Travis Hughes, Ph.D.
Associate Professor
Department of Biomedical & Pharmaceutical Sciences
Center for Biomolecular Structure and Dynamics
The University of Montana, Missoula, MT, USA
Phone: (406) 243-2750
travis.hughes@umontana.edu

Research Interests

My lab focuses on connecting biophysical insights into how drugs change receptor shape 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

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

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

Publications (27 total)

Definition of functionally and structurally distinct repressive states in the nuclear receptor PPARγ
^Heidari, Z., ^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
^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 PPARγ.
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 PPARγ. Shang, J., Brust, R., Mosure, S. A., Bass, J., Munoz-Tello, P., Lin, H., **Hughes, T. S.**, Tang, M., Ge, Q., Kamekencka, T. M. & Kojetin, D. J.
Elife. 2018 Dec 21;7. doi: 10.7554/eLife.43320.

Defining a conformational ensemble that directs activation of PPARγ.
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 PPARγ 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 PPARγ 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-ERBbeta 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-Ordonez 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 PPARγ 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 PPARgamma 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

Current funding

Structural definition of biased agonism in the nuclear receptor PPAR gamma
Principle Investigator: Travis Hughes
Agency: NIH NIDDK
Total costs: $1,795,813
Period: August 1 2022-July 31 2027

IRES Track II: Cross-disciplinary Computational Biology Training
Principle Investigator: Travis Hughes (Co-PI Amitava Roy)
Agency: NSF IRES Track II Adanced Studies Institute
Total costs: $299,968 (Almost all of this funding will be used to support two ten-day workshops in Malaysia and Singapore)
Period: August 15 2020-July 31 2022

Completed funding

Structural definition of biased signaling in the nuclear receptor PPARγ
Principle Investigator: Travis Hughes
Agency: NIH NIGMS COBRE Phase III (P20GM103546; Junior Investigator award)
Total direct costs: $450,000
Period: August 1 2019-July 31 2022

Connecting the functional effects of drugs to how they change PPAR gamma
Principle Investigator: Travis Hughes
Agency: NIH NIDDK (R00DK103116)
Total costs: ~$700,000
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 γ (PPARγ)
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 PPARγ
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 Conocimento) 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

	Course name	*Number of students*	*Type of students*	*Lecture hours*	*Lab hours*
Summers 2022-2023	CompBio Asia (organizer of two-week workshop)	~40	PhD/MS	~6/yr	
Summers 2019-2021	HCOP: Antimicrobials and Medical Microbiology	5-12	Pre-pharmacy	~16/yr	
Spring 2017-present	Microbes and Medicines	50-75	Doctor of Pharmacy	~30/yr	
Spring 2018 and 2020	Molecular Pharmacology	4-5	Graduate students	~20/yr	
Spring 2021	Physical Biochemistry	6	Graduate students	~5/yr	
Fall 2016-present	Integrated studies	10-12	Doctor of Pharmacy		~14/yr

Spring 2017	Medicinal Chemistry	8	Graduate students	1	
Fall 2017	Neuroscience Research Techniques	3	Undergrad		40

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

Current members of the Hughes lab include 3 PhD students, 3 PharmD/MS students, 1 undergraduate student and two high school students.

Lab alumni include a Postdoctoral Fellow, two Master's students and one PhD student. All are currently working in industry.

Other

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 in Bolivia where I became fluent in Spanish.