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Academic education

2010-2015	University of Würzburg, Würzburg, Germany. PhD.
2004-2007	Chinese Academy of Agricultural Science, Beijing, China. Master.
2000-2004	School of Life Science, Shandong University, Jinan, China. Bachelor.

Scientific degrees

Dr. rer. nat.	2015, University of Würzburg, Würzburg, Germany (Mentor: Prof. Dr. Georg Nagel)

Working experience

since 2022	Group leader, Physiology Institute - Neurophysiology, University of Würzburg, Germany
2019-2021	Postdoc in Physiology Institute - Neurophysiology, University of Würzburg, Germany
2016-2019	Postdoc in Julius-von-Sachs-Institute of Biosciences, University of Würzburg, Germany
2008-2010	Assistant research officer in Temasek life sciences laboratory, National University of Singapore, Singapore
2007-2008	Research assistant in Chinese academy of agricultural science, Beijing, China

Awards and scholarships

2012	Optoelectronics Committee Prize for Best Contributed Paper, The Rank Prize Funds Symposium “Optogenetics”, Windermere, UK.
2016	Chinese government award for outstanding self-financed students abroad, Berlin
2018	Poster award, Gordon Research Conference on Photosensory Receptors and Signal Transduction, Lucca, Italy.

Research topics

Photobiology and photoreceptors

Development and application of optogenetic tools

Protein engineering and synthetic biology

Ion channels and ion signaling

cAMP/cGMP signaling

Reviewer for Journals:

Nat Microbiol

PLOS Biology

Proc. Natl. Acad. Sci. U.S.A.

Neuroscience

Cell Reports Methods

European Journal of Physiology
Frontiers in Molecular Biosciences
Frontiers in Environmental Science
Frontiers In Molecular Neuroscience
Frontiers in Plant Science
Bioscience Reports
Methods and Protocols
International Journal of Molecular Sciences
Plants
Applied Sciences
Biomolecules
Biosensors
Biomedicines
Current Issues in Molecular Biology

Selected conference and invited talks

06/2024 11th International Conference on cGMPcGMP: Generators, Effectors and Therapeutic Implications. Lübeck/Germany. “Development and applications of Optogenetic tools for manipulation of cyclic nucleotides.”

04/2024 Seminar for Research Training Group (RTG) - "MoNN&Di" - Monoaminergic Neuronal Networks & Disease, Ruhr-University in Bochum: “Optogenetic tools for research and clinical trials: recent progress and considerations.”

01/2022 School of Life Sciences seminar series, University of Nottingham Medical School (Virtuelles Seminar): “From Photoreceptors to Optogenetics: A Brief Introduction.”

10/2021 100th Meeting of the German Physiological Society / Joint Meeting with the Austrian Physiological Society (APS) and Life Sciences Switzerland (LS^2) Physiology (Frankfurt, Germany): “Development and Applications of Optogenetic Tools for Manipulation of Cyclic Nucleotides.”

10/2021 Plantae Webinar Highlighting Plant Physiology Focus Issue - Sensors and Controllers, for and from Plants (Virtuelles Seminar): “Functional expression of microbial rhodopsins for plant physiological research.”

10/2019 DFG Roundtable Discussion Meeting - Conformational Dynamics of Photoreceptors at Different Time Scales (Schloss Ringberg, Germany): “Green optogenetics for plant physiology study.”

10/2017 DFG Roundtable Discussion Meeting – Photoreceptors, from activation to interaction (Schloss Ringberg, Germany): “Expanding the optogenetic tool box: from lightsensitive ion channels to light-sensitive enzymes.”

12/2016 OPTOGEN 2016, 3rd International Workshop on Technologies for Optogenetics (Freriburg, Germany): “The Cyclop (Cyclase opsin) as a new optogenetic tools for light-gated nucleotide production.”

09/2012 The Rank Prize Funds, Symposium on Optogenetics (Windermere, UK): “Searching for and characterization of new algal rhodopsins.”

Ongoing projects as project leader

1. DFG Project number 525167920, “Optogenetic approaches to study platelet production and function”. 02.2024 – 01.2027
2. Homeworld Garden Grants: Protein Engineering for Climate. “Improve the CO2 Uptake and H2O Retention under High Light and Temperature Conditions“. 01.2024 – 12.2024

3. DFG Project number 538090107, “The cell-specific role of cGMP in striatum and hippocampus“. 03.2024 – 02.2027.

Completed projects as project leader

1. DFG (German Research Foundation, Deutsche Forschungsgemeinschaft) Project number 374031971, TR240 A04 “Optogenetic approaches to study platelet production and function (CRC/Transregios)”. 07.2022 – 06.2023.

Participated projects

1. 2019-2022, Analyzing PKA-dependent synaptic plasticity in the hippocampal mossy fiber synapse using novel optogenetic tools. Deutsche Forschungsgemeinschaft (DFG) - Project number 417451587;
2. 2015-2020, Optogenetic control of ionotropic receptor function by cyclic nucleotides (A03). Deutsche Forschungsgemeinschaft (DFG) - Project number 258780946;
3. 2013-2016, Optophysiological analysis of the clock network of D. melanogaster: Manipulating neuronal excitability and cAMP levels of individual clock neurons (A03). Deutsche Forschungsgemeinschaft (DFG) - Project number 208233609;
4. 2010-2014, Analysis and engineering of natural photoreceptors to Light-manipulate cyclic nucleotides, Ca^{2+} and membrane voltage in animal cells. Deutsche Forschungsgemeinschaft (DFG) - Project number 119438981;

Publications

#co-first author. *corresponding author.

1. Ding M#, Zhou Y#, Becker D#, Yang S#, … Hedrich R*, Nagel G*, Gao S*, Konrad R*. 2024. Probing plant signal processing optogenetically by two channelrhodopsins. **Nature** (accepted).
2. Duan X#, Zhang C#, Wu Y#, ... Nagel G, Hou S#, Gao S#, Song K#. 2024. Suppression of epileptic seizures by transcranial activation of K+-selective channelrhodopsin. **bioRxiv** 2024.01.03.573747
3. Strauss J, Deng L, Gao S, … Mock T. 2023. Plastid-localized xanthorhodopsin increases diatom biomass and ecosystem productivity in iron-limited surface oceans. **Nat Microbiol** 8: 2050–2066.
4. Lin, F, Tang, R, Zhang, C, Scholz N, Nagel G, Gao S*. 2023. Combining different ion-selective channelrhodopsins to control water flux by light. **Pflugers Arch - Eur J Physiol** 10.1007/s00424-023-02853-5.
5. Hayward RF, Brooks FP, Yang S, Gao S, Cohen AE. 2023. Diminishing neuronal acidification by channelrhodopsins with low proton conduction. **eLife** 12:RP86833.
6. Konrad K*#, Gao S*#. Zurbriggen M*#, Nagel G*#. 2023. Optogenetic Methods in Plant Biology. **Annual Review of Plant Biology** 74: 313-339.
7. Höler S, Degreif D, Stix F, Yang S, Gao S, Nagel G, Moroni A, Gerhard Thiel G, Bertl A, Rauhet O. 2023. Tailoring baker’s yeast Saccharomyces cerevisiae for functional testing of channelrhodopsin. **PLOS ONE** 18(4): e0280711.
8. Chen F#, Duan X#, Yu Y#, Shang Yang S, Chen Y, Gee CE, Nagel G, Zhang K*, Gao S*, Shen Y*. 2022. Visual function restoration with a highly sensitive and fast Channelrhodopsin in blind mice. **Signal Transduct Target Ther** 7:104.
9. Zhang Y#, Benz P#, Stehle D, Yang S, Kurz H, Feil S, Nagel G, Feil R, Gao S*, Bender M*. 2022. Optogenetic manipulation of cyclic guanosine monophosphate to probe phosphodiesterase activities in megakaryocytes. **Open Biol** 12(8):220058.
10. Tian Y, Yang S, Nagel G*, Gao S*. 2022. Characterization and Modification of Light-Sensitive Phosphodiesterases from Choanoflagellates. **Biomolecules** 12(1): 88.
11. Henß T, Nagpal J, Gao S, Scheib U, Pieragnolo A, Hirschhäuser A, Schneider-Warme F, Hegemann P, Nagel G, Gottschalk A. 2022. Optogenetic tools for manipulation of cyclic nucleotides, functionally coupled to CNG-channels. **Br J Pharmacol** 179(11):2519-37.

12. Wichers JS, Mesén-Ramírez P, Fuchs G, Yu-Strzelczyk J, Stäcker J, von Thien H, Alder A, Henshall I, Liffner B, Nagel G, Löw C, Wilson D, Spielmann T, Gao S, Gilberger TW, Bachmann A, Strauss J. 2022. PMRT1, a Plasmodium-Specific Parasite Plasma Membrane Transporter, Is Essential for Asexual and Sexual Blood Stage Development. **mBio** 13(2): e0062322.

13. Tian Y, Gao S, Nagel G. 2022. In Vivo and In Vitro Characterization of Cyclase and Phosphodiesterase Rhodopsins. In: **Rhodopsin: Methods and Protocols**. Edited by Gordeliy V. New York, NY: Springer US; 2022: 325-338.

14. Xia G, Shi H, Su Y, Han B, Shen C, Gao S, Chen Z, Xu C. 2022. Photoactivated adenylyl cyclases attenuate sepsis-induced cardiomyopathy by suppressing macrophage-mediated inflammation. **Front Immunol** 13:1008702.

15. Yang S, Heckmann JR, Yu-Strzelczyk J, **Gao S**, Geis C, Heckmann M. 2022. Effects of human monoclonal anti-GluN1 autoantibody on NMDA receptor channel function. **Acta Physiologica** 236: 823-823.

16. Zhang S, Lutas A, Yang S, Diaz A, Fluhr H, Nagel G, Gao S, Andermann M. 2021. Hypothalamic dopamine neurons control the motivation to mate via persistent cAMP signaling. **Nature** 597: 245-249.

17. Zhou Y#, Ding M#, Gao S#*, Yu-Strzelczyk J#, Krischke M, Duan X, Leide J, Riederer M, Mueller MJ, Hedrich R, Konrad KR*, Nagel G*. 2021. Optogenetic control of plant growth by a microbial rhodopsin. **Nat Plants** 7(2): 144-151.

18. Huang S, Ding M, Roelfsema R, Dreyer I, Scherzer S, Al-Rasheid KAS, Gao S, Nagel G, Hedrich R, Konrad KR. 2021. Optogenetic control of the guard cell membrane potential and stomatal movement by the light-gated anion channel GtACR1. **Science Advances** 7(28): eabg4619.

19. Yang S, Constantin OM, Sachidanandan D, Hofmann H, Kunz TC, Kozjak-Pavlovic V, Oertner TG, Nagel G, Kittel RJ*, Gee CE*, Gao S*. 2021. PACmn for improved optogenetic control of intracellular cAMP. **BMC Biology** 19: 227.

20. Zhou Y, Ding M, Nagel G, Konrad KR, Gao S. 2021. Advances and prospects of rhodopsin-based optogenetics in plant research. **Plant Physiol** kiab338.

21. Panzer S, Zhang C, Konte T, Bräuer C, Diemar A, Yogendran P, Yu-Strzelczyk J, Nagel G, Gao S, Terpitz U. 2021. Modified rhodopsins from *Aureobasidium pullulans* excel with very high proton-transport rates. **Front Mol Biosci** 8: 750528.

22. Tang R, Yang S, Nagel G*, Gao S*. 2021. mem-iLID, a fast and economic protein purification method. **Biosci Rep** 41 (7): BSR20210800.

23. Zhou Y, Ding M, Duan X, Konrad KR, Nagel G, Gao S*. 2021. Extending the anion channelrhodopsin-based toolbox for plant optogenetics. **Membranes** 11 (4): 287.

24. Tian Y, Nagel G*, Gao S*. 2021. An engineered membrane-bound guanylyl cyclase with light-switchable activity. **BMC Biology** 19: 54.

25. Walther F, Feind D, Vom Dahl C, Müller CE, Kukaj T, Sattler C, Nagel G, Gao S, Zimmer T. 2020. Action potentials in *Xenopus* oocytes triggered by blue light. **J Gen Physiol** 152(5): e201912489.

26. Kunz TC, Götz R, Gao S, Sauer M, Kozjak-Pavlovic V. 2020. Using Expansion Microscopy to Visualize and Characterize the Morphology of Mitochondrial Cristae. **Front Cell Dev Biol** 15;8: 617.

27. Tian Y, Yang S, Gao S. 2020. Advances, Perspectives and Potential Engineering Strategies of Light-Gated Phosphodiesterases for Optogenetic Applications. **Int J Mol Sci** 21: 20.

28. Zhang C, Yang S, Flossmann T, Gao S, Witte O, Nagel G, Holthoff K, Kirmse K. 2019. Optimized photo-stimulation of halorhodopsin for long-term neuronal inhibition. **BMC biology** 17: 1.

29. König C, Khalili A, Niewalda T, Gao S, Gerber B. 2019. An optogenetic analogue of second-order reinforcement in *Drosophila*. **Biol Lett** 15: 20190084.

30. Duan X, Nagel G*, Gao S*. 2019. Mutated channelrhodopsins with increased sodium and calcium permeability. **Appl Sci** 9: 664.

31. Scheib U, Broser M, Constantin OM, Yang S, Gao S, Mukherjee S, Stehfest K, Nagel G, Gee CE, Hegemann P. 2018. Rhodopsin-cyclases for photocontrol of cGMP/cAMP and 2.3 Å structure of the

adenylyl cyclase domain. **Nat Commun** 9: 2046.

32. Tian Y#, Gao S#*, von der Heyde EL#, Hallmann A, Nagel G.* 2018. Two-component cyclase opsins of green algae are ATP-dependent and light-inhibited guanylyl cyclases. **BMC Biology** 16: 144.
33. Beck S, Yu-Strzelczyk J, Pauls D, Constantin OM, Gee CE, Ehmann N, Kittel RJ, Nagel G*, Gao S*. 2018. Synthetic light-activated ion channels for optogenetic activation and inhibition. **Front Neurosci** 12: 643.
34. Tian Y#, Gao S#*, Yang S, Nagel G*. 2018. A novel rhodopsin phosphodiesterase from Salpingoeca rosetta shows light-enhanced substrate affinity. **Biochem J** 455: 359-65.
35. Scholz N, Guan C, Nieberler M, Grotemeyer A, Maiellaro I, Gao S, Beck S, Pawlak M, Sauer M, Asan E, Rothemund S, Winkler J, Promel S, Nagel G, Langenhan T, Kittel RJ. 2017. Mechano-dependent signaling by Latrophilin/CIRL quenches cAMP in proprioceptive neurons. **Elife** 6: e28360.
36. Gao S#, Nagpal J#, Schneider M, Kozjak-Pavlovic V, Nagel G, Gottschalk A. 2015. Optogenetic manipulation of cGMP in cells and animals by the tightly light-regulated guanylyl-cyclase opsin CyclOp. **Nat Commun** 6: 8046.
37. Ye J, Yang J, Sun Y, Zhao P, Gao S, Jung C, Qu J, Fang R, Chua N. 2015. Geminivirus activates ASYMMETRIC LEAVES 2 to accelerate cytoplasmic DCP2-mediated mRNA turnover and weakens RNA silencing in Arabidopsis. **PLoS Pathog** 11: e1005196.
38. Dawydow A, Gueta R, Ljaschenko D, Ullrich S, Hermann M, Ehmann N, Gao S, Fiala A, Langenhan T, Nagel G, Kittel RJ. 2014. Channelrhodopsin-2-XXL, a powerful optogenetic tool for low-light applications. **Proc Natl Acad Sci USA** 111: 13972-7.
39. Raffelberg S, Wang L, Gao S, Losi A, Gartner W, Nagel G. 2013. A LOV-domain-mediated blue-light-activated adenylate (adenylyl) cyclase from the cyanobacterium Microcoleus chthonoplastes PCC 7420. **The Biochemical journal** 455: 359-365.
40. Qu J, Mao H, Chen W, Gao S, Bai Y, Sun Y, Geng Y, Ye J. 2012. Development of marker-free transgenic Jatropha plants with increased levels of seed oleic acid. **Biotechnology for biofuels** 5: 10
41. Qu J, Ye J, Geng Y, Sun Y, Gao S, Zhang B, Chen W, Chua NH. 2012. Dissecting functions of KATANIN and WRINKLED1 in cotton fiber development by virus-induced gene silencing. **Plant physiology** 160: 738-748.
42. Gao S, Qu J, Chua NH, Ye J. 2010. A new strain of Indian cassava mosaic virus causes a mosaic disease in the biodiesel crop Jatropha curcas. **Archives of virology** 155: 607-612.
43. Gao S, Zhang X, Wu M, He C. 2009. Differential expression of pathogenicity genes of *Xanthomonas oryzae* pv. *oryzae* and deletion mutants Δ*gacAxoo* and Δ*fleQxoo in vitro* and *in planta* revealed by DNA microarray analysis. **Acta Phytopathologica Sinica** 39(6): 653-658.
44. Gao S, Zhang X, Wu M, He C. 2008. Transcriptional profile of plant pathogenic bacteria revealed by DNA microarray analysis. **Scientia Agricultura Sinica** 41(5): 1341-1346.
45. Qi F, Gao S, Wu M, He C. 2006. Analysis of Synergetic Induction of Hypersensitive Response by Nitric Oxide and Hydrogen Peroxide in Rice Suspension Cultured Cells. **Scientia Agricultura Sinica** 39(01): 61-65.

Patents

Ye J, Chua NH, Qu J, Gao S. Control of pests in plants. (world-wide; No. PCT/SG2010/000339, WO2011040880A1, US10017774B2).