

BIOSKETCH**THOMAS P. SAKMAR, M.D.**

Thomas P. Sakmar, M.D. is a physician-scientist and the Richard M. & Isabel P. Furlaud Professor and Head of the Laboratory of Molecular Biology and Biochemistry at The Rockefeller University in New York. He also holds the Marie Krogh Visiting Professorship at University of Copenhagen and an appointment at the Karolinska Institutet in Stockholm.

Dr. Sakmar's multidisciplinary research program is focused on understanding how cells communicate with each other and how organisms sense their environment. For example, how does light stimulate the retina to initiate vision? How does a hormone trigger a response? How does the HIV virus hijack cell surface receptors to enter a target cell?



The common theme in all of these processes is called "signal transduction." The receptors on the cell surface that mediate signaling are important targets of therapeutic drugs. Dr. Sakmar's research on a family of receptors called G protein-coupled receptors (GPCRs) has provided fundamental insights about signal transduction and has advanced drug discovery programs in the biotechnology and pharmaceutical industries.

Dr. Sakmar was born in Detroit, Michigan. He received his A.B. (honors) degree in chemistry from the University of Chicago and his M.D. (honors) degree from the University of Chicago Pritzker School of Medicine. While attending a special biophysics school in France in 1979, Dr. Sakmar was inspired by **Martin Rodbell**, who had just coined the term "signal transduction" and went on to win the Nobel Prize in 1984. Dr. Sakmar completed a residency in internal medicine at the Massachusetts General Hospital, Boston, and conducted post-doctoral research in the laboratory of Nobel Prize winner **H. Gobind Khorana** in the Department of Chemistry at the Massachusetts Institute of Technology. During his research training at MIT, Dr. Sakmar was among the first scientists to employ techniques of molecular biology such as site-directed mutagenesis and heterologous expression to study GPCRs.

Dr. Sakmar was recruited by **David Baltimore** to join Rockefeller University in 1990 as a University Fellow and Assistant Professor. He was promoted to Professor with tenure in 1998 and received the Furlaud chair in 2002.

Using rhodopsin, the receptor for dim light in the retina, as a key model system, Dr. Sakmar has continued to study the molecular mechanism and dy-

namics of receptor activation – the conformational changes that rapidly occur when rhodopsin absorbs a photon of light or a receptor binds to a hormone. Dr. Sakmar also has made major contributions to understanding the chemical basis for color vision.

More recently he has turned his attention to the chemokine receptors involved in HIV entry into target cells and to novel protein modulators of receptor signaling involved in nerve cell morphogenesis. He has developed new computational methods that are being validated in single-molecule detection fluorescence experiments using microfluidics. Dr. Sakmar's published scientific papers have been cited nearly 9,000 times and ~30 of his scientific papers have been cited more than 100 times.

His laboratory has been an excellent training environment for 36 post-doctoral fellows, 10 graduate students and 40 summer students and rotation students. His former trainees hold faculty positions at major research universities worldwide and many work in the biotechnology and pharmaceutical industries.

Dr. Sakmar has been an Investigator of the Howard Hughes Medical Institute in their Neuroscience Program and a Senior Scholar of the Ellison Medical Foundation. He is also a Senior Physician in The Rockefeller University Hospital, a major NIH-funded Clinical and Translational Research Center, and served as Associate Dean in charge of the M.D.-Ph.D. Program.

Dr. Sakmar was Acting President of Rockefeller University for 19 months in 2002–2003. While Acting President, he recruited several exceptional faculty members, including **C. David Allis**, **Tom Tuschl**, and **Cori Bargmann**, wrapped up a successful \$300M fund raising campaign, and founded a privately-funded human embryonic stem cell initiative.

He has served on numerous academic, institutional and governmental committees and panels and has consulted widely for the biotechnology and pharmaceutical industry, including serving on scientific advisory boards of *Leukosite, Inc.*, *Natural Pharmaceuticals, Inc.*, *Resolvyx, Inc.*, and *Anchor Therapeutics, Inc.* He is currently on the Board of the Helen Hay Whitney Foundation and was a Director of The Medical Letter, a non-profit drug evaluation newsletter with nearly 200,000 physician subscribers.

Dr. Sakmar lives in New York City and Stockholm with his wife **Karina Åberg**, twin daughters (age 9) and a 7-1/2 year old son.

Scientists

Seeing the Signal

Thomas Sakmar

Senior Physician and Richard M. and Isabel P. Furlaud Professor, Laboratory of Molecular Biology and Biochemistry, The Rockefeller University, New York, NY, USA



Thomas Sakmar's development of techniques to simulate activation of G protein-coupled receptors and his signal transduction research caught our attention. Curious to know more, *BioTechniques* contacted him to find out about the ambitions, character, and motivations that led to his success.

When did you first become interested in signal transduction?

As an undergraduate student, I saw a poster at the University of Chicago for a summer course in Europe on membrane biophysics, which sounded perfect to me. I applied and was the only undergraduate accepted to the course, which was traditionally a summer school for physicists. About 50 students attended that summer, with groups of professors rotating to teach the courses. Martin Rodbell, who had just coined the term "signal transduction," was actually one of the professors. I really liked his presentations and his hypothesis about the nucleotide effect on hormone signaling in hepatocytes. I spent a lot of time with him during the workshop and maintained a long correspondence afterward while I was in medical school and he was working at the NIH. That was the time when he was writing his classic *Nature* paper for which he won the Nobel Prize in physiology or medicine with Al Gilman in 1994. He shared early drafts of that paper with me and engaged me in thinking about the problem. I really felt honored that someone of his stature would interact with me on this research question. We kept in touch until he passed away.

That personal contact very early in my career led me to the path that I'm on today. I

have been working on the problem of signal transduction and the mechanism of transmembrane signaling by heptahelical G protein-coupled receptors (GPCRs) ever since.

What have been your most significant contributions to your field so far?

When I started my laboratory at Rockefeller University, I focused on the molecular mechanism of spectral tuning by visual pigments. It's a very interesting biological problem because visual pigments across essentially all organisms from insects to humans use the same vitamin A-derived chromophore. The model chromophore in solution absorbs light at 440 nm, but color vision is sensitive from about 320 nm to 600 nm. So somehow the protein portion of the visual pigment tunes the light absorbance of the chromophore. We used a combination of molecular biology, site-directed mutagenesis, heterologous expression, and purification methods to describe this system and then teamed up with Richard Mathies, a physical chemist at University of California Berkeley, to build an apparatus for resonance Raman spectroscopy on very small-scale samples. Using this technique, we were able to define the specific chromophore-protein interactions that explained the physiology. Many of our predictions were verified in 2000 when the crystal structure for bovine rhodopsin was published.

Another contribution was the helix-movement model of receptor activation, which explains how agonist binding causes the conformational changes that activate the receptor. In the mid-90s, we were focused on the photochemistry of rhodopsin activation and noticed that we could simultaneously monitor changes in specific tryptophan residues as the protein went through its activation cycle. We hypothesized that the mechanism for this movement was a bundle of helices changing orientation upon receptor activation. Working with Henry Bourne from the University of California, San

Francisco, we devised a method to constrain the movement of these helices by introducing cross-links. Those constraints prevented activation of the receptor and were specific to particular pairs of helices, which led us to propose a requirement for helix movement upon activation. In parallel, Wayne Hubbell's lab (UCLA) came to the same conclusion using site-directed spin labeling approaches. The helix movement model was established in 1996 in a series of papers from both labs and was proven to be true in 2008 with structural studies on crystal structures of rhodopsin and opsin.

What are you currently working on?

In 2002, I was called on by the trustees of the university to serve as acting president of Rockefeller. I couldn't carry out normal lab work for nearly two years, but the experience was fantastic. I really enjoyed that leadership role, learning a lot about complex organizations and developing a new respect for what it takes to lead a research enterprise at a university. When I came back to the lab, I realized that I didn't have to go back and read the 200 papers piled up on my desk from the last two years; instead, I could just start something new within the framework of GPCR research.

Now we are developing and applying new technologies, such as amber codon suppression methods to genetically encode unnatural amino acids and computational molecular dynamic simulations to study GPCR "signalosomes" in bilayer environments. We are also moving toward single-molecule studies of receptor activation to understand the details of ligand recognition and G protein activation with chemical precision.

Interviewed by Kristie Nybo, Ph.D. Image courtesy of Lubos Stepanek. 

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CURRICULUM VITAE

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Date of Birth: June 24, 1956

Place of Birth: Detroit, MI

Education:

1978 A.B. with General Honors (Chemistry)	The College at the University of Chicago, Chicago, IL
1982 M.D. with Honors	University of Chicago, Pritzker School of Medicine

Current Positions:

2002 –	Richard M. & Isabel P. Furlaud Professor, Rockefeller University, New York, NY
2000 –	Senior Physician, Rockefeller University Hospital, Rockefeller University, New York, NY
1998 –	Professor & Head of Laboratory of Molecular Biology & Bio- chemistry, Rockefeller University, New York, NY

- 2011 – 2012 Marie Krogh Visiting Professor, The Novo Nordisk Foundation Center for Basic Metabolic Research & Department of Neuroscience & Pharmacology, Faculty of Medicine, University of Copenhagen, Copenhagen, Denmark
- 2011 – 2012 KI Alzheimer's Disease Research Center, Department of Neurobiology, Care Sciences and Society, Karolinska Institutet, Huddinge, Stockholm, Sweden

Previous Positions:

- 2002 – 2005 Director, Pels Family Center for Chemistry, Biochemistry & Structural Biology, Rockefeller University, New York, NY
- 2002 – 2003 Acting President, Rockefeller University, New York, NY
- 1998 – 2001 Adjunct Associate Professor, Program in Cell Biology and Genetics, Weill Graduate School of Medical Sciences of Cornell University, New York, NY
- 1997 – 2002 Associate Dean for Graduate Studies (Tri-Institutional MD-PhD Program), Rockefeller University, New York, NY
- 1995 – 2000 Physician, Rockefeller University Hospital, Rockefeller University, New York, NY
- 1994 – 2004 Associate Investigator, Neurosciences Program, Howard Hughes Medical Institute
- 1994 – 1998 Associate Professor & Head of Laboratory of Molecular Biology & Biochemistry, Rockefeller University, New York, NY
- 1991 – 1994 Assistant Investigator, Neurosciences Program, Howard Hughes Medical Institute
- 1991 – 1994 Assistant Professor & Head of Laboratory of Molecular Biology & Biochemistry, Rockefeller University, New York, NY
- 1990 – 1991 Assistant Professor & University Fellow, Rockefeller University, New York, NY
- 1990 Visiting Scientist, Departments of Biology & Chemistry, Massachusetts Institute of Technology, Cambridge, MA
- 1988 – 1990 Research Associate, Departments of Biology & Chemistry, Massachusetts Institute of Technology, Cambridge, MA
- 1985 – 1988 Postdoctoral Fellow, Departments of Biology & Chemistry, Laboratory of Prof. H. G. Khorana, Massachusetts Institute of Technology, Cambridge, MA
- 1985 – 1990 Graduate Assistant in Medicine, Massachusetts General Hospital, Boston, MA
- 1982 – 1985 Clinical Fellow in Medicine (J. T. Potts, Jr., Chairman), Harvard Medical School, Boston, MA
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1983 – 1985	Resident in Medicine, Massachusetts General Hospital, Boston, MA
1982 – 1983	Intern in Medicine, Massachusetts General Hospital, Boston, MA
1979 – 1980	Research Student, Laboratories of R. L. Henrikson & P. B. Sigler, Department of Biochemistry, University of Chicago, Chicago, IL
1977 – 1978	Research Student, Laboratories of J. D. Robbins & D. T. Liu, Biochemistry and Biophysics Branch, Bureau of Biologics, Food and Drug Administration, Bethesda, MD

Professional Licensures & Certifications:

American Board of Internal Medicine, Board Certified, September, 1985; Medical Practitioner's License, Commonwealth of Massachusetts, Reg. No. 54138; U.S. DEA Controlled Substances Registration; Physician Registration, State of New York, Reg. No. 183714; Physician License, State of Michigan, Reg. No. 4301062378

Awards & Honors:

NATO Advanced Study Fellowship, NATO Advanced Study Institute on Membrane Biophysics & Intercellular Communication, Les Houches, France (1979); Alpha Omega Alpha ($\alpha\omega\alpha$) Medical Honor Society (1982); National Research Service Award, National Institutes of Health, NEI (1986-1988); American Society for Photobiology (ASP), New Investigator Award (1995); Ellison Foundation Senior Scholar Award (2001); Interviewed by *Nature Drug Discovery* as one of the 20 world's leading experts on GPCR research, *Nat Revs Drug Disc* **3**:575-626 (2004); Marie Krogh Visiting Professor (2011)

Professional Organizations:

American Association for the Advancement of Science (AAAS); American Chemical Society (ACS); Association for Chemoreception Sciences (ACheM_S); American Medical Association (AMA); American Society for Biochemistry & Molecular Biology (ASBMB); American Society for Photobiology (ASP); American Society of Tropical Medicine and Hygiene; Association for Research in Vision & Ophthalmology (ARVO); Biophysical Society; The Harvey Society; International Society for Eye Research (ISER); Massachusetts Medical Society; New York Academy of Sciences; The Practitioners' Society of New York; The Protein Society; Society of General Physiologists

Academic Committees and University Service:

Faculty Search Committee for Chemistry, Biochemistry & Structural Biology, Rockefeller University (1991–1996); Graduate Program Admissions Committee, Rockefeller University (1991–1993); Tri-Institutional MD-PhD Program Admissions Committee, Cornell Medical

College–Memorial Sloan-Kettering Cancer Center -- Rockefeller University (1992–2002); Awards Nominating Committee, Rockefeller University (1992–1993); Faculty Search Committee in Medical Sciences, Rockefeller University (1993–1995); Tri-Institutional MD-PhD Advisory Committee, Cornell Medical College – Memorial Sloan-Kettering Cancer Center – Rockefeller University (1994–2002); General Clinical Research Center Advisory Committee, Rockefeller University Hospital (1994–1995); Rockefeller University Safety Committee, Rockefeller University (1994–1995); Awards Nominating Committee, Rockefeller University (1995 & 1999–2002); Associate Director, Tri-Institutional MD-PhD Program, Rockefeller University (1995–1997); Scientific Advisory Committee, Rockefeller University Hospital (1995–1997); Faculty Committee on Graduate Studies, Rockefeller University (1995–1998); Tri-Institutional MD-PhD Executive Sub-Committee, Cornell Medical College --Memorial Sloan-Kettering Cancer Center – Rockefeller University (1996–2002); Medical Records & Utilization Review Committee, Rockefeller University Hospital (1996–1997); Chairman, Rockefeller University Safety Committee, Rockefeller University (1996–2002); Associate Dean of Graduate Studies (Tri-Institutional MD-PhD Program), Rockefeller University (1997–2002); Tri-Institutional Ethics Committee, Cornell Medical College --Memorial Sloan-Kettering Cancer Center -- Rockefeller University (1998–2002); General Clinical Research Center Advisory Committee, Rockefeller University Hospital (1998–2000); Faculty Search Committee for Chemistry, Rockefeller University (1998–2000); Executive Committee, Tri-Institutional Training Program in Vision (1999– present); Awards Nominating Committee, Rockefeller University (1999–2001); Academic Council (elected), Rockefeller University (1999–2002); Search Committee for Chairman of the Department of Physiology and Biophysics, Weill Medical College (2000–2001); Faculty Search Committee for Neuroscience, Rockefeller University (2000–2002); Committee for Facilities, Rockefeller University (2001–2002); Selection Committee, Lewis Thomas Award – “Scientist As a Poet,” Rockefeller University (2001–2003); Honorary Degree Selection Committee, Rockefeller University (2001–2002); Chairman (elected), Academic Council, Rockefeller University (2001–2002); Co-Director, Burroughs Wellcome Fund Interfaces Program (2002–2003); Education in Clinical Investigation Subcommittee (2004–2006); Chair, Rockefeller University Human Stem Cell Bioethics Group (2004–2006); Merrifield Memorial Fund Committee (2006–2007); Chair, Scientific Advisory Committee, Spectroscopy Resource Center (2007–present); Rockefeller University Faculty Conflict of Interest Committee (2007–2010, Chair 2009–2010); Tri-Institutional Embryonic Stem Cell Research Oversight (ESCRO) Committee (2008–present; chair, 2009–present); Director, Human Research Protection Program, Rockefeller University Hospital (2010–present); Pfizer Centers of Therapeutic Innovation Program, Steering Committee (2011–present); Executive Committee, Center for Basic and Translational Research on Disorders of the Digestive System (CDDS) funded by the Helmsley Trust (2012–present)

Scientific Review Activities:

Editorial Board – *Journal of General Physiology* (1995–2010); *Journal of Biological Chemistry* (2011–2016, invited); *Proceedings of the National Academy of Sciences U.S.A.* (guest editor)

Journal Referee – (ongoing)

ACS Nano
American Journal of Physiology
Biochemical Journal

Biochemistry
Biochimica et Biophysica Acta
Bioorganic & Medicinal Chemistry

<i>Biophysical Journal</i>	<i>Journal of Physical Chemistry</i>
<i>Cellular & Molecular Life Sciences</i>	<i>Journal of Respiratory Cell & Molecular Biology</i>
<i>Chemical Biology & Drug Design</i>	<i>Journal of Virology</i>
<i>Chemical Reviews</i>	<i>Life Sciences</i>
<i>Chemical Senses</i>	<i>Metabolism: Clinical & Experimental</i>
<i>Chemistry & Biology</i>	<i>Metabolism: Clinical & Therapeutic</i>
<i>Chemistry--A European Journal</i>	<i>Molecular Biology & Evolution</i>
<i>Current Opinions in Chemical Biology</i>	<i>Molecular Cell</i>
<i>Diabetes</i>	<i>Molecular Genetics</i>
<i>EMBO Journal</i>	<i>Nature</i>
<i>Endocrinology</i>	<i>Nature Biotechnology</i>
<i>European Journal of Biochemistry</i>	<i>Nature Genetics</i>
<i>Experimental Eye Research</i>	<i>New England Journal of Medicine</i>
<i>FASEB Journal</i>	<i>Photochemistry & Photobiology</i>
<i>FEBS Journal</i>	<i>PLoS Biology</i>
<i>FEBS Letters</i>	<i>Proceedings of the National Academy of Sciences U.S.A.</i>
<i>Gene</i>	<i>Proceedings of the Royal Academy London B</i>
<i>Journal of the American Chemical Society</i>	<i>Protein Expression & Purification</i>
<i>Journal of Biological Chemistry</i>	<i>Proteins: Structure, Function & Bioinfor- matics</i>
<i>Journal of Clinical Investigation</i>	<i>Science</i>
<i>Journal of Experimental Medicine</i>	<i>Structure</i>
<i>Journal of General Physiology</i>	<i>The Hastings Center Report</i>
<i>Journal of Molecular Biology</i>	<i>Trends in Biochemical Sciences</i>
<i>Journal of Molecular Modeling</i>	<i>Trends in Pharmacological Sciences</i>
<i>Journal of Neuroscience</i>	<i>Visual Neuroscience</i>
<i>Journal of Pharmacology & Experimental Therapeutics</i>	
<i>Journal of Photochemistry and Photobiology</i>	

External Reviewer - (1991–present)

Austrian Science Fund (FWF)	NSF Biophysics Program
Cottrell College Science Award Program	NSF/Experimental Program to Stimulate Competitive Research (EPSCoR), Infrastructure Improvement Program, North Dakota
Department of the Army, Biochemistry & Neuroscience Research Branch	NSF Molecular Biochemistry Program
HHMI, International Grants Program	NSF Molecular Biology Program
International Human Frontier Science Program	NSF Neuroscience Program
Kentucky Science and Engineering Foun- dation	NSF Sensory Systems Program
Manitoba Health Research Council	Qatar National Research Fund
MRC Council's Triage: Molecular & Cellular Medicine Board (t-MCMB)	United States-Israel Binational Science Foundation
Netherlands Organization for Scientific Research (NWO)	The Washington Advisory Group, L.L.C. The Wellcome Trust

Peer Review Panels/Study Sections:

NIH Visual Sciences Study Section, *ad hoc* Reviewer (1992); NIH Visual Sciences C Study Section, Special Reviewer (1995, 1996); NIH Visual Sciences C Study Section, Special Reviewer (1998); NIH Molecular, Cellular & Development Neuroscience Study Section – 3, Spe-

cial Reviewer (1999); NIH Endocrinology Study Section, Special Reviewer (1999); NIH Pharmacology Study Section, Special Reviewer (2000); NIH BRT-A Review Committee, *ad hoc* Reviewer & Site Visitor (2000); NIH Visual Sciences C Study Section, Special Reviewer (2001); American Heart Association NEA5B Study Section (2005); NIH NIDDKD Board of Scientific Counselors, *ad hoc* Member (2005); NIH BDPE Study Section, *ad hoc* Reviewer (2005, 2006); NIH NIDCD Board of Scientific Counselors, *ad hoc* Member (2008); NIH NIDDKD Board of Scientific Counselors, *ad hoc* reviewer (2009); NIH Vascular Cell & Molecular Biology Study Section (VCMB), *ad hoc* reviewer (2010)

Other Review/Advisory Panels:

Industrial Advisory Board, NSF/Experimental Program to Stimulate Competitive Research (EPSCoR), Interdisciplinary Program in Signal Transduction, Medical University of South Carolina (1997); HHMI Research Training Fellowships for Medical Students Program (2001–2003); Radcliffe Institute for Advanced Study Advisory Committee (2003–2006); External Advisory Committee for the Center of Biomedical Research Excellence (COBRE) on Membrane Protein Production and Characterization (COMPPAC), NCCR/NIH Institutional Development Award Program, University of Delaware (2006–present); Tri-Institutional Embryonic Stem Cell Initiative ESCRO Committee (2008–present), chair (2009–2011); International Review Panel, Robarts Research Institute, University of Western Ontario, Canada (2011)

Consulting Activities (Industry):

Consultant, Merck & Co., Rahway, NJ (1996); Consultant, LeukoSite, Inc., Cambridge, MA (1998); Scientific Advisory Board, LeukoSite, Inc., Cambridge, MA (1998–1999); Consultant, Schering-Plough Research Institute, Kenilworth, NJ (1999–2001); Scientific Advisory Board (Founding Member), Natural Pharmaceuticals, Inc., Beverly, MA (1999–present); Consultant, Millennium Pharmaceuticals, Inc., Cambridge, MA (2000–2003); Consultant, Merck & Co., Rahway, NJ (2001); Consultant, Progenics Pharmaceuticals, Inc., Tarrytown, NY (2001–2003); MVM Life Science Partners, Boston, MA (2004); Scientific Advisory Board, NIH-U19 Program Project, Progenics Pharmaceuticals, Inc., Tarrytown, NY (2006–2008); Scientific Advisory Board (Founding Member), Resolvix Pharmaceuticals, Inc., Boston, MA (2006–2010); Scientific Advisory Board (Founding Member), Anchor Therapeutics, Inc., Boston, MA (2007–present); Consultant, Heptares Therapeutics, Hertfordshire, UK; Scientific Advisory Board, Albonia Innovative Technologies, Vancouver, Canada (2011–present)

Consulting Activities (Non-Profit, Educational and Governmental Organizations):

Physician Consultant, Rockefeller University Occupational Health Office (1997–2002, 2003–present); Consultant, “The Genomic Revolution” Exhibition, American Museum of Natural History, New York, NY (2001); Dolan DNA Learning Center <<http://vector.cshl.org/dnaftb/15/concept/index.html>>, Cold Spring Harbor Laboratory, NY (2001); Georgetown University Medical Center (2004–2006); United States Court of Appeals for the Second Circuit, Federal Bar Council American Inn of Court, Stem Cell Biology, Policy and Ethics, New York, NY (2007)

Board Memberships (Non-profit Organizations):

Trustee, Aaron Diamond AIDS Research Center, New York, NY (2002–2003); Member of the Governing Council, Rockefeller Archive Center, Sleepy Hollow, NY (2002–2003); Trustee, Rockefeller University Board of Trustees, New York, NY (2002–2003); Trustee, Aca-

demic Medical Development Corporation (AmDec), New York, NY (2002–2003); Trustee, Helen Hay Whitney Foundation (2003–present); Director, The Medical Letter (2004–2011); Board Member, United Nations International School (2011–present)

Named Lectureships / Plenary Lectures / Keynote Lectures:

May 1995	<i>Sonderforschungsbereich</i> Lecture, Albert-Ludwigs-Universität, Freiburg, Germany
June 1995	New Investigator Award Lecture, American Society for Photobiology, 23rd Annual Meeting, Washington, DC
March 1999	Dr. George W. Raiziss Biochemical Rounds, Department of Biochemistry & Biophysics, University of Pennsylvania, Philadelphia, PA
May 1999	<i>Sonderforschungsbereich</i> Lecture, Zelluläre Funktionen dynamischer Proteinwechselwirkungen, Albert-Ludwigs-Universität, Freiburg, Germany
October 2000	Merck Frosst Lecture, Great Lakes GPCR Symposium, London, Ontario, Canada
December 2001	Alfred E. Mirsky Holiday Lecture, Rockefeller University, New York, NY
April 2004	G-Protein Signaling Workshop - 2004, New York, NY
May 2005	Medicinal Chemistry Symposium, American Chemical Society Regional Meeting, Piscataway, NJ
May 2005	Allosteric Modulation of G Protein-Coupled Receptors Symposium, New York Academy of Sciences, New York, NY
October 2006	11 th International G-Protein Coupled Receptor Conference, IBC USA Symposium, Las Vegas, NV
March 2007	Rhodopsin and the G Protein Activation Cascade: a Special Journey with and for Marc Chabre, Nice, France
September 2007	Screening Targets Conference & Exhibition, SelectBiosciences Symposium, Boston, MA
November 2008	Section Days of the Life Sciences, Ruhr-University, Bochum, Germany (keynote)
October 2009	2009 Hyman Niznik Memorial Lectureship, 10 th Great Lakes GPCR Symposium, Rochester, NY (keynote)
November 2010	GPCR-based Drug Discovery, Discovery on Target (DoT) Conference, Boston, MA

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| November 2011 | Institute for Research in Immunology & Cancer, Distinguished Scientist Lecture Series, Université de Montréal, Montréal, Quebec, Canada |
| February 2012 | Biophysical Society Annual Meeting, San Diego, CA |
| November 2012 | Biophysical Society thematic meeting, Lipid-protein Interactions in Membranes: Implications for Health and Disease, Hyderabad, India |

Symposia Organized:

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| June 1992 | Symposium on "Bacterial Rhodopsins & Visual Pigments," American Society for Photobiology Meeting, Marco Island, FL |
| June 1998 | Symposium on "Photochemistry and Photobiology of Visual Pigments," American Society for Photobiology Meeting, Salt Lake City, UT |
| July 1998 | Symposium on "Phototransduction Proteins," 13th International Congress of Eye Research, Paris, France |

Symposium Organizing Committees:

G-Protein Signaling Workshop, New York, NY (2004); G-Protein Signaling Workshop, Philadelphia, PA (2006); 8th International Symposium on Biochemical Roles of Eukaryotic Cell Surface Macromolecules, Hyderabad, India (2008); G-Protein Signaling Workshop, New York, NY (2008); Pepducin Science Symposium, Cambridge, MA (2009); G-Protein Signaling Workshop, Philadelphia, PA (2010); Gordon Research Conference on Photosensory Receptors and Signal Transduction, Il Cioco, Italy (2010); Pepducin Science Symposium-2, Cambridge, MA (2010); From Innovations in Nucleic Acids Research to Regulation of Biological Processes, Bangalore, India (2011); International Advisory Committee on Retinal Proteins, Ascona, Switzerland (2012); Harnessing Nature's High Performance Materials for Biomedical Applications, Stockholm, Sweden (2012); G-Protein Signaling Workshop, New York, NY (2012); Co-Chairman, Informa Biosciences Conference, Drug Discovery: Targets and Tools: G Protein-Coupled Receptors, Berlin, Germany (2012)

Selected Invited Scientific Presentations:

Walter Reed Institute of Research, Washington, DC (1979); Gordon Research Conference, Molecular Pharmacology Plymouth, NH (1986); Praxis Biologics, Rochester, NY (1987); Applied Biosystems DNA Synthesis Users Meeting, Las Vegas, NV (1988); Gordon Research Conference, Molecular Pharmacology, Tilton, NH (1989); Department of Heart & Hypertension Research, Cleveland Clinic Foundation, Cleveland, OH (1990); Department of Biochemistry & Molecular Pharmacology, Harvard Medical School, Boston, MA (1990); Berman-Gund Laboratory Seminar Series, Harvard Medical School, Massachusetts Eye & Ear Infirmary

ry, Boston, MA (1990); 9th International Congress of Eye Research, Helsinki, Finland (1990); International Symposium on Signal Transduction in Photoreceptor Cells, Jülich, Germany (1990); Cardiac Unit Research Seminar Series, Massachusetts General Hospital, Boston, MA (1990); Lederle Laboratories, American Cyanamid, Pearl River, NY (1991); Department of Microbiology, Cornell Medical College, New York, NY (1991); Gordon Research Conference, Signal Transduction in Microorganisms, (discussion leader), Oxnard, CA (1992); Vth International Conference on Retinal Proteins, Dourdan, France (1992); Department of Neuroscience, Roche Institute of Molecular Biology, Nutley, NJ (1992); International Symposium on Nucleic Acids & Membranes, Vancouver, British Columbia, Canada (1993); VIth International Conference on Retinal Proteins, Leiden, Netherlands (1994); VIIIth International Conference on Retinitis Pigmentosa, Paris, France (1994); Program in Cell & Molecular Biology, State University of New York, Health Science Center, Syracuse, NY (1995); Center for Biologics Evaluation & Research, Food & Drug Administration, Bethesda, MD (1995); Department of Physiology & Biophysics Lecture, Cornell University Medical College, New York, NY (1995); IBC International Symposium, Structure & Function of G Protein-Coupled Receptors, Philadelphia, PA (1995); Neuroscience Seminar Series, Albert Einstein College of Medicine, Bronx, NY (1996); VIIth International Conference on Retinal Proteins (session chair), Zichron Yaacov, Israel (1996); Department of Pharmacology Lecture, University of West Virginia Medical School, Morgantown, WV (1996); Basic Research Seminar Series, Aaron Diamond AIDS Research Center, New York, NY (1996); Neurowissenschaftliches Kolloquium, Humboldt-Universität, Berlin, Germany (1996); Biophysikalishes Hauptseminar, Albert-Ludwigs-Universität, Freiburg, Germany (1996); Biophysics Department Lecture, UC-Irvine, Irvine, CA (1997); US-Japan Seminar on the Structural Basis of Information Transduction in Rhodopsins, Kyoto, Japan (1997); Nagoya University Special Seminar on Retinal Proteins, Nagoya, Japan (1997); Department of Biochemistry, Mt. Sinai School of Medicine, New York, NY (1997); American Chemical Society, Division of Computers In Chemistry Symposium, Las Vegas, NV (1997); Program in Signal Transduction Lecture, Medical University of South Carolina, Charleston, SC (1997); Biochemistry Department, University of Maryland, Baltimore, MD (1998); Pharmacology Department, Columbia P & S, New York, NY (1998); Vision Training Grant Program, University of Washington, Seattle, WA (1998); US Endocrine Society Annual Meeting, New Orleans, LA (1998); American Society for Photobiology Meeting, Salt Lake City, UT (1998); 13th International Congress of Eye Research, Paris, France (1998); Novartis Foundation Symposium, Kyoto, Japan (1998); Jules Stein Eye Institute, University of California at Los Angeles, Los Angeles, CA (1998); Structural Biology Seminar, University of California at Berkeley, Berkeley, CA (1999); Physiology Department Seminar, University of Texas - Southwestern, Dallas, TX (1999); FASEB Meeting, Biology and Chemistry of Vision, Copper Mountain, CO (1999); American Society for Photobiology Meeting, Washington, DC (1999); Fifth International Dahlem Symposium on "Cellular Signal Recognition and Transduction," Berlin, Germany (1999); 3-Dimensional Pharmaceuticals, Inc., Philadelphia, PA (2000); Gordon Research Conference, Biology and Chemistry of Peptides, Ventura, CA (2000); Natural Pharmaceuticals, Inc., Cambridge, MA (2000); Millennium Pharmaceuticals, Inc., Cambridge, MA (2000); International Symposium on Nucleic Acids and Signal Transduction, Waltham, MA (2000); Division of Medicinal Chemistry Lecture, American Chemical Society National Meeting, San Diego, CA (2001); Merck Research Laboratories, Inc., Rahway, NJ (2001); Colloquium on Biology of Aging, MBL, Woods Hole, MA (2001); Department of Biophysics Lecture, University of Rochester Medical School, New York, NY (2001); Committee on Cell Physiology, University of Chicago, Chicago, IL (2001); Seminars in Clinical Research, Rockefeller University, New York, NY (2001); Endocrine Unit, Massachusetts General Hospital, Boston, MA (2001); GPCRs in

Drug Discovery & Development, Philadelphia, PA (2002); Department of Biochemistry, University of Delaware, Newark, DE (2002); Department of Molecular and Cell Biology, University of Connecticut, Storrs, CT (2002); Department of Pathology Lecture, Northwestern University Medical School, Chicago, IL (2002); Adrenoceptor 2002 Symposium, IUPHAR XIVth World Congress of Pharmacology, Napa Valley, CA (2002); XIIth International Conference on Retinal Proteins, Seattle, WA (2002); Gordon Research Conference on Photosensory Receptors & Signal Transduction, Barga, Italy (2002); Victor Chang Cardiac Research Institute, Darlinghurst, Australia (2002); Peking Union Medical College, Beijing, China (2002); Society for Neuroscience Satellite Symposium, Orlando, FL (2002); Department of Biochemistry and Cell Biology, University of Connecticut, Storrs, CT (2003); International Symposium on Vibrational Spectroscopy, Freiburg University, Freiburg, Germany (2003); Twenty-first Annual Stony Brook Symposium, Stony Brook, NY (2003); Department of Chemistry and Biochemistry, University of Delaware, Newark, DE (2003); Institute for Biophysics, Humboldt University, Berlin, Germany (2003); Biochemistry & Molecular Biophysics Department, Columbia P & S, New York, NY (2004); Medicine Grand Rounds, Weill-Cornell Medical College, New York, NY (2005); Keystone Symposium, G Protein-Coupled Receptors: Evolving Concepts and New Techniques, Keystone, CO (2006); Gordon Conference on Photosensory Receptors and Signal Transduction, Il Ciocco, Italy (2006); AChemS Symposium, Sarasota, FL (2006); Department of Chemistry, City College of New York, New York, NY (2006); Department of Pharmacology, Case Western Reserve University, Cleveland, OH (2006); Hoffmann-La Roche, Inc., Nutley, NJ (2006); Department of Biochemistry, Medical College of Wisconsin, Milwaukee, WI (2006); Ellison Foundation Colloquium on Aging, Woods Hole, MA (2006); Department of Biochemistry, Thomas Jefferson School of Medicine, Philadelphia, PA (2007); D.E. Shaw Research Seminar Series, New York, NY (2007); FASEB Summer Research Conference on the Biology & Chemistry of Vision, Snowmass Village, CO (2007); Department of Chemistry, Yale University, New Haven, CT (2007); Department of Structural Biology, Mt. Sinai School of Medicine, New York, NY (2008); Departments of Biochemistry and Pharmacology, UT-Southwestern Medical Center, Dallas, TX (2008); Molecular Pharmacology of G Protein-Coupled Receptors, Sydney, Australia (2008); SFB740 Lecture, Charité Universitätsmedizin, Berlin, Germany (2008); Department of Biophysics, Ruhr-University, Bochum, Germany (2008); Department of Pharmacology, Columbia University, New York, NY (2009); Pepducin Science Symposium, Cambridge, MA (2009); 33rd Steenbock Symposium, University of Wisconsin, Madison, WI (2009); Ophthalmology Grand Rounds, Columbia College of Physicians and Surgeons, New York, NY (2009); Max-Planck-Forschungsstelle für Enzymologie der Proteinfaltung, Halle (Salle), Germany (2010); Informa Biosciences Conference, Drug Discovery: Targets and Tools: G Protein-Coupled Receptors, Berlin, Germany (2010); Novo Nordisk Foundation Center for Basic Metabolic Research, University of Copenhagen, Denmark (2010); Gordon Conference on Photosensory Receptors and Signal Transduction, Il Ciocco, Italy (2010); 14th International Conference on Retinal Proteins, Santa Cruz, CA (2010); Gordon Conference on Molecular Pharmacology, Ventura, CA (2011); Keystone Symposium on Mechanisms of Transmembrane Signaling, Taos, NM (2011); Chemistry Club, Yeshiva University Stern College for Women, New York (2011); Molecular Pharmacology of Receptors, Channels and Transporters, Würzburg, Germany (2011); Novo Nordisk A/S, Copenhagen, Denmark (2011); Department of Biochemistry, University of Freiburg, Freiburg, Germany (2011); Paul Scherrer Institut, Villigen, Switzerland (2011); Institute for Molecular and Cell Biology, Porto, Portugal (2011); MPI Institute of Molecular Cell Biology & Genetics, Dresden, Germany (2011); MPI Institute for Molecular Physiology, Dortmund, Germany (2011); Department of Biochemistry, University of Toronto, Toronto, Canada (2011); Gordon Conference on Photosensory Receptors and Signal Transduction, Galves-

ton, TX (2012); Biophysical Society Annual Meeting, San Diego, CA (2012); Department of Neurobiology, Care Sciences & Society, Karolinska Institute, Stockholm, Sweden (2012); Informa Biosciences Conference, Drug Discovery: Targets and Tools: G Protein-Coupled Receptors, Berlin, Germany (2012); Department of Chemistry, Franklin & Marshall College, Lancaster, PA (2012); 7th International Meeting, Molecular Pharmacology of G Protein-Coupled Receptors 2012, Melbourne, Australia (2012)

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Post-Doctoral Trainees:

1991 – 1993	Padmaja Deval	Indian Institute of Technology, Bombay
1991 – 1994	Karim Fahmy	Freiburg University, Freiburg, Germany
1992 – 1996	Tatyana Zyvaga	Shemyakin Institute, Russia
1994 – 1999	Steven W. Lin	University of California at Berkeley
1994 – 1997	Stephen A. Gravina	Case Western Reserve University
1994 – 1995	Sophia Arnis	Freiburg University, Freiburg, Germany
1994 – 1998	Lenore A. Snyder	City University of New York
1996 – 1997	May Han	Yale University
1996 – 1998	Qing Zeng	Louisiana State University
1998 – 2003	A. Gopal Krishna	Indian Institute of Technology, Poona
1999 – 2009	T. R. Santosh Menon	Indian Institute of Technology, Bangalore
1999 – 2003	Belinda S. W. Chang	Harvard University
1999 – 2002	Youwei Jiang	City University of New York
1999 – 2008	Christoph Seibert	Humboldt University, Berlin
2000 – 2003	Soma De	Indian Institute of Technology, Bangalore
2000 – 2007	Elsa Yan	Columbia University
2001 - 2002	Jian-Min Hou	Peking University, Peking, China
2002 – 2003	Christopher Heise	University of Virginia
2002 –	Thomas Huber	University of Munich, Munich, Germany
2002 – 2010	Pallavi Sachdev	City University of New York
2002 – 2003	Jian-nong Feng	Rockefeller University

2003 – 2004	Andre Hoelz	Rockefeller University
2004 – 2007	Jay Janz	Oregon Health and Science University
2004 – 2009	Shixin Ye	University of Pennsylvania
2005 – 2006	Michael Rosconi	SUNY–Stony Brook
2008 – 2009	Fabien Décaillot	Louis Pasteur University, Strasbourg, France
2008 – 2011	Ruchi Gupta	SUNY–Stony Brook
2008 –	Saranga Naganathan	University of Maryland–College Park
2009 – 2010	Parag Mukhopadhyay	Duke University
2010 –	Kelly Daggett	University of Maryland–College Park
2010 – 2011	Neeraj Kapoor	Rockefeller University
2010 –	Sarmistha Ray	Yale University
2011 –	W Vallen Graham	University of Chicago
2011 – 2011	Katja Stehfest	Humboldt University, Berlin
2011 –	Minyoung Park	Stanford University, Stanford, CA
2011 –	Yamina Berchiche	Université de Montréal, Montréal, Canada

Graduate Student Trainees (M.D.-Ph.D. and Ph.D. Programs):

1991 – 1996	K. Christopher Min	Harvard College
1994 – 1999	Aaron M. Cypess	Princeton
1996 – 2001	Ethan P. Marin	Williams College/University of Michigan
2002 – 2003	Andre Hoelz	Freiburg University
2003 – 2004	Adrian Lee	University of Toronto
2004 – 2008	Sourabh Banerjee	Indian Institute of Technology, Delhi
2005 – 2005	Nikhil Singla	Cambridge University
2005 – 2010	Neeraj Kapoor	Indian Institute of Technology, Kanpur
2008 –	Amy Grunbeck	Dickinson College
2009 –	Adam Knepp	Stanford University
2010 –	He Tian	Peking University
2010 –	Louise Valentin-Hansen	Copenhagen University
2011 –	Jennifer Peeler	Franklin & Marshall College
2011 –	Carlos Rico	Hamilton College

Rotation Graduate Students, Undergraduate & High School Student Trainees:

Theresa Chan	Smith College	Mareike Beck	Freiburg University
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Matthew Albert	Brown University	Nikhil Singla	Cambridge University
Nina Kim	Harvard College	David Kastner	Yeshiva University
Mariya Minkova	M.I.T.	Melissa Rampino	New York University
Yu Wong	University of Chicago	Brian Zoltowski	Cornell University
Kate Carroll	UC-Berkeley	Amrita Hazra	Cornell University
Richard Lee	Duke University	Marshall Miller	Oregon State University
Dorothy Wang	Harvard College	Jackie Wurst	Cornell University
Thomas Nguyen	Harvard College	Guilio Quarta	New York University
Juergen Isele	Freiburg University	M. Chandramouli	New York University
Evan Muse	Univ. of North Carolina	Disan Davis	Carlton College
Angie You	Harvard College	Dennis Kappei	École Normale Supérieure
Oliver Ernst	Freiburg University	Aditi Bhagat	Hunter College
Eugene Simuni	Harvard College	Amy Grunbeck	Cornell University
V. Archambault	McGill University	M. Mahalingam	Freiburg University
Karolina Jönsson	Univ. of Kalmar	Adam Knepp	Stanford University
Tracy Terry	Stanford University	He Tien	Cornell University
Heather Baker	Cornell University	Kriti Thapa	University of Rochester
Qian Yin	Cornell University	Jake Fried	Ramaz High School
Nicole Lehmann	Freiburg University	Jennifer Peeler	Franklin & Marshall College
Steffen Luedeke	Freiburg University	Emily Brown	Swarthmore College
Tobias Stuwe	Heidelberg University	Carlos A. Rico	Hamilton College
Kathryn Morris	University of Michigan	Annika Borrman	Radboud University

Publications

Patents:

- 1). **Sakmar, T. P., Huber, T. & Banerjee, S.** Nanoscale Bound Bilayers, Methods of Use and Production.
WO 2009/097587 A2, 6 August 2009. RU870.
- 2). Volkman, B.F., Veldkamp, C.T., Peterson, F.C., **Sakmar, T. P. & Seibert, C.** Engineered CXCL 12 Alpha Locked Dimer Polypeptide.
USPTO 12/380,30, 26 February 2009. RU898.
- 3). **Sakmar, T. P., Menon, S.T., Kapoor, N., Gupta, R. & Raleigh, D.** Nucleobindin I Variant Protein Compositions and Methods of Use.
WO 2010/009330 A, 21 January 2010. RU859.
- 4). **Sakmar, T. P., Huber, T. & Knepp, A.** Methods to Increase the Yield of Labeled Peptides.
Pending. RU933.

Books:

- 1). **Sakmar, T. P.,** Gardner, P. & Peterson, G. N. Health Guide for International Travelers. Passport Books, National Textbook Co., Lincolnwood, IL. 143 pp. (1989, reprinted 1991).
- 2). **Sakmar, T. P.,** Gardner, P. & Peterson, G. N. Health Guide for International Travelers. 2nd edition. Passport Books, National Textbook Co., Lincolnwood, IL. 171 pp. (1994).

Research Articles, Review Articles, Book Chapters, Commentaries (excluding Abstracts):

Bethesda:

- 1). Liu, T. -Y., Seid, R. C., Tai, J. Y., Liang, S. -M., **Sakmar, T. P.** & Robbins, J. B. Studies on Limulus Lysate Coagulating System.
Prog Clin Biol Res **29**:147–158 (1979).
- 2). Liu, T. -Y., Seid, R. C., Tai, J. Y., Liang, S. -M., **Sakmar, T. P.** & Robbins, J. B. Studies on Limulus Lysate Coagulating System. in *Biomedical Applications of the Horseshoe Crab (Limulidae)* (Cohen, E. B., ed.) Alan R. Liss, Inc., New York, pp. 147–158 (1979).
- 3). Liang, S. M., **Sakmar, T. P.** & Liu, T. -Y. Purification of an Endotoxin-Binding Protein from Limulus Amoebocyte Membranes.
J Biol Chem **255**:5586–5590 (1980).

Chicago:

- 4). Randolph, A., **Sakmar, T. P.** & Heinrikson, R. L. Phospholipases A₂ - Structure, Function, and Evolution.
in *Frontiers in Protein Chemistry* (Liu, T. -Y. & Yasunobu, K., eds.) Elsevier, Amsterdam, pp. 297–322 (1980).
- 5). Seid, R. C., Jr. & **Sakmar, T. P.** A Differential Labeling Model for Determining the Number of Catalytically Essential Carboxyl Groups in Fumarase.
Biochim Biophys Acta (BBA) Enzymology **662**:196–201 (1981).

Boston:

- 6). Ackerman, R. H., Richardson, E. P., Davis, K. R., Boom, W. H., **Sakmar, T. P.** & Haley, E. C. Abrupt Onset of Headache Followed by Rapidly Progressive Encephalopathy in a 30-Year Old Woman - Angiitis of Central Nervous System (CPC).
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Cambridge:

- 7). Oprian, D., **Sakmar, T. P.**, Nakayama, T., Chen, H. -B., Knox, B., Karnik, S., Franke, R. & Khorana, H. G. Molecular Biological Studies of the Visual Pigment, Rhodopsin.
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 - 8). Karnik, S. S., **Sakmar, T. P.**, Franke, R. R., Knox, B. E., Oprian, D. D., Chen, H. -B. & Khorana, H. G. Site-Specific Mutagenesis of Bovine Rhodopsin.
in *Molecular Biology of the Eye: Genes, Vision and Ocular Disease* (Piatigorsky, J., Zelenka, P., & Shinohara, T., eds.), Alan R. Liss, Inc., New York, pp. 23–34 (1988).
 - 9). Franke, R. R., **Sakmar, T. P.**, Graham, R. M. & Khorana, H. G. Structure-Function Studies of Bovine Rhodopsin: Interactions with Transducin.
in *Molecular Biology of the Eye: Genes, Vision and Ocular Disease* (Piatigorsky, J., Zelenka, P. & Shinohara, T., eds.), Alan R. Liss, Inc., New York, pp. 45–52 (1988).
 - 10). Braiman, M., Bubis, J., Doi, T., Chen, H. -B., Flitsch, S. L., Franke, R. R., Gilles-Gonzalez, M. A., Graham, R. M., Karnik, S. S., Khorana, H. G., Knox, B. E., Krebs, M. P., Marti, T., Mogi, T., Nakayama, T., Oprian, D. D., Puckett, K. L., **Sakmar, T. P.**, Stern, L. J., Subramaniam, S. & Thompson, D. A. Studies on Light Transduction by Bacteriorhodopsin and Rhodopsin.
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 - 11). Franke, R. R., **Sakmar, T. P.**, Oprian, D. D. & Khorana, H. G. A Single Amino Acid Substitution in Rhodopsin (Lysine 248 → Leucine) Prevents Activation of Transducin.
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 - 12). **Sakmar, T. P.** & Khorana, H. G. Total Synthesis and Expression of a Gene for the α -Subunit of Bovine Rod Outer Segment Guanine Nucleotide-Binding Protein (Transducin).
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 - 13). Karnik, S. S., **Sakmar, T. P.**, Chen, H. -B. & Khorana, H. G. Cysteine Residues 110 and 187 are Required for the Formation of Correct Structure in Bovine Rhodopsin.
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- 14). **Sakmar, T. P.**, Franke, R. R. & Khorana, H. G. Glutamic Acid 113 Serves as the Retinylidene Schiff Base Counterion in Bovine Rhodopsin.
Proc Natl Acad Sci U S A **86**:8309–8313 (1989). PMID: PMC298270
- 15). Franke, R. R., König, B., **Sakmar, T. P.**, Khorana, H. G. & Hofmann, K. P. Rhodopsin Mutants That Bind But Fail to Activate Transducin.
Science **250**:123–125 (1990).
- 16). **Sakmar, T. P.**, Franke, R. R. & Khorana, H. G. The Role of the Retinylidene Schiff Base Counterion in Rhodopsin in Determining Wavelength Absorbance and Schiff Base pKa.
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- 17). Franke, R. R., **Sakmar, T. P.**, Graham, R. M. & Khorana, H. G. Structure and Function in Rhodopsin. Studies of the Interaction Between the Rhodopsin Cytoplasmic Domain and Transducin.
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New York (Sakmar laboratory members in **bold**):

- 20). **Chan, T., Lee, M. & Sakmar, T. P.** Introduction of Hydroxyl-Bearing Amino Acids Causes Bathochromic Spectral Shifts in Rhodopsin: Amino Acid Substitutions Responsible for Red-Green Color Pigment Spectral Tuning.
J Biol Chem **267**:9478–9480 (1992).
 - 21). **Sakmar, T. P.** The Traveler's Medical Kit.
Infect Dis Clin North Am **6**:355–370 (1992).
 - 22). **Sakmar, T. P., Fahmy, K., Chan, T. & Lee, M.** Mutagenesis Studies of Rhodopsin Photo-transduction.
in *Structures and Functions of Retinal Proteins* (Rigaud, J. L., ed.) Libbey, London, pp. 67-70 (1992).
 - 23). **Zvyaga, T. A., Min, K. C., Beck, M. & Sakmar, T. P.** Movement of the Retinylidene Schiff Base Counterion in Rhodopsin by One Helix Turn Reverses the pH Dependency of the Metarhodopsin I to Metarhodopsin II Transition.
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 - 24). **Min, K. C., Zvyaga, T. A., Cypess, A. M. & Sakmar, T. P.** Characterization of Mutant Rhodopsins Responsible for Autosomal Dominant Retinitis Pigmentosa. Mutations on the Cytoplasmic Surface Affect Transducin Activation.
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- 25). **Fahmy, K. & Sakmar, T. P.** Regulation of the Rhodopsin-Transducin Interaction by a Highly Conserved Carboxylic Acid Group.
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 - 26). **Fahmy, K. & Sakmar, T. P.** Light-Dependent Transducin Activation by an Ultraviolet-Absorbing Rhodopsin Mutant.
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 - 27). **Fahmy, K., Jäger, F., Beck, M., Zvyaga, T. A., Sakmar, T. P. & Siebert, F.** Protonation States of Membrane-Embedded Carboxylic Acid Groups in Rhodopsin and Metarhodopsin II: A Fourier-Transform Infrared Spectroscopy Study of Site-Directed Mutants.
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 - 29). **Zvyaga, T. A., Fahmy, K. & Sakmar, T. P.** Characterization of Rhodopsin-Transducin Interaction: A Mutant Rhodopsin Photoproduct with a Protonated Schiff Base Activates Transducin.
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 - 30). **Arnis, S., Fahmy, K., Hofmann, K. P. & Sakmar, T. P.** A Conserved Carboxylic Acid Group Mediates Light-Dependent Proton Uptake and Signaling by Rhodopsin.
J Biol Chem **269**:23879–23881 (1994).
 - 31). Jäger, F., **Fahmy, K., Sakmar, T. P.** & Siebert, F. Identification of Glutamic Acid 113 as the Schiff Base Proton Acceptor in the Metarhodopsin II Photointermediate of Rhodopsin.
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 - 32). **Carruthers, C. J. L., Unson, C. G., Kim, H. N. & Sakmar, T. P.** Synthesis and Expression of a Gene for the Rat Glucagon Receptor. Replacement of an Aspartic Acid in the Extracellular Domain Prevents Glucagon Binding.
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 - 33). **Fahmy, K., Siebert, F. & Sakmar, T. P.** A Mutant Rhodopsin Photoproduct with a Protonated Schiff Base Displays an Active-state Conformation: a Fourier-Transform Infrared Spectroscopy Study.
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- 36). **Ernst, O., Hofmann, K. P. & Sakmar, T. P.** Characterization of Rhodopsin Mutants That Bind Transducin But Fail To Induce GTP Nucleotide Uptake: Classification of Mutant Pigments by Fluorescence, Nucleotide Uptake, and Light-Scattering Assays.
J Biol Chem **270**:10580–10586 (1995).
 - 37). **Fahmy, K., Siebert, F. & Sakmar, T. P.** The Photoactivated State of Rhodopsin and How It Can Form.
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 - 38). Garcia, P. D., Onrust, R., Bell, S. M., **Sakmar, T. P.** & Bourne, H. R. Transducin- α Carboxyl-Terminal Mutations Prevent Activation by Rhodopsin: A New Assay Using Recombinant Proteins Expressed in Cultured Cells.
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 - 40). **Fahmy, K., Siebert, F. & Sakmar, T. P.** Molecular Determinants of the Active Conformation of Rhodopsin Studied by Attenuated Total Reflectance FTIR Difference Spectroscopy.
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in *Sixth European Conference on the Spectroscopy of Biological Molecules* (Merlin, J. C., Turrell, S. & Huvenne, J. P., eds.) Kluwer Academic Publishers, Dordrecht, Netherlands, pp. 173–174 (1995).
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Israel J Chem **35**:325–338 (1995).
 - 43). Unson, C. G., **Cypess, A. M.,** Wu, C. -R., Goldsmith, P. K., Merrifield, R. B. & **Sakmar, T. P.** Antibodies Against Specific Extracellular Epitopes of the Glucagon Receptor Block Glucagon Binding.
Proc Natl Acad Sci U S A **93**:310–315 (1996). PMID: PMC40228
 - 44). **Zvyaga, T. A., Fahmy, K., Siebert, F. & Sakmar, T. P.** Characterization of the Mutant Visual Pigment Responsible for Congenital Night Blindness: a Biochemical and Fourier-Transform Infrared Spectroscopy Study.
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