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Historical Notes

From the Institute of Molecular Biology of the Jagiellonian University to the Faculty of Biochemistry, Biophysics and Biotechnology UJ – 52 years of history

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This article presents the history of the establishment and development of the Institute of Molecular Biology at Jagiellonian University, describes the reasons for the transformation of the Institute into the Faculty of Biochemistry, Biophysics and Biotechnology, and provides information on the current scientific and teaching potential of the Faculty and prospects for further development.

Keywords: Institute of Molecular Biology; Faculty of Biochemistry, Biophysics and Biotechnology; Jagiellonian University; History

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Abbreviations: IMB, Institute of Molecular Biology; FBBB, Faculty of Biochemistry, Biophysics and Biotechnology; JU, Jagiellonian University

The Institute of Molecular Biology of the Jagiellonian University (IMB), whose continuation is the currently existing Faculty of Biochemistry, Biophysics and Biotechnology (FBBB), was established on 1 May 1970 by the decision of the then rector of the Jagiellonian University, Prof. Mieczysław Klimaszewski, on the basis of the 1969 resolution of the Senate of the Jagiellonian University. This decision was in line with the trend that had dominated at that time in universities to create institutes. The Institute of Molecular Biology was not created out of nothing. It had been established on the basis of two earlier organisational units of the then Faculty of Biology and Earth Sciences: the Department of Plant Physiology established in 1947, headed by Professor Jan Zurzycki, and the recently established, in 1965, Department of Biochemistry and Biophysics, headed by Professor Ignacy Reifer. At the initial stage, the Institute consisted of four departments: Animal Biochemistry (headed by Doc. Maria Sarnecka-Keller), Plant Biochemistry (headed by Prof. Ignacy Reifer), Plant Physiology (headed by Prof. Jan Zurzycki) and Biophysics (headed by Doc. Stanisław Łukiewicz). The Institute occupied premises in the Renaissance building of Collegium Iuridicum (Photo 1) located in the centre of the Old Town at 53 Grodzka Street, where its constituent departments were located. A few months after the establishment of the Institute, another department, the Department of Microbiology, was established there, with Doc. Zofia Porwit-Bóbr taking charge of it. Due to a lack of space in the Collegium Iuridicum, this Department was situated on the other side of Grodzka Street, in the building of Collegium Broscianum, (52 Grodzka Street) formerly belonging to the Kraków court.

The establishment of the Institute of Molecular Biology was in line with the efforts to create a modern scientific unit at the Jagiellonian University, whose main objective was to develop research at the molecular and cellular level in the field of biochemistry and physiology (from plant physiology and biochemistry to medical biochemistry), as well as the development of a new scientific discipline in Poland at that time, biophysics.

The first director of the Institute of Molecular Biology was Professor Jan Zurzycki. The Institute was part of the then Faculty of Biology and Earth Sciences. At the time of its foundation, the Institute employed 27 researchers, seven of them independent. The subjects of the research carried out at that time were a continuation of those previously carried out in the chairs of which the Institute had been formed. The main research directions concerned such issues as structure, metabolism, and functions of animal glycoproteins and glycopeptides, acute phase proteins, lysosomal enzymes, sulfur metabolism in animal cells (Department of Animal Biochemistry); magnetic properties of biological systems, including physicochemical and biological properties of melanins, development of electron paramagnetic resonance spectroscopy (EPR) and its application to the analysis of transition-metal ion complexes, development of a method for EPR measurement of live amphibian oocytes and embryos (Department of Biophysics); plant enzyme inhibitors, metabolism of nucleic acids (Department of Plant Biochemistry); mechanism of chloroplast movement, formation of photosynthetic apparatus, mechanisms of light reactions of photosynthesis (Department of Plant Physiology); structure of DNA and plasmids,

Photo 1. Collegium Iuridicum, the first location of the Institute of Molecular Biology in the years 1970–1982 (photo Kazimierz Strzałka)

immunoregulation of antitumor response (Department of Microbiology).

After its establishment, the Institute of Molecular Biology became an attractive place to work. A large part of its scientific staff were people who had studied or completed internships abroad in very good academic and scientific centres. The skills acquired there and the scientific cooperation built up resulted in publications in good journals with an international reach, despite the difficulties of acquiring at that time modern instruments and importing from abroad the reagents necessary for research. Undoubtedly, Prof. Ignacy Reifer's obtaining funds in foreign currency (100 000 USD) for the purchase of an electron paramagnetic resonance spectrometer, an amino acid analyser, an uvicord for monitoring the separation of ultraviolet absorbing compounds, an ultracentrifuge, and several other modern instruments was a great help in carrying out modern research.

The up-to-date research topics and the high level of research conducted at that time made the Institute a very attractive place of work for many talented young scientists and doctoral students. It was also a popular place for master's theses among students. The consequence of this popularity was a rapid increase in the number of staff, doctoral students, and students. In a short time, the historic building of Collegium Iuridicum, where the Institute was located, filled to capacity, and the lack of space began to be a very serious factor restricting the Institute's further development. An equally significant problem that limited development was the condition of the occupied building, which was completely unsuitable for its current function. Shortly after the Institute was established, the Collegium Iuridicum building began to threaten with structural collapse. Beam-supported ceilings in the laboratories were our everyday reality. Additionally, Collegium Iuridicum is a high-class historical building and is strictly controlled by the conservator of historic monuments, which made any alterations or repairs very difficult. The situation called for quick and radical solutions. At that time, the construction of a new building was out of the question due to the lack of financial resources, so the only option left was to move to a larger building, better adapted to the research specifics of the Institute. The new location of the IMB turned out to be the building of the Silesian Seminary (Seminarium Śląskie), situated in Krakow on Mickiewicza Avenue, number 3 (Photo 2). The Katowice Curia, after the transfer of the Seminary to Silesia, agreed to lease the seminary building to Jagiellonian University for the purpose of housing the Institute of Molecular Biology there, for a period of 25 years. The move of the Institute, from Grodzka Street to the building of the Silesian Seminary, took place in 1982.

Photo 2. The building of the Silesian Seminary – the seat of the Institute of Molecular Biology from 1982 to 2001 (photo Paweł Mazur).

The Institute's accommodation in the building of the Silesian Seminary improved for a time because of its larger volume, but it remained highly unsatisfactory in technical terms. The rented building contained hotel-type rooms, not at all suitable for laboratory work. There was still a lack of basic equipment and facilities necessary for the Institute's normal functioning, such as a cold store, an animal house, plant breeding rooms and many others, and the ceilings could not bear the weight of heavy instruments (centrifuges). Nevertheless, under the new conditions, the Institute was developing rapidly, thanks to its excellent scientific staff and very good students. In these difficult conditions, the dynamic and actively developed international cooperation was invaluable. Particularly noteworthy is the long-standing and extensive cooperation with the Medical College of Wisconsin, Milwaukee and the University of Georgia, Athens. Cooperation with these units has provided opportunities to train young scientific personnel and access to the most modern research techniques. Over the years, it has resulted in several hundred joint publications and many doctorates and habilitations based on research conducted there. International cooperation has always been very important in the Institute's scientific activities and, of course, has not been limited to the two American institutions mentioned above. Due to the extensive international contacts of the Institute's staff, we have been visited by many outstanding scientists from leading academic and research centres from all over the world.

The high position of IMB in the international arena and the quality of its research was confirmed in 2000, when the Institute was awarded the status of a European Centre of Excellence. It should be added that in the first competition for Centres of Excellence announced by the European Union, IMB was the only Polish university institute to be awarded such status. The acquisition of substantial, as for those times, financial resources in the framework of the Centre of Excellence with the acronym BIER (Biotechnology – Integration of Education and Research) and the accompanying SPUB money enabled a further dynamic development of international cooperation, in particular supplementing that cooperation with an extremely important, and so far missing, element, inviting scientists from abroad for research stays of several months in IMB. After initial difficulties (distrust as to the possibility of conducting research at a high scientific level at IMB), such cooperation developed very dynamically; some of the cooperation and contacts initiated at that time have continued up to the present time. The acquisition of the status of European Centre of Excellence by IMB was an extremely important stage in its activities, a milestone that opened the Institute to the world and consolidated its international position.

In the 32 years since its establishment, the Institute has greatly strengthened its staff potential, proved to be very effective in obtaining funding, the Council of the Institute has been authorised to confer degrees in biochemistry and biophysics, and, importantly, the number and especially the quality of publications authored by Institute staff has increased significantly. IMB's overall output consists of over 1500 original publications and over 1000 other types of papers. The Institute also ran a specialisation in Molecular Biology within the field of Biology. All these premises were the basis for the IMB's application to run its own course of study. The Institute

was undoubtedly the strongest scientifically in the field of biochemical research, and therefore these efforts concerned the possibility of running a biochemistry major. At that time, there was no biochemistry on the ministerial list of fields of studies, and the Institute's efforts to obtain permission to set up such a course outside the official list were unsuccessful. Therefore, the Institute decided to apply for permission to run Biotechnology, which was on the ministerial list. A Phare-Tempus grant, "Creation of curriculum in biotechnology", dedicated to that field of studies, which was opened in 1995, was extremely helpful in establishing the biotechnology major through the efforts of Prof. Adam Dubin, then the Institute's Vice-Director for Student Affairs.

At the end of the 1990s, the Institute of Molecular Biology was one of the most dynamically developing institutes of the then Faculty of Biology and Earth Sciences, both in terms of publication output and efficiency in obtaining national and international grants. Motivational principles were implemented, making the amount of money from the fund for statutory activities received by the Departments and Laboratories dependent on the quality of the published work (Impact Factor). The Institute's Council was authorised to grant doctorates and habilitations in biochemistry, and biophysics, the Institute ran its own course of studies (biotechnology), postgraduate courses in molecular biology, and specialisations. The Institute also underwent structural reorganisation, with five departments being set up in place of the two previously existing ones. The prospect of obtaining a new building fully adapted to the functioning of a unit dealing with life sciences was not far off. The move into this building (Photo 3), one of the first structures erected on the site of the 3rd Campus of the 600th Anniversary of the Jagiellonian University Renewal (7 Gronostajowa Str.), took place in the autumn of 2001. After this move, in February 2002, the Institute of Molecular Biology changed its name to the Institute of Molecular Biology and Biotechnology, in accordance with the investment title of its new premises.

Photo 3. Current building of the Faculty of Biochemistry, Biophysics, and Biotechnology (photo Kazimierz Strzałka).

In the last three years preceding the establishment of the Faculty of Biotechnology, IMB received the first category in the ranking of the then Scientific Research Committee, and the Institute's employees published 296 publications with the total IF of 472. The number of research grants obtained was significantly increasing. In 1999 the staff of IMB carried out 32 projects obtained from the State Committee for Scientific Research, for a total amount of 1 348 000 PLN. These numbers increased in 2001 to 55 projects and 2658780 PLN, respectively. In total, in 2001, IMB received grants from Polish institutions for a total amount of more than 6 million PLN, which was a large amount for those times. It should be noted that in addition to grants from domestic institutions, IMB employees also obtained several foreign grants, among them prestigious grants such as Welcome Trust, Foggarthy, projects financed by the Deutsche Forschungsgemeinschaft, or the European Centre of Excellence grant mentioned earlier. The Institute has also grown in terms of staff and organisation. In 2001 the Institute employed more than 100 people (including more than 70 research and teaching staff) and consisted of 10 departments, 1 institute laboratory and 3 in-house laboratories. It should be added that, throughout the years of its history, some IMB employees have held important positions in the authorities of the Jagiellonian University. Prof. Aleksander Koj was the rector of Jagiellonian University three times and Prof. Maria Sarnecka-Keller was the first woman pro-rector in the history of Krakow University. Prof. Jan Zurzycki and Prof. Wojciech Froncisz also served as pro-rectors of the Jagiellonian University.

The premises mentioned above determined that the main point of the Institute's development programme for the years 1999–2002, adopted by the Institute's Council in November 1999, was to take steps aimed at separating the Institute of Molecular Biology from the structure of the Faculty of Biology and Earth Sciences, which was very heterogeneous in terms of the research topics pursued, and to transform it into a new Faculty. The Institute's upgrade to the rank of a faculty, apart from its undoubted prestige, was associated, among other things, with greater autonomy, the chance to obtain a higher position in the ministerial ranking, and therefore better financing, as well as the possibility of applying for some categories of projects reserved for such units (the so-called basic activity units, which included only faculties).

Efforts to transform the Institute of Molecular Biology and Biotechnology into a Faculty of Biotechnology were crowned with a positive decision of the Jagiellonian University Senate on 24 April 2002. On this basis, on 8 May 2002, the then Rector, Prof. Franciszek Ziejka, issued an ordinance establishing, as of the new academic year, another faculty, the Faculty of Biotechnology. The last director of the Institute of Molecular Biology and the first dean of the Faculty of Biotechnology was the author of these words. All IMB directors and faculty deans are listed in Table 1.

Table 1. Directors of the Institute and Deans of the Faculty and their terms of office

Institute of Molecular Biology:
- Jan Zurzycki, 1970–1972
- Maria Sarnecka-Keller, 1972–1977
- Aleksander Koj, 1977–1981
- Włodzimierz Korohoda, 1981–1984
- Zdzisław Żak, 1984–1987
- Wojciech Froncisz, 1987–1991 and 1991–1993
- Tadeusz Sarna, 1993–1996 and 1996–1999
- Kazimierz Strzałka, 1999–2002

Faculty of Biotechnology:
- Kazimierz Strzałka, 2002–2005

Faculty of Biochemistry, Biophysics, and Biotechnology:
- Kazimierz Strzałka, 2005–2008
- Wojciech Froncisz, 2008–2012 and 2012–2014
- Zbigniew Madeja, 2014–2016 and 2016–2020
- Jolanta Jura, 2020 onward

Transformation of the Institute of Molecular Biology and Biotechnology into the Faculty of Biotechnology took place with the understanding and approval of the

then Council of the Faculty of Biology and Earth Sciences, with one reservation, however. The Faculty had to adopt a different name because otherwise, as was argued, one could get the impression that molecular biology was practised only at the newly created Faculty, which did not correspond to reality, as such research was also conducted at some other institutes of the Faculty of Biology and Earth Sciences. In view of the course of study (biotechnology) and the future character of this dynamically developing branch of science, it was decided to call the new Faculty the Faculty of Biotechnology. This name was expanded in 2006 to include additional elements, and since then our Faculty has been called the Faculty of Biochemistry, Biophysics, and Biotechnology, which for many years corresponded with the three fields of study conducted by the Faculty: biotechnology, biophysics, and biochemistry. It should be emphasized that FBBB is so far the only Faculty in Poland, which has established a separate programme of studies in biochemistry. In the following years, the didactic offer of the Faculty was extended, and currently, apart from the aforementioned majors, students can also study bioinformatics. The current teaching offer of the FBBB is presented in Table 2.

Table 2. Teaching offer of the Faculty of Biochemistry, Biophysics, and Biotechnology

Bachelor studies (I degree), full-time, in Polish
- Biochemistry
- Molecular and Cellular Biophysics
- Bioinformatics
- Biotechnology

Master studies (II degree), full-time, in Polish
- Biochemistry
- Molecular and Cellular Biophysics
- Bioinformatics
- Molecular Biotechnology

Master studies (II degree), full-time, fee-based, in English
- Molecular Biotechnology

Postgraduate studies, fee-based, in Polish
- Molecular Biology

Doctoral Studies within the Doctoral School of Exact and Natural Sciences at the Jagiellonian University
- Curriculum: Biochemistry, Biophysics, Molecular Biology, Biotechnology

The move to a modern building at the 3rd Campus of the 600th Anniversary of the Jagiellonian University Renewal, with an area more than twice as large as the building of the Silesian Seminary, as well as the gaining of faculty status, provided a very strong developmental impulse. Parallel to the expansion of the didactic offer presented above, the number of people employed at the Faculty, the number of students and PhD students were increasing, as well as the number of departments and laboratories. A manifestation of the great importance attached by the Faculty authorities to the internationalisation of research and teaching was the creation in 2006 of the post of Vice-Dean for International Cooperation, in addition to the previously existing posts of Vice-Dean for Students and Vice-Dean for General Affairs.

Both IMB and FBBB have always been very active in developing scientific cooperation with various national and international centres. This was reflected in the numerous cooperation agreements signed with renowned academic and research centres from all over the world. Throughout the existence of IMB and FBBB, several dozen such agreements were signed. Scientific exchange with very good foreign research centres was promoted. It should also be noted that as a result of an agreement with the Centre National de la Recherche Scientifique, the only laboratory in Poland in the field of life sciences – Laboratoire International Associe – was established, as well as the active participation of the FBBB in the establishment of Max Planck's Laboratory, which is now located in the Malopolska Centre of Biotechnology. The Institute and the Faculty have often been visited by eminent scholars from all over the world, including Nobel Prize winners (in recent years these have included James Watson, Robert Huber, Ada Yonath). For the development and strengthening of cooperation in the national and international arenas, as well as for increasing the prestige, significance, and recognition of IMB/FBBB in the world, the membership of the employees of both units in scientific councils and research committees of various institutions, as well as work in editorial committees of many national and international journals, were of great importance.

In the years leading up to the 20th anniversary of its founding, FBBB increased not only its staff, the number of departments, and its teaching offer. It should also be emphasized the creation of new (e.g. bioinformatics, structural biology) and further dynamic development of previously existing research directions, which translates into an increased number and, what is very important, quality of publications. Among them, there are papers published in top ranked journals (Nature, Science). In recent years, the Faculty staff have published annually about 180 peer-reviewed scientific articles.

For many years, the Faculty has occupied leading positions in rankings of scientific and didactic activity. Even before the introduction of categorisation of scientific entities, FBBB was highly rated in rankings. In 2007, it topped the ranking list of university units governed by the then Ministry of Science and Higher Education, operating in the Bio area. Since then, FBBB has maintained its high position consistently, being awarded an A+ category in two consecutive parameterizations conducted by the Ministry (2013 and 2017). In recognition of the scientific achievements of the FBBB, the Ministry of Science and Higher Education also granted the Cell-Mol-Tech consortium formed by the FBBB and the Jagiellonian Centre of Innovation the status of a National Leading Scientific Centre (KNOW) for 2014–2018. And in 2016, according to the Nature Index, the Faculty received the highest rating in Poland in the field of life sciences.

The successes achieved by the FBBB also concern the teaching sphere. Thus, in 2012 the Bachelor's programme in Biochemistry and in 2013 the Bachelor's programme in Biotechnology took first place in the competition of the Ministry of Science and Higher Education. In 2014, and then in 7 consecutive years, the biotechnology course taught at the FBBB was awarded 1st place in the journal "Perspektywy" Educational Foundation ranking.

As of December 31, 2021, the Faculty employed 267 people, including 170 research and research-and-teaching staff, 4 teaching staff, 68 scientific-technical staff, 19 administrative staff, and 6 support staff. The number of professors with titles was 22, habilitated doctors 32, 124 people held a doctoral degree, and 57 a master's degree. In all fields of study conducted by the Faculty, there are about 700 students, and 105 doctoral students carry out their doctoral theses.

Currently, the FBBB consists of 16 departments, 3 faculty laboratories, and the Animal Lab. Research conducted by the faculty members is focused on such thematic areas as biochemistry, molecular biology, biotechnology, biophysics, immunology, microbiology, and tissue and cell biology. A detailed list of departments and laboratories and the main research topics carried out is presented in Table 3.

Table 3. Departments and laboratories of the FBBB and the main research topics

Department of Analytical Biochemistry
- Molecular mechanisms of host-pathogen interactions in bacterial and fungal infections
- Biochemical and structural characterization of the virulence factors (mainly secreted proteases and cell-surface adhesins) of pathogenic bacteria (e.g. *Staphylococci*) and fungi (e.g. *Candida* yeasts)
- Biochemical and structural characterization of proteinase inhibitors
- Biochemical and structural characterization of antimicrobial peptides
- Structural and functional modifications of proteins during inflammation
- Functionality of the kinin-generating and blood-coagulation systems during inflammation and infections
- Biochemistry of vitamins and coenzymes
- Bacterial toxin-antitoxin systems

Department of Physical Biochemistry
- Molecular mechanisms of eukariotic gene transcription regulation by Yin Yang 1 and Yin Yang 2 (YY1 and YY2)
- Influence of the cellular environment on the structure and function of YY1
- Thermodynamics of molecular recognition in a model system: recombinant lipocalin – ligand (role of ionization, hydration, dimerization)
- Obtaining new beta-lactoglobulin variants with given properties (increasing stability, changing the quaternary structure, increasing the affinity to selected ligands)
- Mechanisms activating signal transduction pathways involving GPCRs and G proteins
- Mechanism of formation of signal platforms for GPCRs and G proteins with biomembranes
- Role of lipids in signal transduction from GPCRs
- Role of the membranes in homo and hetero oligomerization of GPCRs
- Oligomerization of GPCRs: Influence of anti-psychotic drugs
- Interaction between nanoparticles and target cells – optimizing nanocarriers for controlled transport of therapeutic agents
- Optimization of nanocarriers for transporting therapeutic agents through the blood-brain barrier
- Preparation of directed ligands for targeted drug transport
- Studies on anti-cancer properties of LCS10 mixture
- Proteomic studies of human nervous cells
- Studies of antidepressant and antipsychotic drugs in animal models (rat brain) and on human cells
- Impact of selected gene silencing on the proteome of human nervous cells and their response to antidepressant and antipsychotic drugs

Department of Cell Biochemistry
- Regulation of the expression of genes involved in inflammation and cancer
- Influence of cytokines and growth factors on the expression of selected genes
- Biological evaluation of nanomaterials and biomaterials
- Mechanisms involved in the regulation of transcript stability
- Generation and characterization of monoclonal antibodies specific to selected proteins – their applications in research, diagnostics and therapies
- Influence of hyperthermia on repair of DNA damage in tumour cells
- Structure, stability, and functions of mouse IgG3 immunoglobulins in light of their natural functions and potential use in diagnostics and therapies
- Functions, regulation of expression, and mechanism of action of sheddases of the ADAM family

Department of General Biochemistry
- Regulation of inflammatory processes
- Activation of signaling pathways
- Role of MCPIP1 in adipogenesis
- Structural analysis of MCPIP1
- Molecular background of renal cell carcinoma: genetic and molecular studies
- Cell differentiation and inflammation associated with skin disorders
- Role of inflammation in the etiology of metabolic diseases
- miRNA/lncRNA/mRNA profile in selected disorders/pathogenic states

Department of Comparative Biochemistry and Bioanalytics
- Yeast adhesion and invasion of host cells
- Neutrophil Extracellular Traps (NETs) in fungal infections
- The role of aspartic proteases and adhesins of Candida spp. in fungal infections
- Moonlighting proteins at the surface of Candida spp. cells
- Interactions within the mixed biofilms involving bacterial and fungal opportunistic pathogens
- Biochemistry of vitamins and coenzymes
- The role of vitamin B1 (thiamine) in the protection of plant and yeast cells under stress conditions

Department of Biophysics
- Oxidative stress in disorders of cell structure and function
- Light-induced oxidative modification of biomolecules
- The role of nitric oxide in the response of cancer cells to photodynamic therapy
- Cholesterol hydroperoxides and their role in the pathogenesis of atherosclerosis
- Participation of melanins and carotenoids in photoprotection
- The role of photodynamic phenomena in retinal damage and the development of degenerative diseases of the eye
- Antioxidant properties of plasmalogens
- Domain structure of membranes, effects of oxidative stress and antioxidants
- Liposomes as carriers of photosensitizers in PDT
- Effect of lysenins on model membranes
- Photobiophysical properties of a new generation of photosensitizers for PDT
- The role of TUDCA in protecting photoreceptors from photodamage
- The role of oxidation products of polyunsaturated fatty acids in photodamage of retinal cells.

Department of Biophysics and Cancer Biology
- Radiobiology
- Hypoxia and oximetry
- Phototherapy
- Anticancer therapies
- Melanogenesis
- The hair cycle
- Cancer in the context of the host organism
- Heterogeneity of cancer
- Oxidative stress and nitric oxide
- Slime molds
- Modelling biological processes

- Bioethics
- Non-invasive imaging in preclinical cancer models

Department of Cell Biophysics

- Functions played by the HP1, XRCC1, and 53BP1 proteins in DNA repair,
- Mechanisms of induction of DNA damage by visible light,
- Internal architecture of DNA repair foci that form in the cell nucleus in response to various types of damage, including damage induced by visible light, chemical cytotoxic agents (including antitumour drugs), and CRISPR/Cas9,
- Dynamics of repair factors recruited to DNA repair foci,
- DNA repair processes under conditions of hypoxia and anoxia,
- Phenomena associated with saturating cellular capacity to repair DNA damage,
- Methods of detecting and quantitative analysis of DNA damage: (1) STRIDE – SensiTive Recognition of Individual DNA Ends – a method of direct detection of individual single- and double-strand DNA breaks, (2) algorithm and software for quantitative cytometric analysis of DNA damage and spatial correlations between the damage and discrete localised nuclear phenomena (Dot-to-Dot software)

Department of Molecular Biophysics

- Natural engineering of biological energy conversion systems (bioenergetic systems), including respiratory and photosynthetic chains of eukaryotic and prokaryotic organisms
- Mechanisms of catalytic reactions, electron and proton transfers in multi-cofactor redox chains
- Mechanisms of generation and neutralization of reactive oxygen species
- Molecular architecture and physico-chemical properties of metalloproteins and catalytic redox sites
- Dynamics of protein-protein interactions
- Molecular effects of adaptive mitochondrial and disease-related mutations
- Development of new techniques, hardware and software, for application of optical spectroscopy and electron paramagnetic resonance (EPR) in studying the structure and dynamics of biological systems

Department of Computational Biophysics and Bioinformatics

- Organization of the membrane/water interfacial region as well as dynamical structure of bilayers composed of various lipids
- Correlations between physico-chemical properties of the bilayer and (a) structural characteristics of the bilayer lipids, (b) bilayer lipid composition
- Mechanisms of action of selected membrane-active compounds with therapeutic potential
- Development and validation of the OPLS All Atom force field parameters
- Influence of natural membrane components (peptides, carotenoids, etc.) on the structural organization of the lipid bilayer
- Properties of pure cholesterol domains in bilayers oversaturated with cholesterol
- Translocation of small and medium size molecules across bilayers
- Mechanical properties of bilayers composed of various lipids
- Investigation of the non-lamellar lipid phases
- Initial stages of atherosclerotic plaque formation: self-association of cholesterol molecules in water and the effect of cholesterol oxidation products on this process.
- Prediction of 3D structures and biological functions of proteins
- Application of artificial intelligence to analyze biological data
- Qualitative control of transcripts in the process of RNA interference and functional division of miRNAs
- Development of software tools for analysis of molecular dynamics simulation
- Trajectories and force field parameterization
- Bioinformatics applications of biological data processing employing neural networks and genetic algorithms

Department of Cell Biology

- Functions of direct cell-cell interactions in regulating cancer cell migration activity
- Role of reactive oxygen species in the regulation of migration activity and intercellular communication by gap junctions
- Electrotaxis mechanisms
- Application of electrochemical methods in cell biology
- Involvement of connexins and cell adhesion molecules in the regulation of cancer cells' invasiveness
- Mechanisms of the epithelial-mesenchymal transition (EMT) and its interrelations with cancer stem cells and metabolic elasticity of cancer cells
- Cancer stem cells, drug-resistance, and combined strategies of cancer treatment
- Effect of phytoactive compounds on the resistance of cancer drugs
- Fibroblast to myofibroblast transition (FMT) mechanisms and role of FMT in bronchial wall remodelling in asthma; searching for and testing the selected compounds affecting the FMT efficiency with possible therapeutic potential
- Mechanisms of bronchial/lung cell interactions within the epithelial-mesenchymal trophic unit
- Mechanisms of endocytosis
- The effect of selected compounds of the chalcone family on the inhibition of pro-fibrotic changes in selected diseases
- The use of advanced cell culture techniques (cell cultures at the air-liquid interface in the ALI model; epithelial-mesenchymal trophic unit EMTU – co-cultures of epithelial cells with fibroblasts) in the study of respiratory and skin diseases
- Application of *in vitro* skin cell cultures in clinical practice, such as wound treatment and plastic surgery
- Tissue skin engineering – reconstruction of three-dimensional connective tissue equivalents using mesenchymal stem cells
- Optimization of stem cell and progenitor cell populations for applications in experimental cardiology including induced pluripotent stem cells (iPS), as well as mesenchymal stem cells of different antigenic phenotypes
- Role of stem cell-derived extracellular vesicles (native and genetically modified) in tissue regeneration
- Optimization of biocompatible scaffolds combining graphene and defined stem cell populations for tissue regeneration
- Genetic and epigenetic mechanisms regulating pluripotent stem cell functions, including impact of microRNAs and long non-coding RNAs
- Impact of environmental conditions, such as oxygen concentration and temperature, on genetic stability and the activity of DNA damage repair pathways in stem cells, as well as on their regenerative potential
- Application of the CRISPR/Cas9 tools for precise genetic modification of stem cells in models of genetic diseases
- Analysis of the dynamics of changes in methods of DNA damage repair in stem cells with the use of fluorescent molecular reporters
- Genetic modification *in vivo*, using extracellular vesicles carrying the CRISPR/Cas9 system, TALEN and ZFN
- Signaling mechanisms underlying physiology and pathophysiology of the pancreas; testing new therapeutic strategies against diseases of the pancreas

Department of Medical Biotechnology

- Stem cell biology – mechanisms of cellular reprogramming and differentiation: 1) mechanisms of differentiation of induced pluripotent stem cells into cardiomyocytes, endothelial cells and skeletal muscle cells; 2) satellite cells differentiation; 3) hematopoietic stem cell differentiation
- Methods of hematopoietic cell mobilization
- Molecular mechanisms of Duchenne muscular dystrophy – regeneration and vascularisation of skeletal and cardiac muscles; mechanism of DMD cardiomyopathy; dysfunction of DMD satellite cells
- Vascular biology: molecular mechanisms of angiogenesis and function of endothelial cells
- Mechanisms of myocardial damage and regeneration
- Medical biotechnology: gene and cell therapy in modulation of neovascularization, heart and muscle regeneration
- Cancer biology and anti-cancer therapy: mechanisms of tumour initiation, growth, metastasis and resistance to therapy
- Role of hypoxia, antioxidant genes and microRNAs in regulation of gene expression

- The role of heme oxygenase-1 (HO-1), Nrf2 and microRNAs in the cardiovascular system, skeletal muscles, kidneys, and cancers.

Department of Plant Biotechnology

- Proteins engaged in DNA metabolism (PCNA, Fen1, photolyases) studies
- Signaling role of plant kinases
- The role of post-transcriptional and post-translational modifications in plant stress response
- Applications of DNA aptamers in molecular biology, biotechnology, and medicine
- Role of photoreceptors in plant functioning
- Identification of signals originating from chloroplasts that regulate their movements
- Signaling role of basic metabolites in phototropin-controlled chloroplast responses
- Second messengers of blue light signals, phosphoinositides and Ca^{2+}, in chloroplast responses.
- Involvement of plant GLR channels in blue-light-controlled growth and movement response

Department of Plant Physiology and Biochemistry

- The xanthophyll cycle of higher plants, green algae, and diatoms; analysis of de-epoxidation in thylakoid membranes and in artificial membrane systems
- Protective role of carotenoids – molecular mechanism of epoxy xanthophylls de-epoxidation
- The effect of heavy metals on the germination of seeds, physiology, biochemistry, and genetics of plants from post-mining areas – in *in vitro* culture
- Adaptations of plants to anthropogenic heavy metal stress: mechanisms and propagation
- The role of antioxidants in the response to heavy metal stress
- Plants and microorganisms in bioremediation
- Molecular mechanisms of response in autotrophic organisms to abiotic environmental factors (light, temperature, transition metals), including: environmental regulation of chlorophyll and carotenoid biosynthesis pathways, physiological function of oligomerization of photosystem I in cyanobacteria; plant metabolic adaptations to elevated concentrations of metal ions
- Application of autotrophs to phytoremediation and biotransformation of hazardous waste
- Development of photosynthetic membranes in higher plants; chlorophyll biosynthesis
- Physico-chemical properties of biological membranes
- Thermotropic phase transitions of lipids
- Cyanobacterial cell wall metabolism
- Abiotic stresses in plants and lichens

Department of Immunology

- The role of proteinases and their inhibitors in the regulation of immune responses
- Mechanisms underlying neutropenia
- Pathogenesis of autoimmune and allergic diseases, including skin disease psoriasis
- The role of chemoattractant protein – chemerin in immune and metabolic responses
- Diagnosis and mechanism of drug hypersensitivity reactions
- Mechanisms of recognition of dying cells by professional phagocytes
- The role of 27kDa Heat Shock Protein (HSP27) in the formation of damage-associated molecular patterns (DAMPs)
- The role of cell surface 90kDa Heat Shock Protein (HSP90) in the recognition of molecular patterns
- The influence of low-density oxidised lipoproteins (oxLDL) on the recognition of molecular patterns by professional phagocytes

Department of Microbiology

- Pathogenesis of autoimmune diseases, including rheumatoid arthritis
- Role of posttranslational modifications in immune system regulation
- Role of negative inflammatory regulators in bacterial infection
- Role of kallikrein-related proteases in EGF-related signal transduction
- Role of arginine citrullination in protease-inhibitor interactions in the context of the innate immunity system
- Significance of bacterial citrullination of host proteins/peptides in the pathogenesis of periodontal disease
- Role of citrullination in the healing and regeneration of periodontal tissues
- Etiopathogenesis and novel approaches to therapy of gingival fibromatosis
- Defense mechanisms of bacteria
- Epigenetics of bacterial infections
- Apoptosis of immune cells and its role in the development of periodontitis
- Molecular mechanisms of bacterial opportunistic infections
- Genetic and phenotypic bacterial strains typing
- Pathogens transmission between human and animal
- Advanced molecular diagnostics for bacterial infections
- Next generation sequencing (NGS) in medical microbiology
- The role of fibroblast in the pathogenesis of periodontitis
- Significance of citrullination catalyzed by PPAD in the pathogenesis of periodontitis
- Impact of citrullination on periodontal tissues healing and regeneration
- Significance of polymorphisms in the PPAD gene from *P. gingivalis* in the pathogenesis and prognosis of periodontal disease
- Molecular mechanisms and novel attempts to therapy of gingival fibromatosis
- Proteases and their protein inhibitors
- Mechanisms underlying the clinical and epidemiological connections between periodontitis (parodontosis) and bacteria responsible for the development of periodontosis and systemic human diseases

Laboratory of Bioinformatics and Genome Biology

- Regulatory roles of small RNAs (microRNAs, piRNAs, siRNA)
- Evolution of arthropod genomes
- Transcriptomics basis of insect evolution and development

Laboratory of Metabolomics

- Interaction of cyanobacteria or lichens in natural environment
- Secondary metabolites of cyanobacteria and lichens
- Monitoring, phytoremediation, and bioremediation

Laboratory of Molecular Genetics and Virology

- Chemoimmunotherapy of cancer of neuroectodermal origin
- Structural basis for the recognition of GD2 ganglioside and its peptide mimics by the 14G2a monoclonal antibody
- Molecular mechanisms of neuroblastoma cell death induced by GD2 ganglioside-recognizing monoclonal antibody 14G2a
- Role of MCPIP1 in neuroblastoma

Animal Facility

- The animal house can accommodate up to 10 000 mice (breeding and maintenance) and up to 200 rats (maintenance). The equipment of the Animal House includes, among others:
- *In vivo* imaging equipment, where intravital diagnosis of animals is performed using a Vevo2100 ultrasound machine (VisualSonics)
- Apparatus for measuring tissue perfusion (Perimed Laser Doppler)
- Apparatus for measuring luminescence and fluorescence in vivo (IVIS Lumina)
- Possibility to perform microCT and EPR imaging
- Operating microscopes and magnifiers

- Anaesthetic systems based on the use of isoflurane
- Post-operative rack
- Laminar flow chambers
- Incubator for cell cultures
- Centrifuges, laboratory balances and small laboratory equipment.

Faculty staff are very active and effective in obtaining research projects, both from domestic and foreign sources. These include prestigious grants, such as the recently obtained IRC grant and the Dioscuri competition won by the faculty candidate. In 2021, faculty members carried out 136 research projects worth approximately PLN 150 million. It should be emphasised that the FBBB, together with the Faculty of Biology, the Malopolska Centre of Biotechnology, Jagiellonian Centre for Experimental Therapeutics (JCET) and the SOLARIS National Synchrotron Radiation Centre, actively performs research within the priority research area: Structural and Translational Biology, which is a consequence of the Jagiellonian University obtaining the status of a research university.

Among numerous initiatives of all-university importance, the major contribution of the FBBB to the establishment of the Jagiellonian University Malopolska Centre of Biotechnology (MCB) occupies a special place. The initiative to apply for EU funds for the construction of the MCB from the "Innovative Economy" operational program came from the FBBB and the faculty members made the greatest contribution to the preparation and implementation of this project. The project obtained on the establishment of MCB, worth 100 326 130.00 PLN, is the biggest project implemented by the FBBB so far.

A large number of IMB/FBBB employees were honoured for their work with prestigious decorations, awards, and distinctions. They included honorary doctorates (Professors A. Koj, J. Dulak, and J. Potempa), numerous decorations and awards, including the Main Prize of the Foundation for Polish Science, "Polish Nobel" (Prof. J. Potempa), the Jagiellonian Laurel (Prof. W. Korohoda), golden medal Plus Ratio Quam Vis (Prof. W. Froncisz), numerous national decorations, including various Crosses of the Order of Polonia Restituta and Medals of the Commission of National Education. Some IMB/FBBB employees were elected members of the Polish Academy of Arts and Sciences (Professors A. Koj, W. Korohoda, W. Froncisz, T. Sarna, J. Dulak, A. Józkowicz, K. Strzałka), Polish Academy of Sciences (Professors J. Zurzycki, A. Koj, K. Strzałka), German Academy of Naturalists Leopoldina (Prof. J. Zurzycki) and Chilean Academy of Sciences (Prof. K. Strzałka).

One of the important areas of activity of the Institute, and later the Faculty, was the organization of scientific events such as conferences, congresses, and scientific workshops. The IMB/FBBB employees have been very active in this field organizing numerous scientific events, not only domestic but also prestigious conferences and congresses of international scope, including the privilege of organizing, which has to be won in difficult contests. One of the undoubted achievements of the IMB/FBBB employees is that they were entrusted with the organization of conferences and congresses outside Poland and participated in numerous organizing and scientific committees of such scientific events. It is also worth mentioning that the then Faculty of Biotechnology JU was a co-inventor and co-organizer of a cyclic scientific event of international scope - European Congress of Life Sciences – EUROBIOTECH, held in Krakow, as well as International Workshop on EPR in Biology and Medicine.

Among the events organized by the Institute and later by the Faculty, the Winter Schools occupy a special place. From the very beginning of the Institute's existence, there was a desire to integrate the Institute's departments, which had very different origins. On the initiative of the assistants, a winter seminar was organized for the first time in 1970, i.e. before the formal establishment of the Institute, in the creative work houses (Domy Pracy Twórczej) of the Jagiellonian University in Rabka. After the creation of the Faculty, the seminar was renamed the FBBB Winter School and has continued until the present day. The IMB Seminars, and later the Winter School of the Faculty, have over the years changed their form and formula, as well as their venue. In the initial phase, the seminars took place in the JU-owned creative work houses in Rabka and were attended mainly by IMB employees and a few employees of other institutes of the Faculty of Biology and Earth Sciences. The papers were given in Polish, and the presented contents were made available in the form of a volume containing typescripts of the speeches. Over the years, the Seminars changed their location to finally settle permanently in Zakopane. The formula of the Seminars was extended, eminent scholars from other academic and scientific centres, both in Poland and abroad, were invited, and doctoral students and undergraduates began to participate. The number of participants sometimes exceeded 200 significantly. English slowly made its way in, initially as the language of only some of the sessions attended by foreign scientists, but later it was extended to include all the papers presented, and the materials from the Winter Schools began to be published as special issues of international journals. Throughout the more than 50-year history of the IMB Seminars and FBBB Winter Schools, only one thing has remained the same, which contributes to their attractiveness - the scientific sessions start in the afternoon, and before noon there is free time to spend on walks, excursions, and skiing.

In September 2021, with a one-year delay due to restrictions caused by the Covid-19 pandemic, celebrations were held to commemorate the 50th anniversary of the establishment of the Institute of Molecular Biology of Jagiellonian University (Photo 4). The celebrations were accompanied by a scientific conference entitled "The latest achievements in biochemistry, biophysics and biotechnology – 50 years of history of the Faculty of Biochemistry, Biophysics and Biotechnology". These ceremonies and the conference were a great opportunity to summarize the previous activities of the Institute and the Faculty and to outline further development prospects. The facts presented in this article, as well as the speeches and materials presented during the conference, clearly confirm that the decision of the Jagiellonian University Senate in 1970 to establish the Institute of Molecular Biology was necessary and right. The Institute, and later the Faculty of Biochemistry, Biophysics, and Biotechnology after a little over 50 years of its existence, is counted among the best institutions of its kind in the country and is recognized in Europe and worldwide. The new fields of study and specialization, the publication and organizational achievements, as well as the recently awarded prestigious ERC and Dioscuri grants confirm

Photo 4. Participants of the jubilee conference "The latest achievements in biochemistry, biophysics, and biotechnology - 50 years of history of the Faculty of Biochemistry, Biophysics, and Biotechnology" (photo Jakub Włodek).

the rightness of the adopted concept of functioning of the Institute and the Faculty, and constitute an important indication for further dynamic development of the Faculty in the coming years.

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