



Fifty-five years between chemistry and biology

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Breakthroughs in science often occur at the intersection of different disciplines, when the research methods or even the way of thinking and theoretical considerations underlying research of the neighboring field are adopted. This happened when the methods of chemical kinetics, originally belonging to physical chemistry, and several theoretical approaches developed in organic chemistry found application in investigations of molecular processes occurring in biological systems. From the very beginning, these methods were focused on enzyme catalysis, but later were also used to investigate the mechanisms of action of biologically active substances with cell receptors as their target sites. Deep understanding of the molecular principles of these phenomena is important for the efficient design of new bioactive substances, including drugs.

The overlapping research field of chemistry and biology can be considered as a branch of physicochemical biology [1]; however, the name “bioorganic chemistry”, coined later [2], was preferred locally in Tartu. I have had the privilege to observe and participate directly in the development of this branch of science since 1967, when I started studying chemistry at the University of Tartu. Therefore, a significant part of my scientific activity, as well as the research of my former students, has been related to bioorganic chemistry.

The fusion of chemistry and biology research disciplines ended with changes in the university’s curriculum, to which bioorganic chemistry was added in 1977, and the student enrollment number was increased in the next year. As a result of this change, chemistry students began to study biochemistry, protein and nucleic acid chemistry, and physical biochemistry, which were new subjects in the chemistry department. In addition, these students were also studying cell biology and genetics, which were part of the biology curriculum. Later, the Laboratory of Bioorganic Chemistry was founded in 1985, and the Chair of Bioorganic Chemistry was established in 1992.

However, these developments were preceded by several events that were of great importance for these changes. Thus, in 1958, the Laboratory of Chemical Kinetics and Catalysis was founded at the University of Tartu, where kinetics of organic reactions was studied and methods of quantitative analysis of structure–activity relationships were developed. The scientific supervisor of this laboratory was Prof. Viktor Palm, who presciently opened research also in the field of enzyme catalysis. The studies on enzyme kinetics were carried out and supervised by Aavo Aaviksaar, who later became the head of the Biochemistry Laboratory of the Institute of Chemical and Biological Physics at the Estonian Academy of Sciences, and then was the director of the Institute of Experimental Biology and a professor at the Estonian University of Life Sciences. A more detailed overview of the development of bioorganic chemistry at the University of Tartu until the year 2007 can be found in [3].

An important change in bioorganic chemistry research in Tartu took place in 1980, when kinetic methods were introduced to study the interaction of bioactive compounds with cell receptors. This approach enabled the study of molecular mechanisms of these processes and understanding of the complex content of the parameters, used generally for the description of ligand–receptor interactions. These results were, in turn, important for describing the specificity of the action of different drugs and bioactive substances.

The implementation of bioorganic chemistry into curricula at the University of Tartu created the basis for research cooperation with several laboratories in Estonia and abroad. These contacts enabled the dissemination of ideas about the applicability of the kinetic approach for investigations into the molecular mechanisms of biological processes. And more importantly, the knowledge of these methods has influenced the scientific career of many colleagues who have studied bioorganic chemistry in Tartu. The fact is evident from the articles published in

this special issue of the Proceedings of the Estonian Academy of Sciences, with which we celebrate the development of bioorganic chemistry and organic chemistry at the University of Tartu during half a century.

ACKNOWLEDGMENTS

I would like to express gratitude to my former PhD students, whose work I have supervised or co-supervised (year of commencement is shown in brackets): Ülo Langel (1980), Peep Palumaa (1986), Rannar Sillard (1987), Ago Rinken (1987), Marika Eller (1989), Armin Sepp (1990), Reet Toomik (1997), Martin Lepiku (1998), Katrin Sak (2000), Toonika Rinken (2000), Mart Loog (2002), Boris Rogovoi (2002), Meeri Ehandi (2003), Aldo Oras (2004), Hannes Hagu (2007), Aleksei Kuznetsov (2009), Anu Ploom (2009), Vladimir Stepanov (2009), Säde Viirlaid (2011), Ksenija Kisseljova (2012), Indrek Saar (2013), Sander Piiskop (2013), Ilona Faustova (2013), Jüri Liiv (2014), Rait Kivi (2017), Siim Kukk

(2017), Anton Mastitski (2018), Ida Rahu (2020), Meeli Arujõe-Sado (2023). I would like to thank my colleagues who have contributed to the development of research and innovation in Estonia and with whom I still have cooperation: Ain Langel, Martin Lepiku, Olavi Loog, Pirkko Irene Penttilä-Hiltunen, Sergey Babitchenko and Tarmo Laanetu.

REFERENCES

1. An institute of physico-chemical biology in Paris. *Science*, 1927, **65**(1694), 589. <https://doi.org/10.1126/science.65.1694.589.a>
2. Poulter, C. D. Bioorganic chemistry. A natural reunion of the physical and life sciences. *J. Org. Chem.*, 2009, **74**(7), 2631–2645. <https://doi.org/10.1021/jo900183c>
3. Järv, J. Bioorgaaniline keemia Tartu Ülikoolis 1977–2007 (Bioorganic chemistry at the University of Tartu 1977–2007). In *Tartu Ülikooli Keemiaosakond 1949–2007 (Chemistry Department 1949–2007, University of Tartu)* (Järv, J., comp.). University of Tartu Press, 2007, 119–126.



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