

**Travis Hughes, Ph.D.**  
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Center for Biomolecular Structure and Dynamics  
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## Research Interests

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My lab focuses on connecting basic biophysical insights into how drugs change receptor shape and movement with the functional outputs induced by those drugs in defined biochemical assays and in cells. This knowledge helps guide design of better nuclear receptor drugs.

## Education and Employment

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2020 - present	Associate Professor Dept. of Biomedical and Pharmaceutical Sciences, University of Montana, Missoula
2016 - 2019	Assistant Professor Dept. of Biomedical and Pharmaceutical Sciences, University of Montana, Missoula
2016 - Present	Member of the faculty of the Biochemistry and Biophysics, Pharmaceutical Sciences and Drug Design, and Neuroscience programs.
2014 - 2015	Visiting Research Associate (summers) Thomas Cheatham II Lab, Dept. of Medicinal Chemistry, University of Utah. <i>Molecular dynamics simulation of transcription factors.</i>
2010 - 2015	Research Associate Douglas Kojetin Lab, The Scripps Research Institute, Jupiter, Florida. <i>Biophysics of transcription factor function.</i>
2009 - 2010	Lead Scientist Personal Digital Health Systems, Granada, Spain. <i>Small startup biotech company focused on protein redesign for epigenetic sequencing.</i>
2008	Ph.D. Molecular, Cellular and Developmental Biology, University of Colorado, Boulder. <i>Naked DNA as a vector for delivery of genes to the intrathecal space: expression and immune response.</i>
2003	M.S. Physics, Brigham Young University, Provo, Utah. <i>AFM visualization of mobile influenza A M2 molecules in planar bilayers.</i>
2001	B.S. Physics, Brigham Young University, Provo, Utah. <i>Construction of a miniaturized X-ray diffraction and X-ray fluorescence instrument for analysis of rocks and minerals.</i>

1999 - 2002            Research Assistant, Moxtek Inc., Orem, Utah. *Software design and mechanical engineering*

**Publications (27 total)**

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**Definition of functionally and structurally distinct repressive states in the nuclear receptor PPAR $\gamma$**

<sup>^</sup>Heidari, Z., <sup>^</sup>Chrisman, I. M., Nemetchek, M. D., Novick, S. J., Blayo, A., Patton, T., Mendes, D. E., Diaz, P., Kamenecka, T. M., Griffin, P. R. & **Hughes, T. S.**

*Nature Communications*. 2019 Dec 20;10(1):5825. doi: 10.1038/s41467-019-13768-0

member of Hughes lab

<sup>^</sup>equal contribution

**Defining a canonical ligand-binding pocket in the orphan nuclear receptor Nurr1.**

de Vera, I. M. S., Munoz-Tello, P., Dharmarajan, V., Marciano, D. P., Matta-Camacho, E., Giri, P. K., Shang, J., **Hughes, T. S.**, Rance, M., Griffin, P. R. & Kojetin, D. J.

*Structure* 2019 Jan 2;27(1):66-77.e5. doi: 10.1016/j.str.2018.10.002.

**A structural mechanism for directing corepressor-selective inverse agonism of PPAR $\gamma$ .**

Brust, R., Shang, J., Fuhrmann, J., Bass, J., Cano, A., Heidari, Z., Chrisman, I., Blayo, A.-L., Griffin, P., Kamenecka, T., **Hughes, T.** & Kojetin, D.

*Nature Communications*. 2018 Nov 8;9(1):4687. doi: 10.1038/s41467-018-07133-w.

member of Hughes lab

**Cooperative cobinding of synthetic and natural ligands to the nuclear receptor PPAR $\gamma$ .**

Shang, J., Brust, R., Mosure, S. A., Bass, J., Munoz-Tello, P., Lin, H., **Hughes, T. S.**, Tang, M., Ge, Q., Kamenecka, T. M. & Kojetin, D. J.

*Elife*. 2018 Dec 21;7. doi: 10.7554/eLife.43320.

**Defining a conformational ensemble that directs activation of PPAR $\gamma$ .**

Chrisman IM, Nemetchek MD, de Vera IMS, Shang J, Heidari Z, Long Y, Reyes-Caballero H, Galindo-Murillo R, Cheatham TE 3rd, Blayo AL, Shin Y, Fuhrmann J, Griffin PR, Kamenecka TM, Kojetin DJ, **Hughes T.S.**

*Nature communications*. 2018; 9(1):1794.

member of Hughes lab

**Synergistic Regulation of Coregulator/Nuclear Receptor Interaction by Ligand and DNA.**

de Vera IMS, Zheng J, Novick S, Shang J, **Hughes TS**, Brust R, Munoz-Tello P, Gardner WJ Jr, Marciano DP, Kong X, Griffin PR, Kojetin DJ.

*Structure*. 2017; 25(10):1506-1518.e4.

**Probing the Complex Binding Modes of the PPAR $\gamma$  Partial Agonist 2-Chloro-N-(3-chloro-4-((5-chlorobenzo[d]thiazol-2-yl)thio)phenyl)-4-(trifluoromethyl)benzenesulfonamide (T2384) to Orthosteric and Allosteric Sites with NMR Spectroscopy.**

**Hughes TS**, Shang J, Brust R, de Vera IMS, Fuhrmann J, Ruiz C, Cameron MD, Kamenecka TM, Kojetin DJ.

*Journal of Medicinal Chemistry*. 2016; 59(22):10335-10341.

**Structural mechanism for signal transduction in RXR nuclear receptor heterodimers.**

Kojetin DJ, Matta-Camacho E, **Hughes TS**, Srinivasan S, Nwachukwu JC, et al.

*Nature Communications*. 2015; Aug 20;6:8013

**Pharmacological repression of PPAR $\gamma$  promotes osteogenesis.**

Marciano DP, Kuruvilla DS, Boregowda SV, Asteian A, Hughes TS, et al.  
*Nature Communications*. 2015; Jun 12;6:7443.

**Deconvolution of Complex 1D NMR Spectra Using Objective Model Selection.**

Hughes TS\*, Wilson HD, de Vera IM, Kojetin DJ\*.

*PLoS One*. 2015; 10(8):e0134474.

\*co-corresponding author

**Structure of REV-ERB $\beta$  Ligand-binding Domain Bound to a Porphyrin Antagonist.**

Matta-Camacho E., Banerjee S., Hughes T.S., Solt L.A., Wang Y., Burris T.P., Kojetin D.J.

*J Biological Chemistry*. 2014; 289:20054-66.

**Resveratrol modulates the inflammatory response via an estrogen receptor-signal integration network.**

Nwachukwu J.C., Srinivasan S., Bruno N.E., Parent A.A., Hughes T.S., Pollock J.A., Gjyshi O., Cavett V., Nowak J., Garcia-Ordenez R.D., Houtman R., Griffin P.R., Kojetin D.J., Katzenellenbogen J.A., Conkright M.D. and K.W. Nettles

*eLIFE* 2014; 10.7554/eLife.02057

**An alternate binding site for synthetic PPAR $\gamma$  ligands.**

Hughes T.S., Giri P.K., de Vera I.M.S., Marciano D.P., Kuruvilla D.S., Shin Y., Blayo A., Kamenecka T.M., Burris T.P., Griffin P.R. and D.J. Kojetin

*Nature Communications*. 2014; 5:3571 doi: 10.1038/ncomms4571

**Ligand-binding dynamics rewire cellular signaling via estrogen receptor- $\alpha$ .**

Srinivasan S., Nwachukwu J.C., Parent A.A., Cavett V., Nowak J., Hughes T.S., Kojetin D.J., Katzenellenbogen J.A. and K.W. Nettles

*Nature Chemical Biology*. 2013; 9:326-32. PMID: 23524984

**Nuclear receptors and their selective pharmacologic modulators.**

Burris TP1, Solt LA, Wang Y, Crumbley C, Banerjee S, Griffett K, Lundasen T, Hughes T, Kojetin DJ.

*Pharmacological reviews*. 2013; 65(2):710-78. doi: 10.1124/pr.112.006833.

**Ligand and receptor dynamics contribute to the mechanism of graded PPAR $\gamma$  agonism.**

Hughes, T. S., M. J. Chalmers, S. Novick, D. S. Kuruvilla, M. R. Chang, T. M. Kamenecka, M. Rance, B. A. Johnson, T. P. Burris, P. R. Griffin & D. J. Kojetin

*Structure*. 2012; 20:139-50.

**Regulation of circadian behaviour and metabolism by synthetic REV-ERB agonists.**

Solt, L. A., Y. Wang, S. Banerjee, T. Hughes, D. J. Kojetin, T. Lundasen, Y. Shin, J. Liu, M. D. Cameron, R. Noel, S. H. Yoo, J. S. Takahashi, A. A. Butler, T. M. Kamenecka & T. P. Burris

*Nature*, 2012; 485:62-68.

*Papers from PhD-MCD Biology*

**Evidence that opioids may have toll-like receptor 4 and MD-2 effects.**

Hutchinson, M. R., Y. Zhang, M. Shridhar, J. H. Evans, M. M. Buchanan, T. X. Zhao, P. F. Slivka, B. D. Coats, N. Rezvani, J. Wieseler, **T. S. Hughes**, K. E. Landgraf, S. Chan, S. Fong, S. Phipps, J. J. Falke, L. A. Leinwand, S. F. Maier, H. Yin, K. C. Rice & L. R. Watkins  
*Brain Behav Immun.* 2010; 24:83-95.

**Immunogenicity of intrathecal plasmid gene delivery: cytokine release and effects on transgene expression.**

**Hughes, T. S.**, S. J. Langer, S. I. Virtanen, R. A. Chavez, L. R. Watkins, E. D. Milligan & L. A. Leinwand  
*The Journal of Gene Medicine.* 2009; 11:782-90.

**Intrathecal Injection of Naked Plasmid DNA Provides Long-Term Expression of Secreted Proteins.**

**Hughes, T. S.**, S. J. Langer, K. W. Johnson, R. A. Chavez, L. R. Watkins, E. D. Milligan & L. A. Leinwand  
*Molecular Therapy.* 2009; 17:88-94.

**Immunological priming potentiates non-viral anti-inflammatory gene therapy treatment of neuropathic pain.**

Sloane, E., S. Langer, B. Jekich, J. Mahoney, **T. Hughes**, M. Frank, W. Seibert, G. Huberty, B. Coats, J. Harrison, D. Klinman, S. Poole, S. Maier, K. Johnson, R. Chavez, L. R. Watkins, L. Leinwand & E. Milligan  
*Gene Therapy.* 2009; 16:1210-22.

**PEGylation of brain-derived neurotrophic factor for preserved biological activity and enhanced spinal cord distribution.**

Soderquist, R. G., E. D. Milligan, E. M. Sloane, J. A. Harrison, K. K. Douvas, J. M. Potter, **T. S. Hughes**, R. A. Chavez, K. Johnson, L. R. Watkins & M. J. Mahoney  
*J Biomed Mater Res A.* 2009; 91:719-29. doi: 10.1002/jbm.a.32254

**Repeated intrathecal injections of plasmid DNA encoding interleukin-10 produce prolonged reversal of neuropathic pain.**

Milligan, E. D., E. M. Sloane, S. J. Langer, **T. S. Hughes**, B. M. Jekich, M. G. Frank, J. H. Mahoney, L. H. Levkoff, S. F. Maier, P. E. Cruz, T. R. Flotte, K. W. Johnson, M. M. Mahoney, R. A. Chavez, L. A. Leinwand & L. R. Watkins  
*Pain.* 2006; 126:294-308

**Intrathecal polymer-based interleukin-10 gene delivery for neuropathic pain.**

Milligan, E. D., R. G. Soderquist, S. M. Malone, J. H. Mahoney, **T. S. Hughes**, S. J. Langer, E. M. Sloane, S. F. Maier, L. A. Leinwand, L. R. Watkins & M. J. Mahoney  
*Neuron Glia Biol.* 2006; 2:293-308.

*Paper from MS-Physics*

**AFM visualization of mobile influenza A M2 molecules in planar bilayers.**

**Hughes, T.**, B. Strongin, F. P. Gao, V. Vijayvergiya, D. D. Busath & R. C. Davis  
*Biophysical Journal.* 2004; 87:311-22.

*Papers from BS-physics*

**An XRD/XRF instrument for the microanalysis of rocks and minerals.**

Cornaby, S., A. Reyes-Mena, H. K. Pew, P. W. Moody, **T. Hughes**, A. Stradling, D. C. Turner & L. V. Knight

*Measurement Science and Technology*. 2001; 12:676-683.

**Using a Charge-Coupled Device (CCD) as an x-ray single-photon energy-dispersive detector.**

Cornaby, S., A. Reyes-Mena, H. K. Pew, P. W. Moody, T. Hughes, A. Stradling & L. V. Knight  
*Journal of X-Ray Science and Technology*. 2001; 9:85-97.

**Patents**

Patent no. US8524678 B2 *Method for delivering genes*. Watkins L.M.R., Hughes T., Chavez R.A.

**Funding/Grants**

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Current funding

Agency: NIH NIGMS COBRE Phase III (P20GM103546; Junior Investigator award)

Annual direct costs: \$150,000

Period: August 1 2019-July 31 2021

Principle Investigator: Travis Hughes (Co-PI Amitava Roy)

Agency: NSF IRES Track II Advanced Studies Institute

Total costs: \$299,968 (Supports two ten-day workshops in Malaysia and Singapore)

Period: August 15 2020-July 31 2022

Pending funding

Agency: NIH NIDDK (R01)

Annual direct costs: \$250,000

Period: August 1 2021-July 31 2026

Completed funding

*Connecting the functional effects of drugs to how they change PPAR gamma*

Principle Investigator: Travis Hughes

Agency: NIH NIDDK (R00DK103116)

Annual direct costs: ~\$160,000

Period: January 1 2016 - December 31 2019

*Developing testable Nuclear receptor structure function models*

Co-Principle Investigators: Travis Hughes and Zahra Heidari

Agency: NSF XSEDE (MCB180110)

Annual direct costs: \$3,290 (NSF estimate for value of 7000 GPU hours granted on SDSU computational cluster) Period: October 1 2018 - September 30 2019

*Determination of the "off" structural state of peroxisome proliferator-activated receptor  $\gamma$  (PPAR $\gamma$ )*

Principle Investigator: Travis Hughes

Agency: NIH NIGMS CoBRE Phase II (P20GM103546; Pilot project funding via Center for Biomolecular Structure and Dynamics)

Annual direct costs: \$36,500 Period: August 1 2018 -July 31 2019

*Connecting the functional effects of drugs to how they change PPAR $\gamma$*

Principle Investigator: Travis Hughes

Agency: NIH NIDDK (1-K99-DK103116; Pathway to independence award)

Annual direct costs: \$81,302 Period: September 1 2014 - December 31 2015

*Uncovering a structural-dynamic basis for NR1 nuclear receptor function*

Provisional awardee of the "Talentia Postdoc" Postdoctoral fellowship

Principle Investigator: Travis Hughes

Agency: European Union 7th framework programme (FP7-PEOPLE-2010-COFUND - Marie-Curie Action: "Co-funding of regional, National and International Programmes") and Spain (Agencia Andaluza de Conocimiento) Period: (Application withdrawn after award of the K99)

*Linking partial and non-agonist induced dynamics to PPAR gamma functions*

Principle Investigator: Travis Hughes

Agency: NIH NIDDK (F32DK0978902012; NRSA Postdoctoral fellowship)

Annual direct costs: \$54,000 Period: September 1 2012 - August 31 2014

*Linking partial and non-agonist induced dynamics to PPAR gamma functions*

Principle Investigator: Travis Hughes

Agency: American Heart Association (12POST12050025; fellowship)

Annual direct costs: \$47,000 Period: July 1 2012 - August 31 2012 (resigned to accept F32)

## Teaching Experience

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	<i>Course name</i>	<i>Number of students</i>	<i>Type of students</i>	<i>Lecture hours</i>	<i>Lab hours</i>
Summers 2019-2020	HCOP: Antimicrobials and Medical Microbiology	10	Pre-pharmacy	16/yr	
Spring 2017-present	Microbes and Medicines	~60	Doctor of Pharmacy	~30/yr	
Spring 2018 and 2020	Molecular Pharmacology	4-5	Graduate students	20	
Fall 2016-present	Integrated studies	10	Doctor of Pharmacy		26
Spring 2017	Medicinal Chemistry	8	Graduate students	1	
Fall 2017	Neuroscience Research Techniques	3	Undergrad		40
Spring 2009	Molecular Biology lab	10	Undergrad	6	48
Fall 2003	Genetics lab	15	Undergrad		60
Spring 2004	Cell Biology lab	15	Undergrad		60

2002-2004	Newtonian Mechanics, Electricity and Magnetism and other Physics labs	10	Undergrad	20hr/week for 3 semesters
1999-2001	Physics tutorial lab learning assistant	variable	Undergrad	20 hr/week for 5 semesters

*Formal training in pedagogy*

- Reorganized an experimental physics lab.
  - In conjunction with the center for teaching and learning at BYU, my Master’s degree mentor, a senior faculty member and myself reorganized the advanced experimental physics lab.
- Obtained a teaching certificate through the graduate teacher program at the University of Colorado.
  - I worked as lead graduate teacher (2 years) and received and practiced teaching instruction (4 years) on a variety of teaching subjects via ~20 seminars and workshops. In addition, I gave a workshop on learning styles.

**Mentoring**

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*Current members of my lab:*

Biochemistry and Chemistry graduate students

May 2017 – present	Michelle Nemetcheck, PhD student, 2019 Bertha Morton Scholar
August 2017 – present	Vikash Kumar, PhD student
May 2018 – present	Mariah Rayl, PhD student

PSDD graduate students

Summer 2020-present	Elizabeth Sather, PhD student
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*Lab Alumni*

Aug 2016 – Jan 2019	Ian Chrisman, Biochemistry PhD student; Post doc U. of Delaware
Jan 2018 – May 2019	Trey Patton, PSDD Master’s student (shared with P. Diaz lab); Scientist I at Albany Molecular Research Inc.
June 2017-June 2019	Zahra Heidari (Postdoctoral Fellow in my lab).

**University Service**

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August 2018 – present	Institutional Biosafety Committee
August 2017 – present	Curriculum Committee School of Pharmacy
Fall 2016 – present	Graduate Recruitment Committee Pharmaceutical Sciences and Drug design program
Fall 2016 – Spring 2018	Graduate Recruitment Committee Neurosciences program

## Other

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2017 - 2018	Member, Biophysical Society
2011 - 2012	Member, American Heart Association
2003 - 2004	Member, Biophysical Society
2019	Rho Chi Professor of the Year, Skaggs School of Pharmacy, University of Montana.
2013	Robert M. Sandelman Award for Scientific Excellence, The Scripps Research Institute
2005	Best Should Teach Silver award, University of Colorado
1996 - 1998	Volunteer for two years (1996-1998) in Bolivia where I became fluent in Spanish.