

# BIOLOGICAL CHEMISTRY

*Founded in 1877 by Felix Hoppe-Seyler as  
Zeitschrift für Physiologische Chemie*

Felix Hoppe-Seyler (1825–1895) was a pioneer of biochemistry, remembered not only for his discovery of hemoglobin and his contributions to the chemical characterization of many other biological compounds and processes but also for having been the mentor of Friedrich Miescher and Albrecht Kossel. In his preface to the first issue of *Zeitschrift für Physiologische Chemie*, Felix Hoppe-Seyler coined the term *Biochemistry* ('Biochemie') for the then newly emerging discipline.

**EDITOR-IN-CHIEF**  
*D. Thomas*, Chicago

**EXECUTIVE EDITORS**

*J. Buchner*, Munich  
*J. Herrmann*, Kaiserslautern  
*M. Lei*, Shanghai  
*S. Ludwig*, Münster  
*B. Turk*, Ljubljana  
*A. Wittinghofer*, Dortmund

**EDITORIAL BOARD**

*P. Agostinis*, Leuven  
*L. Banks*, Trieste  
*A.G. Beck-Sickinger*, Leipzig  
*L. Bosca*, Madrid  
*B. Brüne*, Frankfurt/Main  
*E. Cadenas*, Los Angeles  
*H. Cheng*, Shanghai  
*O. Daumke*, Berlin  
*I. Dikic*, Frankfurt/Main  
*W.-X. Ding*, Kansas City  
*N. Gekara*, Stockholm  
*F.U. Hartl*, Martinsried  
*D. Häussinger*, Düsseldorf  
*L.-O. Klotz*, Jena  
*V. Magdolen*, Munich  
*M. Müschen*, San Francisco  
*G. Pejler*, Uppsala  
*N. Pfanner*, Freiburg  
*J. Potempa*, Krakow  
*R. Rosenzweig*, Rehovot  
*K. Sandhoff*, Bonn  
*J. Scheller*, Düsseldorf  
*H. Sies*, Düsseldorf  
*K. Winklhofer*, Bochum

**ASSOCIATE EDITORS (GBM STUDY GROUPS)**

*J.W. Bartsch*, Marburg  
*S. Clemens*, Bayreuth  
*A. Ebert*, Göttingen  
*R. Erdmann*, Bochum  
*K. Giehl*, Giessen  
*S. Hiller*, Basel  
*B. Höcker*, Bayreuth  
*I. Koch*, Frankfurt/Main  
*T. Proikas-Cezanne*, Tübingen  
*J. Riemer*, Cologne  
*C. Seidel*, Düsseldorf  
*C. Villmann*, Würzburg  
*J. Weigand*, Marburg  
*V. Zickermann*, Frankfurt/Main



Biological Chemistry is associated  
with the Gesellschaft für Biochemie und  
Molekularbiologie e.V. (GBM)

**DE GRUYTER**

**ABSTRACTED/INDEXED IN** AGRICOLA (National Agricultural Library) · Baidu Scholar · Cabells JournalAnalytics · CABI (over 50 subsections) · Chemical Abstracts Service (CAS): CAplus; SciFinder · CNKI Scholar (China National Knowledge Infrastructure) · CNPIEC: cnpLINKer · Dimensions · EBSCO (relevant databases) · EBSCO Discovery Service · EMBASE · Genamics JournalSeek · Google Scholar · ICAP Alcohol Information Databases · Japan Science and Technology Agency (JST) · J-Gate · Journal Citation Reports/Science Edition · JournalGuide · JournalTOCs · KESLI-NDSL (Korean National Discovery for Science Leaders) · Medline · MyScienceWork · Naver Academic · Naviga (Softweco) · Norwegian Register for Scientific Journals, Series and Publishers · Pathway Studio · Primo Central (ExLibris) · ProQuest (relevant databases) · Publons · PubMed · QOAM (Quality Open Access Market) · ReadCube · Reaxys · Scilit · SCImago (SJR) · SCOPUS · Semantic Scholar · Sherpa/RoMEO · SIIC Data Bases · Summon (ProQuest) · TDNet · Text Mining · Ulrich's Periodicals Directory/ulrichsweb · WanFang Data · Web of Science: Biological Abstracts; BIOSIS Previews; Current Contents/Life Sciences; Prous Science Integrity; Reaction Citation Index; Science Citation Index; Science Citation Index Expanded · WorldCat (OCLC) · X-MOL · Yewno Discover

The Journal is associated with the Gesellschaft für Biochemie und Molekularbiologie e.V. 

The publisher, together with the authors and editors, has taken great pains to ensure that all information presented in this work (programs, applications, amounts, dosages, etc.) reflects the standard of knowledge at the time of publication. Despite careful manuscript preparation and proof correction, errors can nevertheless occur. Authors, editors and publisher disclaim all responsibility for any errors or omissions or liability for the results obtained from use of the information, or parts thereof, contained in this work.

The citation of registered names, trade names, trademarks, etc. in this work does not imply, even in the absence of a specific statement, that such names are exempt from laws and regulations protecting trademarks etc. and therefore free for general use.

ISSN 1431-6730 · e-ISSN 1437-4315 · CODEN BICHF3

All information regarding notes for contributors, subscriptions, Open access, back volumes and orders is available online at [www.degruyter.com/bc](http://www.degruyter.com/bc).

**RESPONSIBLE EDITOR(S)** Douglas D. Thomas, Department of Pharmaceutical Sciences, University of Illinois at Chicago, College of Pharmacy, 900 S. Ashland Avenue (M/C 870), Chicago, IL 60607, USA, e-mail: [ddthomas@uic.edu](mailto:ddthomas@uic.edu).

**JOURNAL COORDINATOR** Dr. Torsten Krüger, De Gruyter, Genthiner Straße 13, 10785 Berlin, Germany, Tel.: +49 (0)30 260 05-176, Fax: +49 (0)30 260 05-352, e-mail: [biol.chem.editorial@degruyter.com](mailto:biol.chem.editorial@degruyter.com)

**ADVERTISEMENTS** e-mail: [anzeigen@degruyter.com](mailto:anzeigen@degruyter.com)

© 2023 Walter de Gruyter GmbH, Berlin/Boston

**TYPESETTING** TNQ Technologies, Chennai, India

**PRINTING** Franz X. Stückle Druck und Verlag e.K., Ettenheim



Offenlegung der Inhaber und Beteiligungsverhältnisse gem. § 7a Abs. 1 Ziff. 1, Abs. 2 Ziff. 3 des Berliner Pressegesetzes: Die Gesellschafter der Walter de Gruyter GmbH sind: Erbengemeinschaft Cram, Gisela bestehend aus Dr. Georg-Martin Cram, Dr. Hans-Robert Cram und Renate Tran; Cram, Dr. Georg-Martin, Unternehmens-Systemberater, Stadtbergen; Cram, Maike, Wien (Österreich); Cram, Jens, Mannheim; Rodriguez Cram, Catharina, Mexico, DF (Mexiko); Cram, Ingrid, Betriebsleiterin, Tuxpan/Michoacan (Mexiko); Cram, Sabina, Mexico, DF (Mexiko); Cram, Silke, Wissenschaftlerin, Mexico DF (Mexiko); Cram, Björn, Aachen; Cram, Berit, Hamm; Cram-Gomez, Susana, Mexico DF (Mexiko); Cram-Heydrich, Walter, Mexico DF (Mexico); Cram-Heydrich, Kurt, Angestellter, Cancún (Mexico); Duvenbeck, Brigitta, Oberstudienrätin i.R., Bad Homburg; Gädeke, Gudula, M.A., Atemtherapeutin/Lehrerin, Tübingen; Gädeke, Martin, Student, Ingolstadt; Gomez Cram, Arturo Walter, Global Key Account Manager, Bonn, Gomez Cram, Ingrid Arlene, Studentin, Mexico, DF (Mexiko), Gomez Cram, Roberto, Assistant Professor, London (UK), Lubasch, Dr. Annette, Ärztin, Berlin; Schütz, Dr. Christa, Ärztin, Mannheim; Schütz, Sonja, Diplom.-Betriebswirtin (FH), Berlin; Schütz, Juliane, Berlin; Schütz, Antje, Berlin; Schütz, Valentin, Mannheim; Seils, Dorothee, Apothekerin, Stuttgart; Seils, Gabriele, Journalistin, Berlin; Seils, Christoph, Journalist, Berlin; Siebert, John-Walter, Pfarrer, Oberstenfeld; Anh Vinh Alwin Tran, Student, Zürich (Schweiz), Tran, Renate, Mediatorin, Zürich (Schweiz); Carmen Siebert, Angestellte, Kempten; Duyen Anh Johann Tran, Architekt, Zürich (Schweiz); Lang Lieu Laurin Tran, Lehrperson, Zürich (Schweiz); Duyen Mai Marie Tran, Studentin, Zürich (Schweiz); Anh Huy Merlin Tran, Schüler, Zürich (Schweiz)

## Contents

### **Highlight: Horizons in Neuroscience - Organoids, Optogenetics and Remote Control**

**Guest Editorial — 1**

Lukasz Piszczeck, Joanna Kaczanowska and Wulf Haubensak  
**Towards correlative archaeology of the human mind — 5**

Julianne Beirute-Herrera, Beatriz López-Amo Calvo,  
Frank Edenhofer and Christopher Esk  
**The promise of genetic screens in human *in vitro* brain models — 13**

Sarah Janice Hörner, Nathalie Couturier, Mathias Hafner and  
Rüdiger Rudolf  
**Schwann cells in neuromuscular *in vitro* models — 25**

Annika Haak, Heiko M. Lesslich and Irmgard D. Dietzel  
**Visualization of the membrane surface and cytoskeleton of oligodendrocyte progenitor cell growth cones using a combination of scanning ion conductance and four times expansion microscopy — 31**

Saleh Altahini, Isabelle Arnoux and Albrecht Stroh  
**Optogenetics 2.0: challenges and solutions towards a quantitative probing of neural circuits — 43**

Martin Kubitschke and Olivia A. Masseck  
**Illuminating the brain-genetically encoded single wavelength fluorescent biosensors to unravel neurotransmitter dynamics — 55**

Alessandro Falconieri, Allegra Coppini and Vittoria Raffa  
**Microtubules as a signal hub for axon growth in response to mechanical force — 67**

Annika Guntermann, Katrin Marcus and Caroline May  
**The good or the bad: an overview of autoantibodies in traumatic spinal cord injury — 79**