WAKE FOREST SCHOOL OF MEDICINE
Curriculum Vitae

NAME Ryan M. Drenan, Ph.D.

ADDRESS Department of Physiology & Pharmacology
Wake Forest University Health Sciences
115 S Chestnut St.
Winston-Salem, NC 27101
rdrenan@wakehealth.edu

EDUCATION

2000 *University of California, San Diego*
La Jolla, CA
Bachelor of Science
Biology (major #1)
Cognitive Science with Specialization in Neuroscience (major #2)

Research Advisor: Paul A. Insel, M.D.

2006 *Washington University*
St. Louis, MO
Ph.D.
Molecular Cell Biology

Research Advisor(s): Kendall J. Blumer, Ph.D.
Thesis: Cloning and characterization of R7BP, a novel signaling protein regulating neuronal G protein coupled receptor signal transduction

POSTDOCTORAL TRAINING

2006 - 2010 Postdoctoral Scholar
2010 - 2011 Senior Research Fellow
California Institute of Technology
Division of Biology and Biological Engineering

Research Advisor: Henry A. Lester, Ph.D.
Research Project: Neurobiology studies of nicotinic acetylcholine receptors

PROFESSIONAL LICENSURE

2009 - present Patent Agent, United States Patent and Trademark Office
Registration #64339

EMPLOYMENT

Academic Appointments

Wake Forest University

2019 – Present	Associate Professor with Tenure, Dept. of Physiology & Pharmacology
2019 – Present	Associate Director, Tobacco Control Center of Excellence, Comprehensive Cancer Center

Northwestern University, Feinberg School of Medicine

2019 – Present	Adjunct Professor, Department of Pharmacology
2016 – 2019	Associate Professor, Department of Pharmacology
2016 – 2019	Faculty, The Graduate School
2016 – 2019	Member, Interdisciplinary Neuroscience Graduate Program
2016 – 2019	Member, Driskill Graduate Program in Life Sciences

Purdue University

2011 – 2016	Assistant Professor, Department of Medicinal Chemistry and Molecular Pharmacology (MCMP)
2016 – Present	Adjunct Professor
2011 – Present	Member, MCMP Graduate Program
2011 – 2017	Member, Interdisciplinary Life Science (PULSe) Graduate Program

Indiana University School of Medicine

2013 – 2016	Adjunct Assistant Professor, Department of Pharmacology and Toxicology (for teaching purposes)

California Institute of Technology

2010 – 2011	Senior Research Fellow, Division of Biology and Biological Engineering

ADMINISTRATIVE SERVICE

Purdue University (2011 – 2016)

College of Pharmacy

2011 – 2016	Cell Imaging Facility Committee
2011, 2015	Rho Chi event participant
2012 – 2013	Grade Appeals Committee
2013 – 2016	PharmD program interviews
2013 – 2015	MCMP Head Search Committee
2013 – 2014	Speaker: faculty development event
2014	Distinguished Alumni Award host

Institutional Service

2011 – 2016	Life Science (PULSe) graduate program: recruiting, orientation speaker, award review
2015	Member, Neuroscience Pillar of Excellence Focus Group

Department of Medicinal Chemistry and Molecular Pharmacology Service

2011 – 2015	Ph.D. graduate program recruiting, interviewing, advising

2011 – 2016	Facilities and Instrumentation Committee (Chair: 2015 – 2016)
2012 – 2013	Faculty Search Committee
2012 – 2016	Seminar Committee
2015	Travel Award Review
2015	Chair, Purdue Research Foundation (PRF) Grant Review

Northwestern University (2016 – 2019)

Feinberg School of Medicine

2016 – 2017	Research Retreat Sponsor Committee
2016 – 2019	Advisory Committee, Behavioral Phenotyping Core
2018	Driskill Graduate Program lecture series speaker host

Institutional Service

2016 – 2019	Interdisciplinary Neuroscience (NUIN) graduate program recruiting, retreat attendance
2016 – 2019	Preceptor: T32 Neurobiology of Information Storage
2017	The Graduate School fellowship reviewer: Nicholson Fellowship
2018	The Graduate School fellowship reviewer: Management for Scientists and Engineers

Department of Pharmacology Service

2016 – 2017	Annual retreat co-chair
2017 – 2018	Annual retreat chair

Wake Forest University (2019 – Present)

Wake Forest Baptist Medical Center Comprehensive Cancer Center

2019 – Present	Associate Director, Tobacco Control Center of Excellence

EXTRAMURAL APPOINTMENTS AND SERVICE

Funding Agency Reviewer

NIH: Molecular Neuropharmacology and Signaling [MNPS] (Appointed Member, 2017 - 2023)

NIH: Molecular Neuropharmacology and Signaling [MNPS] (Ad hoc Member, 06/2014, 02/2015, 06/2016, 10/2016, 02/2017)

NIH: Motivated Behavior Member Conflict SEP [ZRG1-IFCN-C (02)] (Ad hoc Member, 06/2018)

NIH: Alcohol and Motivated Behavior Member Conflict SEP [ZRG1-IFCN-C (02)] (Ad hoc Member, 03/2017)

NIH: Drugs, Alcohol, and Heavy Metals Member Conflict SEP [ZRG1-IFCN-C (02)] (Ad hoc Member, 07/2017)

NIH: Neurotoxicology and Drugs Member Conflict SEP [ZRG1 IFCN-C] (Ad hoc Member, 03/2015, 03/2016)

NIH: Harnessing Genome-Editing Technologies to Functionally Validate Genetic Variants in Substance Use Disorders SEP [ZDA1 JXR-G (16)] (Ad hoc Member, 11/2015)

Florida Department of Health Biomedical Research Program (2016, 2017)

Danish Council for Independent Research (2014)

Medical Research Council (UK), Neuroscience & Mental Health Board (2013)

Fondazione Cariplo (Italy), Scientific Research in Biomedicine (2013)

Manuscript Reviewer (2011 - Present)

Biological Psychiatry
The Journal of Neuroscience
Journal of Neurophysiology
Molecular Pharmacology
European Journal of Neuroscience
Journal of Pharmacology and Experimental Therapeutics
British Journal of Pharmacology
Progress in Neuro-Psychopharmacology & Biological Psychiatry
Brain Research
Neuropharmacology
PLoS One
Alcoholism: Clinical and Experimental Research
Cell and Molecular Life Sciences
Neurochemistry International
Scientific Reports
Journal of Neurochemistry
Scientia Pharmaceutica

Symposiums Organized

American Society for Pharmacology and Experimental Therapeutics (ASPET), Neuropharmacology Division
Nicotinic acetylcholine receptors in learning and addiction
April 2017
Chicago, IL

PROFESSIONAL MEMBERSHIPS AND SERVICE

2005 – Present	Member, Society for Neuroscience
2011 – 2012, 2015	Society for Research on Nicotine and Tobacco Service: Annual meeting abstract review service
2012 – Present	Member, ASPET
2016 – 2018	Member, ASPET Neuropharmacology Division Executive Committee Duties: Attend annual meeting, discuss symposium planning, review award applications, judge poster session entries

HONORS AND AWARDS

International/National/Regional

2004 – 2006	American Heart Association predoctoral fellowship
2006	NIH NIMH Neurobiology T32 Training Award
2006 – 2008	University of CA Tobacco Related Disease Res. PD fellowship
2007 – 2009	NIH Ruth L. Kirschstein National Research Service (F32) Award
2010 – 2014	NIH Pathway to Independence (K99/R00) Award
2013 – 2015	NARSAD Young Investigator Award
2016	ASPET Early Career Independent Investigator Award

University

2004 – 2006	Washington University Stipend Supplement Award
2014	Purdue Research Foundation International Travel Grant

GRANT FUNDING

Currently Active Grants

R01 DA035942 (Drenan: PI) 08/2014 – 05/2024
Nicotinic acetylcholine receptor function in the mesolimbic dopamine system $279K/yr (direct cost)
Investigation of nAChRs involved in nicotine reward neurobiology

R01 DA040626 (Drenan: PI) 08/2016 – 05/2021
Identifying nicotine withdrawal mechanisms hidden within habenular complexity $225K/yr (direct cost)
Mechanisms of nicotine dependence in medial habenula and interpeduncular nucleus

R21/R33* DA044460 (Drenan: PI) 08/2018 – 07/2022
Photoactivatable ligands for nicotinic optopharmacology $135K/yr (direct cost)
Development of nicotine uncaging ligands and approaches for studying nicotinic receptors
*R33 phase is eligible for 2 yrs funding (~$250K/yr)

R21 DA045507 (Drenan: PI) 09/2017 – 08/2019
Nicotinic Receptor Gene Editing Vectors $137K/yr (direct cost)
Creation and dissemination of CRISPR nAChR gene editing tools for studies of nicotine addiction

Pending Grants

N/A

Past Grant History

NIH/NIDA, K99 DA030396 (Drenan: PI) 09/2010 – 06/2011
alpha6 nAChRs in Dopamine Transmission and Nicotine Dependence* $83K/yr (direct costs)

NIH/NIDA, R00 DA030396 (Drenan: PI) 06/2011 – 05/2014
alpha6 nAChRs in Dopamine Transmission and Nicotine Dependence* $176K/yr (direct costs)

Ralph W. and Grace M. Showalter Research Trust Grant (Drenan: PI) 07/2012 – 06/2013
Nicotinic ACh receptors as therapeutic targets in Parkinson's disease $62K/yr (direct costs)

NARSAD Young Investigator Award 01/2013 – 01/2015
Cholinergic regulation of habenula microcircuits and downstream dopamine transmission
$30K/yr (direct costs)

BIBLIOGRAPHY
(#denotes corresponding authorship)

Peer-Reviewed Publications

1. Ostrom RS, Gregorian C, **Drenan RM**, Gabot K, Rana BK, Insel PA. Key role for constitutive cyclooxygenase-2 of MDCK cells in basal signaling and response to released ATP. *Am J Physiol Cell Physiol.* 2001; 281(2): C524-531.

2. Ostrom RS, Gregorian C, **Drenan RM**, Xiang Y, Regan JW, Insel PA. Receptor number and caveolar co-localization determine receptor coupling efficiency to adenylyl cyclase. *J Biol Chem.* 2001; 276(45): 42063-42069.

3. Choi JH, Bertram PG, **Drenan R**, Carvalho J, Zhou HH, Zheng XF. The FKBP12-rapamycin-associated protein (FRAP) is a CLIP-170 kinase. *EMBO Rep.* 2002; 3(10): 988-994.

4. Tsang CK, Bertram PG, Ai W, **Drenan R**, Zheng XF. Chromatin-mediated regulation of nucleolar structure and RNA Pol I localization by TOR. *The EMBO Journal.* 2003; 22(22): 6045-6056.

5. **Drenan RM**, Liu X, Bertram PG, Zheng XF. FKBP12-rapamycin-associated protein or mammalian target of rapamycin (FRAP/mTOR) localization in the endoplasmic reticulum and the Golgi apparatus. *J Biol Chem.* 2004; 279(1): 772-778.

6. **Drenan RM**, Doupnik CA, Boyle MP, Muglia LJ, Huettner JE, Linder ME, Blumer KJ. Palmitoylation regulates plasma membrane-nuclear shuttling of R7BP, a novel membrane anchor for the RGS7 family. *J Cell Biol.* 2005; 169(4): 623-633.

7. **Drenan RM**, Doupnik CA, Jayaraman M, Buchwalter AL, Kaltenbronn KM, Huettner JE, Linder ME, Blumer KJ. R7BP augments the function of RGS7/Gβ5 complexes by a plasma membrane-targeting mechanism. *J Biol Chem.* 2006; 281(38): 28222-28231.

8. Osei-Owusu P, Sun X, **Drenan RM**, Steinberg TH, Blumer KJ. Regulation of RGS2 and second messenger signaling in vascular smooth muscle cells by cGMP-dependent protein kinase. *J Biol Chem.* 2007; 282(43): 31656-31665.

9. **Drenan RM**, Nashmi R, Imoukhuede P, Just H, McKinney S, Lester HA. Subcellular trafficking, pentameric assembly, and subunit stoichiometry of neuronal nicotinic acetylcholine receptors containing fluorescently labeled α6 and β3 subunits. *Mol Pharmacol.* 2008; 73(1): 27-41.

10. **Drenan RM**, Grady SR, Whiteaker P, McClure-Begley T, McKinney S, Miwa JM, Bupp S, Heintz N, McIntosh JM, Bencherif M, Marks MJ, Lester HA. *In vivo* activation of midbrain dopamine neurons via sensitized, high-affinity α6* nicotinic acetylcholine receptors. *Neuron.* 2008; 60(1): 123-136.

11. Grady SR, **Drenan RM**, Breining SR, Yohannes D, Wageman CR, Fedorov NB, McKinney S, Whiteaker P, Bencherif M, Lester HA, Marks MJ. Structural differences determine the relative selectivity of nicotinic compounds for native α4β2*-, α6β2*-, α3β4*- and α7-nicotine acetylcholine receptors. *Neuropharmacology.* 2010; 58: 1054-1066.

12. **Drenan RM**, Grady SR, Steele AD, McKinney S, Patzlaff NE, McIntosh JM, Marks MJ, Miwa JM, Lester HA. Cholinergic modulation of locomotion and striatal dopamine release is mediated by α6α4* nicotinic acetylcholine receptors. *J Neurosci.* 2010; 30(29): 9877-9889.

13. Gunapala KM, Chang D, Hsu CT, Manaye K, **Drenan RM**, Switzer RC, Steele AD. Striatal pathology underlies prion infection-mediated hyperactivity in mice. *Prion.* 2010; 4(4): 302-315.

14. Xiao C, Srinivasan R, **Drenan RM**, Mackey ED, McIntosh JM, Lester HA. Characterizing functional α6β2 nicotinic acetylcholine receptors in vitro: Mutant β2 subunits improve membrane expression, and fluorescent proteins reveal responsive cells. *Biochemical Pharmacology.* 2011; 82(8): 852-861.

15. Cohen BN, Mackey ED, Grady SR, McKinney S, Patzlaff NE, Wageman CR, McIntosh JM, Marks MJ, Lester HA, **#Drenan RM**. Nicotinic cholinergic mechanisms causing elevated dopamine release and abnormal locomotor behavior. *Neuroscience.* 2012; 200: 31-41.

16. Mackey ED, Engle SE, Kim MR, O'Neill HC, Wageman CR, Patzlaff NE, Wang Y, Grady SR, McIntosh JM, Marks MJ, Lester HA,**#Drenan RM**. α6* Nicotinic acetylcholine receptor expression and function in a

visual salience circuit. *J Neurosci.* 2012; 32(30): 10226-10237.

17. Engle SE, Broderick HJ,**#Drenan RM**. Local application of drugs to study nicotinic acetylcholine receptor function in mouse brain slices. *Journal of Visualized Experiments.* 2012; (68): e50034.

18. Powers MS, Broderick HJ, **#Drenan RM**, #Chester JA. Nicotinic acetylcholine receptors containing α6 subunits contribute to alcohol reward-related behaviours. *Genes Brain Behav.* 2013; 12(5): 543-553.

19. Engle SE, Shih PY, McIntosh JM, **#Drenan RM**. α4α6β2* nicotinic acetylcholine receptor activation on ventral tegmental area dopamine neurons is sufficient to stimulate a depolarizing conductance and enhance surface AMPA receptor function. *Mol Pharmacol.* 2013; 84(3): 393-406.

20. Henderson BJ, Srinivasan R, Nichols WA, Dilworth CN, Gutierrez DF, Mackey ED, McKinney S, **Drenan RM**, Richards CI, Lester HA. Nicotine exploits a COPI-mediated process for chaperone-mediated up-regulation of its receptors. *The Journal of General Physiology.* 2014; 143(1): 51-66.

21. Wang Y, Lee JW, Oh G, Grady SR, McIntosh JM, Brunzell DH, Cannon JR, **#Drenan RM**. Enhanced synthesis and release of dopamine in transgenic mice with gain-of-function α6* nAChRs. *J Neurochem.* 2013; 129: 315-327.

22. Shih PY, Engle SE, Oh G, Deshpande P, Puskar NL, Lester HA, **#Drenan RM**. Differential expression and function of nicotinic acetylcholine receptors in subdivisions of medial habenula. *J Neurosci.* 2014; 34 (29): 9789-9802.

    This project began while I was still a postdoc but the majority of the work was performed in my independent lab. It supported my acquisition of a second R01. It has been cited 48 times in 4 years.

23. Engle SE, McIntosh JM, **#Drenan RM**. Nicotine and ethanol cooperate to enhance ventral tegmental area AMPA receptor function via α6-containing nicotinic receptors. *Neuropharmacology.* 2015; 91: 13-22.

    This study was conducted exclusively by one graduate student in my lab, Staci Engle. I advised her on experimental design and wrote the initial draft of the manuscript. My R01 supported this work.

24. Bordia T, McGregor M, McIntosh JM, **Drenan RM**, Quik M. Evidence for a role for α6* nAChRs in l-dopa-induced dyskinesias using Parkinsonian α6* nAChR gain-of-function mice. *Neuroscience.* 2015; 295: 187-197.

25. Wieskopf JS, Mathur J, Limapichat W, Post MR, Al-Qazzaz M, Sorge RE, Martin LJ, Zaykin DV, Smith SB, Freitas K, Austin JS, Dai F, Zhang J, Marcovitz J, Tuttle AH, Slepian PM, Clarke S, **Drenan RM**, Janes J, Al Sharari S, Segall SK, Aasvang EK, Lai W, Bittner R, Richards CI, Slade GD, Kehlet H, Walker J, Maskos U, Changeux JP, Devor M, Maixner W, Diatchenko L, Belfer I, Dougherty DA, Su AI, Lummis SC, Imad Damaj M, Lester HA, Patapoutian A, Mogil JS. The nicotinic α6 subunit gene determines variability in chronic pain sensitivity via cross-inhibition of P2X2/3 receptors. *Science Translational Medicine.* 2015; 7(287): 287ra272.

26. Berry JN, Engle SE, McIntosh JM, **#Drenan RM**. α6-Containing nicotinic acetylcholine receptors in midbrain dopamine neurons are poised to govern dopamine-mediated behaviors and synaptic plasticity. *Neuroscience.* 2015; 304: 161-175.

27. Shih PY, McIntosh JM, **#Drenan RM**. Nicotine Dependence Reveals Distinct Responses from Neurons and their Resident Nicotinic Receptors in Medial Habenula. *Mol Pharmacol.* 2015; 88(6): 1035-1044.

28. Lee HJ, Zhang D, Jiang Y, Wu X, Shih PY, Liao CS, Bungart B, Xu XM, **Drenan R**, Bartlett E, Cheng JX. Label-Free Vibrational Spectroscopic Imaging of Neuronal Membrane Potential. *J Phys Chem Lett.* 2017; 8(9): 1932-1936.

29. Hurtado-Zavala JI, Ramachandran B, Ahmed S, Halder R, Bolleyer C, Awasthi A, Stahlberg MA, Wagener RJ, Anderson K, **Drenan RM**, Lester HA, Miwa JM, Staiger JF, Fischer A, Dean C. TRPV1 regulates excitatory innervation of OLM neurons in the hippocampus. *Nature Communications.* 2017; 8: 15878.

30. Peng C, Engle SE, Yan Y, Weera MM, Berry JN, Arvin MC, Zhao G, McIntosh JM, Chester JA, **#Drenan RM**. Altered nicotine reward-associated behavior following α4 nAChR subunit deletion in ventral midbrain. *PloS One.* 2017; 12(7): e0182142.

31. Arias HR, Jin X, Feuerbach D, **Drenan RM**. Selectivity of coronaridine congeners at nicotinic

acetylcholine receptors and inhibitory activity on mouse medial habenula. *Int J Biochem Cell Biol.* 2017; 92: 202-209.

32. Parker RL, O'Neill HC, Henley BM, Wageman CR, **Drenan RM**, Marks MJ, Miwa JM, Grady SR, Lester HA. Deletion of lynx1 reduces the function of α6* nicotinic receptors. *PloS One.* 2017; 12(12): e0188715.

33. Banala S, Arvin MC, Bannon NM, Jin XT, Macklin JJ, Wang Y, Peng C, Zhao G, Marshall JJ, Gee KR, Wokosin DL, Kim VJ, McIntosh JM, Contractor A, Lester HA, Kozorovitskiy Y, **#Drenan RM**, #Lavis LD. Photoactivatable drugs for nicotinic optopharmacology. *Nature Methods.* 2018; 15(5): 347-350.

    This project was jointly directed by myself and Dr. Lavis. His group synthesized molecules and I designed and directed all the biological studies, which were nearly all performed in my laboratory.

34. Yan Y, Peng C, Arvin MC, Jin XT, Kim VJ, Ramsey MD, Wang Y, Banala S, Wokosin DL, McIntosh JM, Lavis LD, **#Drenan RM**. Nicotinic cholinergic receptors in VTA glutamate neurons modulate excitatory transmission. *Cell Reports.* 2018; 23(8): 2236-2244.

    This study, derived from my funding/laboratory, was the first demonstration that VTA glutamate neurons express functional nAChRs. This may change existing models of nicotine activation of VTA.

35. Peng C, Yan Y, Kim VJ, Engle SE, Berry JN, McIntosh JM, Neve RL, **#Drenan RM**. Gene editing vectors for studying nicotinic acetylcholine receptors in cholinergic transmission. *Eur. J Neurosci.* 2019; 50(3): 2224-2238.

    This demonstrates my skills at pharmacology tool development. We make novel research tools (mice, molecules, etc.) when needed. Here, we introduced viruses for gene editing of nAChRs.

36. Arvin MC, Wokosin DL, Banala S, Lavis LD, **#Drenan RM**. Probing nicotinic acetylcholine receptor function in mouse brain slices via laser flash photolysis of photoactivatable nicotine. *Journal of Visualized Experiments.* 2019; (143): e58873.

37. Arvin MC, Jin XT, Yan Y, Wang Y, Ramsey MD, Kim VJ, Beckley NA, Henry BA, **#Drenan RM**. Chronic nicotine exposure alters the neurophysiology of habenulo-interpeduncular circuitry. *J Neurosci*. 2019; 39(22): 4268-4281.

38. Arias HR, Jin XT, Gallino S, Peng C, Feuerbach D, Ortells MO, Elgoyhen AB, Drenan RM. Selectivity of (±)-citalopram at nicotinic acetylcholine receptors and different inhibitory mechanisms between habenular α3β4* and α9α10 subtypes. *Neurochemistry International*. 2019; (in press)

39. Yan Y, Beckley NA, Kim VJ, Drenan RM. Differential nicotinic modulation of glutamatergic and GABAergic VTA microcircuits. (in revision)

Invited Publications (Editorially Reviewed)

1. **#Drenan RM**, Lester HA. Neurobiology of the cholinergic system and nicotine probed with mice expressing gain-of-function nAChR subunits. *Pharmacological Reviews.* 2012; 64(4): 869-79.

PRESENTATIONS AT PROFESSIONAL MEETINGS

Oral Abstract Presentations (*presenting author)

1. ***Drenan RM**, Engle SE, Lester HA, McIntosh JM, Brunzell DH. Activation of α6β2* nicotinic acetylcholine receptors is sufficient for nicotine reward-like behavior in mice. Society for Research on Nicotine and Tobacco, 2013.

2. ***Drenan RM**, Lester HA, Shih PY, Engle SE, Oh G, Deshpande P. Differential expression and function of nicotinic acetylcholine receptors in subdivisions of medial habenula. Wellcome Trust Conference: Nicotinic Acetylcholine Receptors, 2014.

Poster Presentations (*presenting author)

1. *Ostrom RS, **Drenan RM**, Gregorian C, Insel PA. P2Y2 receptor-mediated activation of cytosolic PLA2 at

the nuclear membrane: signaling into then out of caveolae. FASEB J, 15(4): A218, 2001.

2. *Ostrom RS, Liu X, Gregorian C, **Drenan RM**, Seasholtz TM, Insel PA. Cell-specific compartmentation of adenylyl cyclase regulation in cardiomyocytes and vascular smooth muscle cells. Circulation, 104(17) II-7, 2001.

3. *Ostrom RS, Gregorian C, **Drenan RM**, Gustafsson A, Brunton LL, Printz MP, Insel PA. Cardiac fibroblasts express seven isoforms of adenylyl cyclase but only AC3 and AC5/6 localize in caveolin-rich membrane fractions. FASEB J, 16(5): A1160, 2002.

4. ***Drenan RM**, Doupnik CA, Linder ME, Blumer KJ. A novel plasticity mechanism controlling GPCR signaling in the central nervous system: Identification of a palmitoylated membrane anchor for the RGS7 family of G protein regulators. Washington University Molecular Oncology / Cell Biology and Physiology Work in Progress, 2004.

5. ***Drenan RM**, Doupnik CA, Buchwalter AL, Croke MR, Huettner JE, Linder ME, Blumer KJ. R7BP controls R7/Gβ5 GAP function and localization via a novel palmitoylation switch mechanism. Washington University Molecular Oncology / Cell Biology and Physiology Work in Progress, 2005.

6. ***Drenan RM**, Huettner JE, Blumer KJ. Intracellular targeting of the RGS7 family specified by R7BP and R9AP. Society for Neuroscience, 2005.

7. ***Drenan RM**, Nashmi R, Imoukhuede PI, Just H, Lester HA. Subcellular Trafficking, Pentameric Assembly and Subunit Stoichiometry of Neuronal Nicotinic ACh Receptors Containing Fluorescently-Labeled α6 and β3 Subunits. Society for Neuroscience Satellite Symposium-Nicotinic Acetylcholine Receptors as Therapeutic Targets: Emerging Frontiers in Basic Research & Clinical Science, 2007.

8. ***Drenan RM**, Xiao C, Whiteaker P, Grady SR, Bupp S, Heintz N, Marks MJ, Lester HA. Bacterial Artificial Chromosome (BAC) Transgenic Mice Expressing Hypersensitive α6L9′S Nicotinic ACh Receptors: Isolation and Amplification of Electrophysiological and Behavioral Responses. Society for Neuroscience, 2007.

9. *Kadambi S, Cohen BN, Tapper A, Just H, Salminen O, **Drenan R**, Lester HA. Block of (α4L9′A)β2 mutant nicotinic receptors by quinpirole results in Parkinson's disease-like symptoms in L9′A knock-in mice. Society for Neuroscience, 2008.

10. ***Drenan RM**, Grady SR, Whiteaker P, McClure-Begley T, McKinney S, Miwa J, Bupp S, Heintz N, McIntosh JM, Bencherif M, Marks MJ, Lester HA. Specific in vivo activation of midbrain dopamine neurons via sensitized, high-affinity nicotinic acetylcholine receptors containing α6 subunits. Society for Neuroscience, 2008.

11. ***Drenan RM**, Grady SR, Steele AD, McKinney S, Patzlaff NE, McIntosh JM, Marks MJ, Miwa JM, Lester HA. Cholinergic modulation of locomotion and striatal dopamine release is mediated by α6α4* nicotinic acetylcholine receptors. Society for Neuroscience, 2010.

12. *Wieskopf JS, Austin J-S, Slepian P, Sorge R, Su A, Mathur J, Uzzell V, Janes J, **Drenan RM**, McIntosh JM, Maskos U, Changeux J-P, Devor M, Lester H, Belfer I, Diatchenko L, Patapoutian A, Mogil JS. The role of chrna6 in chronic pain. Society for Neuroscience, 2011.

13. ***Drenan RM**, Cohen BN, Mackey EDW, Grady SR, McKinney S, Patzlaff NE, Wageman CR, McIntosh JM, Marks MJ, Lester HA. Nicotinic cholinergic mechanisms causing pathological dopamine release and locomotor hyperactivity. Society for Neuroscience, 2011.

14. ***Drenan RM**, Mackey EDW, Grady SR, Patzlaff NE, Wageman CR, McIntosh JM, Marks MJ, Lester HA. α6* nAChR expression and function in brain areas influencing DA transmission probed with α6-GFP transgenic mice. Society for Neuroscience Satellite Symposium-Nicotinic Acetylcholine Receptors as Therapeutic Targets: Emerging Frontiers in Basic Research & Clinical Science, 2011.

15. *Powers MS, Broderick HJ, **Drenan RM**, Chester JA. Involvement of hypersensitive α6 subunit containing neuronal nicotinic acetylcholine receptors in the modulation of alcohol intake and preference. Research Society on Alcoholism, 2012.

16. ***Drenan RM**, Engle SE, Lester HA, McIntosh JM, Brunzell DH. Activation of α6β2* nicotinic acetylcholine receptors is sufficient for nicotine reward. Society for Neuroscience, 2012.

17. *Henderson BJ, Mackey EDW, McKinney S, **Drenan RM**, Lester HA. α6-containing neuronal nicotinic acetylcholine receptors: effects of chronic nicotine treatment and inclusion of β3 subunits. Society for Neuroscience, 2012.
18. *Parker RL, Grady SR, Steele AD, **Drenan RM**, Lester HA, Miwa JM. Modulation of dopaminergic neuron function through lynx1/α6 nAChR interactions. Society for Neuroscience, 2012.
19. *O'Neill HC, Wageman CR, Baddick C, Parker RL, **Drenan RM**, McIntosh JM, Miwa JM, Grady SR. Effect of Lynx1 genotype on synaptosomal activity of α6β2* nAChRs. Society for Neuroscience, 2012.
20. *Engle SE, Stafford A, Brunzell DH, **Drenan RM**. Selective activation of α6* nAChRs is sufficient for activation of VTA DA neurons, the induction of synaptic plasticity, and nicotine reward behavior. Chronic Disease Research Poster Session, Purdue College of Health and Human Sciences, 2013.
21. *Powers MS, Broderick H, **Drenan RM**, Chester JA. Involvement of hypersensitive α6 subunit-containing nicotinic acetylcholine receptors in the modulation of alcohol intake and preference. Chronic Disease Research Poster Session, Purdue College of Health and Human Sciences, 2013.
22. Lester HA, Marks MJ, Grady SR, Dilworth C, Wang Y, Mackey EDW, Penton RE, Xiao C, Henderson BJ, Deshpande P, Oh G, Miwa JM, Leonard S, Freedman R, ***Drenan RM**. Mouse strains carrying fluorescent nicotinic receptor subunits: Review and progress report. Society for Neuroscience, 2013.
23. *Engle SE, McIntosh JM, **Drenan RM**. Activation of α4α6β2* nAChRs on VTA DA neurons is sufficient for depolarization and enhanced function of AMPA receptors on the cell surface. Society for Neuroscience, 2013.
24. *Parker RL, O'Neill HC, Grady SR, Steele AD, **Drenan RM**, Lester HA, Miwa JM. Modulation of dopaminergic neuron function through lynx1/α6 nAChR interactions. Society for Neuroscience, 2013.
25. Wang Y, Lee J-W, Oh G, McIntosh JM, Brunzell DH, Cannon JR, ***Drenan RM**. Increased activity of nicotinic acetylcholine receptors containing alpha6 subunits promotes dopamine tissue content and enhances dopamine release in nucleus accumbens. Society for Neuroscience, 2013.
26. *Weera MM, Shih PY, **Drenan RM**, Chester JA. Reward-related responses to nicotine, alcohol, and their co-administration in mice selectively-bred for high and low alcohol preference. International Behavioural and Neural Genetics Society, 2014.
27. *Shih PY, Engle SE, Oh G, Deshpande P, Puskar N, Lester HA, **Drenan RM**. Differential localization and function of nicotinic acetylcholine receptors in subdivisions of medial habenula. Society for Neuroscience, 2014.
28. *Engle SE, McIntosh JM, **Drenan RM**. Combinations of nicotine and ethanol enhance AMPA receptor function on the surface of VTA DA neurons through activation of α6β2* nAChRs. Society for Neuroscience, 2014.
29. Shih PY, ***Drenan RM**. Nicotine dependence reveals distinct responses from neurons and their resident nicotinic receptors in medial habenula. Society for Neuroscience, 2015
30. *Berry JN, Engle SE, McIntosh JM, **Drenan RM**. α6-containing nicotinic acetylcholine receptors in midbrain dopamine neurons are poised to govern dopamine-mediated behaviors and synaptic plasticity. Society for Neuroscience, 2015
31. *Engle SE, Berry JN, Arvin MC, McIntosh JM, **Drenan RM**. Removal of α4 nAChR subunits from adult VTA neurons alters VTA DA neuron excitability and locomotor activity. Society for Neuroscience, 2015
32. *Engle SE, Berry JN, Weera MM, Arvin MC, McIntosh JM, Chester JA, **Drenan RM**. Nicotinic receptors control nicotine intake by balancing excitation and inhibition in midbrain dopamine neurons. ASPET Great Lakes Chapter Annual Meeting, 2016.
33. *Peng C, Engle SE, Zhao G, **Drenan RM**. Genome editing of α4, α6, and β2 nAChR subunits in ventral midbrain using CRISPR-Cas9. Northwestern University FSM Lewis Landsberg Research Day, 2017.
34. *Arvin MC, Banala S, Bannon NM, Jin X-T, Wang Y, Marshall JJ, Gee KG, Contractor A, Lester HA, Kozorovitskiy Y, **Drenan RM**, Lavis LD. Characterization and utilization of photoactivatable nicotine (PA-Nic) for interrogation of the subcellular expression patterns of nicotinic acetylcholine receptors (nAChRs). Northwestern Dept. of Pharmacology Works in Progress, 2017.

35. *Arvin MC, Banala S, Bannon NM, Jin X-T, Wang Y, Marshall JJ, Gee KG, Contractor A, Lester HA, Kozorovitskiy Y, **Drenan RM**, Lavis LD. Characterization and utilization of photoactivatable nicotine (PA-Nic) for interrogation of the subcellular expression patterns of nicotinic acetylcholine receptors (nAChRs). Society for Neuroscience, 2017

36. *Jin X-T, Arvin MC, Wang Y, **Drenan RM**. Nicotinic acetylcholine receptor up-regulation in cholinergic medial habenula facilitates glutamatergic synaptic transmission in interpeduncular nucleus. ASPET Great Lakes Chapter, 30th Annual Meeting, 2017.

37. *Wang Y, Peng C, Arvin MC, Yan Y, Jin X-T, Zhao G, **Drenan RM**. Chronic nicotine increases the excitability of MHb VI neurons and upregulates overall nicotinic acetylcholine receptor numbers. ASPET Great Lakes Chapter, 30th Annual Meeting, 2017.

38. *Peng C, Engle SE, Zhao G, McIntosh JM, **Drenan RM**. Genome editing of α4, α6, and β2 nAChR subunits in ventral tegmental area using CRISPR-Cas9. ASPET Great Lakes Chapter, 30th Annual Meeting, 2017.

39. *Jin X-T, Arvin MC, Wang Y, **Drenan RM**. Upregulation of nicotinic acetylcholine receptors in cholinergic and non-cholinergic neurons in medial habenula. Northwestern Dept. of Pharmacology 2nd Annual Retreat, 2017.

40. *Arvin MC, Banala S, Bannon NM, Jin X-T, Wang Y, Marshall JJ, Gee KG, Contractor A, Lester HA, Kozorovitskiy Y, **Drenan RM**, Lavis LD. Utilization of photoactivatable nicotine (PA-Nic) for interrogation of nicotinic acetylcholine receptors (nAChRs). Northwestern Dept. of Pharmacology 2nd Annual Retreat, 2017.

41. *Yan Y, Peng C, Arvin MC, Jin X-T, Kim VJ, Ramsey MD, Wang Y, Banala S, Wokosin DL, McIntosh JM, Lavis LD, **Drenan RM**. Nicotinic cholinergic receptors in VTA glutamate neurons modulate excitatory transmission. The 14th Annual Lewis Landsberg Research Day, Northwestern University, 2018.

42. *Yan Y, Peng C, Arvin MC, Jin X-T, Kim VJ, Ramsey MD, Wang Y, Banala S, Wokosin DL, McIntosh JM, Lavis LD, **Drenan RM**. Nicotinic cholinergic receptors in VTA glutamate neurons modulate excitatory transmission. The Brain Research Foundation, 18th Annual Neuroscience Day, 2018.

43. *Arvin MC, Banala S, Bannon NM, Jin X-T, Macklin JJ, Wang Y, Peng C, Zhao G, Marshall JJ, Gee KG, Wokosin DL, Kim VJ, McIntosh JM, Contractor A, Lester HA, Kozorovitskiy Y, **Drenan RM**, Lavis LD. Utilization of photoactivatable nicotine (PA-Nic) for interrogation of nicotinic acetylcholine receptors (nAChRs). Brain Research Foundation Neuroscience Day, 2018 (Winner: Best Student Poster)

44. *Arvin MC, Banala S, Bannon NM, Jin X-T, Macklin JJ, Wang Y, Peng C, Zhao G, Marshall JJ, Gee KG, Wokosin DL, Kim VJ, McIntosh JM, Contractor A, Lester HA, Kozorovitskiy Y, **Drenan RM**, Lavis LD. Utilization of photoactivatable nicotine (PA-Nic) for interrogation of nicotinic acetylcholine receptors (nAChRs). Basal Ganglia Gordon Research Seminar, 2018.

45. *Arvin MC, Banala S, Bannon NM, Jin X-T, Macklin JJ, Wang Y, Peng C, Zhao G, Marshall JJ, Gee KG, Wokosin DL, Kim VJ, McIntosh JM, Contractor A, Lester HA, Kozorovitskiy Y, **Drenan RM**, Lavis LD. Utilization of photoactivatable nicotine (PA-Nic) for interrogation of nicotinic acetylcholine receptors (nAChRs). Basal Ganglia Gordon Research Conference, 2018.

46. *Yan Y, Peng C, Arvin MC, Jin X-T, Kim VJ, Ramsey MD, Wang Y, Banala S, Wokosin DL, McIntosh JM, Lavis LD, **Drenan RM**. Nicotinic cholinergic receptors in VTA glutamate neurons modulate excitatory transmission. Society for Neuroscience, 2018.

<u>Other Abstracts</u> (*presenting author)

1. ***Drenan RM**, Heintz N, Lester HA. α6* Nicotinic ACh Receptors: Role in Nicotine Addiction. Caltech Annual Report, 2006.

2. ***Drenan RM**, McKinney S, Goldflam I, Anamudu EH, Lester HA. Screening nicotinic ligands for smoking cessation therapy using acute hypothermic responses in α4L9′A knock-in mice. Caltech Annual Report, 2007.

3. ***Drenan RM**, Grady SR, Marks MJ, Steele A, Xiao C, Miwa JM, Lester HA. Critical role of α4 subunits in α6* nicotinic ACh receptor function in regulating striatal dopamine release and locomotor behaviors in

mice. Caltech Annual Report, 2009.

4. *Mackey E, **Drenan RM**, Lester HA. Investigating the upregulation of the α6 nAChR subunit in response to chronic nicotine using a modified bacterial artificial chromosome (BAC). Caltech Annual Report, 2010.

INVITED PRESENTATIONS AND SEMINARS (*scheduled)

Extramural

01/2010	Purdue Univ., Dept. of Medicinal Chemistry and Molecular Pharmacology; West Lafayette, IN
01/2010	Case Western Reserve University, Dept. of Pharmacology; Cleveland, OH
01/2010	Northwestern University, Dept. of Neurobiology; Evanston, IL
02/2010	Tufts University, Dept. of Neuroscience; Boston, MA
02/2010	Washington University School of Medicine, Dept. of Anesthesiology; St. Louis, MO
03/2010	The Ohio State University, Department of Neuroscience; Columbus, OH
03/2010	University of California Davis, Dept. of Physiology and Membrane Biology; Davis, CA
10/2011	Stark Neurosciences Research Institute, Indiana Univ. School of Medicine; Indianapolis, IN
11/2011	Society for Neuroscience Satellite Symposium: nAChRs as Therapeutic Targets; Wash. D.C.
03/2013	Society for Research on Nicotine and Tobacco; Boston, MA
10/2013	University of Massachusetts School of Medicine, Neuroscience Seminar Series; Worcester, MA
07/2014	Wellcome Trust Conference: Nicotinic Acetylcholine Receptors; Cambridge, United Kingdom
03/2015	Experimental Biology Symposium: Pharmacological Knock-in Mouse Models; Boston, MA
09/2015	Indiana University Purdue Univ. Indianapolis, Neuroscience Addiction Group; Indianapolis, IN
10/2015	University of Chicago School of Medicine, Committee on Neurobiology; Chicago, IL
10/2015	Northwestern University Feinberg School of Medicine, Dept. of Pharmacology; Chicago, IL
03/2016	Barrow Neurological Institute & Arizona State University; Phoenix, AZ
04/2017	Wake Forest School of Med., Dept. of Physiology and Pharmacology; Winston-Salem, NC
04/2017	ASPET Neuropharm. Division Symposium: nAChRs in Learning and Addiction; Chicago, IL
02/2018	University of Chicago, National Institute on Drug Abuse Training Series; Chicago, IL
03/2018	University of Minnesota School of Medicine, Dept. of Pharmacology; Minneapolis, MN
04/2018	University of Tennessee Health Sciences Center, Dept. of Pharmacology; Memphis, TN
09/2018	Indiana University School of Medicine, Dept. of Pharmacology and Toxicology, Indianapolis, IN
10/2019*	University of Illinois at Chicago, Dept. of Anatomy and Cell Biology; Chicago, IL

Intramural

04/2013	Purdue University Dept. of Chemistry, Biochemistry Division; West Lafayette, IN
10/2013	Showalter Trust Selection Committee Annual Meeting; West Lafayette, IN
11/2015	Purdue University, Dept. of Psychological Sciences Behavioral Neuroscience; West Lafayette, IN
07/2016	Neurobiology of Information Storage T32 Retreat; Northwestern University; Lake Geneva, WI
09/2019	Tobacco Control Center of Excellence; Wake Forest School of Medicine; Winston-Salem, NC

DIDACTIC/SYSTEMATIC INSTRUCTION (*scheduled)

Purdue University, College of Pharmacy
Lecturer, MCMP 408, Cardiovascular and Renal Pharmacology (8 hrs / yr)
2012 – 2013

Indiana University School of Medicine, West Lafayette
Lecturer, LCME 610-611, Medical Pharmacology (16 hrs / yr)
2013 – 2016

Purdue University, College of Pharmacy
Lecturer, PHRM 844-845, Integrated Pharmacotherapy II-III (10 hrs / yr)
2014 – 2016

Purdue University, College of Pharmacy
Lecturer, MCMP 544, Drug Classes and Mechanisms (3 hrs / yr)
2015 – 2016

Northwestern University, The Graduate School
Lecturer, DGP 420, Introduction to Pharmacology (2 hrs / yr)
2017

Northwestern University, The Graduate School
Founding Course Director, NUIN/DGP 436, Drugs and the Brain (8 hrs / yr)
2019 first offering

*Wake Forest University School of Medicine
Introduction to Neuroscience (1.5 hrs / yr)
2019

MENTORING RELATIONSHIPS:

Graduate Students

2011 – 2016	Staci E. Engle, Ph.D. Med. Chem. & Mol. Pharm. Graduate Program Thesis advisor Current position: Postdoctoral fellow, Indiana University
2012 – 2013	Hillary Broderick Purdue Life Sciences Graduate Program Thesis Advisor Left program after 1 yr
2012 – 2014	Gyeon Oh Med. Chem. & Mol. Pharm. Graduate Program Thesis advisor Failed program
2014 – 2019	Matthew C. Arvin, Pharm.D. Med. Chem. & Mol. Pharm. Graduate Program Thesis advisor
2018 – 2019	Gabriela Lopez

NUIN Graduate Program
Thesis advisor
Changed labs due to Drenan move to Wake Forest

Graduate Rotation Students

2011	Staci Engle (MCMP)
2011	Hilary Broderick (PULSe)
2012	Evan Pratt (MCMP)
2012	Maria Sandra Carbajal de Nava (PULSe)
2012	Jessica Page (PULSe)
2012	Ehab Moussa (MCMP)
2012	Gyeon Oh (MCMP)
2013	Marcus Weera (PULSe)
2013	Meridith Robins (MCMP)
2014	Matthew Arvin (MCMP)
2014	Ryan Cross (PULSe)
2018	Gabriela Lopez (NUIN)
2018	Sara Freda (NUIN)

Graduate Student Thesis Committees

2011 – 2012	Hilary Broderick (PULSe)
2011 – 2016	Daniel Ysselstein (PULSe)
2011 – 2016	Staci Engle (MCMP)
2012 – 2014	Timothy Beenen (MCMP)
2012 – 2014	Gyeon Oh (MCMP)
2012 – 2017	Evan Pratt (MCMP)
2013	Jason Conley (MCMP)
2013 – 2017	Jessica Page (PULSe)
2013 – 2017	Marcus Weera (PULSe)
2014 – 2018	Meridith Robins (MCMP)
2014 – Present	Matthew Arvin (MCMP)

2017 – 2019	Brittany Hopkins (NUIN)

Oral Preliminary Exam Committees

2012	Yuchen Wang (MCMP)
2012	Tarsus Brust (MCMP)
2013	Aurélie Jacuet (MCMP)
2014	Monica P. Soto Velasquez (MCMP)
2014	Marcus Weera (PULSe; Committee Chair)
2014	Minervo Perez (PULSe)
2015	Meridith Robins (MCMP; Committee Chair)

Postdoctoral Fellows

2012 – 2013	Yuexiang Wang, Ph.D. Postdoctoral fellow Current position: industry research, China
2013 – 2015	Pei-Yu Shih, Ph.D. Postdoctoral fellow Current position: Janssen Pharmaceuticals
2013 – 2016	Jennifer Berry, Ph.D. Postdoctoral fellow Current position: Assistant Professor, Butler University
2015 – 2018	Can Peng, Ph.D. Postdoctoral fellow Current position: time off with family
2016 – 2017	Yong Wang, Ph.D. Postdoctoral fellow Current position: Assoc. Research Scientist, Arizona State Univ.
2019 – Present	Ellen M. Walker, Ph.D. Postdoctoral fellow

Research Associates

2016 – Present	Xiao-Tao Jin, Ph.D. Research Associate
2016 – 2019	Yijin Yan, Ph.D. Research Associate

Professional Students & Undergraduates

2014 – 2015	Brianne Alman
2015 – 2016	Andrew Stumpf
2018 – 2019	Brittany Henry

Technical Staff

2011 – 2012	Li Li, Ph.D.
2011 – 2012	Mi Ran Kim
2016 – 2017	Guiqing Zhao, Ph.D.
2017 – 2019	Veronica Kim
2017 – 2018	Matthew Ramsey
2018 – Present	Nicole Beckley
2019 – Present	Alison Carvalho

Awards Received by Trainees

2011 – 2013	Staci Engle; Frederick Andrews Graduate Fellowship
2013	Staci Engle; Koo and Paget Travel Award
2014 – 2015	Staci Engle; John Davisson Endowment Fellowship
2015	Staci Engle; Jenkins/Knevel Award for Excellence in Research
2015	Staci Engle; Bilsland Dissertation Fellowship
2016 – 2018	Matthew Arvin; PhRMA Foundation Predoctoral Fellowship
2018	Matthew Arvin; 1st Place, Poster Competition, Brain Research Foundation Annual Neuroscience Day
2018	Brittany Henry; Conference Travel Grant, Northwestern University Office of Undergraduate Research

PUBLIC OUTREACH

Media Coverage / Interviews

2018	"*Expert warns of health risks of JUULs*" The Daily Illini https://dailyillini.com/news/2018/03/12/expert-warns-of-health-risks-of-juuls/
2018	"Scientists develop new tool to study nicotine receptors"

Feinberg School of Medicine News Center
http://news.feinberg.northwestern.edu/2018/03/scientists-develop-new-tool-to-study-nicotine-receptors/

2018 “Lighting up: Development of photoactivatable nicotine”
Scientifica, Inc.
http://www.scientifica.uk.com/research-news/lighting-up-development-of-photoactivatable-nicotine

2018 “*New insights into nicotine’s effect on reward pathways*”
Feinberg School of Medicine News Center
http://news.feinberg.northwestern.edu/2018/05/new-insights-into-nicotines-effect-on-reward-pathways/