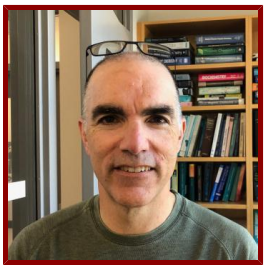
Stanford



Justin Du Bois

Henry Dreyfus Professor of Chemistry and Professor, by courtesy, of Chemical and Systems Biology

CONTACT INFORMATION

- **Administrative Contact**

  Khudaija Khan - Administrative Associate

  Email khank@stanford.edu

  Tel (650) 723-1359

Bio

BIO

The Du Bois lab is heavily invested in exploring voltage-gated ion channel function and physiology and the underlying role of specific channels in human pathologies, particularly nociception, epilepsy, and neurodevelopmental disorders. With expertise in chemical synthesis, we have access to a collection of exceptional natural products—tetrodotoxin, saxitoxin, gonyautoxin, batrachotoxin, veratridine, antillatoxin, to name a few—that act as selective modulators of sodium ion channels (NaVs). In addition, we have developed novel molecules as inhibitors and agonists of specific voltage-gated chloride (ClCs) and calcium (CaVs) channel isoforms. As a lab, we are uniquely positioned to advance high-precision chemical tools to interrogate underlying biochemical mechanisms of electrogenesis. Our work in this arena is guided by a number of questions related to the basic functioning of voltage-gated channels in neuronal cells and glia that include: 1) what is the rate at which channels are being made and degraded and is the rate of channel turnover context dependent (i.e., is protein turnover affected by increased neuronal activity, nerve cell damage, etc.); 2) to what extent is channel expression and cellular distribution affected by external factors (pH, inflammatory modulators, injury); 3) how do post-translational protein modifications influence channel function and how are such modifications altered in response to external factors; 4) how do neighboring glia influence channel expression and ion gating. Answers to these types of questions will provide a deeper understanding of the molecular mechanisms by which neuronal cells and tissue respond to external stimuli, stress, and injury. We benefit from the strong interest of others in our work and multiple collaborators at Stanford and at other institutions.

Ion channel function and physiology. We wish to understand the role of individual subtypes of voltage-gated sodium, chloride, and calcium channels in neuronal signaling and how structural changes (i.e., point mutations, post-translational modifications, partner proteins) alter channel function. Our interests include the design, development, and application of chemogenetic technologies for targeting individual channel subtypes and allosteric modulators of select channel isoforms. Our work aims to inform efforts in translational research, as voltage-gated ion channel dysregulation and malfunction underlie a wide range of human diseases and disorders.

Natural products synthesis. We are interested in developing efficient and flexible synthetic routes to natural products that serve as ‘lead’ compounds for advancing high precision pharmacological tools. Most of the targets we are interested in obtaining are not available in sufficient quantities from natural

sources, thus necessitating de novo preparation. To streamline the assembly process of these complex molecules, we are challenged to develop, in parallel, new tactics and chemical methods that facilitate C–C, C–N, and C–O bond formation.

Toxin ‘sponge’ proteins. A longstanding collaboration with the Minor lab at UCSF has focused on understanding how certain organisms that ingest dietary toxins such as saxitoxin, tetrodotoxin, and batrachotoxin survive their poisonous effects. This work has resulted in the elucidation of the structures of novel paralytic shellfish-binding proteins (so-called saxiphilins) and the toxin ‘binding code’. Studies are ongoing to integrate saxiphilins into a diagnostic device for measuring toxin concentrations in shellfish and to advance an engineered toxin-binding protein as a countermeasure for paralytic shellfish poisoning.

ACADEMIC APPOINTMENTS

- Professor, Chemistry
- Professor (By courtesy), Chemical and Systems Biology
- Member, Bio-X
- Member, Maternal & Child Health Research Institute (MCHRI)
- Member, Wu Tsai Neurosciences Institute

ADMINISTRATIVE APPOINTMENTS

- Courtesy faculty, Dept. of Chemical and Systems Biology, Stanford University, (2013- present)
- Faculty Affiliate, Stanford Neuroscience Institute, (2013- present)
- Executive Committee Member, Stanford ChEM-H, (2012- present)
- Cofounder, Board Member, SiteOne Therapeutics, Inc, (2011- present)
- Founder, Center for Molecular Analysis and Design at Stanford, (2009- present)
- Founding Member, NSF Center for Selective C–H Functionalization, (2009- present)
- Permanent Member, NIH study section, Synthetic & Biological Chemistry A, (2009-2013)
- Member, Bio-X, (2004- present)
- Member, American Chemical Society, (1992- present)

HONORS AND AWARDS

- John A. and Cynthia Fry Gunn University Fellow in Undergraduate Education, Stanford University (2011–2020)
- Dean’s Award for Distinguished Achievements in Teaching, Stanford University (2008)

BOARDS, ADVISORY COMMITTEES, PROFESSIONAL ORGANIZATIONS

- Scientist Consultant, Pfizer Inc. (2004 - present)
- Scientist Consultant, Gilead Sciences (2007 - present)
- Founder and Board Member, SiteOne Therapeutics (2010 - present)

PROFESSIONAL EDUCATION

- Postdoc, Massachusetts Institute of Technology , Chemistry (1999)
- PhD, California Institute of Technology , Chemistry (1997)
- BS, University of California, Berkeley , Chemistry (1992)

LINKS

- The Du Bois Laboratory: http://duboislab.stanford.edu/

Teaching

COURSES

2026-27

- Chemical Foundations and 21st Century Problems: CHEM 31E (Aut)
- Structure and Reactivity of Carbon-Based Molecules: CHEM 33 (Win)

2025-26

- Chemical Foundations and 21st Century Problems: CHEM 31E (Aut)
- Structure and Reactivity of Carbon-Based Molecules: CHEM 33 (Win)

2024-25

- Chemical Foundations and 21st Century Problems: CHEM 31E (Aut)
- Structure and Reactivity of Carbon-Based Molecules: CHEM 33 (Win)

2023-24

- The Chemical Principles of Life I: CHEM 141 (Win)
- Understanding the Natural and Unnatural World through Chemistry: CHEM 121 (Aut)

STANFORD ADVISEES

Doctoral Dissertation Reader (AC)

Casey Chan, Ryan Golden, Anna Makar-Limanov, Camille Petrakian, Nicolas Robalin, Anastasiia Safronova, Cara Starnbach, Amy Su, Kaan Tarhan

Postdoctoral Faculty Sponsor

Petru Albertini, Deshka Neill, Elizabeth Park, Michael Poekl, Wenjun Yue

Doctoral Dissertation Advisor (AC)

Richard Cardrino, Chris Codogni, Signe Dahlberg-Wright, Aaron Forman, Dayne Goss, Hannah Grupe, Enrique Moya, Claudia Zhang

Publications

PUBLICATIONS

- **Site-selective bromination of sp3 C–H bonds** *Chem.Sci*
  Sathyamoorthi, S., Banerjee, S., Du Bois, J., Burns, N. Z., Zare, R. N.
  2018; 9: 100-104
- **Intermolecular sp3 C-H Amination of Complex Molecules.** *Angewandte Chemie (International ed. in English)*
  Chiappini, N. D., Mack, J. B., Du Bois, J. n.
  2018
- **Ruthenium-Catalyzed C-H Hydroxylation in Aqueous Acid Enables Selective Functionalization of Amine Derivatives.** *Journal of the American Chemical Society*
  Mack, J. B., Gipson, J. D., Du Bois, J., Sigman, M. S.
  2017; 139 (28): 9503-9506
- **Mechanistic analysis of a copper-catalyzed C-H oxidative cyclization of carboxylic acids.** *Chemical science*
  Banerjee, S. n., Sathyamoorthi, S. n., Du Bois, J. n., Zare, R. N.
  2017; 8 (10): 7003–8
- **Copper-Catalyzed Oxidative Cyclization of Carboxylic Acids** *ORGANIC LETTERS*
  Sathyamoorthi, S., Du Bois, J.

2016; 18 (24): 6308-6311

- **Asymmetric synthesis of batrachotoxin: Enantiomeric toxins show functional divergence against Na-V** *SCIENCE*
  Logan, M. M., Toma, T., Thomas-Tran, R., Du Bois, J.
  2016; 354 (6314): 865-869
- **Manganese(II)/Picolinic Acid Catalyst System for Epoxidation of Olefins** *ORGANIC LETTERS*
  Moretti, R. A., Du Bois, J., Stack, T. D.
  2016; 18 (11): 2528-2531
- **Mutant cycle analysis with modified saxitoxins reveals specific interactions critical to attaining high-affinity inhibition of hNa(V)1.7** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*
  Thomas-Tran, R., Du Bois, J.
  2016; 113 (21): 5856-5861
- **Synthesis of the Paralytic Shellfish Poisons (+)-Gonyautoxin 2, (+)-Gonyautoxin 3, and (+)-11,11-Dihydroxysaxitoxin** *JOURNAL OF THE AMERICAN CHEMICAL SOCIETY*
  Mulcahy, J. V., Walker, J. R., Merit, J. E., Whitehead, A., Du Bois, J.
  2016; 138 (18): 5994-6001
- **Rh2(II,III) Catalysts with Chelating Carboxylate and Carboxamidate Supports: Electronic Structure and Nitrene Transfer Reactivity.** *Journal of the American Chemical Society*
  Varela-Álvarez, A., Yang, T., Jennings, H., Kornecki, K. P., MacMillan, S. N., Lancaster, K. M., Mack, J. B., Du Bois, J., Berry, J. F., Musaev, D. G.
  2016; 138 (7): 2327-2341
- **Inhibition of Sodium Ion Channel Function with Truncated Forms of Batrachotoxin** *ACS Chem. Neurosci.*
  Toma, T., Logan, M. M., Maynard, F., Devlin, A. S., Du Bois, J.
  2016; 7 (10): 1463-1468
- **Saxitoxin.** *Angewandte Chemie (International ed. in English)*
  Thottumkara, A. P., Parsons, W. H., Du Bois, J.
  2014; 53 (23): 5760-5784
- **Organocatalytic C-H hydroxylation with Oxone (R) enabled by an aqueous fluoroalcohol solvent system** *CHEMICAL SCIENCE*
  Adams, A. M., Du Bois, J.
  2014; 5 (2): 656-659
- **Selective Intermolecular Amination of C-H Bonds at Tertiary Carbon Centers** *ANGEWANDTE CHEMIE-INTERNATIONAL EDITION*
  Roizen, J. L., Zalatan, D. N., Du Bois, J.
  2013; 52 (43): 11343-11346
- **Marked difference in saxitoxin and tetrodotoxin affinity for the human nociceptive voltage-gated sodium channel (Nav1.7) [corrected].** *Proceedings of the National Academy of Sciences of the United States of America*
  Walker, J. R., Novick, P. A., Parsons, W. H., McGregor, M., Zablocki, J., Pande, V. S., Du Bois, J.
  2012; 109 (44): 18102-18107
- **Fluorescent Saxitoxins for Live Cell Imaging of Single Voltage-Gated Sodium Ion Channels beyond the Optical Diffraction Limit** *CHEMISTRY & BIOLOGY*
  Ondrus, A. E., Lee, H. D., Iwanaga, S., Parsons, W. H., Andresen, B. M., Moerner, W. E., Du Bois, J.
  2012; 19 (7): 902-912
- **Metal-Catalyzed Nitrogen-Atom Transfer Methods for the Oxidation of Aliphatic C-H Bonds** *ACCOUNTS OF CHEMICAL RESEARCH*
  Roizen, J. L., Harvey, M. E., Du Bois, J.
  2012; 45 (6): 911-922