Darren W. Engers, Ph.D.

Vanderbilt Center for Neuroscience Drug Discovery
Vanderbilt University
393 Nichol Mill Lane
Franklin, TN 37067

Work: (615) 322-0673
Mobile: (615) 517-5545
darren.engers@vanderbilt.edu

EDUCATION

2006 – 2008 **Postdoctoral Research Fellow, Department of Chemistry**
Vanderbilt University, Nashville, Tennessee

2000 – 2006 **Ph.D., Organic Chemistry**
The University of Texas at Austin, Austin, Texas

1994 – 1998 **B.S., Chemistry**
University of Delaware, Newark, Delaware

RESEARCH EXPERIENCE

2018 - Present **Vanderbilt University, Vanderbilt Center for Neuroscience for Drug Discovery**

Research Assistant Professor; Associate Director of Medicinal Chemistry

- Coordinate with the Director of Medicinal Chemistry, Dr. Lindsley, about all matters related to VCNDD Medicinal Chemistry programs and operations
- Medicinal Chemistry Group Leader for multiple Muscarinic & Glutamate receptor programs
- Provide effective leadership in the direction, design and interpretation of structure-activity relationship (SAR) for numerous programs/projects, including M1/M4 PAM, M4 Antagonist and Ion Channel targets.
- Several of these drug discovery programs are in active collaborations with major pharmaceutical companies resulting in licensing deals and milestone payments.
- Supervise 10-15 very productive research assistants, post-doctoral fellows and staff scientists on various internal projects.

2012 – 2018 **Vanderbilt University Medical Center, Vanderbilt Center for Neuroscience Drug Discovery**

Research Instructor

- Medicinal Chemistry Group Leader for multiple Muscarinic receptor programs
- Provide effective leadership in the direction, design and interpretation of structure-activity relationship (SAR) for numerous programs/projects, including metabotropic glutamate receptor (mGluR) 4 PAM, mGluR5 PAM/NAM and M1/M4 PAM.
- Collaborated with Prof. Charles Hong on the discovery and design of selective modulators for the Bone Morphogenetic Protein (BMP) that led to a licensing deal with Lajolla Pharmaceuticals (9/2015).
- Supervise 8-10 very productive research assistants, post-doctoral fellows and staff scientists on various internal projects.

2008 – 2012 **Vanderbilt University Medical Center, Vanderbilt Center for Neuroscience Drug Discovery**

Drug Discovery I Scientist (promoted to Drug Discovery Scientist II in 2011)

- Provided leadership in the design and interpretation of SAR for numerous programs/projects, including mGluR4 PAM, mGluR5 PAM/NAM and mGluR1 NAM.
- Integral member of mGluR4 PAM team that has submitted 10 patent applications, of which I was co-inventor of 6 patents.
- Active collaboration within the numerous MLPCN projects and contributed to 3 declared probes (Kir 2.1 and mGluR 4 PAM (2)).
- Supervised and mentored junior chemists (graduate students/staff) with a focus on individual growth and successful project completion.

2006 – 2008 **Vanderbilt University, Department of Chemistry**

Postdoctoral research fellow
Advisor: Prof. Gary A. Sulikowski

- Independently designed and implemented a novel approach toward the systematic synthesis of both HMP-Y1, a metabolite produced from blocked mutant of hibarimicins, and hibarimicinone, a *Src* tyrosine inhibitor.
- Developed an efficient synthesis towards a highly functionalized enone using a chiron based strategy and studied intramolecular Diels-Alder reactions leading to the fully functionalized *cis*-decalin fragment of both HMP-Y1 and hibarimicinone.
- Supervising and mentored several graduate students with a focus on intellectual and project development.
- Served as a judge for the graduate student and post-doc poster presentations at the 3rd Annual Vanderbilt Institute Chemical Biology Member Retreat.

2000 – 2006 **University of Texas at Austin, Department of Chemistry**

Advisor: Prof. Brian L. Pagenkopf
Thesis title: *Studies Toward the Total Synthesis of Peloruside A*

- Synthesized a complex polyoxygenated 16-membered macrolactone, Peloruside A, with an emphasis on efficient routes, catalytic reactions and chiron based strategies.
- Studied the effects of β-heterocyclic aldehydes with a α-benzyloxymethyl ketone in the Mukaiyama and boron-mediated aldol reactions that resulted in unprecedented facial selectivity.
- Supervised and mentored a 1st year graduate student in the synthesis, purification and characterization of β-heterocyclic aldehydes for use in the above aldol study.
- Contributed to the design, implementation, and supervision of an advanced undergraduate-level laboratory in modern organic synthesis (CH 341).

1999 – 2000 **Rhone-Poulenc Rorer**, Collegeville, PA

Research Assistant, New Leads Discovery Department
Department Director: Joseph M. Salvino, Ph.D.

- Research focused on traditional single compound synthesis, as well as, parallel

solution and solid phase synthesis, including Irori technology.

- Synthesized tetraflourophenol (TFP) activated resins that were extensively used for the synthesis of focused libraries.
- Prepared substituted piperazines using solid phase synthesis and heterocyclic amines via the Bienamye reaction from solution phase synthesis. These amines were used with TFP resins to form potential biologically active molecules.
- Completed the synthesis of a focused library of sulfonamides and amides from α-amino lactams that provided SAR with a 10 fold enhancement in biological activity and resulted in a lead compound that was advanced for consideration as a product candidate.
- Demonstrated the keen ability to work both independently and in a team environment: demonstrated ability to collaborate with Biological and Medicinal Chemistry team members.

1994 – 1998 **University of Delaware, Newark, Delaware**

Advisor: Prof. P. Andrew Evans

- Completed the methodology of α,α-dimethyl silyl enol ethers via cyclopropanation followed by a mercury-mediated oxidative Rubottom rearrangement for the synthesis of the B ring of Mycalamide A.
- Collaborated with all members of the group and learned valuable organic synthetic techniques.

PUBLICATIONS

53) "Surveying heterocycles as amide bioisosteres within a series of mGlu7 NAMs: Discovery of VU6019278", Reed C.W.; Washecheck, J.P.; Quitlag, M.C.; Jenkins, M.T.; Rodriguez, A.L.; **Engers, D.W.**; Blobaum, A.L.; Conn, P.J.; Niswender, C.M.; Lindsley, C.W. *Bioorg. Med. Chem. Lett.* **2019**, *In press*.

52) "Discovery of VU2957 (Valiglurax): An $mGlu_4$ Positive Allosteric Modulator Evaluated as a Preclinical Candidate for the Treatment of Parkinson's Disease", Panarese, J.D.; **Engers, D.W.**; Wu, Y.J.; Bronson, J.J.; Macor, J.E.; Chun, A.; Rodriguez, A.L.; Felts, A.S.; Engers, J.L.; Loch, M.T.; Emmitte, K.A.; Castelhano, A.L.; Kates, M.J.; Nader, M.A.; Jones, C.K.; Blobaum, A.L.; Conn, P.J.; Niswender, C.M.; Hopkins, C.R.; Lindsley, C.W. *ACS Med. Chem. Lett.* **2019**, *10*, 255-260.

51) "Discovery of an Orally Bioavailable and Central Nervous System (CNS) Penetrant mGlu7 Negative Allosteric Modulator (NAM) in Vivo Tool Compound: N-(2-(1H-1,2,4-triazol-1-yl)-5-(trifluoromethoxy)phenyl)-4-(cyclopropylmethoxy)-3-methoxybenzamide (VU6012962)", Reed, C.W.; Yohn, S.E.; Washechck, J.P.; Roenfanz, H.F.; Quitalig, M.C.; Luscombe, V.B.; Jenkins, M.T.; Rodriguez, A.L.; **Engers, D.W.**; Blobaum, A.L.; Conn, P.J.; Niswender, C.M.; Lindsley, C.W. . *J. Med. Chem.*, **2019**, *62*, 1690-1695.

50) "Novel M4 Positive allosteric modulators derived from questioning the role and impact of a presumed intramolecular hydrogen-bonding motif in B-amino carboxamide-harboring ligands", Poslusney, M.S.; Salovich, J.M.; Wood, M.R.; Melancon, B.J.; Bollinger, K.A.; Luscombe, V.B.; Rodriguez, A.L.; **Engers, D.W.**; Bridges, T.M.; Niswender, C.M.; Conn, P.J.; Lindsley, C.W. *Bioorg. Med. Chem. Lett.* **2019**, *29*, 362-366.

49) "The discovery of VU0652957 (VU2957, Valiglurax): SAR and DMPK challenges en route to an mGlu4 PAM development candidate", Panarese, J.D.; **Engers, D.W.**; Wu, Y.J.; Guernon, J.M.; Chun, A.; Gregro, A.R.; Bender, A.M.; Capstick, R.A.; Witing, J.M.; Bronson, J.J.; Macor, J.E.; Westphal, R.; Soars, M.; Engers, J.E.; Felts, A.S.; Rodriguez, A.L.; Emmitte, K.A.; Jones, C.K.; Blobaum, A.L.; Conn, P.J.; Niswender, C.M.; Hopkins, C.R.; Lindsley, C.W. *Bioorg. Med. Chem. Lett.* **2019**, *29*, 342-346.

48) "Discovery, Structure-Activity Relationship, and Biological Characterization of a Novel Series of 6-((1H-pyrazolo[4,3-b]pyridine-3-yl)amino)-benzo[d]isothiazole-3-carboxamides as Positive Allosteric Modulators of the Metabotropic Glutamate Receptor 4 (mGlu4)", Bollinger, S.R,; **Engers, D.W.**; Panerese, J.D.; West, M.; Engers, J.L.; Loch, M.T.; Rodriguez, A.L.; Blobaum, A.L.; Jones, C.K.; Thompson, G.A.; Conn, P.J.; Lindsley, C.W.; Niswender, C.M.; Hopkins, C.R. *J. Med. Chem.*, **2019**, *62*, 342-358.

47) "VU6007477, a Novel M_1 PAM Based on a Pyrrolo[2,3-b]pyridine Carboxamide Core Devoid of Cholinergic Adverse Events", Engers, J.L.; Childress, E.S.; Long, M.F.; Capstick, R.A.; Luscombe, V.B.; Cho, H.P.; Dickerson, J.W.; Rook, J.M.; Blobaum, A.L.; Niswender, C.M.; **Engers, D.W.**; Conn, P.J.; Lindsley, C.W. *ACS Med. Chem. Lett.* **2018**, *9*, 917-922.

46) "Discovery and characterization of N-(1,3-dialkyl-1H-indazol-6-yl)-1H-pyrazolo[4,3-b]pyridine-3-amine scaffold as $mGlu_4$ positive allosteric modulators that mitigate CYP1A2 induction liability", **Engers, D.W.**; Bollinger, S.R.; Engers, J.L.; Panerese, J.D.; Breiner, M.M.; Gregro, A.R.; Blobaum, A.L.; Bronson, J.J.; Wu, Y.J.; Macor, J.E.; Rodriguez, A.L.; Zamorano, R.; Conn, P.J.; Lindsley, C.W.; Niswender, C.M.; Hopkins, C.R. *Bioorg. Med. Chem. Lett.* **2018**, *28*, 2641-2646.

45) "The Discovery of VU0486846: steep SAR from a series of M_1 PAMs based on a novel benzomorpholine core", Bertron, J.L.; Cho, H.P.; Garcia-Barrantes, P.M.; Panarese, J.D.; Salovich, J.M.; Nance, K.D.; **Engers, D.W.**; Rook, J.M.; Blobaum, A.L.; Niswender, C.M.; Stauffer, S.R.; Conn, P.J.; Lindsley, C.W. *Bioorg. Med. Chem. Lett.* **2018**, *28*, 2175-2179.

44) "M1-postive allosteric modulators lacking agonist activity provide the optimal profile for enhancing cognition", Moran, S.P.; Dickerson, J.W.; Cho, H.P.; Maksymetz, J.; Remke, D.H.; Lv, X.; Doyle, C.A.; Rajan, D.H.; Niswender, C.M.; Engers, D.W.; Lindsley, C.W.; Rook, J.M.; Conn, P.J. *Neuropsychopharmacology* **2018**, *43*, 1763-1771.

43) "VU6010608, a Novel $mGlu_7$ NAM from a Series of N-(2-(1H-1,2,4-triazol-1-yl)-5-(trifluoromethoxy)phenyl)benzamides", Reed, C.W.; McGowan, K.M.; Spearing, P.K.; Stansley, B.J.; Roenfanz, H.F.; **Engers, D.W.**; Rodriguez, A.L.; Engelberg, E.M.; Luscombe, V.B.; Loch, M.T.; Remke, D.H.; Rook, J.M.; Blobaum, A.L.; Conn, P.J.; Niswender, C.M.; Lindsley, C.W. *ACS Med. Chem. Lett.* **2017**, *12*, 1326-1330.

42) "Challenges in the development of an M_4 PAM preclinical candidate: The discovery, SAR, and biological characterization of a series of azetidine-derived tertiary amides", Tarr, J.C.; Wood, M.R.; Noetzel, M.J.; Melancon, B.J.; Lamsal, A.; Luscombe, V.B.; Rodriguez, A.L.; Byers, F.W.; Chang, S.; Cho, H.P.; **Engers, D.W.**; Jones, C.K.; Niswender, C.M.; Wood, M.W.; Brandon, N.J.; Duggan, M.E.; Conn, P.J.; Bridges, T.M.; Lindsley, C.W. *Bioorg. Med. Chem. Lett.* **2017**, *27*, 5179-5184.

41) "Discovery of VU6005649, a CNS Penetrant $mGlu_{7/8}$ Receptor PAM Derived from a Series of Pyrazolo[1,5-*a*]pyrimidines", Abe, M.; Seto, M.; Gogliotti, R.G.; Loch, M.T.; Bollinger, K.A.; Chang, S.; Engelberg, E.M.; Luscombe, V.B.; Harp, J.M.; Bubser, M.; **Engers, D.W.**; Jones, C.K.; Rodriguez, A.L.; Blobaum, A.L.; Conn, P.J.; Niswender, C.M.; Lindsley, C.W. *ACS Med. Chem. Lett.* **2017**, *8*, 1110-1115.

40) "Discovery of a novel 2,4-dimethylquinoline-6-carboxamide M_4 positive allosteric modulator (PAM) chemotype via scaffold", Long, M.F.; Engers, J.L.; Chang, S.; Zhan, X.; Weiner, R.L; Luscombe, V.B.; Rodriguez, A.L.; Cho, H.P.; Niswender, C.M.; Bridges, T.M.; Conn, P.J.; **Engers, D.W.**; Lindsley, C.W. *Bioorg. Med. Chem. Lett.* **2017**, *27*, 4999-5001.

39) "Discovery of a novel, CNS penetrant M_4 PAM chemotype based on a 6-fluoro-4-(piperidinyl-1-yl)quinolone-3-carbonitrile core", Bewley, B.R.; Spearing, P.K.; Weiner, R.L.; Luscombe, V.B.; Zhan, X.; Chang, S.; Cho, H.P.; Rodriguez, A.L.; Niswender, C.M.; Conn, P.J.; Bridges, T.M.; **Engers, D.W.**; Lindsley, C.W. *Bioorg. Med. Chem. Lett.* **2017**, *27*, 4274-4279.

38) "$mGlu_7$ potentiation rescues cognitive, social, and respiratory phenotypes in a mouse model of Rett syndrome", Gogliotti, R.G.; Senter, R.K.; Fisher, N.M.; Adams, J.; Zamorano, R.; Walker, A.G.; Blobaum, A.L.; **Engers, D.W.**; Hopkins, C.R.; Daniels, J.S.; Jones, C.K.; Lindsley, C.W.; Xiang, Z.; Conn, P.J.; Niswender, C.M. *Sci. Transl. Med.* **2017**, *9*, 1-11.

37) "Discovery and optimization of 3-(4-aryl/heteroarylsulfonyl)piperazin-1-yl)-6-(piperidin-1-yl)pyridazines as novel, CNS penetrant pan-muscarinic antagonists", Bender, A.M.; Weiner, R.L.; Luscombe, V.B.; Ajmera, S.; Cho, H.P.; Chang, S.; Zhan, X.; Rodriguez, A.L.; Niswender, C.M.; **Engers, D.W.**; Bridges, T.M.; Conn, P.J.; Lindsley, C.W. *Bioorg. Med. Chem. Lett.* **2017**, *27*, 3576-3581.

36) "Optimization of M_4 positive allosteric modulators (PAMs): The discovery of VU0476406, a non-human primate *in vivo* tool compound for translational pharmacology", Melancon, B.J.; Wood, M.R.; Noetzel, M.J.; Nance, K.D.; Engelberg, E.M.; Han, C.; Lamsal, A.; Chang, S.; Cho, H.P.; Byers, F.W.; Bubser, M.; Jones, C.K.; Niswender, C.M.; Wood, M.W.; **Engers, D.W.**; Wu, D.; Brandon, N.J.; Duggan, M.E.; Conn, P.J.; Bridges, T.M.; Lindsley, C.W. *Bioorg. Med. Chem. Lett.* **2017**, *27*, 2296-2301.

35) "Synthesis and evaluation of 4,6-disubstituted pyrimidines and CNS penetrant *pan*-muscarinic antagonists with a novel chemotype", Bender, A.M.; Weiner, R.L.; Luscombe, V.B.; Cho, H.P.; Niswender, C.M.; **Engers, D.W.**; Bridges, T.M.; Conn, P.J.; Lindsley, C.W. *Bioorg. Med. Chem. Lett.* **2017**, *27*, 2479-2483.

34) "Discovery of VU0467485/AZ13713945: An M_4 PAM Evaluated as a Preclinical Candidate for the Treatment of Schizophrenia", Wood, M.R.; Noetzel, M.J.; Melancon, B.J.; Poslusney, M.S.; Nance, K.D.; Hurtado, M.A.; Luscombe, V.B.; Weiner, R.L.; Rodriquez, A.L.; Lamsal, A.; Chang, S.; Bubser, M.; Blobaum, A.L.; **Engers, D.W.**; Niswender, C.M.; Jones, C.K.; Brandon, N.J.; Wood, M.W.; Duggan, M.E.; Conn, P.J.; Lindsley, C.W. *ACS Med. Chem. Lett.* **2017**, *8*, 233-238.

33) "Diverse Effects on M_1 Signaling and Adverse Effect Liability within a Series of M_1 Ago-PAMs", Rook, J.M.; Abe, M.; Cho, H.P.; Nance, K.D.; Luscombe, V.B.; Adams, J.J.; Dickerson, J.W.; Remke, D.H.; Garcia-Barrantes, P.M.; **Engers, D.W.**; Engers, J.L.; Chang, S.; Foster, J.J.; Blobaum, A.L.; Niswender, C.M.; Jones, C.K.; Conn, P.J.; Lindsley, C.W. *ACS Chem. Neurosci.* **2017**, *8*, 866-883.

32) "Challenges in the development of an M_4 PAM *in vivo* tool compound: The discovery of VU0467154 and unexpected DMPK profiles of close analogs", Wood, M.R.; Noetzel, M.J.; Poslusney, M.S.; Melancon, B.J.; Tarr, J.C.; Lamsal, A.; Chang, S.; Luscombe, V.B.; Weiner, R.L.; Cho, H.P.; Bubser, M.; Jones, C.K.; Niswender, C.M.; Wood, M.W.; **Engers, D.W.**; Brandon, N.J.; Duggan, M.E.; Conn, P.J.; Lindsley, C.W. *Bioorg. Med. Chem. Lett.* **2017**, *27*, 171-175.

31) "An insecticide resistance-breaking mosquitocide targeting inward rectifier potassium channels in vectors of Zika virus and malaria", Swale, D.R; **Engers, D.W.**; Bolliger, S.W.; Gross, A.; Inocente,

E.A.; Days, E.; Kanga, F.; Johnson, R.M.; Yang, L.; Bloomquist, J.R.; Hopkins, C.R.; Piermarini, P.M.; Denton, J.S. *Sci. Rep.* **2016**, *6*, 1-11.

30) "Discovery and SAR of a novel series of potent, CNS penetrant M4 PAMs based on a non-enolizable ketone core: Challenges in disposition", Wood, M.R.; Noetzel, M.J.; Tarr, J.C.; Rodriguez, A.L.; Lamsal, A.; Chang, S.; Foster, J.J.; Smith, E.; Chase, P.; Hodder, P.S.; **Engers, D.W.**; Niswender, C.M.; Brandon, N.J.; Wood, M.W.; Duggan, M.E.; Conn, P.J.; Bridges, T.M.; Lindsley, C.W. *Bioorg. Med. Chem. Lett.* **2016**, *26*, 4282-4286.

29) "Development and Antiparkinsonian Activity of VU0418506, a Selective Positive Allosteric Modulator of Metabotropic Glutamate Receptor 4 Homomers without Activity at $mGlu_{2/4}$ Heteromers", Niswender C.M.; Jones, C.K.; Lin, X.; Bubser, M.; Thompson, A.; Blobaum, A.L.; **Engers, D.W.;** Rodriguez, A.L.; Loch, M.T.; Daniels, J.S.; Lindsley, C.W.; Hopkins, C.R.; Javitch, J.A.; Conn, P.J. *ACS Chem. Neurosci.***2016**, *7*, 1201-1211.

28) "Discovery of 3-aminopicolinamides as metabotropic glutamate receptor subtype 4 (mGlu4) positive allosteric modulator warheads engendering CNS exposure and in vivo efficacy", Gogliotti, R.D.; **Engers, D.W.;** Garcia-Barrantes, P.M.; Panarese, J.D.; Gentry, P.R.; Blobaum, A.L.; Morrison, R.D.; Daniels, J.S.; Thompson, A.D.; Jones, C.K.; Conn, P.J.; Niswender, C.M.; Lindsley, C.W.; Hopkins, C.R. *Bioorg. Med. Chem. Lett.* **2016**, *26*, 2915-2919.

27) "Discovery, Synthesis, and Preclinical Characterization of N-(3-Chloro-4-fluorophenyl)-1H-pyrazolo[4,3-b]pyridin-3-amine (VU0418506), a Novel Positive Allosteric Modulator of the Metabotropic Glutamate Receptor 4 ($mGlu_4$)", **Engers, D.W.**; Blobaum, A.L.; Gogliotti, R.D.; Cheung, Y.Y.; Salovich, J.M.; Garcia-Barrantes, P.M.; Daniels, J.S.; Morrison, R.; Jones, C.K.; Soars, M.G.; Zhuo, X.; Hurley, J.; Macor, J.E.; Bronson, J.J.; Conn, P.J.; Lindsley, C.W.; Niswender, C.M.; Hopkins, C.R. *ACS Chem. Neurosci.***2016**, *7*, 1192-1200.

26) "Activation of Metabotropic Glutamate Receptor 7 is Required for Induction of the Long-Term Potentiation at SC-CA1 Synapses in the Hippocampus", Klar, R.; Walker, A.G.; Ghose, D.; Grueter, B.A.; **Engers, D.W.;** Hopkins, C.R.; Lindsley, C.W.; Xiang, Z.; Conn, P.J.; Niswender, C.M. *J. Neurosci.* **2015**, *35*, 7600-7615.

25) "Synthesis and structure-activity relationships of a series of 4-methoxy-3-(piperidin-4-yl)oxy benzamides as novel inhibitors of the presynaptic choline transporter", Bollinger, S.R.; **Engers, D.W.;** Ennis, E.A.; Wright, J.; Locuson, C.W.; Lindsley, C.W.; Blakely, R.D.; Hopkins, C.R. *Bioorg. Med. Chem. Lett.* **2015**, *25*, 1757-1760.

24) "Discovery and characterization of a potent and selective inhibitor of Aedes aegypti inward rectifier potassium channels", Raphemot, R.; Rouhier, M.F.; Swale, D.R.; Days, E.; Weaver, C.D.; Lovell, K.M.; Konkel, L.C.; **Engers, D.W.;** Bollinger, S.R.; Hopkins, C.R.; Piermarini, P.M.; Denton, J.S. *PLoS One*, **2014**, *9*, e110772.

23) "Specific activing receptor-like kinase 3 inhibitors enhance liver regeneration", Tsugawa, D.; Oya, Y.; Masuzaki, R.; Ray, K.; **Engers, D.W.;** Dib, M.; Do, N.; Kuramitsu, K.; Ho, K.; Frist, A.; Yu, P.B.; Bloch, K.D.; Lindsley, C.W.; Hopkins, C.R.; Hong, C.C.; Karp, S.J. *J. Pharmacol. Exper. Ther.* **2014**, *351*, 549-558.

22) "Identification of positive allosteric modulators (VU0155094 (ML397) and VU0422288 (ML396) reveals new insights into the biology of metabotropic glutamate receptor 7", Jalan-Sakrikar, N.; Field, J.R.; Klar, R.; Mattmann, M.E.; Gregory, K.J.; Zamorano, R.; **Engers, D.W.;** Bollinger, S.R.; Weaver, C.D.; Days, E.L.; Lewis, L.M.; Utley, T.J.; Hurtado, M.; Rigault, D.; Acher, F.; Walker, A.G.; Melancon, B.J.; Wood, M.R.; Lindsley, C.W.; Conn, P.J.; Xiang, Z.; Hopkins, C.R.; Niswender, C.M. *ACS Chem. Neurosci.***2014**, *5*, 1221-1237.

21) "Synthetic studies directed toward the AB decalin common to HMP-Y1 and hibarimicinone", Hempel, J.E.; **Engers, D.W.**; Sulikowski, G.A. *Tetrahedron Lett.* **2014**, *55*, 2157-2159.

20) "A novel class of succinimide-derived negative allosteric modulators of metabotropic glutamate receptor subtype 1 provides insight into a disconnect in activity between the rat and human receptors", Cho, H.P.; **Engers, D.W.**; Venable, D.F.; Niswender, C.M.; Lindsley, C.W.; Conn, P.J.; Emmitte, K.A.; Rodriguez, A.L. *ACS Chem. Neurosci.* **2014**, *5*, 597-610.

19) "Discovery and SAR of a novel series of GIRK 1/2 and GIRK 1/4 activators", Ramos-Hunter, S.J.; **Engers, D.W.**; Kaufmann, K.; Du, Y.; Lindsley, C.W.; Weaver, C.D.; Sulikowski, G.A. *Bioorg. Med. Chem. Lett.* **2013**, *23*, 5195-5198.

18) "Synthesis and structure–activity relationships of a novel and selective bone morphogenetic protein receptor (BMP) inhibitor derived from the pyrazolo[1.5-*a*]pyrimidine scaffold of Dorsomorphin: The discovery of ML347 as an ALK2 versus ALK3 selective MLPCN probe", **Engers, D.W.**; Frist, A.Y.; Lindsley, C.W.; Hong, C.C.; Hopkins, C.R. *Bioorg. Med. Chem. Lett.* **2013**, *23*, 3248-3252.

17) "Allosteric Modulation of Class C GPCRs: A Novel Approach for the Treatment of CNS Disorders", **Engers, D.W.**; Lindsley, C.W. *Drug Discov Today: Technol.* **2013**, *10*, 269-276.

16) "Identification and characterization of a compound that protects cardiac tissue from human Ether-a-go-go-related gene (hERG)-related drug-induced arrhythmias", Potet, F.; Lorinc, A.N.; Chaigne, S.; Hopkins, C.R.; Venkataraman, R.; Stepanovic, S.Z.; Lewis, L.M.; Days, E.; Sidorov, V.Y.; **Engers, D.W.**; Zou, B.; Afshartous, D.; George, A.L.; Campbell, C.M.; Balser, J.R.; Li, M.; Baudenbacher, F.J.; Lindsley, C.W.; Weaver, C.D.; Kupershimdt, S. *J. Biol. Chem.* **2012**, *47*, 39613-39625.

15) "Identification of (*R*)-*N*-(4-(4-methoxyphenyl)thiazol-2-yl)-1-tosylpiperidine-2-carboxamide, ML277, as a novel, potent and selective Kv7.1 (KCNQ1) potassium channel activator", Mattmann, M.E.; Yu, H.; Lin, A.; Xu, K.; Huang, X.; Long, S.; Wu, M.; McManus, O.B.; **Engers, D.W.**; Le, U.M.; Li, M.; Lindsley, C.W.; Hopkins, C.R. *Bioorg. Med. Chem. Lett.* **2012**, *22*, 5936-5941.

14) "The $mGlu_4$ positive allosteric modulator VU0364770 produces efficacy alone and in combination with L-DOPA or an adenosine A_{2A} antagonist in preclinical rodent models of Parkinson's disease", Jones, C. K.; Bubser, M.; Thompson, A. D.; Dickerson, J. W.; Turle-Lorenzo, N.; Amalric, M.; Blobaum, A. L.; Bridges, T. M.; Morrison, R. D.; Jadhav, S.; **Engers, D. W.**; Italiano, K.; Bode, J.; Daniels, J. S.; Lindsley, C. W.; Hopkins, C. R.; Conn, J. P.; Niswender, C. M. *J. Pharmacol. Exper. Ther.* **2012**, *340*, 404-421.

13) "Recent Progress on the Identification of Metabotropic Glutamate 4 Receptor Ligands and Their Potential Utility as CNS Therapeutics", Robichaud, A.J.; **Engers, D.W.**; Lindsley, C.W.; Hopkins, C.R. *ACS Chem. Neurosci.* **2011**, *2*, 433-449.

12) "Selective inhibition of the $K_{ir}2$ family of inward rectifier potassium channels by a small molecule probe: the discovery, SAR and pharmacological characterization of ML133", Wang, H-R; Wu, M.; Yu, H.; Long, S.; Stevens, A.; **Engers, D.W.**; Sackin, H.; Daniels, J.S.; Dawson, E.S.; Hopkins,C.R.; Lindsley, C.W.; Li, M.; McManus, O.B. *ACS Chem. Bio.* **2011**, *6*, 845-856.

11) "Discovery, Synthesis, SAR Development of a Series of *N*-4-(2,5-dioxopyrrolidin-1-yl)-phenylpicolinamides: Characterization of VU0195 (ML182) as a Centrally Active Positive Allosteric Modulator of Metabotropic Glutamate Receptor 4 ($mGlu_4$) with Oral Efficacy in an anti-Parkinsonian Animal Model", Jones, C.K.; **Engers, D.W.**, Thompson, A.D.; Field, J.R.; Blobaum, A.L.; Lindsley, S.R.; Zhou, Y.; Gogliotti, R.D.; Jadhav, S.; Zamorano, R.; Daniels, J.S.; Morrison, R.; Weaver, C.D.; Conn, P.J.; Lindsley, C.W.; Niswender, C.M.; Hopkins, C.R. *J. Med. Chem.*, **2011**, *54*, 7639-7647.

10) "Discovery of molecular switches within the ADX-47273 mGlu(5) PAM scaffold that modulate modes of pharmacology to afford potent mGlu(5) NAMs, PAMs and partial antagonists", Lamb, J.P.; **Engers, D.W.**; Niswender, C.M.; Rodriguez, A.L.; Venable, D.F.; Conn, J.P.; Lindsley, C.W. *Bioorg. Med. Chem. Lett.* **2011**, *21*, 2711-2714.

9) "Discovery, synthesis, and structure-activity relationship development of a series of N-(4-acetamido)phenylpicolinamides as positive allosteric modulators of metabotropic glutamate receptor 4 (mGlu(4)) with CNS exposure in rats", **Engers, D.W.**; Field, J.R.; Le, U.; Zhou, Y.; Bolinger, J.D.; Zamorano, R.; Blobaum, A.L.; Jones, C.K.; Jadhav, S.; Weaver, C.D.; Conn, P.J.; Lindsley, C.W.; Niswender, C.M.; Hopkins, C.R. *J. Med. Chem.*, **2011**, *54*, 1106-1110.

8) "Synthesis and SAR of novel, 4-(phenylsulfamoyl)phenylacetamide mGlu4 positive allosteric modulators (PAMs) identified by functional high-throughput screening (HTS)", **Engers, D.W.**; Gentry, P.R.; Williams, R.; Bolinger, J.D.; Weaver, C.D.; Menon, U.N.; Conn, P.J.; Lindsley, C.W.; Niswender, C.M.; Hopkins, C.R. *Bioorg. Med. Chem. Lett.* **2010**, *20*, 5175-5178.

7) "Recent progress in the development of mGluR4 positiive allosteric modulators for the treatment of Parkinson's disease", Lindsley, C. W.; **Engers, D. W.**; Niswender, C. M.; Hopkins, C. R. *Curr. Top. Med. Chem.* **2009**, *9*, 949-963.

6) "Synthesis and Evaluation of a Series of Heterobiaryl Amides that are Centrally Penetrant Metabotropic glutamate Receptor 4 (mGluR4) Positive Allosteric Modulators (PAMs)", **Engers, D.W.**; Niswender, C.M.; Weaver, C.D.; Jadhav, S.; Menon, U.; Conn, P.J**.;** Lindsley, C.W.; Hopkins, C.R. *J. Med. Chem.*, **2009**, *52*, 4115-4118.

5) "Synthesis, SAR and unanticipated pharmacological profiles of analogs of the mGluR5 ago-potentiator ADX-47273", **Engers, D.W.**; Rodriguez, A.L.; Oluwatola, O.; Hammond, A.S.; Venable, D.F.; Williams, R.; Sulikowski, G.A.; Conn, P.J.; Lindsley, C.W. *ChemMedChem*., **2009**, *4*, 405. Paper was the 6th most accessed article in **2009**.

4) "Reaction of Alanes and Aluminates with Trisubstituted Epoxides. Development of a Stereospecific Alkynylation at the More Hindered Carbon", Zhao, H.; **Engers, D. W.**; Morales, C. L.; Pagenkopf, B. L. *Tetrahedron* **2007**, *63*, 8774-8780.

3) "Structure Based Design of 4-(3-Aminomethylphenyl)piperdinyl-1-Amides: Novel, Potent, Selective, and Orally Bioavailable Inhibitors of β-II Tryptase", Levell, J.; Astles, P.; Eastwood, P.; Cairns, J.; Houille, O.; Aldous, S.; Merriman, G.; Whitely, B.; Pribish, J.; Czekaj, M.; Liang, G.; Maignan, S.; Guilloteau, J.-P.; Dupuy, A.; Davidson, J.; Harrison, T.; Morley, A.; Waston, S.; Fenton, G.; McCarthy, C.; Romano, J.; Mathew, R.; **Engers, D. W.**; Gardyan, M.; Sides, K.; Kwong, J.; Tsay, J.; Rebello, S.; Shen, L.; Wang, J.; Luo, Y.; Giardino, O.; Kim, H.-K.; Smith, K.; Pauls, H. *Bioorg. Med. Chem.* **2005**, *13*, 2859-2872.

2) "Synthesis of the C1-C12 Segment of Peloruside A by an α-Benzyloxymethyl Ketone Aldol Strategy", **Engers, D. W.**; Bassindale, M. J.; Pagenkopf, B. L. *Org. Lett.* **2004**, *6*, 664-666.

1) "Polymer-Supported Tetrafluorophenol: A New Activated Resin for Chemical Library Synthesis", Salvino, J. M.; Kumar, N. V.; Airey, J.; Kiesow, T.; Crawford, K.; Mathew, R.; Paul, K.; Drew, M. D.; **Engers, D.**; Orton, E.; Krolikolski, D.; Herpin, T.; Gardyan, M.; McGeehan, G.; Labaudininiere, R. *J. Comb. Chem.* **2000**, *2*, 691-697.

PATENTS

23) Lindsley, C.W.; Conn, P.J.; **Engers, D.W.**; Temple, K.J. "Antagonists of the muscarinic acetylcholine receptor M4" PCT Int. Appl. WO/2019/032654, **2019**.

22) Lindsley, C.W.; Bridges, T.M.; Conn, P.J.; Bender, A.M.; **Engers, D.W.** "Antagonists of the muscarinic acetylcholine receptor M4" PCT Int. Appl. WO/2019/014427, **2019**.

21) Lindsley, C.W.; Conn, P.J.; **Engers, D.W.**; Engers, J.L.; Long, M.F. "Positive allosteric modulators of the muscarinic acetylcholine receptor M4" PCT Int. Appl. WO/2018/112312, **2018**.

20) Lindsley, C.W.; **Engers, D.W.**; Conn, P.J.; Bollinger, S.R.; Engers, J.L. "Positive allosteric modulators of the muscarinic acetylcholine receptor M4" PCT Int. Appl. WO/2018/085803, **2018**.

19) Lindsley, C.W.; **Engers, D.W.**; Conn, P.J.; Bollinger, K.A.; Capstick, R.; Spearing, P.K.; Bollinger, S.R. "Positive allosteric modulators of the muscarinic acetylcholine receptor M4" PCT Int. Appl. WO/2018/085808, **2018**.

18) Lindsley, C.W.; Conn, P.J.; **Engers, D.W.**; Gregro, A.R.; Temple, K.; Spearing, P.K.; Long, M.F. Engers, J.L. "Positive allosteric modulators of the muscarinic acetylcholine receptor M4" PCT Int. Appl. WO/2018/085813, **2018**.

17) Lindsley, C.W.; Conn, P.J.; Bollinger, K.A.; **Engers, D.W.**; Blobaum, A.L.; Engers, J.L.; Rook, J.M. "Positive allosteric modulators of the muscarinic acetylcholine receptor M1" PCT Int. Appl. WO/2018/063552, **2018**.

16) Hopkins, C.R.; Hong, C.C.; Lindsley, C.W.; **Engers, D.W.** "Inhibition of BMP Signalling, Compounds, Compositions and Uses Thereof" PCT Int. Appl. WO 2018/053126, **2018**.

15) Lindsley, C.W.; Conn, P.J.; Niswender, C.M.; Jones, C.K.; Bridges, T.M.; **Engers, D.W.**; Gregro, A.R.; Bollinger, S. "Positive allosteric modulators of the muscarinic acetylcholine receptor M4" PCT Int. Appl. WO/2018/035444, **2018**.

14) Lindsley, C.W.; Conn, P.J.; **Engers, D.W.**; Bollinger, S.; Tarr, J.C.; Spearing, P.; Engers, J.L.; Long, M.; Bridges, T.M. "Positive allosteric modulators of the muscarinic acetylcholine receptor M4" PCT Int. Appl. WO/2017/223290, **2017**.

13) Lindsley, C.W.; Conn, P.J.; **Engers, D.W.**; Bollinger, K.A.; Engers, J.L. "Preparation of substituted thienopyridine, pyrrolopyridine and pyrazolopyridine analogs as positive allosteric modulators of muscarinic acetylcholine receptor M1" PCT Int. Appl. WO/2017/143041, **2017**.

12) Conn, P.J.; Hopkins, C.R.; Lindsley, C.W.; Niswender, C.M.; **Engers, D.W.**; Panarese, J.; Bollinger, S.; Engers, J.; Bronson, J.; Wu, Y-J.; Guernon, J. "Indazole and azaindoazole-substituted compounds as mGluR4 Allosteric Potentiators, Compositions, and Methods of treating Neurological Dysfunction" PCT Int. Appl. WO/2016/123629, **2016**.

11) Conn, P.J.; Hopkins, C.R.; Lindsley, C.W.; Niswender, C.M.; Emmitte, K.; Bronson, J.; Wu, Y-J.; Panarese, J.; **Engers, D.W.**; Engers, J. "Isoquiniline and naphthalene-substituted compounds as mGluR4 Allosteric Potentiators, Compositions, and Methods of treating Neurological Dysfunction" PCT Int. Appl. WO/2016/123627, **2016**.

10) Conn, P.J.; Hopkins, C.R.; Lindsley, C.W.; Niswender, C.M.; **Engers, D.W.**; Panarese, J.; Bollinger, S.; Engers, J. "Benzoisoxazole-substituted compounds as mGluR4 Allosteric Potentiators, Compositions, and Methods of treating Neurological Dysfunction" PCT Int. Appl. WO/2016/115282, **2016**.

9) Conn, P.J.; Hopkins, C.R.; Lindsley, C.W.; Niswender, C.M.; **Engers, D.W.**; Bollinger, S. "Benzothiazole and benzisothiazole-substituted compounds as mGluR4 Allosteric Potentiators, Compositions, and Methods of treating Neurological Dysfunction" PCT Int. Appl. WO/2016/115272, **2016**.

8) Hopkins, C.R.; Hong, C.C.; Lindsley, C.W.; **Engers, D.W.** "Fused Heterocyclic compounds as Selective BMP inhibitors" PCT Int. Appl. WO 2014/051698, **2014**.

7) Lindsley, C.W.; Conn, P.J.; Wood, M.R.; Hopkins, C.R.; Melacon, B.J.: Polusney, M.S.; **Engers, D.W.** "Substituted 2-(4-heterocyclylbenzyl)isoindolin-1-one analogs as positive allosteric modulators of the muscarinic acetylcholine receptor M1" PCT Int. Appl. WO 2013/063549, **2013**.

6) Conn, P.J.; Lindsley, C.W.; Hopkins, C.R.; Weaver, C.D.; Niswender, C.M. Gogliotti, R.D.; Cheung, Y-Y; Salovich, J.M.; **Engers, D.W.**. "Heterocyclic sulfone mGluR4 allosteric potentiators, compositions, and method of treating neurological dysfunction" PCT Int. Appl. WO 2011/143466, **2011**.

5) Conn, P.J.; Lindsley, C.W.; Hopkins, C.R.; Niswender, C.M. Gogliotti, R.D.; Salovich, J.M.; **Engers, D.W.**; Cheung, Y-Y. "Pyrazolopyridine, pyrazolopyrazine, pyrazolopyrimidine, pyrazolothiophene and pyrazolothiazole compounds as mGluR4 allosteric potentiators, compounds, and methods of treating neurological dysfunction" PCT Int. Appl. WO 2011/100607, **2011**.

4) Conn, P.J.; Lindsley, C.W.; Hopkins, C.R.; Weaver, C.D.; Niswender, C.M.; **Engers, D.W.** "Benzisoxazoles and azabenisoxazoles as mGluR4 allosteric potentiators, compositions, and methods of treating neurological dysfunction" PCT Int. Appl. WO 2011/100614, **2011**.

3) Conn, P.J.; Lindsley, C.W.; Hopkins, C.R.; Weaver, C.D.; Niswender, C.M.; **Engers, D.W.** "Substituted dioxopiperidines and dioxopyrrolidines as mGluR4 allosteric potentiators, compositions and methods of treating neurological disease" PCT Int. Appl. WO 2011/0124663, **2011**.

2) Conn, P.J.; Lindsley, C.W.; Hopkins, C.R.; Weaver, C.D.; Niswender, C.M.; **Engers, D.W.**; Gentry, P.R.; Cheung, Y-Y.; Salovich, J.M.; Gogliotti, R.D. "mGluR4 allosteric potentiators, compositions, and methods of treating neurological dysfunction" PCT Int. Appl. WO 2011/029104, **2011**.

1) Conn, P.J.; Lindsley, C.W.; Hopkins, C.R.; Weaver, C.D.; Niswender, C.M.; Gogliotti, R.D.; **Engers, D.W.**; "Substituted 1,1,3,3-tetraoxidobenzo[d][1,3,2]dithiazoles as mGluR4 allosteric potentiators, compositions, and methods of treating neurological dysfunction" PCT Int. Appl. WO 2010/088406, **2010**.

PRESENTATIONS

11) "Discovery and structure-activity relationship of a novel chlorine transporter inhibitor: ML352", **Engers, D.W.**; Bollinger, S.R.; Ennis, E.A.; Wright, J.; Wu, M.; Ruggiero, A.M.; McManus, O.B.; Lin, Z.; Huang, X.; Blakely, R.D.; Lindsley, C.W.; Li, M.; Hopkins, C.R., Poster presented at the ACS National Meeting, Indianapolis, IN, September **2013**.

10) "Highly Selective Muscarinic Ligands as Potential Tool Compounds for Dystonia", **Engers, D.W.**, Invited speaker at the Dystonia Medical Research Foundation workshop, Atlanta, GA, April **2013**.

9) "Discovery and SAR Development of a Novel Series of *N*-4-(2,5-dioxopyrrolidin-1-yl)-phenylpicolinamides, including ML182, as Positive Allosteric Modulators of Metabotropic Glutamate Receptor 4: A Novel Approach for the Treatment of Parkinson's Disease", **Engers, D.W.**; Le, U.M.; Zhou, Y.; Thompson, A.D.; Jadhav, S.; Gogliotti, R.D.; Lindsley, S.R.; Bolinger, J.L; Menon, U.N.;

Zamorano, R.; Field, J.R.; Daniels, S.; Morrison, R.; Blobaum, A.L.; Jones, C.K.; Weaver, C.D.; Conn, P.J.; Lindsley, C.W.; Niswender, C.M.; Hopkins, C.R., Poster presented at 7th International Meeting on Metabotropic Glutamate Receptors, Taormina, Sicily, Italy, October **2011**.

8) "Discovery and SAR Development of a Series of *N*-(4-acetamido)- and 4-(2,5-dioxopyrrolidin-1-yl)phenylpicolinamides as Positive Allosteric Modulators of Metabotropic Glutamate Receptor 4: A Novel Approach for the Treatment of Parkinson's Disease", **Engers, D.W.**; Le, U.M.; Zhou, Y.; Jones, C.K.; Thompson, A.D.; Jadhav, S.; Menon, U.N.; Zamorano, R.; Daniels, S.; Morrison, R.; Blobaum, A.L.; Weaver, C.D.; Conn, P.J.; Lindsley, C.W.; Niswender, C.M.; Hopkins, C.R., Poster presented at Gordon Research Conference on High Throughput Chemistry & Chemical Biology, Les Diablerets, Switzerland, June **2010**.

7) "Recent progress in the development of positive allosteric modulators of mGluR4 for the treatment of Parkinson's disease", Niswender, C. M.; Hopkins, C. R.; Jones, C. K.; Thompson, A. D.; **Engers, D.**; Williams, R.; Zhou, S.; Salovich, J.; Cheung, Y.-Y.; Gogliotti, R. D.; Gentry, P. R.; Johnson, K. A.; Jadhav, S.; Menon, U.; Zamorano, R.; Days, E. L.; Lindsley, C.W.; Weaver, C. D.; Conn, P. J. *Abstracts of Papters*, Poster presented at Parkinson's Disease: Mechanisms of Action, Neuroscience 2009: Chicago, IL: Abstract 828.27, October **2009**.

6) "The development of positive allosteric modulators of mGluR4 for the treatment of Parkinson's disease.", Niswender, C.M.; Hopkins, C.R.; Jones, C.K.; Thompson, A.D.; **Engers, D.W.**; Williams, R.; Zhou, S.; Salovich, J.M.; Cheung, Y.Y.; Gogliotti, R.; Gentry, P.; Johnson, K.A.; Jadhav, S.; Menon, U.; Zamorano, R.; Days, E.L.; Lindsley, C.W.; Weaver, C.D.; Conn, P.J., International Parkinson's
Disease Congress, **2009**.

5) "Advances in the Development of Positive Allosteric Modulators for Metabotropic Glutamate Receptor Subtype 5 (mGluR5)", Oluwatola, O.O.; **Engers, D.W.**; Sulikowski, G.A.; Lindsley, C.W., 60th Southeast Regional Meeting of the American Chemical Society, Nashville, TN, United States, November 12-15, **2008**.

4) "Optimization of mGluR5 PAMs related to ADX47273", Hammond, A.S.; Rodriguez, A.L.; **Engers, D.W.**; Jones, C.K.; Ayala, J.; Chen, Y.; Venable, D.F.; Oluwatola, O.; Lindsley, C.W.; Conn, P.J., 6th International Meeting on Metabotropic Glutamate Receptors, Taormina, Sicily – Italy, September 14-19, **2008**.

3) "Progress Towards the Total Synthesis of Hibarimicins.", Romaine I.; **Engers, D.**; Sulikowski, G., Poster presentation, 10th International Conference on the Chemistry of Antibiotics & other Bioactive Compounds, Vanderbilt University, Nashville, TN, August **2007**.

2) "Studies Directed Towards the Total Synthesis of Hibarimicinone and HMP-Y1.", **Engers, D.**; Sulikowski, G., Poster presentation, Vanderbilt Institute of Chemical Biology-St. Jude Children's Research Hospital Retreat, Marriot Shoals Resort, Florence, AL, March **2007**.

1) "Synthesis of α,α-Dimethyl Silyl Enol Ethers via Cyclopropanation and A Mercury Mediated Oxidative Rubottom Rearrangement.", **Engers, D. W.**; Evans, P. A., Poster presentation, ACS Regional Meeting, University of Maryland, Baltimore, MD, **1999**.

HONORS and AWARDS

- Welch Teaching Award (2001) for outstanding teaching in Organic Chemistry

EXTRACURRICULAR ACTIVITIES

- American Chemical Society (1999 – Present)
- USSF Licensed National and Major League Soccer Referee (2000-2006)
- USSF State Assessor (2004-2006)

REFERENCES

Prof. Craig W. Lindsley
Vanderbilt University Medical Center
Department of Pharmacology
Vanderbilt Center for Neuroscience Drug Discovery
1205 Light Hall
Nashville, TN 37232-0697
(615) 322-8700
craig.lindsley@vanderbilt.edu

Prof. P. Jeffrey Conn
Vanderbilt University Medical Center
Department of Pharmacology
Vanderbilt Center for Neuroscience Drug Discovery
1205 Light Hall
Nashville, TN 37232-0697
(615) 936-2189
jeff.conn@vanderbilt.edu

Prof. Gary A. Sulikowski
Vanderbilt University
Department of Chemistry
VU Station B#351822
Nashville, TN 37235
(615) 343-4155
gary.a.sulikowski@vanderbilt.edu