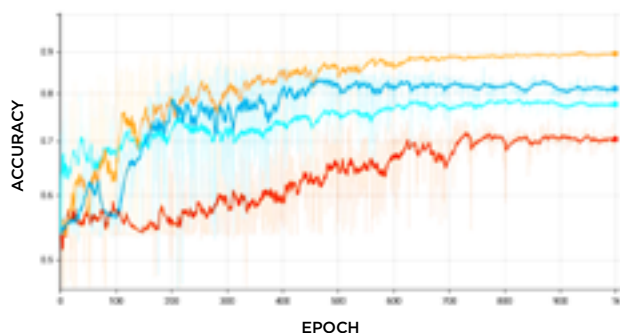
RESEARCH PROJECTS

Elucidating neurodegenerative processes using direct profiling of selectively vulnerable neurons (NSC Sonata, PI: P.M. Switonski)

Multimomic characterization of neurogenerative processes in Zebrin-II positive and Zebrin-II negative Purkinje cells (NSC Preludium, PI: G. Adamek)



Mapping of differentiating features of SCA7 Purkinje cells



AI Classification of Purkinje Cell Nuclei

SELECTED PUBLICATIONS

Switonski PM & La Spada AR, Spinocerebellar Ataxia Type 7: From Mechanistic Pathways to Therapeutic Opportunities, *Trials for Cerebellar Ataxias*, 2023, ISBN: 9783031243448, publisher Springer Cham, Pages 433-467

Switonski PM et al. Altered H3 histone acetylation impairs high-fidelity DNA repair to promote cerebellar degeneration in spinocerebellar ataxia type 7, *Cell Reports*, 2021, 37(9):110062

Stoyas CA et al. Nicotinamide Pathway-Dependent Sirt1 Activation Restores Calcium Homeostasis to Achieve Neuroprotection in Spinocerebellar Ataxia Type 7, *Neuron*, 2020, 105(4):630-644.e9

Ward JM et al. Metabolic and Organelle Morphology Defects in Mice and Human Patients Define Spinocerebellar Ataxia Type 7 as a Mitochondrial Disease, *Cell Reports*, 2019, 26(5):1189-1202.e6

Switonski PM et al. A new humanized ataxin-3 knock-in mouse model combines the genetic features, pathogenesis of neurons and glia and late disease onset of SCA3/MJD, *Neurobiology of Disease*, 2015, 73:174-188

DEPARTMENT OF COMPUTATIONAL BIOLOGY OF NON-CODING RNA

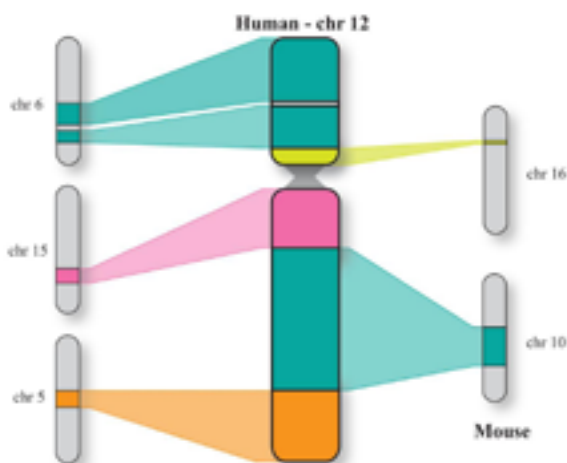
lncRNA | big data | genomics | transcriptomics | RNA-seq

<https://portal.ichb.pl/departament-of-computational-biology-of-non-coding-rna/>

RESEARCH SCOPE

The biological importance of long noncoding RNAs (lncRNAs) within the cell.

Employing a comprehensive approach that integrates computational and experimen-



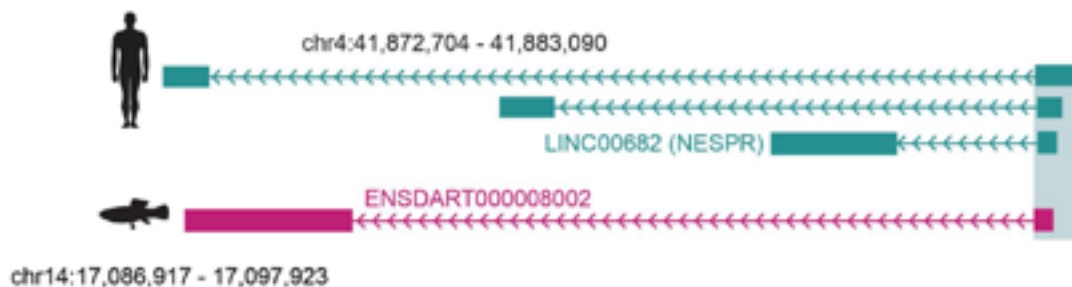
Synteny between human and mouse chromosomes. Colors in the human chromosome indicate regions homologous with parts of the mouse chromosome of the same color.

tal methodologies, we aim to enhance our understanding of the biological roles of long noncoding RNAs within the cell. The findings from these investigations serve as a basis for further discoveries, including the potential to uncover regulatory mechanisms and the functional significance of lncRNAs, thereby contributing to the broader field of RNA biology and its implications for health and disease.

MAIN RESEARCH TOPICS

The team's research projects are centered on four key areas:

- Identification of lncRNAs in vertebrate genomes
- Analysis of the evolutionary conservation of lncRNAs
- Functional characterization of lncRNAs *in vivo*
- Development of bioinformatics tools for genome-wide lncRNA analysis



Example of a new alternative transcript version of the lncRNA nespr in zebrafish



HEAD

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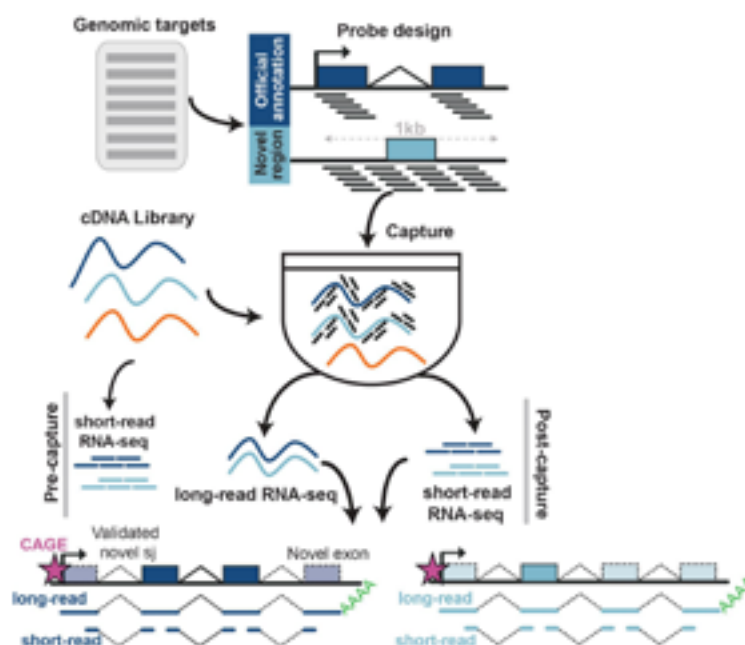
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RESEARCH PROJECTS

Shedding new light on genome's dark matter: identification of novel long non-coding RNAs in zebrafish (NSC OPUS, PI: B. Uszczyńska-Ratajczak)

Functional or not functional? Studying positionally conserved vertebrate lncRNA orthologues at subcellular resolution (NSC SONATA BIS, PI: B. Uszczyńska-Ratajczak)

Game of Tails: Understanding the role of 3'-end processing of long noncoding RNAs during zebrafish development (NSC PRELUDIUM, PI: M. Kwiatkowska)



The Capture Long-read Sequencing (CLS) strategy for automated, high-quality transcriptome annotation

SELECTED PUBLICATIONS

Julien Lagarde et al. High-throughput annotation of full-length long noncoding RNAs with capture long-read sequencing, *Nature Genetics*, 2017, 49(12), 1731-1740

Barbara Uszczyńska-Ratajczak et al. Towards a complete map of the human long non-coding RNA transcriptome, *Nature Reviews Genetics*, 2018, 19(9), 535-548

Julien Lagarde et al. Extension of human lncRNA transcripts by RACE coupled with long read high-throughput sequencing (RACE-Seq) *Nature Communications*, 2016, 17(7), 12339

The ENCODE Project Consortium, Expanded Encyclopedias of DNA Elements in the Human and Mouse Genomes, *Nature*, 2020, 699-710

The ENCODE Project Consortium, Perspectives on ENCODE, *Nature*, 2020, 583(7818), 693-698

DEPARTMENT OF STRUCTURAL BIOLOGY OF PROKARYOTIC ORGANISMS

crystallography | cryo-EM | structural enzymology | antibiotic resistance | cellular methylation

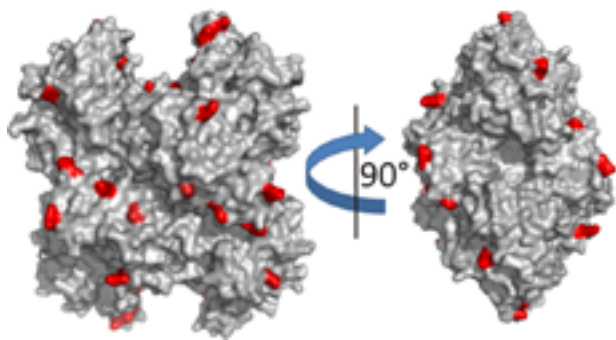
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RESEARCH SCOPE

Development of inhibitors of enzymes involved in the regulation of methylation processes in pathogenic microorganisms.

To achieve our goals, we apply structural chemistry and biology methods, including macromolecular crystallography, cryo-EM, and NMR spectroscopy, as well as numerous microbiology, biochemical, and biophysical techniques.

Our goal is to create highly potent and selective inhibitors that interfere with fundamental biochemical processes that occur in all living cells to provide a novel class of antibacterial compounds. In particular, we target a regulatory mechanism of S-adenosyl-L-methionine (SAM)-dependent methylation reactions, where SAM is the most common methyl group donor in cellular methylation of a wide range of substrates, including small-molecule compounds as well as all biological macromolecules. Apart from this biological project, we are also interested in the structural analysis of small-molecule compounds and non-crystalline materials.



Surface representation of S-adenosyl-L-homocysteine hydrolase with rare single amino acid substitutions (shown in red) present among *Pseudomonas aeruginosa* strains

syl-L-methionine (SAM)-dependent methylation reactions, where SAM is the most common methyl group donor in cellular methylation of a wide range of substrates, including small-molecule compounds as well as all biological macromolecules. Apart from this biological project, we are also interested in the structural analysis of small-molecule compounds and non-crystalline materials.

MAIN RESEARCH TOPICS

- Structural enzymology of enzymes of pathogenic origin involved in cellular methylation, including S-adenosyl-L-homocysteine hydrolases and methylenetetrahydrofolate reductases
- Development of species-specific inhibitors of S-adenosyl-L-homocysteine hydrolase targeting the enzyme dynamics
- Application of high-throughput macromolecular crystallography in drug design
- Crystallographic studies of biologically active small molecules
- X-ray diffraction studies of non-crystalline (bio)materials



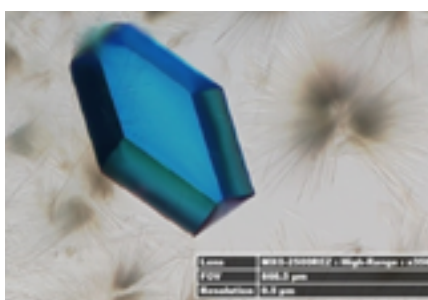
HEAD

Krzysztof Brzeziński, PhD, DSc, Assoc. Prof.

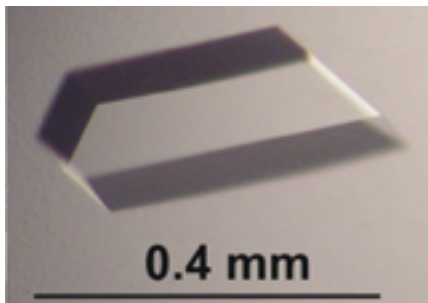
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Single crystals of
S-adenosyl-L-homo-
cysteine hydrolases
from *Thermotoga*
maritima



Single crystals of
S-adenosyl-L-homo-
cysteine hydrolases
from *Pseudomonas*
aeruginosa



RESEARCH PROJECTS

Inhibition of S-adenosyl-L-homocysteine hydrolase from *Pseudomonas aeruginosa* by targeting the enzyme dynamics (NSC, SONATA BIS, PI: K. Brzeziński)

Rational, structure-guided design of histone demethylase inhibitors for cancer therapy (NSC, SONATA, PI: P.H. Małecki)

SELECTED PUBLICATIONS

Małecki PH et al. Biochemical and Structural Insights into an Unusual, Alkali Metal-independent S-adenosyl-L-homocysteine Hydrolase from *Synechocystis* sp. PCC 6803. *Acta Cryst.* 2022; D78:865

Wozniak K & Brzezinski K. Biological Catalysis and Information Storage Have Relied on N-Glycosyl Derivatives of β -D-Ribofuranose since the Origins of Life. *Biomolecules.* 2023; 13, 782

Brzezinski K. S-adenosyl-L-homocysteine hydrolase: a structural perspective on the enzyme with two Rossmann-fold domains. *Biomolecules.* 2020; 10:1682

Puckowska A et al. Synthesis and Structural Characterization of Pyridine-2,6-dicarboxamide and Furan-2,5-dicarboxamide Derivatives. *Molecules.* 2022; 27:1819

Wojtulewski S et al. A new look at two polymorphic crystal structures of dibenzoylmethane: Relationship between the Crystal Packing and the Hydrogen Atom Position revealed by Quantum Chemistry and Quantum Crystallography Methods. *Acta Cryst.* 2020; B76, 95:966

DEPARTMENT OF RARE DISEASES

myotonic dystrophies | non-canonical RNA splicing | circular RNA | small molecule compounds | introns' processing and functions

portal.ichb.pl/departament-of-rare-diseases/

RESEARCH SCOPE

Pathomechanisms and therapeutic approaches in neurodegenerative and neuromuscular diseases associated with mutational expansions of microsatellites.

Our primary focus lies in unraveling the molecular basis underlying the pathogenesis of myotonic dystrophy types 1 (DM1) and 2 (DM2). Our ongoing research focuses on characterizing known biomarkers and identifying novel ones for myotonic dystrophies. Additionally, we are engaged in high-throughput screening of small-molecule compounds to diminish the molecular toxicity of DM2. Furthermore, we investigate the mechanisms responsible for non-canonical splicing of introns, exploring

their fate and functionality in neurodegenerative and neuromuscular diseases.

MAIN RESEARCH TOPICS

- Searching for novel biomarkers of DM1 and DM2
- Screening for small-molecule compounds that alleviate the pathogenesis of DM2
- Elucidating the biological role of circular RNAs in DM1 pathogenesis
- Processing of introns harbouring expansions of microsatellites in neuromuscular disorders
- Non-canonical splicing of introns
- Molecular mechanisms and consequences of intron retention in mature transcripts





HEAD

Marzena Wojciechowska, PhD, DSc, Assoc. Prof.

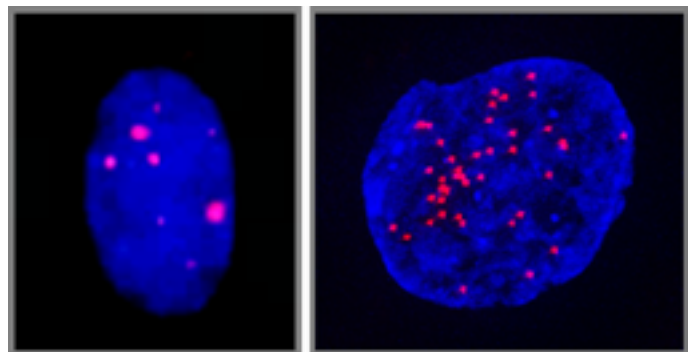
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RESEARCH PROJECTS

Deciphering the molecular causes and consequences of circular RNAs elevated expression levels in myotonic dystrophy type 1 (DM1); (NCN, OPUS, PI: M. Wojciechowska)

Cell-based high-throughput screening for small-molecule compounds diminishing molecular markers of pathogenesis in myotonic dystrophy type 2 (DM2); (NCN, OPUS, PI: M. Wojciechowska)



Therapeutic targets (toxic RNAs) in human DM1 and DM2 fibroblasts

Non-canonical pre-mRNA splicing participates in the editing of CNBP mutant allele in myotonic dystrophy type 2 (DM2); (NCN, Preludium Bis, PI: M. Wojciechowska)

SELECTED PUBLICATIONS

Ketley A et al. CDK12 inhibition reduces abnormalities in cells from patients with myotonic dystrophy and in a mouse model. *Science Translational Medicine* 2020; 12,541

Wojciechowska M et al. Quantitative Methods to Monitor RNA Biomarkers in Myotonic Dystrophy. *Scientific Reports*, 2018

Kumari A et al. Differential fates of introns in gene expression due to global alternative splicing. *Human Genetics* 2022

Czubak K et al. Global increase in circRNA levels in myotonic dystrophy. *Frontiers in Genetics* 2019

Sedehizadeh S et al. Splicing in two skeletal muscle transcripts correlates with clinical phenotype in myotonic dystrophy type 1 patients. *Journal of Neurology* 2022

Yenigun V et al. (CCUG)_n RNA toxicity in a Drosophila model of myotonic dystrophy type 2 (DM2) activates apoptosis. *Disease Models & Mechanisms* 2017

Lopez-Morato M et al. Small molecules which improve pathogenesis of myotonic dystrophy type 1 (DM1). *Frontiers in Neurology* 2018

DEPARTMENT OF PLANT GENOMICS

structural variation | model plants | transposable elements | epigenetics | stress

portal.ichb.pl/departament-of-plant-genomics/

RESEARCH SCOPE

Genome structure, plant genetic variation, and the relationship between genotype and phenotype.

We are interested in the copy number polymorphism of genes encoding proteins and microRNAs, the polymorphism of genomic repeats and the mechanisms of their formation, as well as their putative impact on gene expression diversity. We also study the effects of transposable element presence on genomic DNA methylation patterns and the role of genomic duplications in the adaptation and evolution of a species. Our main plant models are *Arabidopsis thaliana* and *Medicago truncatula*. In our research, we combine experimental and bioinformatics approaches, including short- and long-read DNA/RNA sequencing as well as genome-wide association studies. We create novel genomic resources, one of which is an online catalog of gene copy number variation in *Arabidopsis* (<http://athcnv.ibch.poznan.pl/>).



MAIN RESEARCH TOPICS

- Natural variation of genomic sequence repeats and the mechanisms involved in their formation
- The role of gene copy number polymorphism in shaping plant responses to stress
- Links between the non-coding RNA metabolism and the accumulation of structural variations
- The role of structural and epigenetic changes in plant adaptation to climate change
- The diversity of symbiotic gene islands in the *Medicago* genome and its impact on nodulation



HEAD

Agnieszka Żmieńko, PhD, DSc, Assoc. Prof.

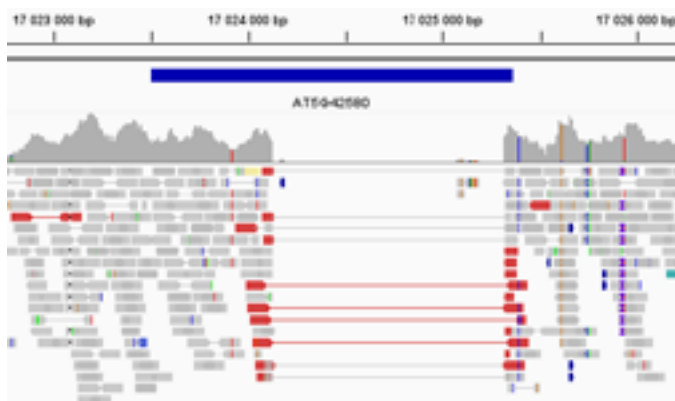
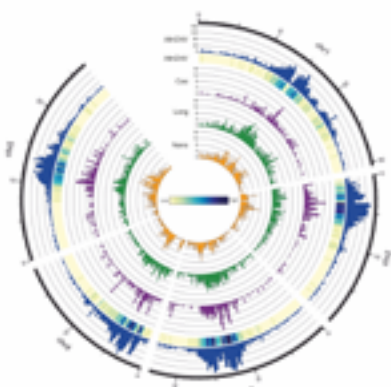
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RESEARCH PROJECTS

The role of transposable elements and epigenetic regulation of gene expression in *Medicago truncatula* root nodules development (NSC, Preludium BIS, PI: A. Żmieńko)

The role of transposable elements in shaping structural and transcriptional variation of *Arabidopsis thaliana* genome (NAWA, Bilateral research projects for Poland and Germany, PI: A. Żmieńko)



SELECTED PUBLICATIONS

Marszałek-Zenczak M et al. Analysis of Arabidopsis non-reference accessions reveals high diversity of metabolic gene clusters and discovers new candidate cluster members. *Front Plant Sci.* 2023; 14:1104303

Samelak-Czajka A et al. Differences in the intraspecies copy number variation of *Arabidopsis thaliana* conserved and nonconserved miRNA genes. *Funct Integr Genomics.* 2023; 23:120

Żmieńko A et al. AthCNV: A Map of DNA Copy Number Variations in the Arabidopsis Genome. *Plant Cell.* 2020; 32:1797-1819

Samelak-Czajka A et al. MLPA-based Analysis of Copy Number Variation in Plant Populations. *Front. Plant Sci.* 2017; 8:222

Żmieńko A et al. Copy number polymorphism in plant genomes. *Theor Appl Genet.* 2014; 127: 1-18

DEPARTMENT OF NON-CODING RNA'S

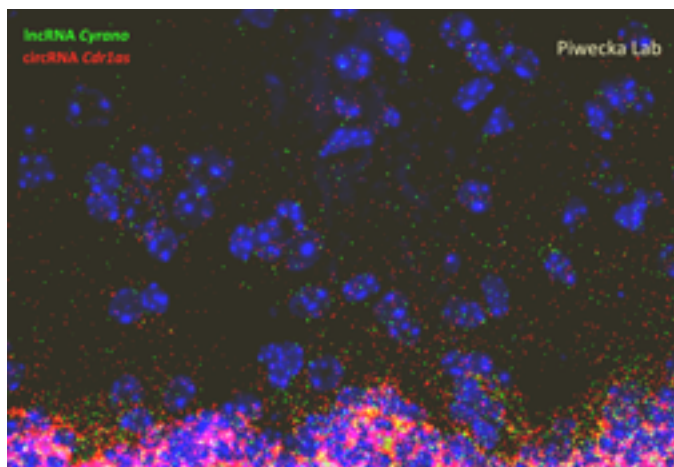
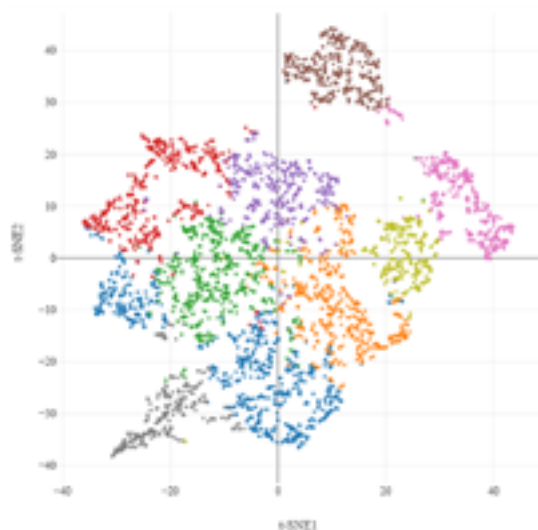
non-coding RNA | miRNA | circular RNAs | regulatory RNAs | nervous system | pituitary gland

portal.ichb.pl/department-of-non-coding-rnas/

RESEARCH SCOPE

Regulatory RNAs and processes underlying gene expression regulation in neurons, glial cells, and the neuroendocrine system. We combine molecular biology with cell biology, neurobiology, and systems biology.

We study how regulatory RNAs, especially microRNAs, circular RNAs, and long non-coding RNAs, influence protein-coding genes. We are interested in the cellular specificity of regulatory RNAs and their interactions with proteins. We are fascinated by the recognition of gene expression regulation processes in different cell types and subtypes of the brain and pituitary gland. We use mice and cell cultures as models.



MAIN RESEARCH TOPICS

- Expression patterns of ncRNAs in single cells of the nervous and neuroendocrine systems, in different cell types and subtypes.
- Subcellular localization of regulatory RNAs in neurons and neuroglia.
- RNA-protein interactions.
- Regulatory networks formed by ncRNA, their influence on protein-coding genes.
- Functions of ncRNA.
- Deregulation of the non-coding transcriptome in CNS/neuroendocrine system pathologies.



HEAD

Monika Piwecka, PhD

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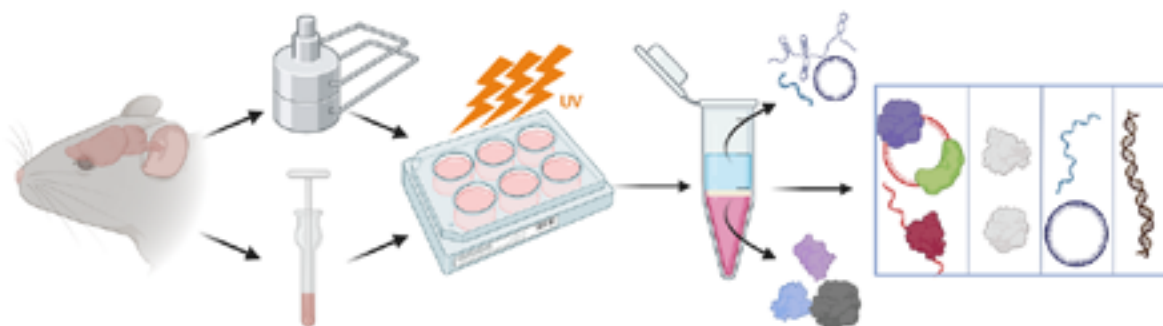
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RESEARCH PROJECTS

Non-coding RNAs at single-cell resolution in the pituitary gland and their role in the regulation of gene expression (NSC Opus, PI: M. Piwecka)

Functional implications of brain-enriched circular RNAs (NSC Sonata Bis, PI: M. Piwecka)

Deciphering networks of regulatory RNAs in the central nervous system (NAWA Polish Returns, PI: M. Piwecka)



SELECTED PUBLICATIONS

Piwecka M et al. Single-cell and spatial transcriptomics: deciphering brain complexity in health and disease. *Nature Reviews Neurology* 2023, 19(6):346-362

Piwecka M et al. Loss of a mammalian circular RNA locus causes miRNA deregulation and affects brain function. *Science* 2017, 357(6357):eaam8526. DOI: 10.1126/science.aam8526

Koliński M et al. RNA-protein interactomes as invaluable resources to study RNA viruses: Insights from SARS CoV-2 studies. *Wiley Interdiscip Rev RNA* 2022,13(6):e1727

Ivanov A et al. Analyses of circRNA Expression throughout the Light-Dark Cycle Reveal a Strong Regulation of Cdr1as, Associated with Light Entrainment in the SCN. *Int J Mol Sci.* 2022, 23(20):12347

Piwecka M., Rolle K. et al. Comprehensive analysis of microRNA expression profile in malignant glioma tissues. *Molecular Oncology* 2015, 9(7):1324-40

DEPARTMENT OF MOLECULAR VIROLOGY

emerging viruses | influenza virus | coronaviruses | virus-host interactions | novel antiviral strategies

portal.ichb.pl/departament-of-molecular-virology/

RESEARCH SCOPE

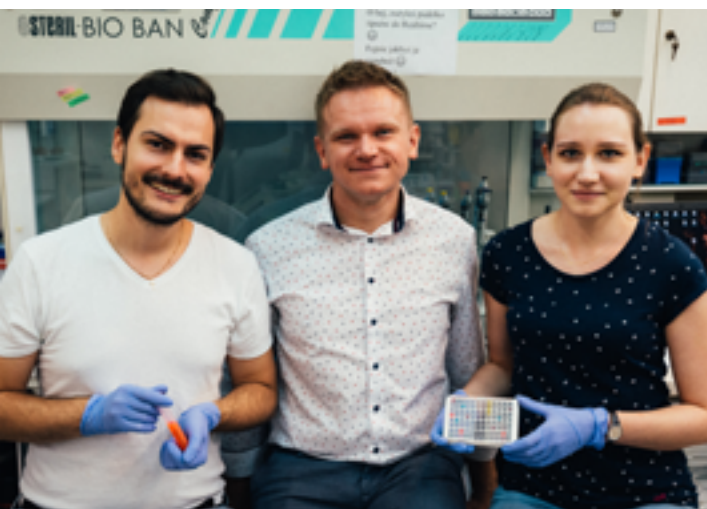
Viruses – host cells interactions, with particular interest in the virus entry, and development of novel antiviral strategies.

As part of our research, we focus on the proteolytic activation of influenza virus hemagglutinin and the emerging coronaviruses spike protein, as well as the search for new inhibitors blocking virus entry. In addition, we are interested in the analysis of the pathogens genetic diversity and its effect on the virus replication, spread and pathogenesis, as well as interactions between virus and host cell. Our scientific interests focus also on the analysis of the viruses spread in the human population with the so-called wastewater-based epidemiology.



MAIN RESEARCH TOPICS

- Analysis of the virus-host cells interactions.
- Identification of the host cell factors involved in the proteolytic activation of influenza virus hemagglutinin and coronavirus spike proteins.
- Development of novel antiviral strategies.
- Analysis of the pathogens' genetic diversity.
- Monitoring of the respiratory viruses spread in the population based on serosurveillance and wastewater-based epidemiology.
- Development of new molecular diagnostic tests for viral, parasitic, and tropical diseases.





HEAD

Paweł Zmora, PhD

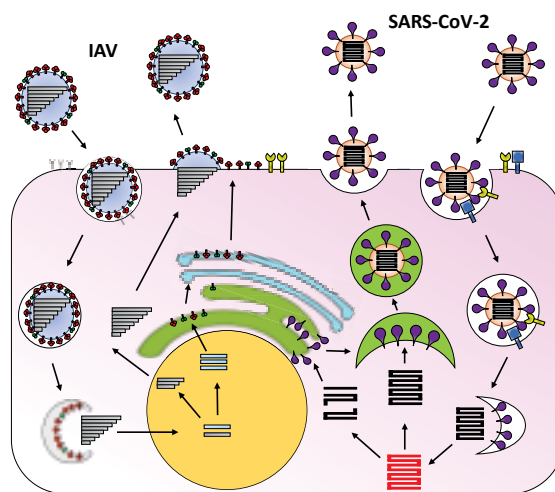
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RESEARCH PROJECTS

Molecular basics of type II transmembrane serine proteases (TTSPs)-mediated activation of influenza viruses (NSC, Beethoven Life 1, principal investigator: P. Zmora)

Development of a universal fast-response platform, based on RNA technology, ensuring the national drug and epidemiological safety (Medical Research Agency, project implemented in the consortium, project leader: Polfa S.A. Pharmaceutical Works, principal investigator: M. Figlerowicz, task leader: P. Zmora)



Replication cycles of influenza viruses and coronaviruses

Connect and align ELIXIR Nodes to deliver sustainable FAIR life-science data management services – ELIXIR CONVERGE (European Commission, Horizon 2020, principal investigator: P. Zmora)

SELECTED PUBLICATIONS

Pawełczyk A, Nowak R et al. Novel molecular consortia of cannabidiol with nonsteroidal anti-inflammatory drugs inhibit emerging coronaviruses entry. *Pathogens*, 2023, 12(7), 951

Gazecka M et al. Mpox virus detection in the wastewater and the number of hospitalized patients in the Poznan metropolitan area, Poland. *International Journal of Infectious Diseases*, 2023, 133:75-77

Lorent D et al. The Longitudinal Analysis on the Anti-SARS-CoV-2 Antibodies among Healthcare Workers in Poland-Before and after BNT126b2 mRNA COVID-19 Vaccination. *Vaccines*, 2022, 10(10):1576

Lorent D et al. Prevalence of Anti-SARS-CoV-2 Antibodies in Poznań, Poland, after the First Wave of the COVID-19 Pandemic. *Vaccines*, 2021, 9(6):541

Tymoniuk B, Zmora P et al. Genetic tests based on the RT-PCR reaction in the diagnostics of SARS-CoV-2 infection. *Epidemiological Reviews*, 2021, 75(1):14-26

DEPARTMENT OF MEDICAL BIOLOGY

epigenetics | m5C | human brain tumors | modified nucleosides | 8-oxo-dG | temozolomide

portal.ichb.pl/departament-of-medical-biology/

RESEARCH SCOPE

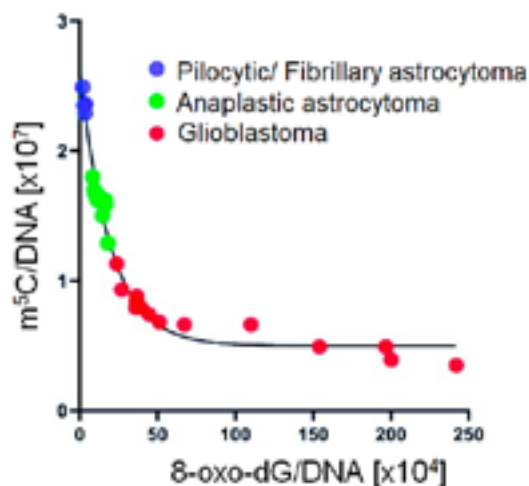
The search for new molecular markers of neoplastic diseases and the development of new therapeutic strategies for high-grade brain gliomas.

Our scope is to understand the role of epigenetic modifications, mostly DNA methylation, on various cellular processes, such as cell differentiation and cell death. DNA methylation is a mammalian epigenetic marker that determines where and when genes are expressed in both normal and cancer cells. It is known that DNA methylation, which represses genes, can be controlled with low molecular weight chemical compounds. The aim of our study is to analyze the impact of small molecules on the activation of genes silenced by DNA

methylation. Our efforts are focused on the search for new compounds or the selection of known drugs that can effectively change DNA methylation in brain tumor cells. The extension of the application of drugs (drug repurposing) to treat other diseases is now increasingly used in medicine.

MAIN RESEARCH TOPICS

- Analysis of 8-oxo-dG and m5C content in DNA isolated from brain tumors.
- Evaluation of the cytotoxicity of selected compounds (valproic acid, temozolomide, juglone, dexamethasone, metformin, cannabidiol, tetrahydrocannabinol) and their effect on cell proliferation
- The use of selected low-molecular-weight compounds in the therapy of brain tumors.
- Induction of stem cells (SCM), determination of pluripotency markers, treatment of cell lines with selected compounds in a selected concentration range, and temozolomide with selected compounds.
- Evaluation of 5-methylcytosine content in DNA isolated from deciduous tree seeds.





HEAD

Prof. Mirosława Z. Naskręt-Barciszewska

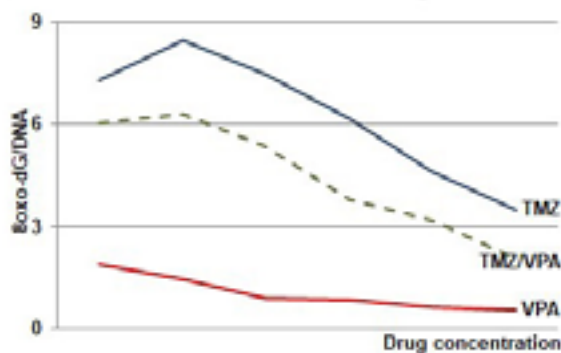
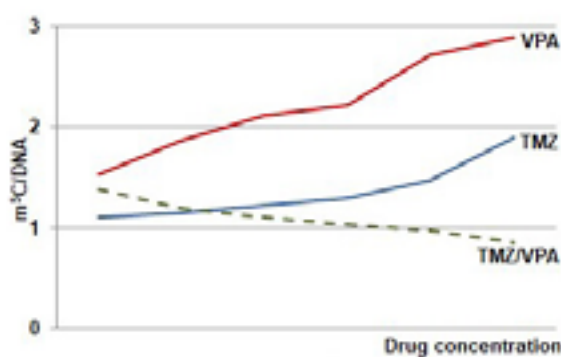
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RESEARCH PROJECTS

Application of small compounds in the epigenetic therapy of malignant brain gliomas (NSC, OPUS, PI: M. Z. Naskręt-Barciszewska)

Pioniering structural and functional studies of miRNA G-quadruplexes (NSC, SONATINA, PI: A. Belter)



SELECTED PUBLICATIONS

Barciszewska AM et al. Juglone in Combination with Temozolomide Shows a Promising Epigenetic Therapeutic Effect on the Glioblastoma Cell Line. *IJMS*, 2023, 24, 6998.

Barciszewska AM et al. Cross-reactivity between histone demethylase inhibitor valproic acid and DNA methylation in glioblastoma cell lines. *Front Oncol.* 2022, 12,

Barciszewska AM et al. Total DNA methylation changes reflect random oxidative DNA damage in gliomas. *Cells* 2019,8,1065.

Barciszewska AM et al. A New Epigenetic Mechanism of Temozolomide Action in Glioma Cells. *PLoS One* 10(8), e0136669 (2015).

Barciszewska AM et al. The Degree of Global DNA Hypomethylation in Peripheral Blood Correlates with that in Matched Tumor Tissues in Several Neoplasia. *PLoS One* 9(3), e92599 (2014)

Michalak M et al. DNA methylation as an early indicator of aging during the storage of the “exceptional” seed species *Populus nigra* L. *Cells* 2022, 11,2080.

DEPARTMENT OF STRUCTURAL CHEMISTRY AND BIOLOGY OF NUCLEIC ACIDS

RNA structure | thermodynamics of nucleic acids | RNA modifications | therapeutic RNA

portal.ichb.pl/department-of-structural-chemistry-and-biology-of-nucleic-acids/

RESEARCH SCOPE

Understanding of the secondary structure of native RNAs and their thermodynamic stability, which determines their folding process. Using RNA oligonucleotides as effective therapeutic tools.

RNA is one of the most important biomolecules necessary for the development of cells, in which it performs a variety of biological, structural, and regulatory functions. RNA is also a molecule involved in a number of human diseases. Modified nucleotides are particularly important for the diverse functions of native RNAs. The most common of them are N6-methyladenosine and pseudouridine. They specifically af-

fect the thermodynamic stability of native RNAs and, thus, their secondary and tertiary structures. Some of the RNA modifications, especially N1-methylpseudouridine, have become very useful components of RNA vaccines by significantly improving their biological and immunological functions. Such features of modified RNA vaccines make them the subject of intensive research for the development of new antiviral and anticancer vaccines.

MAIN RESEARCH TOPICS

- Structural studies of nucleic acids.
- Chemical synthesis of various oligonucleotides.
- Thermodynamics stability of RNA.
- Therapeutic application of natural and modified oligonucleotides.
- Thermodynamic parameters to predict the folding of RNAs.





HEAD

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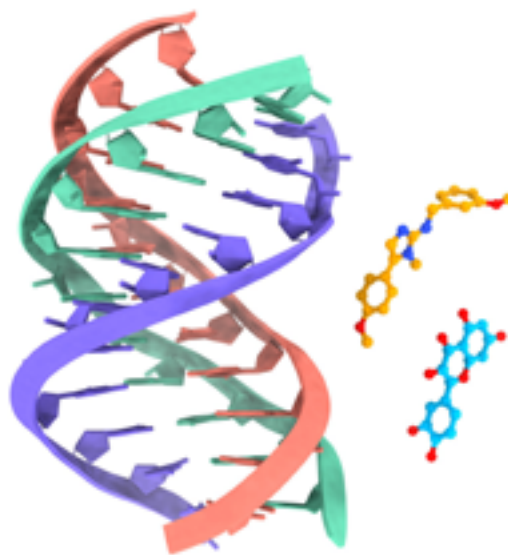
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RESEARCH PROJECTS

Thermodynamic parameters and rules towards the determination of RNA folding in *in vivo*-like conditions. RNA folding predictions for a better understanding of their structure and function in mammalian cells (NSC, Opus, PI: R. Kierzek)

Thermodynamics of modified RNAs. Impact of RNA modifications on structure and function of natural RNA and vaccine-type *in vitro* transcribed mRNA (IVT mRNA) (NSC, Opus, PI: R. Kierzek)

Effects of small-molecule ligands, selectively targeting the MALAT1 RNA triple helix, on the formation of the MALAT1/METTL16 complex (NSC, Miniatura, PI: A. Ruszkowska)



The RNA triple helix and examples of ligands that specifically interact with it

SELECTED PUBLICATIONS

Piasecka J et al.; RNA Secondary Structure Motifs of the Influenza A Virus as Targets for siRNA-Mediated RNA Interference. *Molecular Therapy-Nucleic Acids*, 19, 627 (2020)

Soszynska-Jozwiak M et al.; Universal and strain specific structure features of segment 8 genomic RNA of influenza A virus - application of 4-thiouridine photocrosslinking; *Journal of Biological Chemistry*, 297, 6, 101245 (2021)

Soszynska-Jozwiak M et al.; Secondary Structure of Subgenomic RNA M of SARS-CoV-2; *Viruses-Basel*, 14, 322 (2022)

Kierzek E et al.; Secondary Structure Prediction for RNA Sequences Including N6-methyladenosine; *Nature Communications*, 13, 1271 (2022)

Czapik T et al.; Structural variants and modifications of hammerhead ribozymes targeting influenza A virus conserved structural motifs; *Molecular Therapy - Nucleic Acids*, 29, 64 (2022)

Magner D et al.; A Structural Potential of Rare Trinucleotide Repeat Tracts in RNA; *International Journal of Molecular Sciences*, 23, 5850 (2022)





SPECIALIZED
LABORATORIES

LABORATORY OF SUBCELLULAR STRUCTURE ANALYSES

properties of small compounds | gene expression | cellular respiration and glycolysis |
microscopic and flow cytometry visualisation of cells

portal.ichb.pl/laboratory-of-subcellular-structures-analyses/

RESEARCH SCOPE

The expertise to analyze the biological properties of small molecular compounds in animal and cellular models.

The equipment available in the laboratory facilitates analyses related to cell cycle, cell death induction (e.g., autophagy, apoptosis, necrosis), oxidative stress and cellular respiration, methylation level, gene expression level, and real-time cell migration and proliferation monitoring.

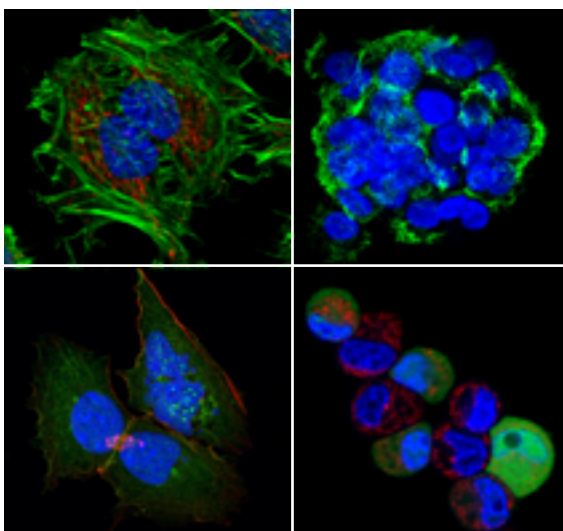
Our scientific activity focuses on nucleic acid derivatives' anticancer and antiaging properties. We demonstrated that kinetin riboside induces cell death, leading to autophagy, apoptosis, and necrosis through oxidative

stress activation. We indicated that cytosine derivatives reveal antioxidative, antiaging, and antiapoptotic properties in cells and eukaryotic model organisms, such as budding yeasts, planarians, and mice. The investigated compound reduces the number of senescent cells, decreases the level of oxidative stress markers and DNA and lipid damage, and stimulates mitochondrial activity.

Using bioprinting technology, we established a 3D hepatocellular carcinoma model to analyze the therapeutic properties of small compounds.

EQUIPMENT

- | Confocal Microscope TCS SP5 with lasers: white (470-670 nm, 1 nm accuracy), 405 nm, argon (458 nm, 476 nm, 488 nm, 496 nm, 514 nm)
- | Flow cytometer FACSCalibur with green (488 nm) and red laser (635 nm)
- | Thermocycler LightCycler 480 II
- | xCELLigence RTCA system
- | Seahorse XFp analyzer
- | Oxygraph+ system





HEAD

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SERVICE OFFER

Confocal microscopy:

- visualization of intravital and fixed preparations (environmental chamber providing optimal culturing conditions)
- 2D and 3D analysis,
- fluorescence intensity analysis, FRET, FRAP assays
- colocalization of fluorophores

Flow cytometry:

- cell cycle analysis
- cell viability (apoptosis, necrosis)
- immunodetection of cellular antigens
- oxidative stress

Termocycler LightCycler 480 II:

- real-time PCR with fluorescent probes
- analysis of point mutations (HRM)
- analysis of methylation and genotyping

System xCELLigence:

- real-time analysis of cell migration and proliferation

Oxygraph + system:

- Oxygen uptake analysis in organisms (e.g. *C. elegans*, *S. cerevisiae*), cells and organelles (np. chloroplasts, mitochondria)

Seahorse XFp analyzer:

- Oxygen consumption rate (OCR) and extracellular acidification rate (ECAR) measurements in mammalian cells
- Analysis of the ATP production rate

High performance liquid chromatography (HPLC) with electrochemical detector:

- Detection of nucleic acids components and their derivatives
- Detection epigenetic modifications of nucleic acids

SELECTED PUBLICATIONS

Orlicka-Płocka M et al Circumventing the Crabtree effect: forcing oxidative phosphorylation (OXPHOS) via galactose medium increases sensitivity of HepG2 cells to the purine derivative kinetin riboside Apoptosis 2020; 25, 835–852

Orlicka-Płocka M et al Implications of Oxidative stress in glioblastoma multiforme following treatment with purine derivatives. Antioxidants 2021; 10:950

Pawelczak P et al Antiaging Effect of 4-N-Furfurylcytosine in Yeast Model Manifests through Enhancement of Mitochondrial Activity and ROS Reduction. Antioxidants 2022; 11:850

Rykowski S et al Carboranyl-1,8-naphthalimide intercalators induce lysosomal membrane permeabilization and ferroptosis in cancer cell lines. J. Enzyme Inhib. Med. Chem. 2023; 38:1

Rykowski S et al Design of DNA Intercalators Based on 4-Carboranyl-1,8-Naphthalimides: Investigation of Their DNA-Binding Ability and Anticancer Activity. Int. J. Mol. Sci. 2022; 23, 4598

LABORATORY OF PROTEIN ENGINEERING

recombinant protein | interprotein interactions | enzymatic kinetics | ligand | affinity

portal.ichb.pl/laboratory-of-protein-engineering

RESEARCH SCOPE

We offer equipment and provide expertise in terms of the preparation of bacterial expression vectors, the production of recombinant proteins, and their purification, as well as the evaluation of the quality of protein preparations intended for functional and structural research.

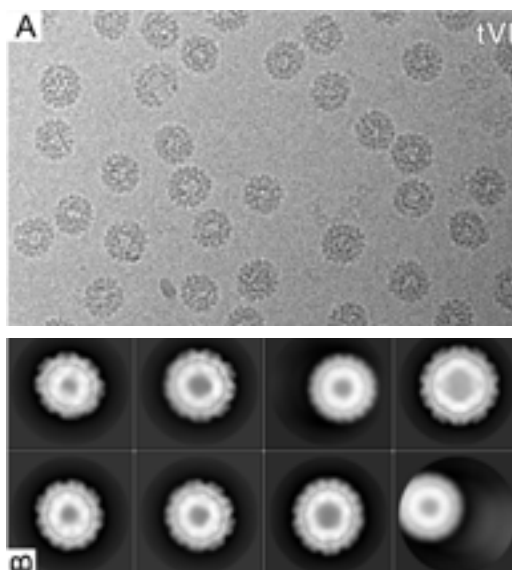
We have experience and equipment enabling the physicochemical characteristics of interactions between proteins and other macromolecules. Our measurement methods allow not only to assess affinity and measure con-

stants of association and dissociation but also to determine the number of ligand binding sites or thermodynamic parameters of binding such as enthalpy or entropy, as well as enzymatic kinetics studies.

Our scientific interests include interactions occurring at the molecular level between *Borrelia* spirochetes and their vectors and hosts, the process of self-assembly of virions and virus-like particles and their use as RNA carriers, as well as studies of the interactions and enzymatic kinetics of proteins.

SERVICE OFFER

- Protein production in the bacterial system and purification using chromatographic methods
- Dynamic and static light scattering measurements (DLS and SLS) in order to assess molecular mass and hydrodynamic diameter of macromolecules
- Isothermal titration calorimetry (ITC), microscale thermophoresis (MST) and biolayer interferometry (BLI) measurements for assessing the parameters of ligand binding and enzymatic parameters
- X-ray diffraction measurements for crystal quality testing and diffraction pattern recording



BMV-derived VLPs - cryoEM picture



HEAD

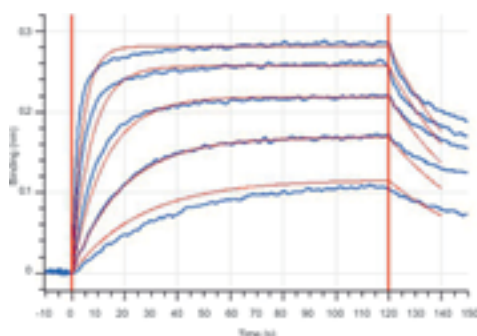
Anna Urbanowicz, PhD, DSc, Assoc. Prof.

aniau@ibch.poznan.pl

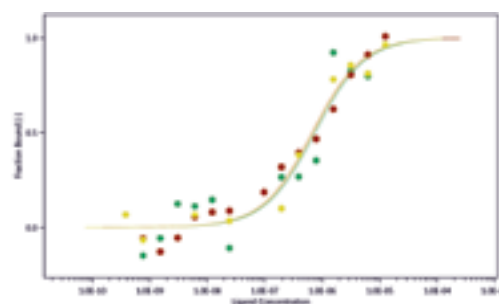
phone: +48 61852 85 03 (1518)

EQUIPMENT

- | Incubators, sonicators, centrifuges,
- | FPLC system ACTA Prime plus GE with columns,
- | Zetasizer μ V Malvern analyzer for DLS and SLS measurements,
- | Microcal iTC200 and Microcal PEAQ-ITC Malvern calorimeters for ITC,
- | Monolith NT.115 Nanotemper system for MST,
- | Octet K2 ForteBio system for BLI,
- | Agilent 8453 spectrometer for concentration and kinetics measurements,
- | ARI Gryphon crystallization robot,
- | Rigaku XtaLAB Synergy-R diffractometer



MST binding curve



Real time interaction monitoring using BLI

SELECTED PUBLICATIONS

Ruszkowski M et al. Cryo-EM reconstructions of BMV-derived virus-like particles reveal assembly defects in the icosahedral lattice structure. *Nanoscale* 2022; 14: 3224

Loch J I et al. Crystal structures of the elusive *Rhizobium etli* I-asparaginase reveal a peculiar active site. *Nat. Comm.* 2021; 12: 6717

Witek W et al. Structural and mechanistic insights into the bifunctional HSN2 enzyme catalyzing the second and third steps of histidine biosynthesis in plants. *Sci. Rep.* 2021; 11: 9647

Bierwagen P et al. Strong interactions between Salp15 homologues from the tick *I. ricinus* and distinct types of the outer surface OspC protein from *Borrelia*. *Ticks Tick Borne Dis.* 2021; 12: 101630

Bierwagen P et al. *Borrelia* outer surface protein C is capable of human fibrinogen binding *FEBS J.* 2019; 286: 2415-2428

Sliwiak J et al. PR-10 proteins as potential mediators of melatonin-cytokinin cross-talk in plants: crystallographic studies of LIPR-10.2B isoform from yellow lupine. *FEBS J.* 2018; 285: 1907-1922

LABORATORY OF NMR

high resolution NMR spectroscopy | spectroscopy CD | spectroscopy UV-Vis

portal.ichb.pl/laboratory-of-nmr/

RESEARCH SCOPE

The Laboratory of NMR is conducting research in advanced structural studies of both small molecules and biomolecules, in particular nucleic acids, RNA, and DNA.

The research scope of the Laboratory is:

- structural problem studies
- determining the conformation of compounds of natural or synthetic origin
- intramolecular and intermolecular interaction studies
- ligand interaction studies

- Spectroscopic study of intra- and inter-molecular interactions
- High-throughput and automated acquisition of 1D, 2D NMR spectra (for example, COSY, HSQC, HMBC, NOESY, TOCSY).

SERVICE OFFER

- Assessment of the nucleic acid purity based on HPLC, NMR, UV, and CD
- Application of spectroscopic techniques such as NMR, UV-VIS, CD, and ORD for structure determination of nucleic acids and study of ligand-RNA/DNA interaction
- Structure elucidation of organic compounds based on the analysis of 1D and 2D NMR spectra
- Acquisition and analysis of high-resolution NMR spectra
- Expertise in the interpretation of NMR spectra. Conformational study of natural or synthetic organic compounds





HEAD

Karol Pasternak, PhD

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EQUIPMENT

- | NMR 400 MHz (9.39 T) AVANCE II Bruker spectrometer equipped with BBFO or BBI probe
- | NMR 500 MHz (11.74 T) AVANCE III Bruker spectrometer equipped with BBO or TXI probe
- | NMR 700 MHz (16.44 T) AVANCE III Bruker spectrometer equipped with QCI-P (Quadruple Resonance CryoProbe™) or BBO or TXI probe
- | Spectropolarimeter circular dichroism (CD) Jasco J-815 S
- | Spektrofotometr UV VIS Jasco V-650
- | High Performance Liquid Chromatography system Agilent Tech 1260 Infinity



SELECTED PUBLICATIONS

Sutor-Swiezy K et al. Structural Studies on Diverse Betacyanin Classes in Matured Pigment-Rich Fruits of *Basella alba* L. and *Basella alba* L. var. 'Rubra' (Malabar Spinach). International Journal of Molecular Science, 2022, 23(19), 11243

Lazewski D et al. Novel Short PEG Chain-Substituted Porphyrins: Synthesis, Photochemistry, and In Vitro Photodynamic Activity against Cancer Cells. International Journal of Molecular Sciences, 2022, 23, 10029

Koczorowski T et al. The Valence and Spin State Tuning of Iron(II/III) Porphyrazines with Bulky Pyrrolyl Periphery in Solution and Solid State. Molecules, 2022, 27, 7820

Gabryel-Skrodzka M et al. Coordination Chemistry of Phosphate Groups in Systems Including Copper(II) Ions, Phosphoethanolamine and Pyrimidine Nucleotides. International Journal of Molecular Sciences 2022, 23, 13718

LABORATORY OF SINGLE CELL ANALYSES

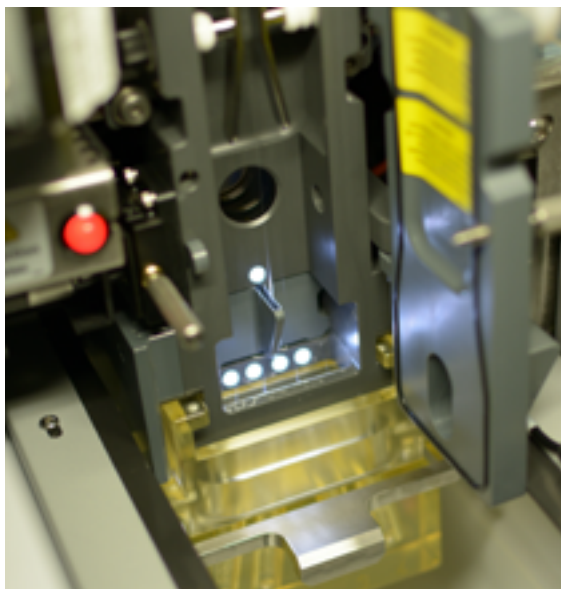
single cell RNA-Seq | flow cytometry | cell sorting | high-throughput imaging

portal.ichb.pl/laboratory-of-single-cell-analyses/

RESEARCH SCOPE

Integration of experimental and computational approaches for comprehensive characterization of diverse biological material at single-cell resolution.

We perform gene expression and chromatin accessibility profiling, as well as cell sorting and advanced analyses using classical and imaging flow cytometry. Our research includes the identification of heterogeneous or rare cell populations, the detection of extracellular vesicles, and the visualization of intracellular processes or interactions.



SERVICE OFFER

- Designing and performing analyses using classical and imaging flow cytometry
- Extended analysis of flow cytometry data (including machine learning approaches for imaging data)
- Cell sorting
- Preparation of libraries for single-cell RNA/ATAC-Seq
- Single-cell RNA/ATAC-Seq data analysis
- Comprehensive consulting on the single-cell-targeted studies

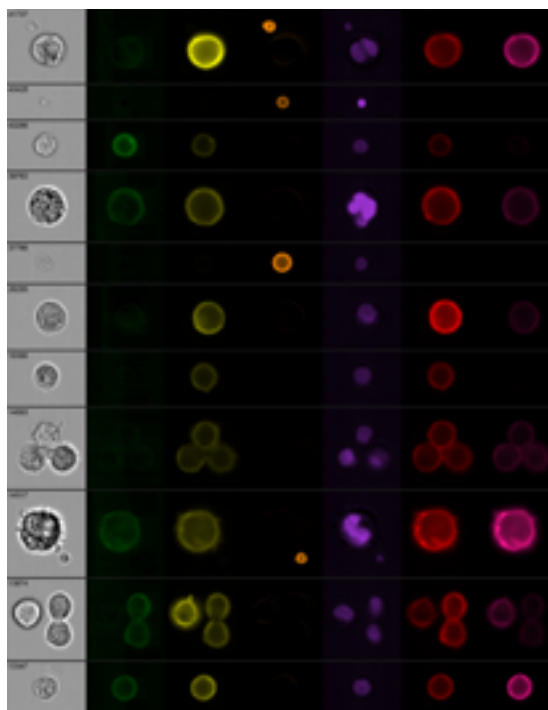


HEAD

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EQUIPMENT

- | Chromium Controller (10x Genomics)
- | Drop-Seq (Fluigent)
- | Amnis ImageStreamX Mk II imaging flow cytometer (Cytek Biosciences)
- | FACSARIA Fusion cell sorter (Becton Dickinson)
- | Guava easyCyte 12HT flow cytometer (Cytek Biosciences)
- | QX200 Droplet Digital PCR system (BioRad)
- | TapeStation 4150 analyzer (Agilent)
- | Countess 3 FL automated cell counter (Invitrogen)
- | epMotion 5073t liquid handler (Eppendorf)

SELECTED PUBLICATIONS

Stolarek I et al. Dimensionality reduction by UMAP for visualizing and aiding in classification of imaging flow cytometry data. *iScience*, 2022, 25 (10): 105142.

Szostak N et al. The standardisation of the approach to metagenomic human gut analysis: from sample collection to microbiome profiling. *Sci Rep*, 2022, 12 (1): 8470.

Strybel U et al. A. Molecular Composition of Serum Exosomes Could Discriminate Rectal Cancer Patients with Different Responses to Neoadjuvant Radiotherapy. *Cancers (Basel)*, 2022, 14 (4).

Butkiewicz D et al. Polymorphisms in EGFR Gene Predict Clinical Outcome in Unresectable Non-Small Cell Lung Cancer Treated with Radiotherapy and Platinum-Based Chemoradiotherapy. *Int J Mol Sci*, 2021, 22 (11): 5605.

BIOINFORMATICS LABORATORY

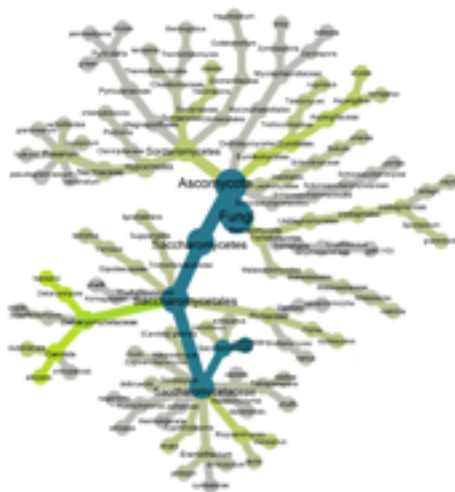
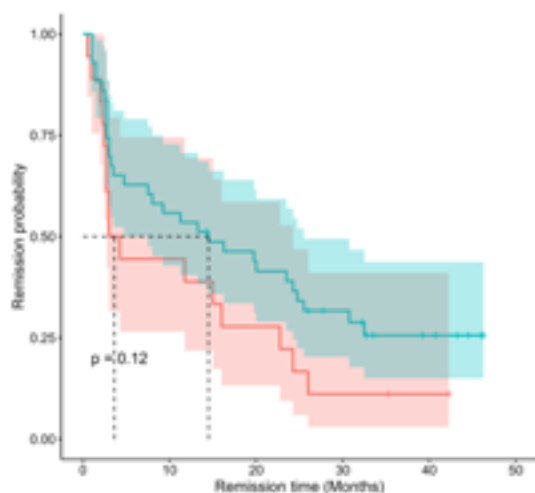
metagenomics | transcriptomics | statistics | big data | NGS

portal.ichb.pl/laboratory-of-bioinformatics/

RESEARCH SCOPE

The use of advanced bioinformatics tools and methods to analyze large data sets, including various types of NGS data, e.g., whole genome, exome, RNA, and metagenomic sequencing.

In the area of genomics, we focus on the identification of genetic variants, including pathogenic ones, the analysis of genome structure, and comparative genomics. In cooperation with biologists and clinicians, we study somatic mutations in cancer and discover potential therapeutic targets. We analyze genes' expression patterns, alternative RNA isoforms, and regulatory gene networks.



Using metagenome sequencing, we examine the composition, genetic diversity, and functional potential of microbial communities inhabiting various environments, such as soil, water, air, the gastrointestinal tract, and skin. Our goal is to understand the complex interactions between microorganisms and between microorganisms and the host.

SERVICE OFFER

- Genomic analysis: we offer analysis of the genomes of a variety of organisms, including humans, animals, plants, and microorganisms. We use bioinformatics approaches to identify genetic variants, analyze genome structure, run comparative analysis, and study evolutionary relationships.



HEAD

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- Gene expression analysis: we examine gene expression patterns using RNA sequencing data. We use bioinformatics methods to analyze differential gene expression and alternative RNA isoforms; we identify biomarkers and modified RNA ends; and we analyze regulatory networks.
- Metagenomic analysis: we analyze the microbiomes of various environments, such as soil, water, air, the gastrointestinal tract, and skin. We identify species, investigate the composition and functions of microbial communities, genetic variability, and potential interactions between microorganisms and the host.
- Clinical data analysis: we analyze clinical data, including data from the whole genome or exome sequencing of patients. We use bioinformatics tools to identify pathogenic genetic variants, analyze somatic mutations in cancer, perform differential gene expression analysis, and identify potential therapeutic targets.

EQUIPMENT

- High-class computer equipment that enables effective processing of large data sets and performing complex computational operations.
- Infrastructure for data visualization and communication with external servers.

SELECTED PUBLICATIONS

Szóstak N et al. Host Factors Associated with Gut Mycobiome Structure. *mSystems* 2023; 8(2):e0098622

Philips A et al. Expression Landscape of circRNAs in *Arabidopsis thaliana* Seedlings and Adult Tissues. *Frontiers in Plant Science* 2020; 11:576581

Philips A et al. Analysis of oral microbiome from fossil human remains revealed the significant differences in virulence factors of modern and ancient *Tannerella forsythia*. *BMC Genomics* 2020; 21(1):402

Makowska N et al. Metagenomic analysis of β -lactamase and carbapenemase genes in the wastewater resistome. *Water Research* 2020; 170:115277

Philips A et al. Comprehensive analysis of microorganisms accompanying human archaeological remains. *Giga-science*. 2017; 6(7):1-13

Nawrocka PM et al. Profile of Basal Cell Carcinoma Mutations and Copy Number Alterations - Focus on Gene-Associated Noncoding Variants. *Frontiers in Oncology* 2021; 11:752579

LABORATORY OF GENOMICS

genomics | transcriptomics | archaeogenomics | next generation sequencing (NGS)

portal.ichb.pl/laboratory-of-genomics/

RESEARCH SCOPE

Based on long-term experience and sophisticated equipment, the Laboratory of Genomics participates in the implementation of projects related mainly to human genomics, including oncogenomics, archaeogenomics, and population genomics.

Apart from whole genomes, we study exomes, transcriptomes, microbiomes, and selected genes. We detect mutations, alternative transcripts, determine the expression levels of protein-coding genes and short regulatory RNAs. For this purpose, we use modern technologies of high-throughput sequencing, both second- and third-generation. We isolate nucleic acids and prepare libraries for sequencing using automatic pipetting stations, which allows us to increase the scale of our experiments. We contribute to the Genomic Map of Poland, study ancient DNA and genome – transcriptome relationships in the process of neoplastic transformation. Our main research model is acute myeloid leukemia.

SERVICE OFFER

The Laboratory of Genomics offers high-throughput DNA sequencing using two types of technologies, based on short (Illumina platform) and long reads (Pac-Bio platform). We implement projects both in scientific cooperation and in the form of services. Our offer includes:

- whole genome sequencing on the Illumina platform (2x150 bp, minimum 30x coverage)
- transcriptome sequencing on the Illumina platform (total RNA, mRNA, ribodepleted RNA, short non-coding RNA)
- whole genome and transcriptome sequencing on the Pac-Bio platform (HiFi reads, up to 25,000 bp, precision >99.9%)
- planning and estimating the cost of a high-throughput sequencing experiment
- automatic isolation of DNA and RNA from the entrusted material
- quality assessment of the material and library preparation
- analysis of results to the extent agreed with the customer
- verification of the obtained results using quantitative PCR.





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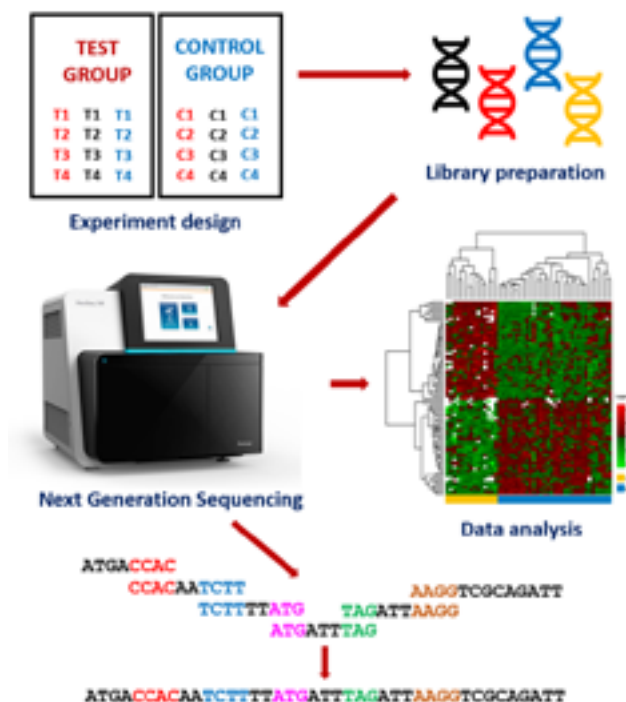
Luiza Handschuh, PhD, DSc, Assoc. Prof.

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EQUIPMENT

- High-throughput sequencers NovaSeq 6000, NovaSeq X and NextSeq 550 (Illumina)
- Sequencer for long DNA reads with the use of SMRT technology - Sequel IIe (Pacific Biosciences)
- Two automated workstations Biomek i5 (Beckman Coulter)
- Quantitative emulsion PCR system - QX200 Droplet Digital PCR System (BioRad)
- Rotor-Gene Q real-time PCR cyclers (Qiagen)
- 2100 Bioanalyzer (Agilent)
- Bioruptor NextGen sonicator (Diagenode)



SELECTED PUBLICATIONS

Stolarek I et al. Genetic history of East-Central Europe in the first millennium CE. *Genome Biol.* 2023; 24:173

Szóstak N et al. The standardisation of the approach to metagenomic human gut analysis: from sample collection to microbiome profiling. *Sci Rep.* 2022; 12:8470.

Handschuh L et al. Transcript-Level Dysregulation of BCL2 Family Genes in Acute Myeloblastic Leukemia. *Cancers* 2021; 13:3175

Szenajch J et al. Transcriptome Remodeling in Gradual Development of Inverse Resistance between Paclitaxel and Cisplatin in Ovarian Cancer Cells. *Int J Mol Sci.* 2020; 21:9218

Handschuh L. Not Only Mutations Matter: Molecular Picture of Acute Myeloid Leukemia Emerging from Transcriptome Studies. *J Oncol.* 2019; 2019:7239206

Handschuh L et al. NPM1 alternative transcripts are upregulated in acute myeloid and lymphoblastic leukemia and their expression level affects patient outcome. *J Transl Med.* 2018; 16:232

LABORATORY OF MASS SPECTROMETRY

mass spectrometry | liquid chromatography | gas chromatography | proteomics | metabolomics

portal.ichb.pl/laboratory-of-mass-spectrometry/

RESEARCH SCOPE

In our laboratory, we employ carefully selected and optimized research approaches based on chromatographic methods and mass spectrometry to identify and quantitatively assess a wide range of compounds isolated from biological material.

These approaches include:

- comprehensive analysis of proteins, metabolites, and lipids from any biological material (plants, tissues, body fluids, small extracellular vesicles, etc.)
- profiling, identification, targeted analysis of proteins and metabolites
- multi-omic functional analysis using bioinformatics tools

Currently pursued projects focus on the analysis of serum at various stages of human disease. We aim to understand the underlying factors contributing to the observed changes in patients with cancers such as acute myeloid leukemia, melanoma, and colorectal cancer. We conduct analyses of serum fractions, blood cells, and isolated extracellular vesicles. Additionally, we investigate in vitro-cultured cells derived from primary tumors and metastases.

OFEROWANE USŁUGI

- Identification of proteins using MS methods
- *De novo* analysis of peptide and protein sequences (MALDI, ISD-MALDI)
- Analysis of post-translational modifications of proteins using MS methods
- Quantitative analysis of proteins using MS methods
- Determination of monoisotopic masses of low-molecular-weight compounds using HR-MS methods
- Structural analysis of low-molecular-weight compounds using tandem mass spectrometry
- Quantitative analysis of low-molecular-weight compounds using MS methods
- Analysis of volatile compounds using GC-MSn methods
- Analysis of protein, metabolite, and lipid profiles using MS methods
- Targeted analysis of proteins, metabolites, and lipids using MS methods



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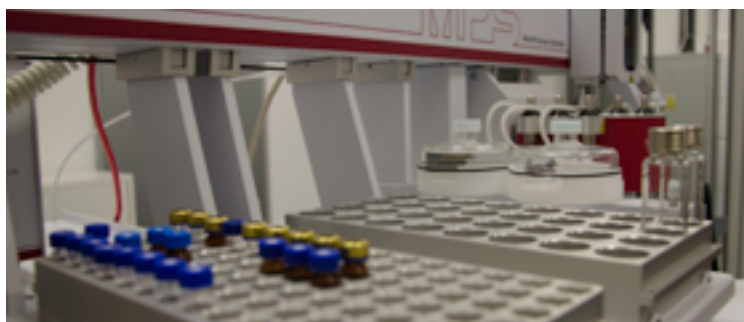
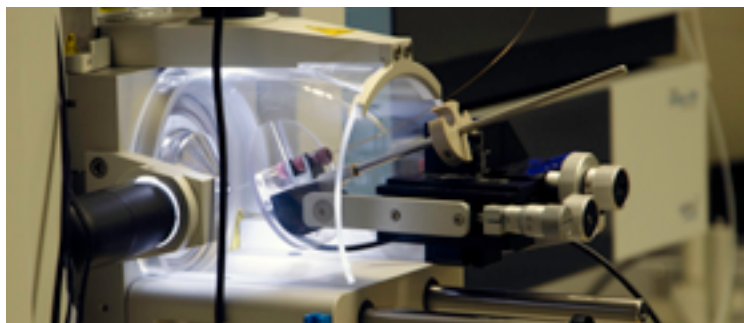
Łukasz Marczak, PhD

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EQUIPMENT

- | LC-MS system – Bruker timsTOF Pro + Dionex RSLC 3000
- | LC-MS system – Thermo Exploris 480 + Dionex nanoRSLC 3000 + Vanquish UPLC
- | MALDI-TOF/TOF spectrometer – Bruker UltrafleXtreme
- | NanoLC-MS system (ion trap) – Waters nanoAcquity + Bruker Amazon SL
- | Nano/micro LC-MS system (OrbiTrap) – Thermo QExactive + Dionex nanoRSLC 3000
- | GCxGC-MS (TOF) system – Leco Pegasus 4D
- | GC-MS system (TripleQuad) – Thermo TSQ8000



SELECTED PUBLICATIONS

Strybel U et al. Molecular Composition of Serum Exosomes Could Discriminate Rectal Cancer Patients with Different Responses to Neoadjuvant Radiotherapy. *Cancers*; 14 (2022)

Pietrowska M et al. Proteomic profile of melanoma cell-derived small extracellular vesicles in patients' plasma: a potential correlate of melanoma progression. *J. Extracell. VESICLES*. 10 (2021)

Marczak L et al. Mass spectrometry-based lipidomics reveals differential changes in the accumulated lipid classes in chronic kidney disease. *Metabolites*; 11 (2021)

Kimakova K et al. Phenotyping the genus *Hypericum* by secondary metabolite profiling: emodin vs. skyrin, two possible key intermediates in hypericin biosynthesis. *Anal. Bioanal. Chem*; 410, 7689–7699 (2018)

Marczak L et al. The use of mass spectrometric techniques to differentiate isobaric and isomeric flavonoid conjugates from *Axyris amaranthoides*. *Molecules*; 21 (2016)

Wojakowska A et al. Detection of metabolites discriminating subtypes of thyroid cancer: Molecular profiling of FFPE samples using the GC/MS approach. *Mol. Cell. Endocrinol.*; 417, 149–157 (2015)

LABORATORY OF MEDICINAL CHEMISTRY

medicinal chemistry | hit to lead | chemical synthesis | biosynthesis | natural products | chemoinformatics

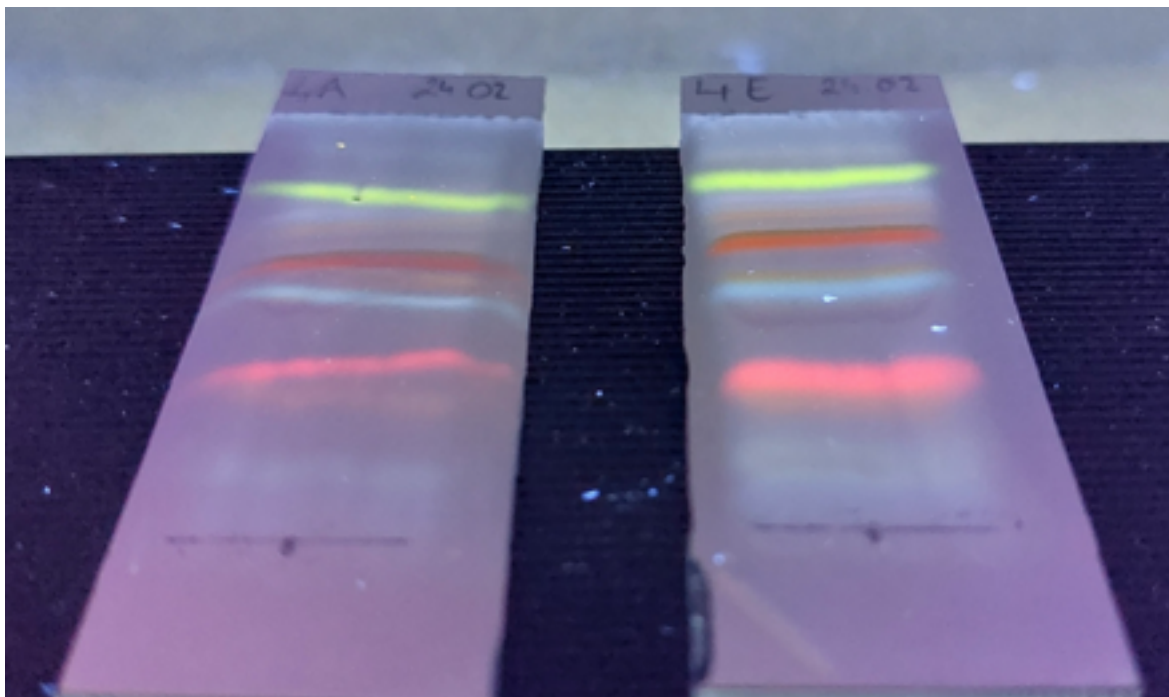
portal.ichb.pl/laboratory-of-medicinal-chemistry/

RESEARCH SCOPE

Development of new methods for the creation of bioactive molecules, mainly for medicinal applications but also for agricultural or any other industrial applications. Medicinal chemistry services.

Our preliminary research on the chemical programming of fungi using *Ramularia collo-cygni* as a model led to the creation and optimization of a method for producing new analogues of secondary metabo-

lites with potential biological activities. This method is now being applied to our services in medicinal chemistry. The Laboratory offers access to expertise and infrastructure for bioactive molecules optimization, including chemoinformatic design, chemical synthesis, biosynthesis, and semi-synthesis of dedicated libraries, especially for compounds difficult to synthesize using classical synthetic chemistry.



Chromatographic separation of new analogues of natural products



HEAD

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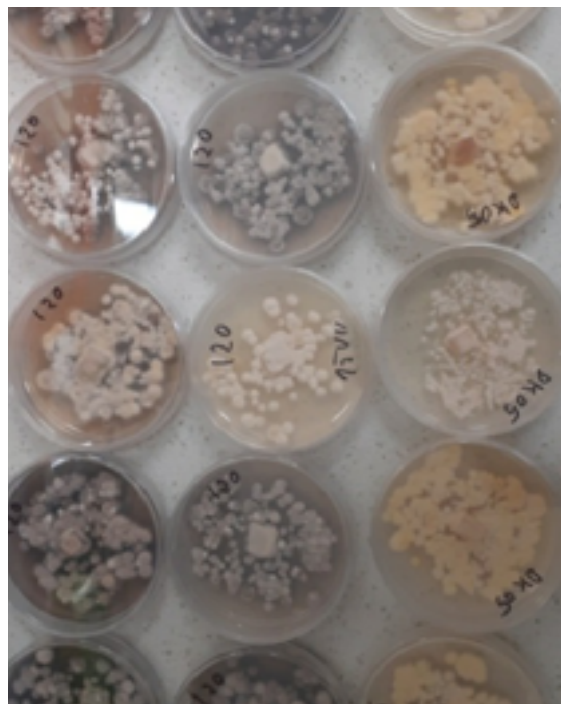
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SERVICE OFFER

- Chemical synthesis of bioactive molecules
- “Hit to lead” – molecules optimization – chemoinformatic design, the synthesis, bio-synthesis, and semi-synthesis of bioactive compounds
- Selection of already existing libraries for bio-activity tests
- Automated isolation and purification of chemical compounds - from biological material or enzymatic reactions

EQUIPMENT

- Chromatograph Flash Agilent Technologies 971-FP
- LCMS-8040 Shimadzu



Ramularia collo-cygni isolates

SELECTED PUBLICATIONS

Dussart F., Jakubczyk D.*, Biosynthesis of Rubellins in *Ramularia collo-cygni* — Genetic Basis and Pathway Proposition. *Int. J. Mol. Sci.* (2022), 23, 3475

Jakubczyk D.*, Francois D. Selected Fungal Natural Products with Antimicrobial Properties. *Molecules* (2020), 25, 911: 1-18

Jakubczyk D. et al, Structural characterization of EasH (*Aspergillus japonicus*) – an oxidase involved in cycloclavine biosynthesis. *Chem. Comm.* (2016) 52: 14306-14309

Jakubczyk D., et al, Discovery and reconstitution of the cycloclavine biosynthetic pathway — enzymatic formation of a cyclopropyl group. *Angew. Chem. Int. Ed.* (2015) 54: 5117 –5121

LABORATORY OF MOLECULAR ASSAYS AND IMAGING

bioimaging | high-throughput screening | MINFLUX | high-throughput microscopy | biochemical assays

portal.ichb.pl/laboratory-of-molecular-assays-and-imaging/

RESEARCH SCOPE

Developing molecular assays, performing high-throughput screening, high-throughput microscopy, ultra-high-resolution microscopy, and image analysis.

The laboratory was created as a result of the Institute's cooperation with European partners as a part of the EU-OPENSOURCE consortium. It collaborates with users around the world to identify biologically active molecules and deconvolve their mechanisms of action. Thanks to miniaturization, automation, and advanced scientific expertise, the laboratory can test the biological activity of hundreds of thousands of chemical compounds in a high-throughput (HTS) format. The laboratory is also equipped with an ultra-high-resolution microscopy system combining high-resolution imaging technologies

such as STED, FLIM, FCS, and Minflux. The unique MINFLUX microscope (one of several such systems in the world) allows imaging with a resolution below 2 nm.

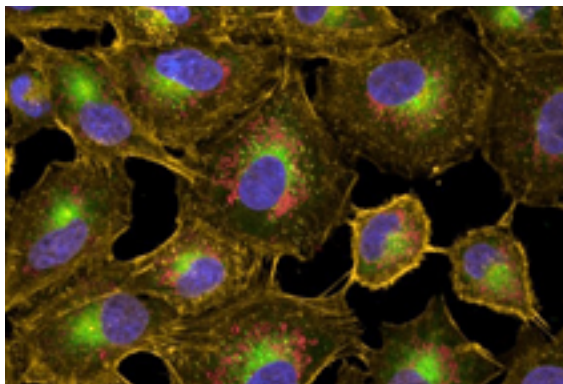
EQUIPMENT

Detection and analysis:

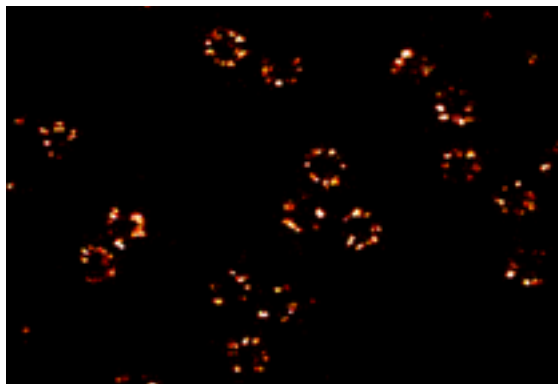
- | Ultra-super-resolution microscope MINFLUX/STED (Abberior)
- | Opera Phenix high-throughput confocal microscope (Revvity)
- | CLARIOstar Plus (BMGLabtech) and Cytation (Biotek) plate readers

Automation:

- | Echo Acoustic Dispenser (Beckman Coulter)
- | Multidrop combi liquid dispenser (ThermoFisher)
- | Hydrospeed plate washer (Tecan)



Cell painting



MINFLUX 2D



HEAD

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SERVICE OFFER

Imaging services:

- Stimulation Depletion Microscopy (STED): 2D and 3D imaging, multicolor imaging
- MINIFLUX (Minimal Photon Flux) microscopy: 2D and 3D, multicolor imaging, tracking
- FLIM (Fluorescence Lifetime Imaging) microscopy
- FCS microscopy (Fluorescence Correlation Spectroscopy microscopy)
- High-content multiparametric imaging assays (e.g., cell painting, Opera Phenix)
- Image analysis

Screening services:

Assay development

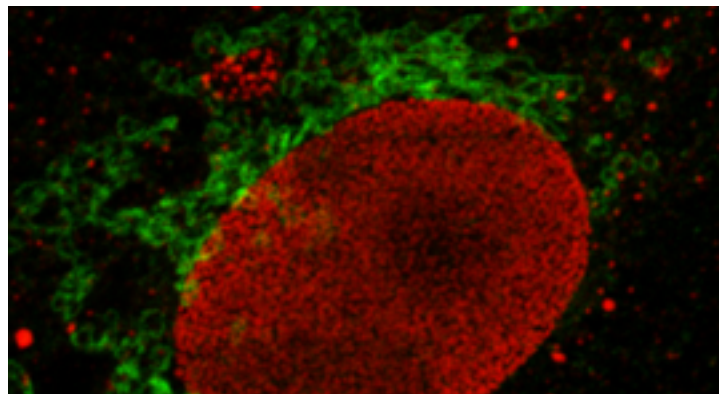
- Single and multi-parametric assays
- Miniaturization and optimization
- Automation and assay transfer
- Orthogonal assay

High-throughput screening:

- Primary screening (1 – 100k)
- Hit validation:
- Counter or orthogonal screening
- Combinatorial screening (AI-assisted)

Assay types

- Biochemical assays (bioprofiling)
- Cell-based assays (cell painting)



STED 2 colour/2D

SELECTED PUBLICATIONS

Golczak A. et al. Tetramethylalloxazines as efficient singlet oxygen photosensitizers and potential redox-sensitive agents, *Scientific Reports*, 2023, 13(1), 13426

Insińska-Rak M. et al. 5-Deazaalloxazine as photosensitizer of singlet oxygen and potential redox-sensitive agent, *Photochemical & Photobiological Sciences*, 2023

Kwiatek D. et al. Surface Modification of Luminescent Ln(III)Fluoride Core-Shell Nanoparticles with Acetylsalicylic acid (Aspirin): Synthesis, Spectroscopic and in Vitro Hemocompatibility Studies, *CHEMMEDCHEM*, 2020, 15, 1490–1496

Brennecke P. et al. EU-OPENSREEN: A Novel Collaborative Approach to Facilitate Chemical Biology, *SLAS Discovery*, 2019, 24, 3, 398–413

CELL AND TISSUE CULTURE LABORATORY

cell cultures | tissue cultures | preclinical disease models | bioimaging

portal.ichb.pl/cell-and-tissue-culture-laboratory/

RESEARCH SCOPE

Cell and tissue cultures represent fundamental research models widely used in molecular biology and biomedicine.

Our laboratory provides specialized equipment and conditions for both animal and plant *in vitro* cultures, offering infrastructure for safe work in BSL-2 standards, work with viruses, and transgenic material. All the Laboratory's rooms and equipment adhere to strict aseptic policies (UV sterilization, ozonation), and appropriate waste security and disposal systems are also ensured.



Stem cells visualized in *Schmidtea mediterranea*.
Credit: C. Odrzygóźdź

EQUIPMENT

- | Laminar airflow cabinets (Holten, Alpina, BioTectum)
- | Shaking incubators (New Brunswick Innova, Binder), CO₂ incubators (Memmert, Binder), and incubators with additional O₂ control (Thermo Scientific)
- | Plant growth chambers with temperature, humidity, and lighting control (Percival chambers and a walk-in fitotron complex)
- | PDS-1000/He Bio-Rad ballistic cell transfection device
- | Nanoject III Drummond microinjector
- | Inverted microscopes (Leica DM IL LED with fluorescence and CoolLED illuminator, Leica DM500)
- | Stereoscopic microscopes (Leica M205 FA, Nikon SMZ1270, Nikon SMZ800N, Nikon SMZ-10, Motic SMZ-171)
- | Nikon Ti2e confocal microscope with a spinning disc CrestOptics X-Light V3
- | Ultracentrifuges, preparative centrifuges, mini centrifuges, and refrigerated benchtop centrifuges (Beckman/Eppendorf)
- | Automatic cell counters: TC20 Bio-Rad, Countess 3 FL Invitrogen
- | Water baths
- | Set of dewars for liquid nitrogen and low-temperature freezers for biobanking biological material



HEAD

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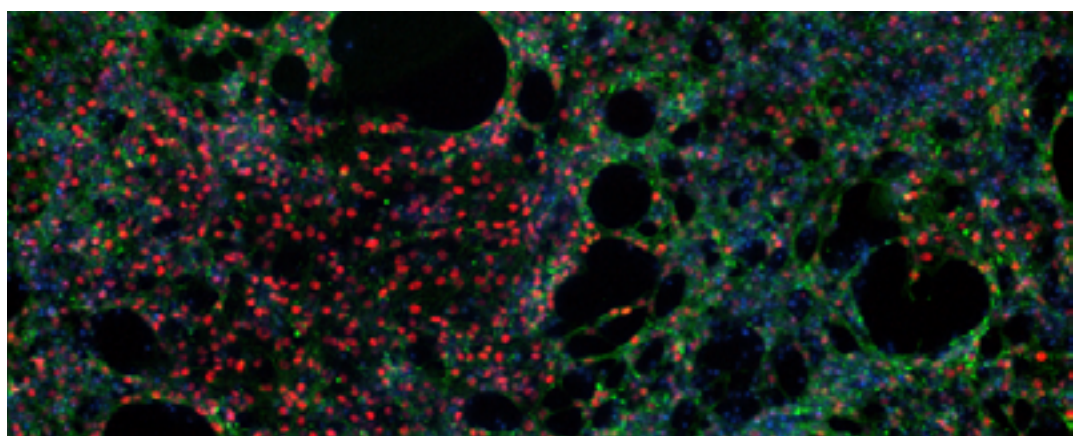
SERVICE OFFER

- Primary cell and cell line culture & maintenance
- Derivation of induced pluripotent stem cell lines from clinical material
- Stem cell differentiation and reprogramming
- Plant cultivation, including transgenic plants
- Analysis of cell morphology, proliferation, adhesion, migration, and viability
- Cytotoxicity analyses
- Biobanking of biological material
- Support in preparing research funding proposals involving work with *in vitro* models



Medicago truncatula cultivation. Credit: A. Błaszczak, IBCH PAS

In vitro culture of human cardiomyocytes imaged using fluorescence microscopy.
Credit:
J. Delimata-Raczek,
IBCH PAS



LABORATORY OF MAMMALIAN MODEL ORGANISMS

in vivo | mice | model organisms | breeding | surgery | immunity

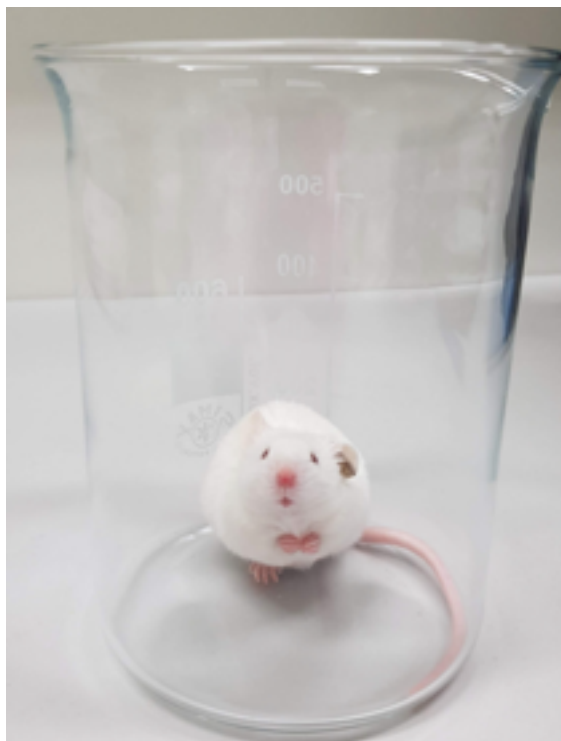
portal.ichb.pl/laboratory-of-mammalian-model-organisms/

RESEARCH SCOPE

Organization and conduct of various *in vivo* experiments using mice as model organisms, from planning the budget for the grant applications through obtaining appropriate approvals to statistical analyses of the results.

The extensive experience of the Laboratory team allows for the implementation of complex experiments using various animal models, from cardiovascular diseases through pregnancy pathology and oncology to neurodegenerative diseases. In addition to performing surgeries, the team

conducts and analyzes a panel of behavioral tests (assessment of psychomotor skills, cognitive disorders, etc.). Our immunology specialists are able to perform a detailed analysis of the immunophenotype (response of T lymphocytes, monocytes, cytokines, etc.) using flow cytometry and also study inflammation and macrophage polarization using real-time RT-qPCR. We also assess cell proliferation, apoptosis, and the cell cycle. Currently, we are developing new methods in immunohistochemistry and *in vitro* functional tests (migration, adhesion, invasion, wound healing, and a model of the blood-brain barrier).



EQUIPMENT

- | Digital Operating Microscope
- | Multi-Functional Surgical Platform
- | Endotracheal intubation kits for mice
- | Low-Flow Anesthesia System
- | Laminar hoods
- | Surgical tools
- | Incubators
- | Real-time PCR apparatus
- | HPLC
- | Tissue homogenizer
- | Peristaltic pump
- | Vibratome
- | Ibidi pump system for cell culture under flow conditions



HEAD

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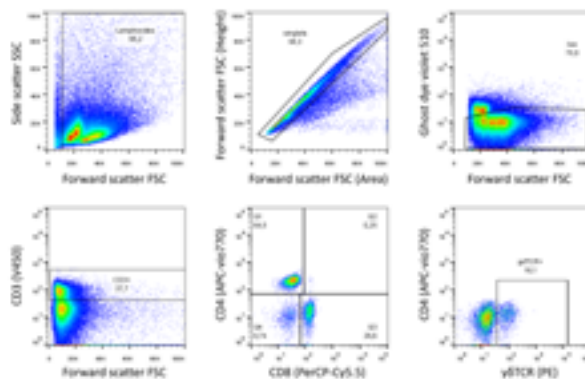
SERVICE OFFER

Complex assistance in performing animal experiments including:

- experimental design of timelines and groups according to the 3 R's rule and ARRIVE guidelines, and preparation of an application to the Local Ethics Committee
- training in the basic techniques used in animal research
- behavioral testing
- intra-stomach administration and injections: intramuscular, intraperitoneal, subcutaneous, and intracranial
- microsurgery - intubation, uninephrectomy, acute kidney injury, implantation of osmotic pumps, xenograft inoculations
- transcardial perfusion, organ weighing and sampling, blood withdrawal, tissue collection including: en face preparation

of the whole aorta, brain dissection, and bronchoalveolar lavage

- deep mouse immunophenotyping using flow cytometry
- isolation of mouse primary cells: astrocytes, neurons, microglia, embryonic fibroblasts, bone marrow macrophages, and vascular smooth muscle cells



SELECTED PUBLICATIONS

Wronka D et al. What the Gut Tells the Brain—Is There a Link between Microbiota and Huntington's Disease? *International Journal of Molecular Sciences*. 2023; 24(5):4477

Kotowska-Zimmer A et al. A CAG repeat-targeting artificial miRNA lowers the mutant huntingtin level in the YAC128 model of Huntington's disease. *Molecular Therapy Nucl. Acids*, 2022; 702-715

Przybył L et al. What, When and How to Measure-Peripheral Biomarkers in Therapy of Huntington's Disease. *Int J Mol Sci* 2021 22(4), 1561, <https://doi.org/10.3390/ijms22041561>

Przybył L et al. CD74 dysregulation of placental macrophage-trophoblastic interactions in preeclampsia. *Circ Res*. 2016 Jun 24;119(1):55-68

Przybył et al. Regulatory T cells ameliorate intrauterine growth retardation in a transgenic rat model for preeclampsia. *Hypertension*. 2015 Jun;65(6):1298-306

LABORATORY OF ANIMAL MODEL ORGANISMS

Caenorhabditis elegans | *Schmidtea mediterranea* | microinjection | model organisms | aging

portal.ichb.pl/laboratory-of-animal-model-organisms/

RESEARCH SCOPE

Identification and characterization of tRNA-derived short non-coding RNAs (tRFs) during aging in the model organism *Caenorhabditis elegans*.

The laboratory conducts research using model invertebrate organisms, such as nematodes (*Caenorhabditis elegans*) and planaria (*Schmidtea mediterranea*). It has a rich collection of *C. elegans* strains, including mutants, that can be used in functional studies. The laboratory also has the “Ahringer” (*C. elegans* RNAi feeding library) and “Vidal” (ORFeome-Based RNAi Library) libraries, which enable RNAi analysis of 94% of *C. elegans* genes. Equipment such as Mediaclave 10 and MediaJet vario (Integra) enable the preparation of sterile

media and pouring them into Petri dishes, in the amount of over a thousand per week. The Axio Vert.A1 microscope with an installed microinjection kit (InjectMan®4 and FemtoJet®4i micromanipulator, Eppendorf) allows us to perform microinjections, among others, to the gonads of *C. elegans*. The infrastructure available in the Laboratory (including stereoscopes, microscopes, and incubators) provides the opportunity to conduct research on both *C. elegans* and *S. mediterranea*.

The scientific interests of the Laboratory include tRF molecules, their role in the aging process, and genes whose expression is disturbed as a result of tRF activity.

SERVICE OFFER

- Nutrient media sterilization (from 1 l to 10 l) and Petri plates pouring (Ø 35 mm, 60 mm, 90 mm), 330 plates per hour;
- Microneedle preparation;
- Microinjections (possibility to use with *C. elegans*, cell nuclei and cytoplasm of adherent cells, pronucleuses of fertilized mouse oocytes, *Xenopus laevis* oocytes, fish embryos in early development phases).



Nematodes (*C. elegans*) observed under a stereoscope



HEAD

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EQUIPMENT

- | Mediaclave 10 and MediaJet vario (Integra), with sets for Ø 35 mm, 60 mm, 90 mm Petri plates;
- | PC-100 microneedle puller (Narishige);
- | Axio Vert.A1 microscope (Zeiss), with the Eppendorf microinjection set mounted: the InjectMan®4 micro-manipulator with dynamic motion control and the programmable FemtoJet®4i micro diaphragm with integrated pressure supply;
- | Tissue Lyser (Eppendorf).



AxioVert.A1 microscope (Zeiss) available in the Laboratory

SELECTED PUBLICATIONS

Tyczewska A et al. The emerging roles of tRNAs and tRNA-derived fragments during aging: Lessons from studies on model organisms. *Ageing Research Reviews* 2023; 101863

Sobanska D et al. The silencing of *ets-4* mRNA relies on the functional cooperation between REGE-1/Regnase-1 and RLE-1/Roquin-1, *Nucleic Acids Research* 2022, 50: 8226-8239

Pekec T et al. Ferritin-mediated iron detoxification promotes hypothermia survival in *Caenorhabditis elegans* and murine neurons. *Nature Communications* 2022, 13:4883

Aygün I et al. A germline-targeted genetic screen for *xrn-2* suppressors identifies a novel gene C34C12.2 in *Caenorhabditis elegans*. *Genet Mol Biol.* 2023; 46(2):e20220328





RESEARCH GROUPS

LABORATORY AUTOMATION AND ROBOTICS GROUP

AGAMEDE | combinatorial screening | HTS systems design and engineering | artificial intelligence

portal.ichb.pl/automatics-and-laboratory-robotics-group/
www.agamede.ai

RESEARCH SCOPE

Development and maintaining the AGAMEDE system in operation 24/7.

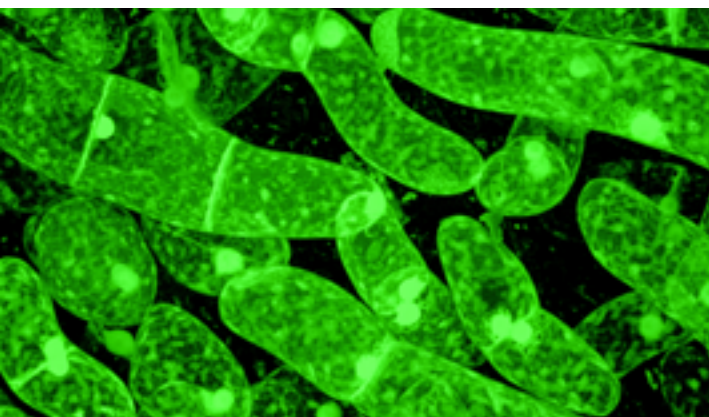
AGAMEDE is the first high-throughput screening system in Poland, which was built at the Institute of Bioorganic Chemistry of the Polish Academy of Sciences in 2013-2023 and named in honour of the first European woman in science.

The system enables microscale experiments on 96- and 384-well microplates using advanced instrumentation operated by six-axis industrial robots. Integrated Gene Game technology based on artificial intelligence allows combinatorial searching of multidimensional data spaces of 10^{24} solutions with processing of more than 1 000 000 samples per week without operator involvement. AGAMEDE

can be used by central diagnostic laboratories, pharmaceutical companies in drug discovery, and oncology laboratories seeking personalized therapies for a patient. It can also be used in the R&D departments of chemical and biotechnology companies to optimize bioprocesses. The system is available to a broad community of European researchers, pharmaceutical companies, and various industries as a screening site for the EU-OPENSOURCE consortium.

MAIN RESEARCH TOPICS

- combinatorial screening of chemical compound repositories
- optimization of stem cell media for their differentiation into various cell types
- formulation of chemical solutions for efficient crystallization of proteins and peptides
- optimizations of bioprocesses and biotechnologies
- determination of optimal buffer compositions for enzymatic reactions
- modeling evolutionary processes





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AWARDS

iF Design Award – International Forum Design, Hannover, Winner, 2023

Muse Design Award – International Awards Associate (IAA), New York, Gold Winner, 2022

A'Design Award – A' Design Award & Competition SRL, Rome, Silver Winner, 2022

Rethinking the Future Award – Global Architecture & Design Awards (GADA), New Delhi, Third Place, 2022

SELECTED PUBLICATIONS

Sadoch, J et al. High-throughput evolutionary optimization of the induction medium towards recombinant protein production in BY-2 tobacco. *Biotechnology and Bioengineering*. 2021; 118: 676–689.

Brennecke P et al. EU-OPENSREEN: A Novel Collaborative Approach to Facilitate Chemical Biology. *SLAS Discovery* 2019, 24(3), 298–413.

BIOECONOMY AND SUSTAINABLE DEVELOPMENT TEAM

bioeconomy | biotechnology | education | food security | plant genome editing | social opinion | sustainable development

portal.ichb.pl/bioeconomy-and-sustainable-development-group/#pll_switcher

RESEARCH SCOPE

The social, economic, and legal conditions of the bioeconomy and biotechnology development in the world, especially in Poland and the European Union.

The specific objectives implemented by the Team are the following: (1) analysis and monitoring of public opinion and acceptance of biotechnology, bioeconomy, and plant gene technologies; (2) analysis of economic indicators of bioeconomy and biotechnology development, e.g., production and cultivation area of genetically modified plants worldwide; (3) monitoring of changes in legal regulations regarding plant gene editing technology in the world.

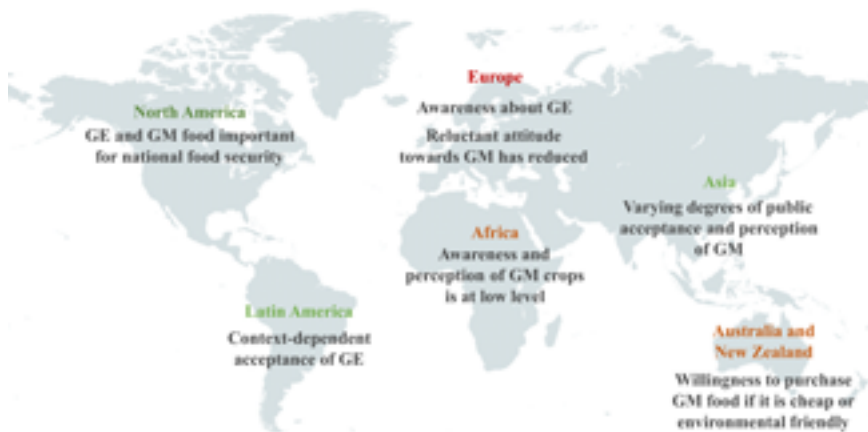
The team's research interests extend to the potential development and application of

plant gene technologies in the context of food security. This exploration aligns with several initiatives from the European Commission, including the European Green Deal, the 'Farm to Fork' Strategy, and the United Nations' Sustainable Development Goals.

MAIN RESEARCH TOPICS

- Analysis of social acceptance and public opinion in relation to GMOs, genetically modified plants, new techniques of genetic engineering in the context of the legal status and development of biotechnology and bioeconomy.
- Analysis of bioeconomy development conditions in Poland and the European Union.
- Defining the role of societal education in promoting the circular economy and fostering sustainable market behaviors.

- Educating young people about the bioeconomy, raising awareness and interest in the environmental, social and economic benefits of a sustainable and circular bioeconomy (at the regional and local levels).



Public perception of plant gene technologies across different regions in the world



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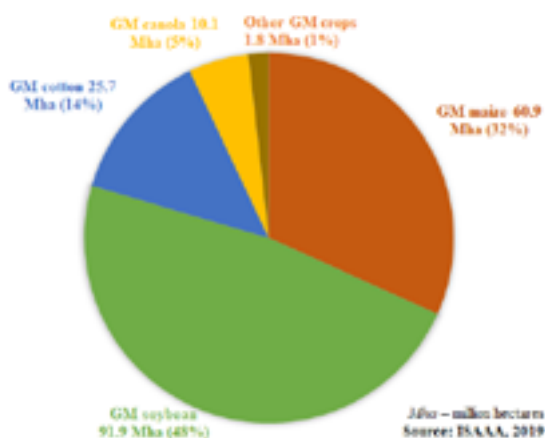
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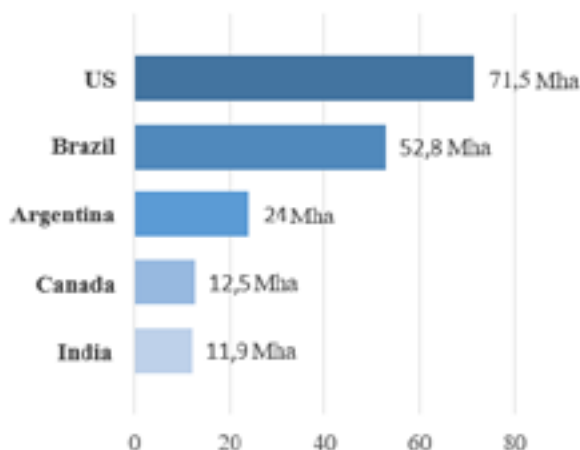
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RESEARCH PROJECTS

Conditions for the development of bioeconomy from a regional perspective (NSC MINIA-TURA, PI: E. Woźniak-Gientka)



Area of GM crops cultivated worldwide (2019)



Top 5 countries that planted GM crops

SELECTED PUBLICATIONS

Tyczewska A et al. Agricultural biotechnology for sustainable food security. Trends in Biotechnology 2023; 41(3):331-341,
Woźniak-Gientka E et al. Public perception of plant gene technologies worldwide in the light of food security. GM Crops & Food 2022;13(1), 218-241

Woźniak-Gientka E et al. Public opinion on biotechnology and genetic engineering in the European Union: Polish consumer study. Biotechnologia 2022; 103 (2) C pp. 185-201


Woźniak E et al. A shift towards biotechnology: Social opinion in the EU. Trends in Biotechnology 2021; 39(3):214-218,

Wozniak E et al. Bioeconomy development factors in the European Union and Poland. New Biotechnology 2021; 60:2-8

Tyczewska A et al. Towards Food Security: Current State and Future Prospects of Agrobiotechnology. Trends in Biotechnology 2018; 36(12), 1219-1229

Woźniak E et al. Bioeconomy during the COVID-19 and perspectives for the post-pandemic world: Example from EU. EFB Bioeconomy Journal 2021; 1:100013





POZNAŃ
SUPERCOMPUTING
AND NETWORKING
CENTER (PSNC)

POZNAŃ SUPERCOMPUTING AND NETWORKING CENTER (PSNC)

Affiliated to the Institute of Bioorganic Chemistry, Polish Academy of Sciences, Poznan Supercomputing and Networking Center (PSNC) is an independent unit, which has been developing the information infrastructure for science since 1993 as a national center for High Performance Computers and operator of the national scientific network PIONIER, distinguished by its exceptionally broad commitment to research and development in the field of information and communication technologies and their applications.

PSNC was established by the decision of the College of Rectors of the City of Poznan to coordinate the use of the metropolitan network and supercomputers in Poznan by the units represented in the College. In the following years, the activities of PSNC successfully led to the launch a pilot of the POL-34 national network, followed by developing a program to build a national network of the Polish Optical Internet as part of the PIONIER program.

PSNC hosts a node of the GÉANT pan-European scientific network. Through this node, the PIONIER network and the municipal fiber-optic networks attached to it, the Polish scientific community is provided with a broadband connection to the Internet and scientific networks around the world.

The PIONIER network and the computing infrastructure attached to it are an integral part of the European Research Area.

PSNC is also systematically developing high performance computing services based on supercomputers, which have been ranked among the 500 most powerful supercomputers in the world in more than 20 editions of the prestigious TOP-500 list since 1995. Thanks to this, since 2008 PSNC has represented Poland in the PRACE consortium, and Polish scientists have the opportunity to use the most powerful supercomputers in Europe. Since 2022, PSNC has also offered access to a quantum computer as part of its IBM Quantum Innovation Center activities. In addition, in 2023 the PSNC was awarded a EuroHPC Joint Undertaking contract to install one of the first six European quantum computers in Poznan.

The development of competencies and increase in the number of staff (in 2000, PSNC had more than 60 employees, in 2010 - more than 200, and in 2023-480), as well as modern infrastructure, have allowed successful acquisition of projects in competitions of European framework programs and national research programs. To date, PSNC has implemented more than 300 such projects, including 50 as coordinator.



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Plenipotentiary of the Director
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Head of the Network Technologies Division

TOMASZ PIONTEK, MSc, Eng.
Head of the Applications Division

URSZULA GRYGIER-SOBOŃ, MA
Deputy Chief Accountant for PSNC

ARLETA RUTKOWSKA, MA
Head of the Administrative and Financial
Department of PSNC

AGNIESZKA STOKŁOSA, MA
Projects Administration Department of PSNC

JOANNA URBANIAK, MA
Deputy Head of the Human Resources Department

STEERING COMMITTEE

The Steering Committee is a team that supports the Director of the Institute in matters related to the strategic activities and directions of the development of PSNC, in particular, the strategic programs of infrastructure research and development, scientific progress and extensive building of domestic and foreign cooperation.

The Steering Committee consists of:

Prof. JAN WĘGLARZ
Chairman of the Steering Committee for
PSNC Development

MACIEJ STROIŃSKI, PhD, Eng.
Deputy Chairman of the Steering Committee for
PSNC Development

with Cezary Mazurek, PhD, Eng., Krzysztof Kurowski PhD, Eng. and Robert Pękał, MSc, Eng.

PIONIER

POLISH OPTICAL INTERNET PIONIER

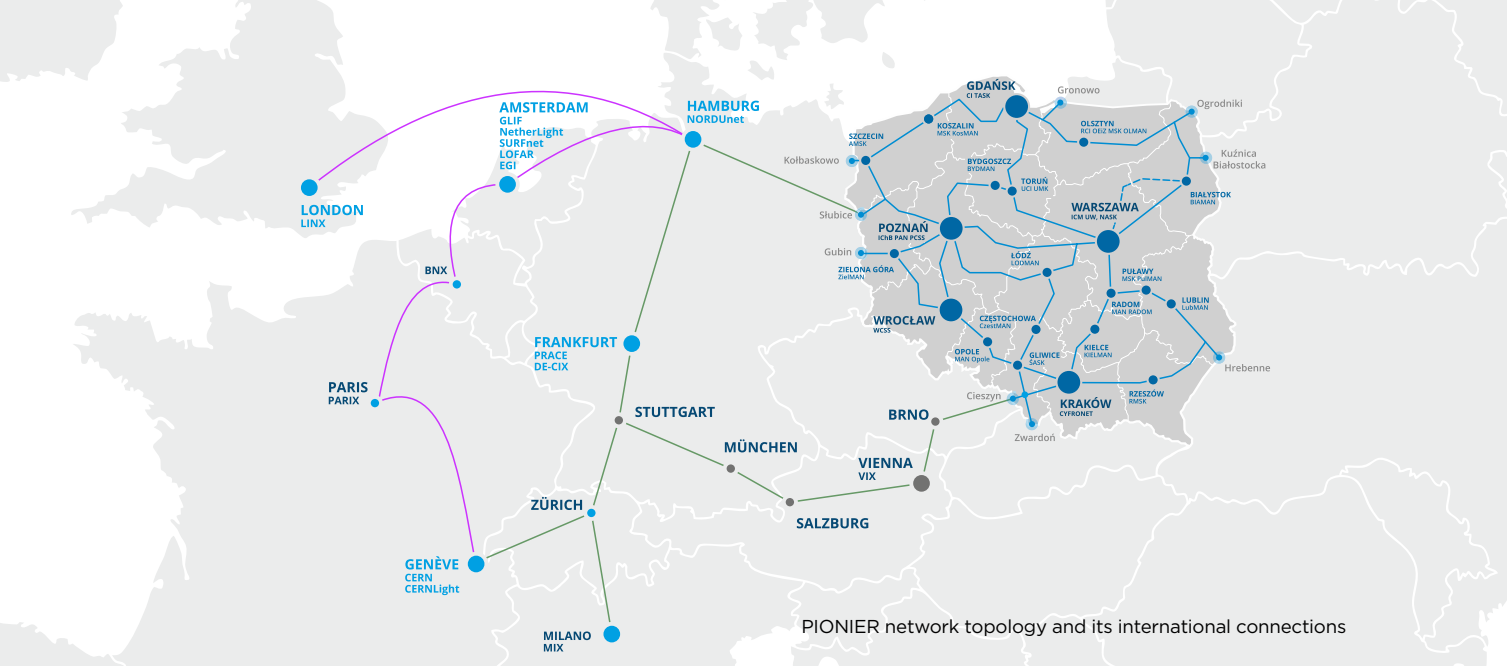
One of the key areas of the Poznan Supercomputing and Networking Center's activity is the development and maintenance of the national scientific network PIONIER - Polish Optical Internet. Currently, the network covers about 11,000 km of fiber optic lines in Poland and abroad and offers its services to the Polish scientific and research community.

Operating for over 20 years, the PIONIER fiber-optic network is now one of the most modern in the world. Its construction was possible thanks to the implementation of the Program for the Development of Information Infrastructure of Science PIONIER, prepared on the initiative and with significant contribution of PSNC. The network gathered a community of 22 Leading Units (operators of scientific metropolitan area networks and HPC supercomputing centers), forming the PIONIER Consortium in 2003. In the following years, the Consortium developed successive strategies for upgrading the information infrastructure of science ("Concept of the PIONIER2 -Advanced Service Platforms Program for 2007-2013", "Program for the development of information infrastructure of science in Poland, within the framework of the "Europe 2020" strategy for 2014-2020") and implemented structural and R&D projects, developing the communication capabilities and services of the PIONIER/MANs network ecosystem.

The establishment of the program, the network and the PIONIER Consortium was preceded by building the community by network enthusiasts from MANs from the early 1990s. The cyclical POLMAN conference (1994-1999) played a major role in this. Within 20 years, the PIONIER Consortium has solidified, finding and implementing numerous challenges. Against all odds, it succeeded in building a network with multiple fiber loops and modern transmission technologies (DWDM, Ethernet). The PIONIER network and MANs were at that time modified and developed through joint projects such as New-MAN and 100net. Meanwhile, the next-generation PIONIER-MAN ecosystem was built under the PIONIER-LAB project.

A number of "added" services have also been made available on this modern network, resulting from the National Data Repository (1, 2), PLATON, and MAN-HA projects. Three projects have just been completed: PRACE-LAB, PRACE-LAB2 and NDR (Universal Infrastructure for Data Storage and Sharing), which will transform MANs with PIONIER into a distributed service platform environment to support the digital transformation of science and economy.

In 2023, the total length of fiber optic lines was 10,923 km, including 6843 km in Poland and 4080 km outside the country. The



network also has fiber optic connections to the academic networks of neighboring countries: Germany (Kołbaskowo, Słubice, Gubin), the Czech Republic (Cieszyn), Slovakia (Zwardoń), Ukraine (Hrebenne), Belarus (Kuźnica Białostocka), Lithuania (Ogrodniki), and the Kaliningrad Region (Braniewo). Through a long-standing mutual exchange of fibers with telecommunications operators, the fiber optics of the PIONIER network reach Hamburg, where they have direct points of contact with the Scandinavian networks NORDUnet and SURFnet (Dutch national research and academic network), Frankfurt am Main and Geneva (CERN). A DWDM/Ethernet $n \times 400/100$ Gbps transmission network was launched on this topological structure.

Since its very beginning, the PIONIER network has been and continues to be of great importance for the entire Polish scientific community, especially for those research disciplines in which progress depends on access to high-speed computer networks and resources linked to these networks. At the same time, the Polish e-infrastructure,

based on the PIONIER network, was an integral part of the European Research Area (ERA). The PIONIER environment made a very large contribution to the development of this infrastructure, participating in a very large number of European projects related to the development of this infrastructure at all levels of its architecture, i.e. network, computing and scientific data.

Currently, the PIONIER network ecosystem is developing towards terabit bandwidths, offering services to support digital innovation. This is an important element of open science, developed in the European Union under the EOSC (European Open Science Cloud) initiative, allowing the Polish scientific community to develop at a global level and exchange knowledge internationally. Through direct connections to the European GÉANT network and contact with the most important traffic exchange points in Europe, the PIONIER network provides connectivity to European scientific networks (NRENs), as well as providing the Polish scientific community with access to the global Internet.

HPC AND DATA INFRASTRUCTURE

PSNC has two data centers: main and back-up, providing production cloud and HPC infrastructures along with high reliability services for science, economy and administration. The PSNC's data centers of more than 2,000 m² in geographically remote locations allow the provision of cloud services with increased reliability, thanks to duplicated cooling, protected power, unprotected power and independent power supply systems.

The resources of PSNC are used by the scientific community from all over Poland: not just Poznan, but also centers from Torun, Wroclaw, Bydgoszcz, Krakow, Katowice, Warsaw, and Gdansk. A significant part of the users are also scientists from abroad, using the resources of PSNC as part of the implementation of obligations arising from

agreements on the exchange of computing power PRACE (Partnership for Advanced Computing in Europe), in the field of nuclear physics - WLCG (Worldwide LHC Grid Computing), LOFAR (Low-Frequency Array for Radio Astronomy), as well as scientists associated with numerous ESFRI (European Strategy Forum for Research Infrastructures) international projects.

The recent years have also brought significant expansion of the National Data Repository infrastructure - a universal infrastructure for storing and sharing data and efficiently processing large volumes of data in HPC, Big-Data and artificial intelligence models. This is a national project coordinated by PSNC, which aims to build a national data repository with services for science and economy. In the area of science, NDR supports the guidelines of open science (EOSC - European Open Science Cloud), giving the scientific community the opportunity to store data according to the postulates of EOSC, protection and reliability of stored data. Other projects in the area of key research infrastructures in Poland are PRACE-LAB and PRACE-LAB2 (Partnership for Advanced Computing in



One of the most state-of-the-art
Data Centers in Poland - PSNC



Altair supercomputer purchased under the national research infrastructure project - PRACE-LAB (Building Advanced Computing in Europe)

Europe), which in turn provide computing services for the scientific community with user support in the area of artificial intelligence, big data analytics or typical conventional or cloud computing. Both of the aforementioned NDR and PRACE-LAB2 environments make their services available in the form of federated 9 NDC and MAN cen-

ters. It should be added that PRACE-LAB's 3 computing systems have been continuously ranked for 2 years in the TOP500 list of the world's fastest computers.

The data and computing infrastructures of the PSNC have also been made available for economic purposes, in accordance with the guidelines of the European Commission granting structural funds for their construction. To meet these requirements, the PSNC has reorganized its structures and organization of services, obtaining ISO9001 and ISO27001 certification in the areas of information security and service quality management.



Critical infrastructure in the National Data Repository



POZNAN METROPOLITAN NETWORK

Poznan Supercomputing and Networking Center is the operator of the POZMAN Metropolitan Computer Network. As part of this activity, PSNC provides access to the Internet and many services dedicated to education and science.

The POZMAN network currently boasts about 300 km of fiber-optic cables in Poznan and the immediate vicinity (Plewiska, Borówiec, Kórnik). Universities and research institutes from Poznan and surrounding towns are connected to the network, and thanks to the

use of PIONIER network regional connections also those from Piła, Konin, Leszno and Gniezno. Government and local government administration units, schools, cultural institutions and enterprises are also connected to the network.

Thanks to the closed ring topology, most of the connections of the POZMAN network have fiber-optic backup links enabling network operation in case of damage or failure of one of the links. The POZMAN network operates in MPLS technology based on PSNC-owned fiber optics, which provides network users with virtually unlimited transmission capabilities. The speed of users' access to the network is currently 100 Gbit/s, compared to 10 Mbit/s in the initial period of network operation.

Along with Internet access, the POZMAN network also offers access to high performance computing and data archiving systems as well as the European scientific network GÉANT, and offers a number of services dedicated to the scientific community that have been produced by PSNC or result from cooperation between European scientific networks. These include eduroam and federated login services. An example of a state-of-the-art service available to all



POZMAN metropolitan network



users of the POZMAN network is the ability to use high accuracy time and frequency signals.

Through the POZMAN network, users have access to PIONIER services including those related to the network layer (as dedicated fiber, dedicated lambdas, VPN service); identity and security (services: PIONIER.Id, PIONIER CERT, eduGAIN); cloud and data (campus services, archiving, digital libraries);

Video services (Pionier.TV, Videoconferencing, eduMeet) or support services (HELP-Desk, perfSONAR, PERT).

Moreover, due to the completion of research infrastructure construction projects from the Polish Research Infrastructure Map, PSNC users have gained access to the services and laboratories of the PIONIER-LAB, PRACE-LAB, PRACE-LAB2 and National Data Repository infrastructures.

QUANTUM COMPUTERS AND QUANTUM COMMUNICATION INFRASTRUCTURE

For several years now, we have witnessed an almost unimaginable race in the development of quantum technologies, with the world's strongest economies behind them. Many practical solutions using quantum technologies, such as quantum communications, have been successfully implemented in the national PIONIER infrastructure. Continuous and intensive work is underway to make the next technological breakthrough, which will significantly impact the further development of not only computational science but also computer science, physics, chemistry, biology and medicine. However, it is worth summarizing the rapid growth of quantum technologies and their PSNC applications over the past few years.

Within the PIONIER consortium, research and implementation work in the field of quantum communication technologies has been carried out since 2018, the results of which are implemented in European projects within the framework of cooperation with GÉANT and the leading European project OpenQKD in development of quantum key distribution technology. In addition, PSNC has been actively involved in several national projects for several years, including

the NLPQT project for the construction of the National Laboratory of Photonics and Quantum Technologies within the framework of the Polish Research Infrastructure Roadmap and the development of quantum technology applications for national security and defence.

On the Ministry of Digital Affairs initiative, the first Polish Quantum Innovation Center in Central Europe was established in February 2022. As a result, it was possible to launch a nationwide platform allowing scientific users to remotely access the resources of IBM Q quantum computers, including the world's largest IBM Quantum systems. PSNC teams support scientific users and participate in research, development, and implementation work to develop new quantum methods and algorithms for solving computationally tricky and complex problems in combinatorics, cryptography, artificial intelligence, and quantum chemistry.

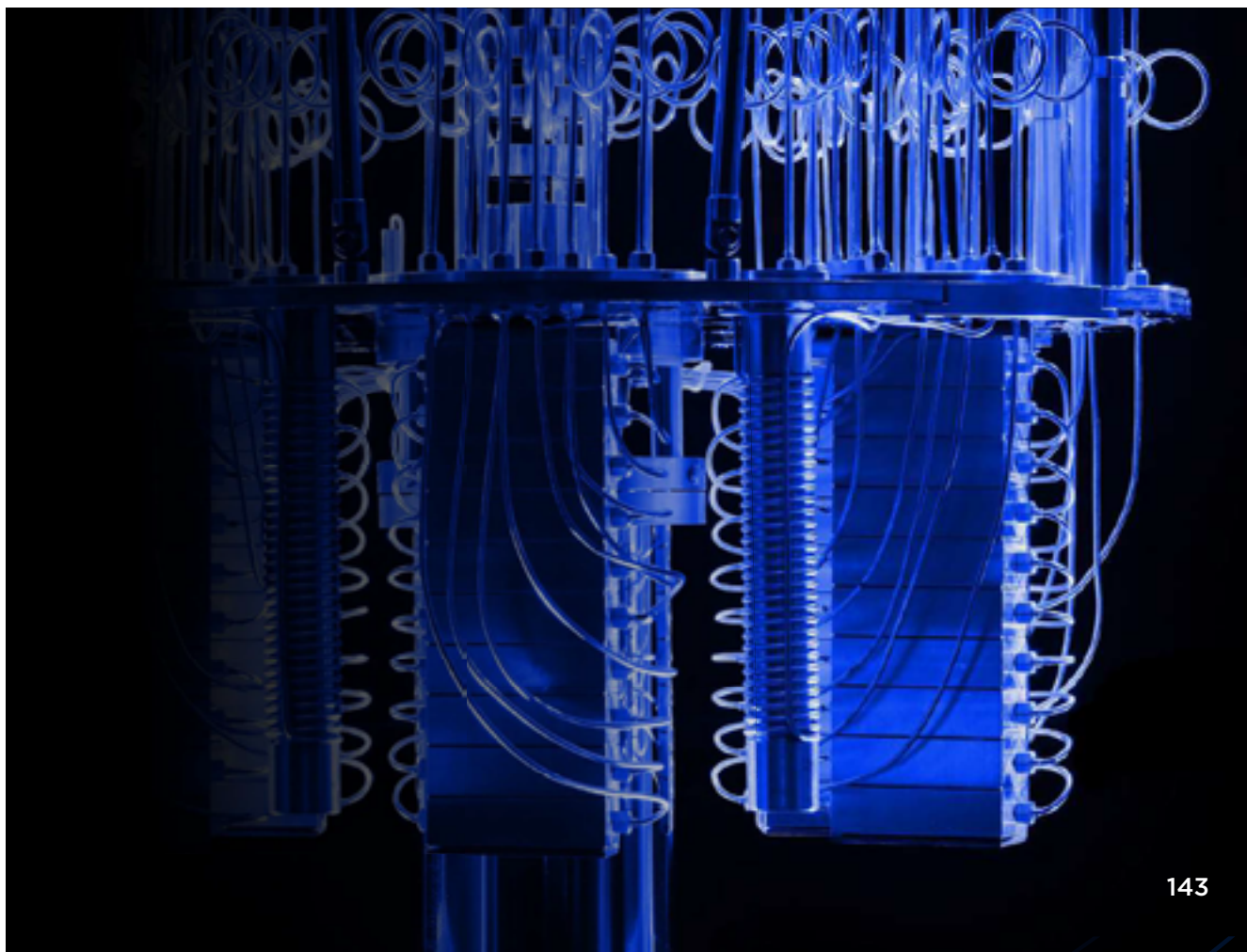
PSNC has recently coordinated the PIONIER-Q Consortium within the European EuroQCI initiative and further developed the national quantum communications infrastructure linking all High-Performance Computing centres in Poland. PSNC has

also engaged in developing photonic-based quantum computer technology and will launch a unique distributed optical computer architecture.

Additionally, PSNC, as a leader in the Euro-QCS-Poland Consortium, has been selected in the EuroHPC JU competition for one of the first six European quantum computers. Thanks to cooperation with leading supercomputing centres in Europe and the involvement of many research and development institutions, PSNC will create the first European hybrid supercomputer infrastructure combining the advantages of classical

and quantum computing using advanced trapped ion technology by 2025.

PSNC successfully installed the first two photonic quantum computers in Poland in 2023. Additionally, PSNC has organized various forms of support for researchers interested in using quantum technologies, including lectures, hackathons, training, consultations and workshops, and leading the Workshop on Quantum Computing and Communication at Parallel Processing & Applied Mathematics and the QL Future hackathon with business partners.







PSNC DIVISIONS

NETWORK TECHNOLOGIES DIVISION

optical networks | new media | quantum key distribution | network automation

pcss.pl

RESEARCH AND DEVELOPMENT SCOPE

The Division's tasks include conducting work related to the following areas of activity:

- operation and development of network and service infrastructure, particularly related to the PIONIER and POZMAN networks;
- maintenance and provision of specialized laboratories;
- R&D works related to modern ICT network technologies, including new generation networks, time and frequency pattern signal distribution services, quantum communications, Internet of the Future, resource virtualization, and new media, including 8K, 3D and 360° video processing, ambisonic sound and XR - Extended Reality.

The Division is composed of three departments:

- Network Infrastructure and Services Department (Raimundas Tuminauskas),
- New Media Department (Maciej Głowiak),
- New Generation Networks Department (Bartosz Belter),
- Network Management Center (Szymon Trocha),
- PIONIER Network Maintenance Team (Krzysztof Kołat)
- POZMAN Metropolitan Area Network Maintenance Team (Marcin Garstka)



Laboratory of programmable optical networks

MAIN RESEARCH TOPICS

- virtualization, integration and automation of network and cloud resources including EOSC
- 5G/6G technology development
- research work on quantum key distribution (QKD) technology
- development of technology for distribution of optical carrier signals, time and frequency pattern signals in fiber optic networks
- network streaming of large audiovisual data streams over long distances with low latency
- innovative methods of production and delivery of audiovisual content in new technologies



HEAD

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CURRENT PROJECTS

PIONIER-LAB - National Platform for Integration of Research Infrastructures for Innovation Ecosystems (POIR, PI: A. Binczewski)

NLPQT - National Laboratory of Photonics and Quantum Technologies (POIR, PI: A. Binczewski)

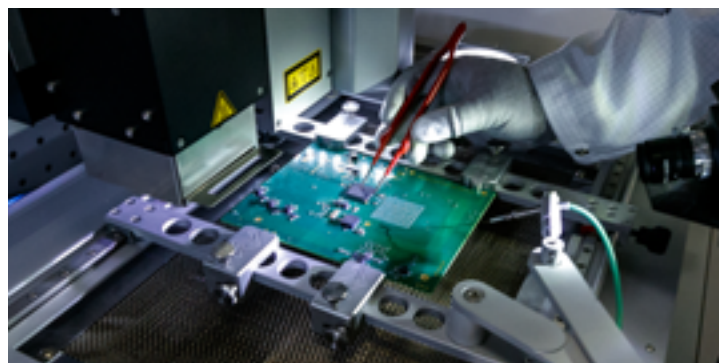
PL-5G - National Laboratory for Advanced Research (POIR, PI: B. Belter)

PIONIER-Q - Polish Quantum Communication Infrastructure (DIGITAL, PI: A. Binczewski)

GN5-1 (HORIZON, PI: A. Binczewski)

EOSC-FUTURE (H2020, PI: R. Tuminauskas)

SUBMERSE - Submarine Cables for Research and Exploration (HORIZON, PI: K. Turza)



Electronic circuit lab (Open network equipment lab)

SELECTED PUBLICATIONS

Krehlik, P., Turza, K. et al. Controlling of the bidirectional amplifier chain for optical frequency distribution based on a two-dimensional noise detector. *Optics Express*, 2023;31(8):12083 – 12096

Fdida, S., Belter B. et al. SLICES, a scientific instrument for the networking community. *Computer Communications*, 2022(193):189–203

Scaffardi, M., Rydlichowski, P. et al. 10 Oam × 16 wavelengths two-layer switch based on an integrated mode multiplexer for 19.2 tb/s data traffic. *Journal of Lightwave Technology*, 2021, 39 (10):3217-3224

Hare, B.M., Pekal, R. et al. Needle-like structures discovered on positively charged lightning branches. *Nature*, 2019,568(7752): 360-363

Krehlik, P, Binczewski, A. et al. Fibre-optic delivery of time and frequency to VLBI station. *Astronomy & Astrophysics*, 2017(603):1-8

NETWORK SERVICES DIVISION

smart city | digital humanities | personalized medicine | software engineering | speech recognition

pcss.pl

RESEARCH AND DEVELOPMENT SCOPE

The Division's tasks include conducting work related to the following areas of activity:

- Development and implementation of network services software;
- Maintenance and provision of specialized laboratories;
- R&D works on scientific data platforms, Future Internet services, digital libraries and knowledge platforms, and new interfaces with the user,
- Maintenance of the Digital Libraries Federation of the PIONIER network
- Development and maintenance of an official e-services platform for the residents of the city of Poznań

The Division's operations also include software distribution:

- NABOR - a system that supports school recruitment,
- DINGO - a system for digitizing, sharing and storing digital cultural heritage resources,

- SINUS - a system for managing information on current academic activities of employees
- ARM - automatic speech recognition system for the Polish language, based on neural networks

There are four departments in the structure of the Division::

- Digital Libraries and Knowledge Platforms Department (Tomasz Parkoła),
- Data Engineering and Analytical Platforms Department (Juliusz Pukacki),
- New User Interfaces Department (Robert Cecko),
- Department of Future Internet Services (Michał Kosiedowski).

MAIN RESEARCH TOPICS

- digital humanities, cultural heritage
- the use of ICT to support the elderly and people with disabilities
- building solutions based on Big Data processing and AI using scalable analytics platforms and Big Data technologies in biomedical areas.
- application of AI methods for image and sound analysis, including media analysis and development of modern user interfaces



ASR - Advanced system for automatic speech recognition for Polish



HEAD

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CURRENT PROJECTS

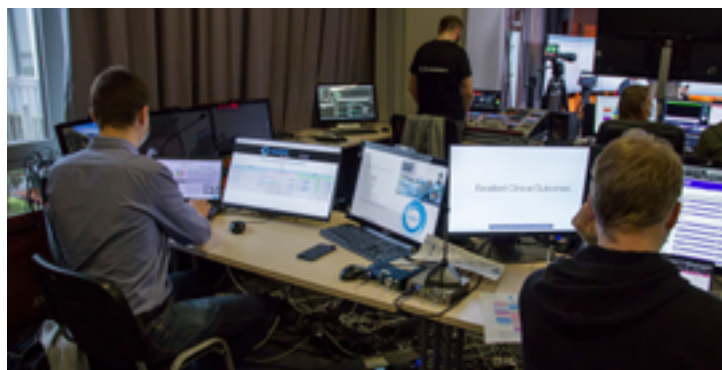
DARIAH-PL - Digital Research Infrastructure for the Arts and Humanities (POIR, T. Parkoła)

MOSAIC - ECBiG - European Center for Bioinformatics and Genomics (POIR, R. Pękal)

NEBI - National Centre for Advanced Analysis of Biological and Biomedical Imaging (POIR, R. Pękal)

FBC-TENE: Increasing Availability of Scientific and Cultural Resources in FBC (Digital Libraries Federation) by Acquiring Textual and Musical Representations (POPC, T. Parkoła)

Safe-Home - Security-aware Fog-Based Efficient Home Monitoring for Elders (CELTIC-NEXT, M. Kosiedowski)



Implementation of the international session of the European Laryngology Surgery Live - Telemedicine Laboratory

POSEMO - An Automatic Tool for Estimating Person's Engagement and Emotional Valence Based on Camera Video (TANGO 5, J. Pukacki)

EMMA44 - Extracting Information from Electronic Media Using Artificial Intelligence and Machine Learning Methods (NCBiR, E. Kuśmierek)

SELECTED PUBLICATIONS

Świerczyński, H., Pukacki, J. et al. Sensor data analysis and development of machine learning models for detection of glaucoma. *Biomedical Signal Processing and Control*, 2023 (86)

Behnke, M., Buchwald, M. et al. Psychophysiology of positive and negative emotions, dataset of 1157 cases and 8 biosignals. *Scientific Data*, 2022, 9(1). Art. no.10

Broderick, J.W., Pękal, R. et al. Predictive Reliability and Fault Management in Exascale Systems: State of the Art and Perspectives. *ACM Computing Surveys*, 2020, 53(5):1-32

Jęsko, W. Vocalization Recognition of People with Profound Intellectual and Multiple Disabilities (PIMD) Using Machine Learning Algorithms. *Proceedings of 22nd Annual Conference of the International Speech Communication Association. Interspeech 2021*:2921-2925

Garcia-Silva, A.A., Palma, R. et al. Enabling FAIR research in Earth Science through research objects. *Future Generation Computer Systems*, 2019(98):550-564

DATA PROCESSING TECHNOLOGIES DIVISION

HPC | Cloud | Cyber Security | Internet of Things | Data Services

pcss.pl

RESEARCH AND DEVELOPMENT SCOPE

The Division's tasks include conducting work related to the following areas of activity: operation and development of computing infrastructure, data storage and provision of services; maintenance of security of processing systems, networks and services provided; maintenance and provision of specialized laboratories; research and development of cloud architecture and computing, data management, security, integration of services and infrastructures in Poland and Europe; development of Internet of Things (IoT) technology and applications in relevant areas. The Division's activities also include software sales: Conference4Me - a mobile device application for conference and event organizers.



The Division consists of five departments:

- ICT Security Department (Gerard Frankowski)
- Data Processing Infrastructure Department (Rafał Mikołajczak)
- New HPC Architectures Department (Radosław Januszewski)
- Internet of Things Technologies Department (Marcin Płóciennik)
- Data Management Technologies Department (Maciej Brzeźniak)

MAIN RESEARCH TOPICS

- Cyber security - protection of infrastructure, IT services
- Smart Agriculture: e-Services for Farmers
- EUROfusion: coordination of the Advanced Computing Hub - support in scientific computing and software engineering.
- Internet of Things: prototyping and making components for Internet of Things applications
- Development of data processing and access technologies; increase in reliability of data storage, backup, replication

Internet of Things (IoT) experimental laboratory



HEAD

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CURRENT PROJECTS

PRACE-LAB i PRACE-LAB2: Cooperation on Advanced Computing in Europe (POIR, N. Meyer, R. Januszewski)

KMD - National Data Storage. Universal infrastructure for sharing, storage and effective processing of large data volumes in HPC, Big-Data and artificial Intelligence models (POIR, N. Meyer, M. Brzeźniak)

HIDALGO2: HPC and Big Data Technologies for Global Challenges (HORIZON, M. Lawenda)

agrifoodTEF - Test and Experiment Facilities for the Agri-Food Domain (DIGITAL, N. Meyer)

DATAMITE - DATA Monetization, Interoperability, Trading & Exchange (HORIZON, N. Meyer)



Industrial network security

AI4EOSC - Artificial Intelligence for the European Open Science Cloud (HORIZON, N. Meyer)

ICOS - Towards a functional continuum operating system (HORIZON, N. Meyer)

ScaleAgData (HORIZON, N. Meyer)

illuMINEation Bright concepts for a safe and sustainable digital mining future (H2020, N. Meyer)

SELECTED PUBLICATIONS

Halbiniak, K., Meyer, N. et al. Performance exploration of various C/C++ compilers for AMD EPYC processors in numerical modeling of solidification. *Advances in Engineering Software*, 2022(166). Art. no.10307

Szustak L., Lawenda, M. et al. Profiling and optimization of Python-based social sciences applications on HPC systems by means of task and data parallelism. *Future Generation Computer Systems*, 2023(148):623-635

Ejarque, J., Kupczyk, M. et al. Enabling dynamic and intelligent workflows for HPC, data analytics, and AI convergence. *Future Generation Computer Systems*, 2022(134):414-429

Frassinetti, L., Owsiak M. et al. Pedestal structure, stability and scalings in JET-ILW: The EUROfusion JET-ILW pedestal database. *Nuclear Fusion*, 2021:61(1). Art.no. 016001

Gogolenko, S., Lawenda, M. et al. Towards accurate simulation of global challenges on data centers infrastructures via co-upling of models and data sources. *Lecture Notes in Computer Science, ICCS 2020*, 12142 LNCS: 410-424

APPLICATIONS DIVISION

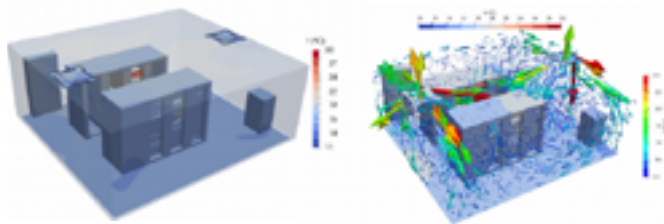
services | visualization | energy efficiency | semantics | artificial intelligence | quantum technologies

pcss.pl | psnc.pl

RESEARCH AND DEVELOPMENT SCOPE

The Division's tasks include conducting work related to the following areas of activity:

- Development of generic and problem-oriented application tools and services, as well as portal applications, particularly related to access to computing infrastructure (HPC, cloud and hybrid) for the scientific and business communities;
- Maintenance and provision of specialized laboratories;
- R&D works in large-scale applications, energy-efficient ICT, interactive visualization, artificial intelligence and quantum technologies in scientific and industrial applications.
- Conducting domain-specific courses and training in such areas as artificial intelligence using a service platform under development.



Thermal-flow analyses of server rooms for commercial customers

The Division is composed of four departments:

- Data Analytics and Semantics Department (Raul Palma, PhD)
- Large Scale Applications and Services Department (Tomasz Kuczyński)
- Department of Energy Efficient ICT Technologies (Ariel Oleksiak, PhD)
- Advanced Visualization and Interaction Department (Bogdan Ludwiczak)

MAIN RESEARCH TOPICS

- Optimization and automation of software development and deployment processes in containerized environments.
- Quantum and hybrid computing using quantum computers and simulators.
- Using computer simulations and AI and ML techniques to optimize energy consumption and production and in biomedical scenarios.
- Data analytics and semantic technologies to support aspects of data management, analysis and knowledge extraction.
- Photorealistic real-time visualizations using VR, AR, XR, Web3D and Cave technologies



HEAD

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CURRENT PROJECTS

RELIANCE - REsearch Lifecycle mAnagement for Earth Science Communities and CopErmicus users in EOSC (H2020, R. Palma de Leon)

SUCCESS - Supporting success for all - Universal Design Principles in Digital Learning for students with disabilities (Erasmus +, T. Piontek)

Up2DigiSchool - A viable pedagogical approach for digital school education based on the experience of Up2U (Erasmus +, T. Piontek)

RENERGETIC - Community-empowered Sustainable Multi-Vector Energy Islands (H2020, A. Oleksiak)

TEXTAROSSA - Towards EXtreme scale Technologies and Accelerators for euROhpc hw/Sw Supercomputing Applications for exascale (EuroHPC-RIA H2020, A. Oleksiak)



CAVE - Immersive Visualization System

ADMIRE - Adaptive multi-tier intelligent data manager for Exascale (EuroHPC-RIA H2020, A. Oleksiak)

QATM - Applications of Quantum Technologies in Air Traffic Management of the Polish Armed Forces (NCBiR, K. Kurowski)

Assyst - Construction of a Platform for Conducting Tests, Process Experiments and Neutralization of Explosive Materials and Devices (NCBiR, T. Piontek)

SELECTED PUBLICATIONS

Kurowski, K., Pecyna, T. et al. Application of quantum approximate optimization algorithm to job shop scheduling problem. *European Journal of Operational Research*. 2023 (310):518-528

Różycki R., Kurowski, K. et al. A Quantum Approach to the Problem of Charging Electric Cars on a Motorway. *Energies*, 2023;16(1), art. no. 442.

Ciżnicki, M., Kurowski, K. et al. Energy and performance improvements in stencil computations on multi-node HPC systems with different network and communication topologies. *Future Generation Computer Systems*, 2021(115): 45-58

Canal, R., Oleksiak, A. et al. Predictive Reliability and Fault Management in Exascale Systems: State of the Art and Perspectives. *ACM Computing Surveys* 2020,53(5):1-32

Alowayyed, S., Piontek, T. et al. Patterns for High Performance Multiscale Computing. *Future Generation Computer Systems*, 2019(91): 335-346

PSNC FUTURE LABS

living labs | social innovation incubator | art & science | coworking | digital twin | green deal

futurelabs.psnk.pl

RESEARCH AND DEVELOPMENT SCOPE

PSNC Future Labs - living labs of PSNC - supporting change leaders through the following activities:

- Developing a network of living labs that introduce research thinking to small and medium-sized organizations.
- Creating spaces for interdisciplinary collaboration to jointly address complex problems.
- Organizing networking events to identify and inspire change leaders.
- Redefining non-functional spaces to unlock the potential of local communities.
- Democratizing science and technology to have verified tools and knowledge help dreams come true.
- Providing researchers with practical knowledge and data to spur real-life cross-disciplinary discoveries.



MAIN RESEARCH TOPICS

- Climate Change
- Health care
- Industry 4.0/Digital twin
- Future education
- Art and Science
- Living labs/cross-disciplinary collaborative space

Seat of PSNC Future Labs: 20 Zwierzyniecka st.,
Poznan, Poland



HEAD

Adam Olszewski, PhD

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CURRENT PROJECTS

SMART COMMUNITY

QL Future - human, planet, climate - the use of quantum tech for sake of humans

Planet-ON - a green industry & planet saving hackathon

HEALTH

Oncoform - online blood test assessment tool for carers of young oncological patients

Wait Safe - on-site patient queue management system for small healthcare units

Next Data AI - incubation of an AI DICOM cancer recognition system

ART & SCIENCE

Design and experimentation space for artists who apply the cutting edge tech tools, such as the ambisonic installation, XR, VR, advanced interactive interfaces

OptiTrack workshops and artistic residencies around the use of the 42 camera motion tracking system

INDUSTRY 4.0

Change2Twin - digital twin tools and marketplace for SMEs wishing to become green and ergonomic factories of the future

Shop4cf - AI and digital twin applications to improve the ergonomics and efficiency of manufacturing workstations in the factories of VW and Bosch

EDUCATION

Design Sprint - interdisciplinary IT/MED/ART workshops

Design Thinking - inclusive solution prototyping workshops

COWORKING / SPACES

Continuous growth of the Future Labs network collaborative spaces & communities

BIBLIOSTACJA - redesign of the library's local community functions, user journeys, interior and visual identity



PLANET- ON hackathon

PSNC AEROSPACE LAB

cyber-physical systems | robotics | UAV | autonomy | AI | airspace

aerospacelab.psnc.pl

RESEARCH AND DEVELOPMENT SCOPE

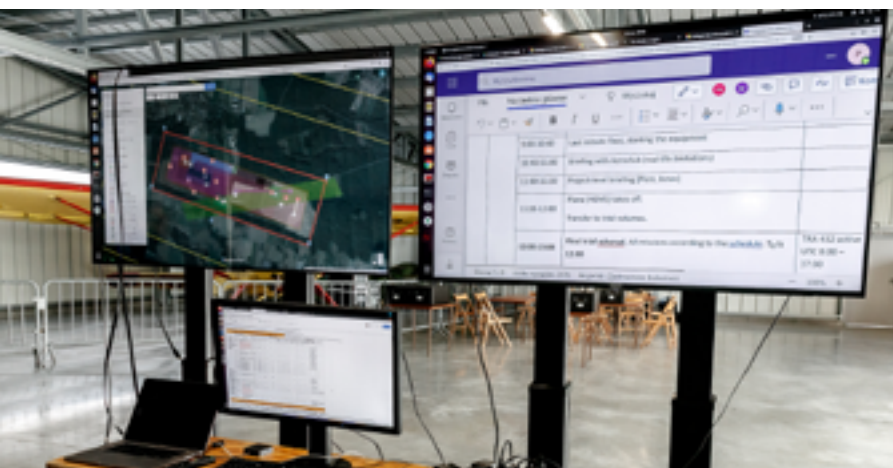
The Team's activities focus on the issues of autonomy of robotic vehicles, mainly aerial and wheeled ground vehicles, in various service (application) scenarios. Information about the environment is acquired from a variety of sensors, depending on specific scenario. The data feeds decision-making processes that perform multi-criteria optimizations, supported by artificial intelligence (AI) mechanisms. The systems operate under the control of multi-level control software, from a single robot (drone) and the onboard modules to the optimal management of multiple robots in multi-actor scenarios. An independent but inseparable area is the legal environment in which unmanned aerial missions are and will be carried out. All the indicated processes are within the Team's area of interest and activity.

MODERN LABORATORY BASE

- Laboratory for Autonomous and Energy Efficient Airport Infrastructure
- Laboratory for the Development of Unmanned Aerial Vehicles.
- Laboratory for Safety and Security of Airport Operations
- Laboratory for the Development of Flight and Airspace Control Systems.

MAIN RESEARCH TOPICS

- Autonomous robotic swarms in complex scenarios, in multi-stage missions and with handling of unusual situations.
- Navigation in environments without access to satellite data, in the presence of obstacles.



- Software for multi-criteria optimal management of unmanned aerial systems.
- Creation, development and provision of services based on unmanned aerial vehicles

GOF2.0 project, practical workshop



HEAD

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CURRENT PROJECTS

GOF 2.0 - demonstrator of integrated urban airspace (H2020, T.Piontek, P. Szymaniak)

PJ13 - W2 ERICA - Enabling the introduction of Remotely Piloted Aircraft Systems in controlled airspace (H2020, T. Piontek)

TAPAS – Towards an Automated and exPlain-able ATM System (SESAR, P. Szymaniak)



Drone flight

PSNC Aerospace Lab, 7 Lotnicza st., 62-065 Kąkolewo



Hangar in Kąkolewo





ADMINISTRATION,
FINANCE, SERVICES

FINANCIAL AND ACCOUNTING DEPARTMENT

Chief Accountant
Renata Wilnicka, MSc, Eng.

The Financial and Accounting Department is responsible for financial settlements across all spheres of the Institute's activities, ranging from scientific research to economic operations.

The primary task of the department is to manage the institution's finances, settling funds originating from various sources, including the state budget, national research-funding institutions, and foreign entities.

The Financial and Accounting Department collaborates with other administrative units of the Institute and scientific staff to implement optimal financial solutions, facilitating the efficient execution of projects and research activities.

HUMAN RESOURCES DEPARTMENT

Head
Dorota Nosal, MA

The primary task of the HR Department is to maintain documentation related to the employment of staff (including preparing employment contracts, reporting employees to social security and health insurance, managing personnel files, recording working hours, and handling periodic health check-ups). The department is also responsible for maintaining documentation for doctoral students, including participants in the Partnership-based Doctoral Program of the IBCH PAS and the Poznań Doctoral School of the Institutes of the PAS. In addition, department staff deal with drafting and registering civil-law contracts as well as agreements related to volunteering. The HR Department is also responsible for preparing periodic statistical reports on employment.

INSTITUTE'S LEGAL ASSISTANCE TEAM

Head
Ewa Bartoszek, Atty

The Institute's Legal Assistance Team provides legal services for the Institute aimed at protecting its interests.

The scope of legal support includes, in particular: providing legal advice and consultations, issuing legal opinions, drafting and reviewing contracts, legal assessment of internal documents of the Institute, preparing drafts of internal legal acts of the Institute, legal assessment of documentation related to public procurement, and legal advice in its preparation, representing the Institute in administrative proceedings, and acting as a legal representative in legal proceedings before judicial authorities.

SCIENTIFIC SECRETARIAT

Head

Paweł Goderski, MA

The responsibilities of the Scientific Secretariat include supporting scientists involved in research, development, or investment projects, as well as those applying for funding. The team of specialists coordinates formal activities related to project implementation and the application for grants and scholarships, such as searching for funding, providing information on application procedures, and conducting correspondence with external institutions regarding applications, agreements, and project reports. The Secretariat fulfills reporting duties regarding the Institute's activities for the needs of the Ministry of Science and Higher Education (MNiSW), the Polish Academy of Sciences (PAN), and the Central Statistical Office (GUS). It also coordinates audits of ongoing projects, prepares data and analyses for evaluations, and handles official foreign trips and visits by foreign guests.





DIRECTOR'S SECRETARIAT

Head

Agata Redmer, MSc

The Director's Secretariat supports and coordinates all administrative and organizational activities undertaken by the Institute's Director, establishes schedules, and organizes the Director's meetings. It ensures the proper and timely circulation of documents and information and maintains records of incoming and outgoing correspondence, invoices, internal legal acts, powers of attorney, queries, and responses provided as part of public information. The Director's Secretariat also organizes secretarial and office support, drafts letters, and arranges domestic business trips.

PROMOTION AND COMMERCIALIZATION OFFICE

Head
Elżbieta Kopińska, MA

The Commercialization and Promotion Office plays a crucial role in the process of utilizing and promoting the results of scientific research and innovative solutions. The main goal of the office is to assist in the commercialization of scientific discoveries and innovative technologies developed at the Institute. The team of specialists operates at the intersection of business and science, creating offers for services provided by the Institute. They collaborate with patent offices to ensure the protection of inventions and research results.

The office is responsible for full marketing support, public relations, as well as the promotion of achievements and the internal and external image of the Institute.

RESEARCH SUPPORT UNIT

Head
Katarzyna Chojnacka, MSc

The main task of the Research Support Unit is to assist project leaders and heads of departments, specialized laboratories, and research groups by ensuring efficient collaboration with internal units of the Institute and external entities. The unit supports the process of implementing scientific projects in terms of organization, as well as other activities carried out at the Institute, such as organizing conferences or scientific meetings. It supervises and coordinates the expenditure process for ongoing projects. The unit supports all activities related to the employment of foreigners.

DEPARTMENT OF LABORATORY SUPPLY

Head
Agata Chmielewska, MSc

The Department of Laboratory Supply is responsible for procuring reagents, laboratory materials, small laboratory equipment, and consumables from domestic and international markets based on requests submitted by scientific staff. It handles customs clearance for imported deliveries and monitors expenditures from agreements made by the Institute. The department ensures timely processing of procurement-related documents, checks the compliance of shipments with order specifications, and manages qualitative and quantitative complaints regarding purchases. It organizes the collection of chemical and biological waste and prepares associated documentation.

CHIEF ENGINEER DEPARTMENT

Head
Krzysztof Bąk, MSc

The responsibilities of the Chief Engineer's Department include: managing the Institute's unites; maintaining the technical efficiency of equipment and buildings; placing orders for supplies, services, and construction works, as well as service contracts for equipment; preparing investment estimates for tender procedures; participating in the acceptance of construction works, services, and repairs; settling individual organizational units of the Institute for internet usage; preparing environmental protection reports; receiving financial documents related to deliveries, services, and construction works, as well as their substantive control; reviewing documentation from periodic inspections conducted at the Institute and performing building inspections.

ORGANIZATIONAL AND TECHNICAL DEPARTMENT

Head
Grażyna Wawrzyniak, MA

The Technical and Organizational Department serves as the caretaker of the Institute's facilities, ensuring general order, cleanliness, and the secure and efficient functioning of the Institute's buildings. The department manages the supply of necessary administrative and general-use articles and materials. It coordinates the warehouse and inventory management of assets and the use of company vehicles. The department is responsible for organizing equipment repairs and ordering service contracts. It also handles matters related to foreign and domestic courier shipments. The department is also tasked with coordinating activities related to social issues, settling costs associated with employees' stays at a recreational center, and overseeing the facility and adjacent areas of the conference, training, and recreational center in Jurata.

CENTER FOR SCIENCE SERVICE DEPARTMENT

Head
Renata Schoenfeld

The Center for Science Service Department at IBCH PAS manages the reservation and comprehensive service of conference rooms, oversees the operation of audiovisual equipment, and implements marketing activities to promote the center.

It serves as the custodian of Building B-10 and the IBCH PAS Science Center, ensuring general order, cleanliness, and the secure and efficient functioning of these facilities.

DEPARTMENT OF MANAGEMENT SYSTEMS AND INFORMATION SECURITY

Head

Agnieszka Ławniczak, MA

The Management Systems and Information Security Department is responsible for tasks related to managing IT security and information security, including data protection, administration, and supervision of management systems implemented at the Institute, as well as the administration of email accounts. The department oversees activities related to the development and implementation of security-related documents, provides substantive support to Institute employees regarding implemented information systems, and manages the Institute's website and the Public Information Bulletin website.





DATA PROTECTION DEPARTMENT

Head
Natalia Szymkowiak

The Data Protection Department ensures that the processing of personal data within the Institute complies with the provisions of the European General Data Protection Regulation (GDPR). The main task of the department's employees is to analyze and verify the compliance of data processing with applicable regulations, including providing information, advice, recommending specific actions, providing recommendations upon request within the scope of impact assessments for data protection, and monitoring the implementation of these recommendations.

PUBLIC PROCUREMENT DEPARTMENT

Head

**Katarzyna Wielentejczyk,
MSc, Eng.**

The Public Procurement Department is responsible for the preparation and conduct of public procurement procedures in accordance with the provisions of the Public Procurement Law. The department's tasks include preparing documentation related to ongoing procedures, creating contracts for the supply of materials, equipment, various types of services, and construction works. They also develop and update internal regulations of the Institute, including the Regulations for the Award of Public Contracts at IBCH PAS, provide opinions on the procurement procedure in accordance with the Public Procurement Law, prepare plans, reports, and maintain registers related to public procurement.

IT DEPARTMENT

Head

Marcin Kicuła, MSc, Eng.

The scope of activities of the IT Department includes the administration of service-oriented information systems at the Institute, technical support for servers, computers, and telecommunication and electronic equipment, network management, user support in computer operation, procurement support in the field of electronic equipment, creating tender specifications, and participation in tender committees. The department also handles the operation of IBCH telephone systems.

INTERNAL AUDITOR

Head

Barbara Szeląg, MA

Internal auditing is an independent and objective activity aimed at supporting the Director in achieving the goals and tasks of the Institute by systematically assessing managerial control and providing advisory services.

This assessment focuses on the adequacy, effectiveness, and efficiency of the managerial control system. The internal auditor's tasks include the implementation of audit and advisory tasks, conducting checks on the degree of implementation of recommendations, developing annual internal audit plans based on a conducted and documented risk analysis, and collaborating with the Institute's management in analyzing, assessing, and managing risk.



ADMINISTRATIVE AND FINANCIAL DEPARTMENT OF PSNC

Head
Arleta Rutkowska, MA

The department ensures the provision of indispensable administrative materials, coordinates the storage and inventory management of assets and the use of company cars, makes arrangements related to domestic and foreign business trips, ensures proper and timely circulation of documents and information, handles sales of services provided (issuing invoices and supervising the execution of orders), participates in the development of proposals and reports on funding for scientific activities and applications for equipment, construction investments, and supervises their disbursement. The department is responsible for preparing and conducting procurement proceedings in accordance with the Procurement Law. The department includes the Reception and the Registrar's Office.

PUBLIC RELATIONS DEPARTMENT

Head
Damian Niemir, MSc

The department is widely involved in the promotion and popularization of PSNC projects, initiatives, and research work. Its tasks include maintaining major news websites, social media channels, internal communication newsletters, and intranet information. At PSNC, the department supports the coordination of events, the organization of information and demonstration stands, maintains contact with the media and external institutions, edits news texts, and co-creates the editorial team of the consortium television PIONIER.TV. The department is also a conceptual support for the implementation of many projects in the fields of art&science, graphic and multimedia setting, up to the marketing activities of PSNC products.

PROJECTS ADMINISTRATION DEPARTMENT OF PSNC

Head
Agnieszka Stokłosa, MA

The tasks of the department include carrying out work related to administrative and financial support of projects implemented by PSNC, in particular participation in preparing applications for funding of the grants in terms of compliance with the financial guidelines of relevant programs and projects. The department also participates in the preparation of draft agreements with financing institutions and supervises the correct disbursement of funds under the projects.

PSNC LEGAL SERVICES TEAM

Head
Piotr Gabriel, MA

Headed by the Team Coordinator, the department is particularly engaged in providing legal advice, consultations, and clarifications on the content of applicable laws. To this end, legal opinions, normative acts and other acts (such as decisions) are also prepared. Legal advisors participate in the work of committees and problem teams established at the Institute. In addition, they represent PSNC in proceedings in courts, administrative bodies, offices, and other authorities.



| OTHER
UNITS

DOCTORAL EDUCATION



POZNAŃ DOCTORAL SCHOOL OF THE INSTITUTES OF THE PAS

psd-ipan.ichb.pl/index.php/en/home/

The Poznań Doctoral School of the Institutes of the Polish Academy of Sciences (PDS IPAS) is run jointly by the Institute of Bioorganic Chemistry PAS, the Institute of Dendrology PAS, the Institute of Molecular Physics PAS, the Institute of Human Genetics PAS, and the Institute of Plant Genetics PAS.

Doctoral education takes place in the following disciplines:

- biological sciences (IBCH PAS, ID PAS)
- chemical sciences (IBCH PAS)
- medical sciences (IHG PAS)
- physical sciences (IMP PAS)
- agriculture and horticulture (IPG PAS)

Recruitment to the PDS IPAS takes place on a continuous basis, in line with the acquisition of funds for the implementation of scientific projects, and announcements about the recruitment of new doctoral students are posted, among others, on the PDS IPAS website, EURAXESS, and on the websites of the institutes co-running the Doctoral School.

The provisions governing recruitment and the functioning of the School are included in the Rules of the PDS IPAS, Rules on Recruitment to the PDS IPAS, and in the Programme of Study. They can be found, among other

places, on the websites of the School or on the BIP pages of individual institutes.

Classes are conducted by qualified lecturers who are not only capable of sharing knowledge but also have their passion for science. The results of research within the scope of doctoral work are published in international journals with a high impact factor, and funding for scholarships and research is obtained from grants provided by institutions funding science.

As of June 1, 2023, PDS IPAS educates 80 PhD students: IBCH PAS: 8 chemists, 32 biologists; ID PAS: 8 biologists; IMP PAS: 6 molecular physicists; IPG PAS: 11 agrobiologists; and IHG PAS: 15 medical scientists. The majority of PhD students are women. 22 participants come from outside Poland, from countries such as Albania, India, Cameroon, Lebanon, Nigeria, Pakistan, Turkey, Ukraine, and Vietnam.

We invite young, ambitious, and science enthusiasts to acquire knowledge and experience at the Poznań Doctoral School of the Institutes of the Polish Academy of Sciences and thereby develop their passions and scientific careers in our institutes.



**MARIOLA
DUTKIEWICZ**

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THE PARTNERSHIP-BASED DOCTORAL PROGRAM OF THE IBCH

portal.ichb.pl/the-ibch-pas-phd-program/



The Partnership-based Doctoral Program of the IBCH PAS (in Polish: \dot{S} SD ICHB PAN) has been in existence since 1994, when it was established by the Director of the IBCH, Prof. Andrzej Legocki. For many years, the position of head of the Doctoral Program was held by Prof. Adam Kraszewski; currently, this role is filled by Mariola Dutkiewicz, PhD, DSc, Assoc. Prof. Due to changes introduced by the Act of July 28, 2023, amending the Act, the Teacher's Charter, and some other acts (including "Act of July 3rd, 2018 Rules for Implementation of the Act - Law on Higher Education and Science"), the activities of the Program will be terminated as of December 31, 2024.

Graduates of the Partnership-based Doctoral Program IBCH PAS with Prof. Adam Kraszewski and Prof. Marek Figlerowicz during the diploma award ceremony.

The Partnership-based Doctoral Program IBCH PAS offers education in the fields of chemistry and biology in a full-time mode. Since the beginning of its activity, approximately 350 students have been admitted to the Program, who conducted their doctoral research at IBCH PAS as well as other scientific institutes in Poznań and its vicinity. As of June 2023, there were still 30 PhD students on the list of participants. In preparing young scientists for independent research work, the Doctoral Program has trained many doctoral candidates, and nearly 190 of them have obtained their doctoral degrees by resolutions of the IBCH PAS Scientific Council.



SCIENTIFIC PUBLISHERS OWN

Scientific Publishers OWN was founded in 1991 and affiliated with the Poznań Branch of the Polish Academy of Sciences. In 2001, OWN was incorporated into the Institute of Bioorganic Chemistry, Polish Academy of Sciences in Poznań.

Since its establishment, OWN has been engaged in publishing scientific texts, translating, and coordinating the publication processes of books, journals, and conference proceedings. OWN has published, among others, the following scientific journals: *Molecular Physics Reports*; *Quaternary Studies*

in Poland; *Kliniczna Perinatologia i Ginekologia*; *Computational Methods in Science and Technology*; *Archives of Perinatal Medicine*; *Chirurgia Narządów Ruchu Ortopedia Polska*; *Ultrasonografia w Ginekologii i Położnictwie*; *Perinatologia, Neonatologia i Ginekologia*; *Seminars on Perinatal Medicine*, and *Archives of Electrical Engineering*.

Since 2024, OWN has been participating in the publication of the quarterly journal *Nauka* (a total of 80 volumes) and, since 2011, the quarterly journal *BioTechnologia* (a total of 48 volumes). Moreover, Scientific Publishers OWN publishes various types of books, including academic textbooks, scientific monographs, translations, and conference materials. In its nearly 32 years of activity, OWN has published more than six hundred scientific books and journals, primarily in the fields of medicine, biochemistry, biotechnology, and computer science.

ANDRZEJ
WÓJTOWICZ
PhD

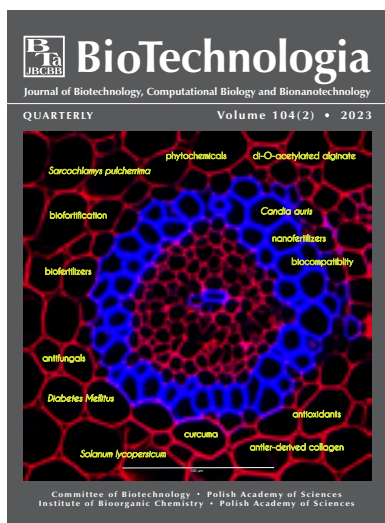
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In 2019, a series of popular science books, *The Institute of Bioorganic Chemistry PAS Recommends*, was initiated. The series includes the following titles: S. Roosth *Syntetyczne. Jak zrobiono życie*, E.O. Wilson *O pochodzeniu kreatywności*, S.J. Heine *DNA to nie przeznaczenie*, B. Barres *Autobiografia transpłciowego naukowca* and C. Lalueza-Fox *Genetyczna historia nierówności*.

Scientific Publishers OWN also produces editions *pro publico bono* and occasional

publications, serving as supplements for various awards or conferences, including *Teoria jestestw organicznych* by J. Śniadecki, *Akademii, tryptyk i flamingi* and *Krótką historia budowy Ośrodka Nauki PAN w Poznaniu* by A.B. Legocki, *Gdy bocian przybywa zbyt wcześnie* by C. Amiel-Tison and D. Vidyasagar, and *Wiek i starzenie* by S. Rattan. Since its inception, the publishing activities of Scientific Publishers OWN have been headed by Dr. Andrzej Wójtowicz.



BIOTECHNOLOGIA

The BioTechnologia quarterly is published by the Institute of Bioorganic Chemistry PAS and the Biotechnology Committee PAS, under the direction of Prof. Marek Figlerowicz (Editor-in-Chief) and Dr. Agata Tyczewska (Deputy Editor-in-Chief). The topics covered include areas of biotechnology, computational biology, and bionanotechnology. The journal, published in English, is listed in the catalogue of scientific journals and reviewed materials from international conferences, as well as in the publications of scientific monographs by the Ministry of Education and Science (MEiN), with a rating of 70 points. Published articles are available online in Open Access mode on the Termedia platform.



COMPUTATIONAL METHODS IN SCIENCE AND TECHNOLOGY

Computational Methods in Science and Technology is a quarterly journal published by OWN and the Poznań Supercomputing and Networking Center, under the editorial direction of Prof. Krzysztof W. Wojciechowski, Dr. Maciej Stroiński, and Prof. Jan Węglarz. The articles focus on computational methods and information technology. They are available online in Open Access mode on the PSNC platform.

IBCH PAS RECOMMENDS



CARLES LALUEZA-FOX

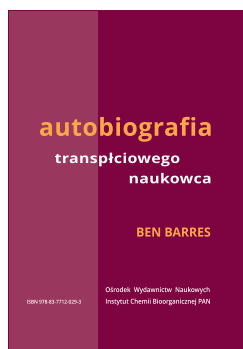
Genetyczna historia
nierówności

Inequality: A Genetic History

Poznań 2023

For over a decade, the world has been watching with bated breath, and often astonishment, as archaeogenomics reveals new facts about the biological history of humankind. As a result, we have begun to realize that our conceptions of the past are not always confirmed by hard genetic data. Carles Lalueza-Fox's book represents another milestone on the challenging journey of discovering the truth about ourselves and the civilization we create. It shows that archaeogenomics is a source of

information not only about our origins and past migrations but also about interpersonal relationships. The picture emerging from these studies is rather bleak, indicating that inequality and injustice are fundamental elements around which human communities have formed at all levels of their organization, from the family to the state. The book exposes a series of phenomena hitherto unnoticed or overlooked in so-called official history, thus providing an important voice in the ongoing global debate on fundamental human values and rights. | Marek Figlerowicz



BEN BARRES

Autobiografia transpłciowego
naukowca

The Autobiography of
a Transgender Scientist

Poznań 2020

Ben Barres' book is not only the autobiography of a famous scientist, a professor of neurobiology at Stanford University, but also a kind of message, or rather a testament, written shortly before his death by

a man who had the opportunity to look at life from many very different perspectives. Therefore, I would like to recommend it to all fascinated by the extraordinary complexity of the human brain, as well as to those who wish to better understand the complexity of human nature. | Marek Figlerowicz



EDWARD O. WILSON

O pochodzeniu kreatywności

The Origins of Creativity

Poznań 2020

In the challenging times of the COVID-19 pandemic, which prompt reflection on human powerlessness in the face of natural forces, I would like to recommend the book by American biologist and zoologist Edward Osborn Wilson titled "The Origins of Creativity". The author is recognized as one of the founders of modern sociobiology, a scientific discipline that seeks to explain social behaviors by considering them in the context of natural selec-

tion. This fundamental aspect of humanity has long escaped the attention not only of biologists but also of humanists. As both creators and products of an extremely anthropocentric civilization, we rarely consider that our behaviors result from experiences gained not only over the past 10,000 years, but at least 200–300,000 years, and that the only way to understand the nature of humans is to understand their biological history. | [Marek Figlerowicz](#)



STEVEN J. HEINE

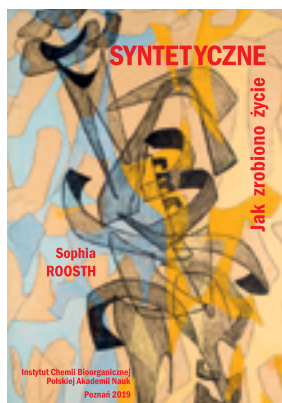
DNA to nie przeznaczenie.
Niezwykły i zupełnie błędnie
rozumiany związek między tobą
a twoimi genami

DNA Is Not Destiny: The Remarkable, Completely Misunderstood Relationship between You and Your Genes

Poznań 2020

Although the full sequence of the human genome has been known for almost 20 years, we still cannot read it with full comprehension. To what extent does this result from a lack of

knowledge, and to what extent from our biases and stereotypes? Is the information encoded in the genome sequence unambiguous, and will we ever be able to decipher it completely? Steven J. Heine poses many other fascinating questions in his book. It is worth acquainting oneself with it, even if we do not receive satisfying answers to all the questions posed. I highly recommend this book to readers interested in how human-made culture influences the understanding of their own biology. | [Marek Figlerowicz](#)



SOPHIA ROOSTH

Syntetyczne.
Jak zrobiono życie

Synthetic: How Life Got Made

Poznań 2019

Sophia Roosth is a cultural anthropologist at the Department of the History of Science at Harvard University. She is not a biologist or biochemist, as the title of the book might suggest.

Unlike classical anthropologists who studied the customs of distant tribes, the author spent a few years in MIT laboratories, observing the tribe of synthetic biologists. She was interested not only in what they do but, above all, in what they believe, how they perceive the world, and how it affects the way they conduct science. Therefore, this book is not a textbook for those wishing to engage in synthetic biology. It intrigued us for entirely different reasons. Firstly, it shows how exceptionally innovative research is conducted in leading scientific centers, how theories and research approaches are created, and how old mental frameworks are challenged and new ones are created. Secondly, it shows what questions, doubts, and concerns arise from any ideas and actions aimed at improving or modifying the products of nature. The extremely dynamic development of life sciences in recent years requires a broad discussion, preparing contemporary societies for a better understanding of the practical implications of many breakthrough discoveries. This book is an excellent introduction to such considerations, as it demonstrates how varied and unexpected reactions can be to new possibilities offered by medicine and biotechnology. | [Marek Figlerowicz](#)

IBCH PAS LIBRARY

The Library hosts approximately 4,200 book titles cataloged in electronic format, accessible online. These books cover various fields, such as organic and inorganic chemistry, molecular biology, biochemistry, and genetics. The Library also houses a unique collection, comprising over 100 titles of scientific journals in print.

Currently, journals from publishers such as Nature, Science, Elsevier, Springer, Wiley, and Taylor & Francis (comprising over 524 titles in total) are available online.

Thanks to the Library's activities, Institute staff have access to databases such as Reaxys, Scopus, and Web of Science.





POZNAŃ CHAMBER CHOIR OF THE PAS

The Poznań Chamber Choir of the Polish Academy of Sciences was established in October 2011 as the initiative of Prof. Jan Barciszewski from the Institute of Bioorganic Chemistry, with the approval and full acceptance of the Institute's Director. The choir primarily brings together doctoral students and Institute employees—enthusiasts of singing who, in addition to their scientific work, share a passion for choral

music. None of the ensemble members are professionally trained in music; all choir members are amateurs in the positive sense of the word, united by their love for music. The choir is led by Dr. Alicja Szeluga, the conductor of one of the best girls' choirs in Europe, the SKOWRONKI Girls' Choir in Poznań. The collaboration between young scientists and their conductor quickly yielded the expected results, with successful performances at international symposiums and scientific sessions organized at the IBCH PAS and the Poznań Branch of the PAS. The choir also enhanced the solemn session of the General Assembly of the PAS on the occasion of the 60th anniversary of the Polish Academy of Sciences in Powsin. The ensemble's annual concerts enjoy considerable interest and acclaim among music enthusiasts in Poznań.



**ALICJA
SZELUGA**
PhD

Choir
Conductor



**Prof. JAN
BARCISZEWSKI**

Initiator of
the Choir



| PANGEN

PANgen Laboratory is a modern molecular diagnostics laboratory located on the IBCH PAS campus at Wieniawskiego Street 17/19. The diagnostic services of the laboratory are continuously expanded to meet the current needs of both individual and business clients. In June 2023, collaboration was initiated with specialists in allergology, tropical diseases, and Lyme disease diagnostics, resulting in the establishment of outpatient / medical clinics. The allergology clinic offers non-invasive diagnostics of inhalant and food allergies, insect venom allergies, gluten and milk allergies, as well as consultations for deciding on the commencement of immunotherapy. For individuals planning distant tropical vacations, PANgen provides consultations with a travel medicine physician. During the visit, patients receive recommendations regarding travel, hygiene, and the prevention of tropical diseases and complete a pre-travel questionnaire.

The current offer of the PANgen laboratory is available on the website: www.pangen.pl



ICHB PAN FOUNDATION



The ICHB PAN Foundation has been in operation since 2018. Among its founders are distinguished representatives of scientific communities associated with the Institute of Bioorganic Chemistry PAS in Poznań. The Foundation was established with the idea of promoting science and fostering dialogue and effective collaboration between partners representing the realms of science and business. The first five years of the Foundation's operation were a period of dynamic development. The Foundation successfully implemented projects with local, national, and international scope. These projects include the organization of the English-language scientific conference "RNA goes viral" in two editions and the national scientific conference "Social Sciences and the Crisis of the COVID-19 Pandemic," as well as the implementation of the "IBCH PAS Patents for the Economy" project. The Foundation consistently supports the activities of the IBCH PAS in the areas of promo-

tion, technology transfer, and the organization of scientific and popular science events. The Foundation is open to cooperation, as evidenced by projects carried out in collaboration with the Faculty of Political Science and Journalism at Adam Mickiewicz University, the Institute of Film, Media, and Audiovisual Arts of the Faculty of Polish and Classical Philology at Adam Mickiewicz University, the Poznań Opera House, and Aquanet Laboratory Sp. z o.o. Future planned activities related to the Foundation's statutory goals include supporting integrated initiatives related to the development of science and the economy, active participation in the innovation transfer process, training activities related to the promotion of scientific, technical, and economic progress, providing assistance to the Polish scientific community in carrying out tasks in the field of science and the development of scientific personnel, teaching, and the creation of new inter-university study programs. Additionally, supporting entrepreneurship with a particular focus on academic entrepreneurship, promoting the idea of European integration and broadly understood European scientific and economic cooperation, supporting the internationalization of science in Poland, and conducting educational activities, especially in the field of life sciences.

INSTITUTE LOCATIONS



N-W IBCH PAS CAMPUS

1a. Wieniawskiego 17/19 | 1b. Wieniawskiego 21/23 |
1c. Noskowskiego 10 | 1d. Noskowskiego 12/14

Within the Noskowskiego-Wieniawskiego (N-W) campus, you will find the main headquarters of the Institute, state-of-the-art biochemical laboratories, conference rooms, as well as the IBCH PAS Center for Innovation and Education (housed in a historic townhouse at Wieniawskiego 21/23), backup server room, and a second network management center for PSNC.



PSNC FUTURE LABS - INTELLIGENT LAB SPACE OF THE FUTURE

2. Zwirzyniecka 20

In the historic building at Zwirzyniecka 20 (Art Nouveau tenement), the vibrant PSNC Future Labs laboratory operates. This place is one of the most advanced laboratories for social innovation in Poznań. Social projects are implemented here, artistic initiatives take place, as well as scientific and business events. Since 2011, the building has also housed Poznań's first co-working space.



POZNAŃ

2

1

3

POLISH OPTICAL INTERNET CENTER RESEARCH FACILITY

3. Jana Pawła 10



The main headquarters of PSNC comprises a complex of three buildings: the Building of Technological Halls (BST), housing the Main Data Center of PSNC on two levels with an area of 1600 m², and Buildings A and B where 14 PSNC research laboratories, Network Management Center, Scientific Television Studio PIONIER.TV, conference rooms, and staff offices are located.

INSTITUTE LOCATIONS POLAND



CONFERENCE, TRAINING, AND RECREATIONAL CENTER

1. Gołębiowskiego 3, Jurata

The center is utilized by the Institute within its statutory activities for organizing scientific meetings and training sessions, as well as serving as a place for creative work and accommodation for participating staff involved in dissemination of science tasks conducted in collaboration with the Polish Academy of Sciences. This includes the organization of annual summer science events called “Science on Vacation.”

PALACE AND PARK COMPLEX IN TUREW

2. Szkolna 4, Turew

The Turew Palace is a place intricately connected with the history, tradition, and cultural heritage of Poland. Once a model farmstead owned by the Chłapowski family and the cradle of the idea of organic farming, it is now a place whose potential is being rediscovered. The Institute has been the owner of the palace and park ensemble since October 2022.



JURATA

1

POZNAŃ

KĄKOLEWO

3

2

TUREW

KĄKOLEWO AIRPORT (EPPG) PSNC AEROSPACE LAB

3. Lotnisko Kąkolewo, Kąkolewo

A modern laboratory space and hangar for testing Unmanned Aerial Vehicles (UAVs) with a total area of 2000 m², where research and development work is carried out in the field of unmanned aerial vehicle applications, autonomous systems, and flight control systems. Located in the Grodzisk Wielkopolski municipality, 58 km from the center of Poznań.



3



GLOSSARY

ABM	Medical Research Agency Agencja Badań Medycznych
EIC	European Innovation Council Europejska Rada ds. Innowacji
FNP	Foundation for Polish Science Fundacja na Rzecz Nauki Polskiej
H2020	Horizon 2020
HE	Horizon Europe Horyzont Europa
NCBiR	National Centre for Research and Development Narodowe Centrum Badań i Rozwoju
NCN	National Science Centre Narodowe Centrum Nauki
POIR	Smart Growth Operational Programme Program Operacyjny Inteligentny Rozwój

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Printing and Binding | **Moś i Łuczak, Poznań**

The publication includes photos by employees and doctoral students of IBCH PAS, including Konrad Kuczyński, Magdalena Madaj, Maciej Rutkowski, Donata Sikorska, Andrzej Wójtowicz



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