

METHODS IN MOLECULAR BIOLOGY™

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Dopamine

Methods and Protocols

Edited by

Nadine Kabbani

*Department of Molecular Neuroscience, Krasnow Institute for Advanced Study,
George Mason University, Fairfax, VA, USA*

Editor

Nadine Kabbani
Department of Molecular Neuroscience
Krasnow Institute for Advanced Study
George Mason University
Fairfax, VA, USA

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Cover illustration: The image depicts a whole mount adult *Drosophila* brain triple-labeled with rabbit anti-GFP antibody (green), mouse anti-FasII (1D4) antibody (red) and DAPI (blue) which mark the dopaminergic neurons (revealed by genetically labeling with *ple-GAL4,UAS-mCDS::GFP*), axon tracts of the mushroom bodies and the central complex, and all brain cell nuclei, respectively. Note in the merged image the projections of dopamine neurons to areas of the mushroom body, the *Drosophila* center for learning and memory, and to the central complex, which contributes to the regulation of locomotion. (See Chapter 13.)

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Preface

Dopamine, a catecholamine transmitter, plays a number of important physiological roles in the brain and body. Clues to dopamine's role in motivation and learning have come from over 50 years of studies in laboratory animals, which have included rodents and nonhuman primates. In more recent years, studies on the role of dopamine in disease have opened new avenues of research and discovery. Genetic cloning has further enabled studies of dopamine in other species such as *Drosophila melanogaster* and *Danio rerio*. This edition of *Methods in Molecular Biology* brings together and provides detailed protocols on leading approaches in the study of dopamine within biological systems.

In the brain, dopamine functions as a key neurotransmitter in regions such as the cortex and striatum. Dopamine is also an important modulator of ion balance in the kidney and adaptation to light in the retina. The many effects of dopamine on physiological systems and organs are dependent on a class of receptors, which are coupled to heterotrimeric G proteins. In mammals, five dopamine receptors (D1–D5) have been identified. A fundamental aspect of dopamine function is the localization of these receptors at the membrane, their interaction with signaling and regulatory molecules, and their ability to assemble into higher-order receptor oligomers (with dopamine and non-dopamine receptors) within cells.

In many species, dopamine plays a major role in reward-driven learning. Indeed, almost every type of reward that has been studied increases dopamine transmission in the brain, and a variety of highly addictive drugs, including stimulants such as cocaine and methamphetamine, act directly on the dopamine system. Several prominent diseases of the nervous system are associated with dopamine. In particular, alterations in dopamine levels are intimately linked with the onset and progression of Parkinson's disease, which results from the death of dopaminergic neurons within the substantia nigra. Schizophrenia, a disease of multiple genes and origins, has long been linked to dopamine imbalances within the striatum and cortex with the majority of classical antipsychotic drugs acting as antagonists at D2 receptors and many newer generation antipsychotics maintaining an effect on D4 receptors.

This book is of interest to a range of scientists including cellular and molecular biologists, electrophysiologists, and pharmacologists. The chapters are intended for students and experts alike and for anyone interested in exploring the vast field of dopamine research. The book is divided into four parts based on methods: cellular/biochemical, imaging, genetics, and electrophysiology. Presented are chapters with step-by-step, clear, and precise instructions for various research procedures. This includes protocols for bioluminescence and fluorescence imaging, receptor immunoprecipitation and proteomic analysis, creation and characterization of a mouse model of Parkinson's disease, real-time measurement of dopamine in the brain, and modeling signal transduction in silico.

This volume is the product of contributions from experts and key figures within the field. I would like to thank the authors for their outstanding work and cooperation during the preparation of the volume. Specifically, I would like to thank the series editor, Professor John Walker, for his support during the assembly of this book.

Nadine Kabbani, Ph.D.

Contents

<i>Preface</i>	<i>v</i>
<i>Contributors</i>	<i>ix</i>

PART I BIOCHEMICAL, PROTEOMIC, AND COMPUTATIONAL TOOLS

1	Detection of Cell Surface Dopamine Receptors	3
	<i>Jiping Xiao and Clare Bergson</i>	
2	Methods for the Study of Dopamine Receptors Within Lipid Rafts of Kidney Cells	15
	<i>Peiyong Yu, Van Anthony Villar, and Pedro A. Jose</i>	
3	Methods of Dopamine Research in Retina Cells	25
	<i>Ana Lucia Marques Ventura, Fernando Garcia de Mello, and Ricardo Augusto de Melo Reis</i>	
4	Capture of D2 Dopamine Receptor Signaling Complexes in Striatal Cells for Mass Spectrometry Proteomic Analysis	43
	<i>Nadine Kabbani and Jacob C. Nordman</i>	
5	Modeling Spatial Aspects of Intracellular Dopamine Signaling	61
	<i>Kim T. Blackwell, Lane J. Wallace, BoHung Kim, Rodrigo F. Oliveira, and Wonryull Koh</i>	

PART II CELLULAR IMAGING

6	A Biophysical Approach for the Study of Dopamine Receptor Oligomerization	79
	<i>Sylvia Lukaszewicz, Agata Faron-Górecka, and Marta Dziedzicka-Wasylewska</i>	
7	Detection of Receptor Heteromers Involving Dopamine Receptors by the Sequential BRET-FRET Technology	95
	<i>Gemma Navarro, Peter J. McCormick, Josefa Mallol, Carme Lluís, Rafael Franco, Antoni Cortés, Vicent Casadó, Enric I. Canela, and Sergi Ferré</i>	
8	BRET Approaches to Characterize Dopamine and TAAR1 Receptor Pharmacology and Signaling	107
	<i>Stefano Espinoza, Bernard Masri, Ali Salahpour, and Raul R. Gainetdinov</i>	
9	Dopaminergic Regulation of Dendritic Calcium: Fast Multisite Calcium Imaging	123
	<i>Wen-Liang Zhou, Katerina D. Oikonomou, Shaina M. Short, and Srdjan D. Antic</i>	

PART III GENETIC MANIPULATION IN CELLS AND ORGANISMS

- 10 Functional Analysis of Human D1 and D5 Dopaminergic G Protein-Coupled Receptors: Lessons from Mutagenesis of a Conserved Serine Residue in the Cytosolic End of Transmembrane Region 6 141
Bianca Plouffe and Mario Tiberi
- 11 A Molecular Genetic Approach to Uncovering the Differential Functions of Dopamine D2 Receptor Isoforms 181
Yanyan Wang, Toshikuni Sasaoka, and Mai T. Dang
- 12 Genomic Strategies for the Identification of Dopamine Receptor Genes in Zebrafish 201
Wendy Boehmler, Jessica Petko, Victor A. Canfield, and Robert Levenson
- 13 Application of Cell-Specific Isolation to the Study of Dopamine Signaling in *Drosophila* 215
Eswar Prasad R. Iyer, Srividya Chandramouli Iyer, and Daniel N. Cox

PART IV ELECTROCHEMICAL, PHYSIOLOGICAL, AND BEHAVIORAL ANALYSIS

- 14 Regulation of Dopamine Transporter Expression by Neuronal Activity 229
Shalini Padmanabhan, Thach Pham, and Balakrishna M. Prasad
- 15 Monitoring Axonal and Somatodendritic Dopamine Release Using Fast-Scan Cyclic Voltammetry in Brain Slices 243
Jyoti C. Patel and Margaret E. Rice
- 16 Real-Time Chemical Measurements of Dopamine Release in the Brain 275
James G. Roberts, Leyda Z. Lugo-Morales, Philip L. Loziuk, and Leslie A. Sombers
- 17 The MPTP/Probenecid Model of Progressive Parkinson's Disease 295
Anna R. Carta, Ezio Carboni, and Saturnino Spiga
- Index* 309

Contributors

- SRDJAN D. ANTIC • *Department of Neuroscience, University of Connecticut Health Center, Farmington, CT, USA*
- RICARDO AUGUSTO DE MELO REIS • *Laboratory of Neurochemistry, Program in Neurobiology IBCCF, UFRJ, Rio de Janeiro, Brazil*
- KIM T. BLACKWELL • *The Krasnow Institute for Advanced Study, George Mason University, Fairfax, VA, USA*
- CLARE BERGSON • *Department of Pharmacology and Toxicology, Georgia Health Sciences University, Augusta, GA, USA*
- WENDY BOEHLER • *Department of Biological Sciences, York College of Pennsylvania, York, PA, USA*
- ENRIC I. CANELA • *Department of Biochemistry and Molecular Biology, Faculty of Biology, University of Barcelona, Barcelona, Spain*
- VICTOR A. CANFIELD • *Department of Pharmacology, Penn State College of Medicine, Hershey, PA, USA*
- EZIO CARBONI • *Department of Biomedical Sciences, University of Cagliari, Cagliari, Italy*
- ANNA R. CARTA • *Department of Biomedical Sciences, University of Cagliari, Cagliari, Italy*
- VICENT CASADÓ • *Department of Biochemistry and Molecular Biology, Faculty of Biology, University of Barcelona, Barcelona, Spain*
- ANTONI CORTÉS • *Department of Biochemistry and Molecular Biology, Faculty of Biology, University of Barcelona, Barcelona, Spain*
- DANIEL N. COX • *School of Systems Biology, Krasnow Institute for Advanced Study, George Mason University, Fairfax, VA, USA*
- MAI T. DANG • *Department of Neurology, Hospital of University of Pennsylvania, Philadelphia, PA, USA*
- MARTA DZIEDZICKA-WASYLEWSKA • *Institute of Pharmacology, Polish Academy of Sciences, Kraków, Poland; Faculty of Biochemistry, Biophysics and Biotechnology, Jagiellonian University, Krakow, Poland*
- STEFANO ESPINOZA • *Department of Neuroscience and Brain Technologies, Italian Institute of Technology, Genoa, Italy*
- AGATA FARON-GÓRECKA • *Institute of Pharmacology, Polish Academy of Sciences, Krakow, Poland*
- SERGI FERRÉ • *Department of Health and Human Services, Intramural Research Program, National Institute on Drug Abuse, National Institutes of Health, Baltimore, MD, USA*
- RAFAEL FRANCO • *Department of Biochemistry and Molecular Biology, University of Barcelona, Barcelona, Spain*

- RAUL R. GAINETDINOV • *Department of Neuroscience and Brain Technologies, Italian Institute of Technology, Genoa, Italy*
- FERNANDO GARCIA DE MELLO • *Laboratory of Neurochemistry, Program in Neurobiology IBCCF, UFRJ, Rio de Janeiro, Brazil*
- ESWAR PRASAD R. IYER • *School of Systems Biology, George Mason University, Manassas, VA, USA*
- SRIVIDYA CHANDRAMOULI IYER • *School of Systems Biology, George Mason University, Manassas, VA, USA*
- PEDRO A. JOSE • *Department of Pediatrics, Center for Molecular Physiology Research, Children's National Medical Center, and School of Medicine, George Washington University, Washington, DC, USA*
- NADINE KABBANI • *Department of Molecular Neuroscience, Krasnow Institute for Advanced Study, George Mason University, Fairfax, VA, USA*
- BOHUNG KIM • *The Krasnow Institute for Advanced Study, George Mason University, Fairfax, VA, USA*
- WONRYULL KOH • *The Krasnow Institute for Advanced Study, George Mason University, Fairfax, VA, USA*
- ROBERT LEVENSON • *Department of Pharmacology, Penn State College of Medicine, Hershey, PA, USA*
- CARME LLUÍS • *Department of Biochemistry and Molecular Biology, University of Barcelona, Barcelona, Spain*
- PHILIP L. LOZIUK • *Department of Chemistry, North Carolina State University, Raleigh, NC, USA*
- LEYDA Z. LUGO-MORALES • *Department of Chemistry, North Carolina State University, Raleigh, NC, USA*
- SYLWIA LUKASIEWICZ • *Faculty of Biochemistry, Biophysics and Biotechnology, Jagiellonian University, Krakow, Poland*
- JOSEFA MALLOL • *Department of Biochemistry and Molecular Biology, University of Barcelona, Barcelona, Spain*
- BERNARD MASRI • *Cancer Research Center of Toulouse, INSERM U1037 - Université Paul Sabatier Toulouse III, CHU Rangueil, Toulouse, France*
- PETER J. MCCORMICK • *Department of Biochemistry and Molecular Biology, University of Barcelona, Barcelona, Spain*
- GEMMA NAVARRO • *Department of Biochemistry and Molecular Biology, University of Barcelona, Barcelona, Spain*
- JACOB C. NORDMAN • *Department of Molecular Neuroscience, Krasnow Institute for Advanced Study, George Mason University, Fairfax, VA, USA*
- KATERINA D. OIKONOMOU • *Department of Neuroscience, University of Connecticut Health Center, Farmington, CT, USA*
- RODRIGO F. OLIVEIRA • *The Krasnow Institute for Advanced Study, George Mason University, Fairfax, VA, USA*
- SHALINI PADMANABHAN • *Department of Pharmacology, Medical College of Georgia, Augusta, GA, USA*
- JYOTI C. PATEL • *Departments of Neurosurgery and Physiology & Neuroscience, New York University School of Medicine, New York, NY, USA*

- JESSICA PETKO • *Department of Pharmacology, Penn State College of Medicine, Hershey, PA, USA*
- THACH PHAM • *General Surgery, Dwight D. Eisenhower Army Medical Center, Fort Gordon, GA, USA*
- BIANCA PLOUFFE • *Departments of Medicine/Cellular and Molecular Medicine/Psychiatry, Ottawa Hospital Research Institute (Neuroscience Program), University of Ottawa, Ottawa, ON, Canada*
- BALAKRISHNA M. PRASAD • *Department of Pharmacology, Medical College of Georgia, Augusta, GA, USA; Clinical Investigation, Dwight D. Eisenhower Army Medical Center, Fort Gordon, GA, USA*
- MARGARET E. RICE • *Departments of Neurosurgery and Physiology & Neuroscience, New York University School of Medicine, New York, NY, USA*
- JAMES G. ROBERTS • *Department of Chemistry, North Carolina State University, Raleigh, NC, USA*
- ALI SALAHPOUR • *Department of Pharmacology and Toxicology, University of Toronto, Toronto, ON, Canada*
- TOSHIKUNI SASAOKA • *Department of Laboratory Animal Science, Kitasato University School of Medicine, Kanagawa, Japan*
- SHAINA M. SHORT • *Department of Neuroscience, University of Connecticut Health Center, Farmington, CT, USA*
- LESLIE A. SOMBERS • *Department of Chemistry, North Carolina State University, Raleigh, NC, USA*
- SATURNINO SPIGA • *Department of Life and Environmental Sciences, University of Cagliari, Cagliari, Italy*
- MARIO TIBERI • *Departments of Medicine/Cellular and Molecular Medicine/Psychiatry, Ottawa Hospital Research Institute (Neuroscience Program), University of Ottawa, Ottawa, ON, Canada*
- ANA LUCIA MARQUES VENTURA • *Department of Neurobiology, Program in Neurosciences, Universidade Federal Fluminense, Niterói, Brazil*
- VAN ANTHONY VILLAR • *Department of Pediatrics, Center for Molecular Physiology Research, Children's National Medical Center, and School of Medicine, George Washington University, Washington, DC, USA*
- LANE J. WALLACE • *College of Pharmacy, Ohio State University, Columbus, OH, USA*
- YANYAN WANG • *Department of Pharmacology, College of Medicine, Beckman Institute for Advanced Science and Technology, University of Illinois at Urbana-Champaign, Urbana, IL, USA*
- JIPING XIAO • *Cardiovascular Institute, University of Pennsylvania, Philadelphia, PA, USA*
- PEIYING YU • *Department of Pediatrics, Center for Molecular Physiology Research, Children's National Medical Center, School of Medicine, George Washington University, Washington, DC, USA*
- WEN-LIANG ZHOU • *Department of Neuroscience, University of Connecticut Health Center, Farmington, CT, USA*