STEVEN E. PATTERSON, PH.D.

Professor, Center for Drug Design, The University of Minnesota

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EDUCATION

• UNIVERSITY OF NOTRE DAME
Bayer Postdoctoral Research Associate 1996-1998

• GEORGIA STATE UNIVERSITY
Received Dissertation Grant Award 1992
Ph.D., Chemistry, 1995 Dissertation Title: *Synthesis and Computational Studies of Heterocyclic Systems that Bind to Nucleic Acids*

• GEORGIA STATE UNIVERSITY
B.S., Chemistry, 1991

RESEARCH EXPERIENCE

CENTER FOR DRUG DESIGN, THE UNIVERSITY OF MINNESOTA AUG 2004-PRESENT

• Professor

Research concerns efficient preparation of novel nucleosides, nucleotide analogs and heterocyclics as anti-infectives, antiprotozoals, antiviral, anti-cancer agents and cyanide antidotes. Responsible for care and operation of the departmental LCMS system. Discovered new class of antiprotozoal agents that are 10 times as potent as metronidazole. Currently investigating novel HIV combination therapy that induces error catastrophe what was discovered in my group. Developing the cyanide antidote sulfanegen. Funded by the NSF, NIH-NINDS and NIH-NIAID.

PHARMASSET, INC. Feb 2000-Jul 2004

• Senior Scientist – Discovery-Analytical Dr. Kyoichi Watanabe and Dr. Kris Pankiewicz

Head of analytical chemistry group. Research concerns efficient preparation of novel nucleoside analogs as anti-infectives, nucleotide anti-cancer agents and mycophenolic acid analogues. The focus is on antivirals, specifically HBV, HCV, and HIV as well as anti-leukemia agents and immunosuppressants. Extensive experience with NMR, HPLC and preparative LC. Familiar with LCMS, GC, GCMS, FTNMR, FTIR and computational chemistry. Hired with job title *Lead Scientist*. Promoted to *Senior Scientist* July 2002.

GEORGIA COMBICHEM CENTER May 1998-Jan 2000

• Visiting Research Scholar Prof. David W. Boykin

Research concerned solid phase parallel synthesis of novel heterocyclic molecules using automated combinatorial methodology. The research was focused on efficient preparation of small molecule organic libraries as potential therapeutic agents. Research experience includes preparation of libraries on the ACT 496Ω and 384HTS synthesizers. Familiar with HPLC, LCMS, GC, GCMS, FTNMR, FTIR and computational chemistry.

UNIVERSITY OF NOTRE DAME February 1996-April 1998

• Bayer Postdoctoral Research Associate Prof. Richard E. Taylor

Research concerned two aspects of developing selective receptors for carbohydrates and carbohydrate derivatives such as sialic acid and UTP. The first was combinatorial libraries of fluorescent peptide based sensors on solid support. The second involved libraries of water soluble fluorescent sensors for carbohydrates.

GEORGIA STATE UNIVERSITY September 1991-January 1996

• Graduate Research Assistant Prof. Lucjan Strekowski

Research concerned efficient synthesis and rational design of non-nucleoside anti-HIV agents that bind to DNA and RNA. Extensive application of molecular mechanics and semi-empirical methods to design potential anti-HIV agents, explain the interaction of intercalators with nucleic acid and understand the reactivity of heterocyclic systems. Extensive experience with FTNMR.

GEORGIA STATE UNIVERSITY — November 1989 - September 1991

• Research Assistant — Prof. Lucjan Strekowski

Research concerned efficient synthesis of novel potential anti-cancer agents and bleomycin amplifiers that bind to DNA via intercalation and efficient synthesis of potential anti-HIV agents.

AWARDS

DISSERTATION GRANT AWARD, GEORGIA STATE UNIVERSITY, 1992

BAYER FELLOWSHIP, THE UNIVERSITY OF NOTRE DAME, 1996-1998

PUBLICATIONS

• Strekowski, L; **Patterson, S**; Cegla, M T.; Wydra, R L.; Czarny, A; Harden, D B. "Addition and lithiation reactions of N-(1-phenylalkylidene)anilines with lithium dialkylamides" *Tetrahedron Letters* **1989** *30*, 5197-200.

• Strekowski, L; Wydra, R L.; Cegla, M T.; Czarny, A; Harden, D B.; **Patterson, S E**.; Battiste, M A.; Coxon, J M. "An unusual base-mediated cyclization of ketimines derived from 2-(trifluoromethyl)aniline that involves the trifluoromethyl group: an expedient route to 2-arylquinolines" *J Org Chem.* **1990** *55*, 4777-9.

• Wydra, RL.; **Patterson, S E**.; Strekowski, L;" An activated trifluoromethyl group as a new synthon for 4,5-dihydro-1H-imidazole and 1,4,5,6-tetrahydropyrimidine systems" *J.Heterocycl Chem.* **1990** *27*, 803-5.

• Strekowski, L; Harden, D; Grubb, WB; III; **Patterson, S E.**; Czarny, A; Mokrosz, M J.; Cegla, M T.; Wydra, R L." Synthesis of 2-chloro-4,6-di(heteroaryl)pyrimidines" *J.Heterocycl Chem.* **1990** *27*, 1393-400.

• Strekowski, L; Mokrosz, J L.; Honkan, V A.; Czarny, A; Cegla, M T.; Wydra, R L.; **Patterson, SE**.; Schinazi, RF. "Synthesis and quantitative structure-activity relationship analysis of 2-(aryl or heteroaryl) quinolin-4-amines, a new class of anti-HIV-1 agents" *J Med Chem* **1991** *34*, 1739-46.

• Janda, L; Nguyen, J; **Patterson, S.E.**; Strekowski, L. "Synthesis of fluoro and trifluoromethyl derivatives of 2-phenylquinolin-4-ol" *J.Heterocycl Chem.* **1992** *29*, 1753-6.

• L. Strekowski, **S.E. Patterson**, L. Janda, R.L. Wydra, D.B. Harden, M. Lipowska, and M.T. Cegla, "Further Studies on the Cyclization of Aromatic Azomethines *ortho*-Substituted with a Trifluoromethyl Group: Synthesis of 2,4-Di or 2,3,4-Trisubstituted Quinolines," *J.Org.Chem.* **1992** *57*, 196-201.

• **S.E. Patterson**, L. Janda, and L. Strekowski " A new synthesis of N-substituted-2-alkyl(or aryl) quinazolin-4-amines by amide base-mediated cyclization of carboximidamides derived from 2-(trifluoromethyl)benzenamine" *J. Heterocyclic Chem.* **1992** *29*, 703-6.

• W.D. Wilson, M. Zhao, **S.E. Patterson**, R.L. Wydra, L. Janda, and L. Strekowski, "Design of RNA Interactive Anti-HIV-1 Agents: Unfused Aromatic Intercalators," *Med Chem Res* **1992,** *2*, 102-10.

• M. Lipowska, **S.E. Patterson**, G. Patonay, and L. Strekowski "A Highly Selective Hydrogen Deuterium Exchange in Indolinium Cyanines" *J Heterocyclic Chem.* **1993,** *30*, 1977-80.

• L. Strekowski, M. Hojaat, **S.E. Patterson** and A.S. Kiselyov "Experimental and Computational Studies of Trifluoromethylation of Aromatic Amines by the System Trifluoroiodomethane-Zinc-Sulfur Dioxide," *J.Heterocyclic Chem.* **1994** *31*, 1413-16.

• L. Strekowski, L. Janda, **S.E. Patterson** and J. Nguyen "Amination by Lithium Alkylamide Reagents of Ketimines Derived from 2-(Trifluoromethylanilines and Methyl Halophenyl Ketones and their Cyclization Products 2-(Halophenyl)quinolin-4-amines," *Tetrahedron* **1996** *52*, 3273-82.

• L. Strekowski, S.-Y. Lin, K. Van Aken and **S.E. Patterson** "Three Heterocyclic Rings Fused (6:6:6)" in *Comperhensive Heterocyclic Chemistry II* vol. 8; A.R. Katritzky, C.W. Rees and E.F.V. Scriven, Eds.; Elsevier Science: Tarrytown, 1996; pp 1109-1134.

• **S. Patterson**, J.M. Coxon, W.D. Wilson, and L. Strekowski "Intercalation of Ethidium and Analogues with Nucleic Acids: A Molecular Orbital Study," *Bioorg.Med.Chem*. **1997,** *5*, 277-81.

• **Patterson**, **S.E;** Smith, B.D. and Taylor, R.E. "Fluorescence Sensing of a Ribonucleoside 5'-Triphosphate," *Tetrahedron Letters* **1997** *38*, 6323.

• **Patterson**, **S;** Smith, B.D; and Taylor, R.E. "Tuning the Affinity of a Synthetic Sialic Acid Receptor Using Combinatorial Chemistry," *Tetrahedron Lett*, **1998,** *37*, 3111.

• Strekowski, L; Abdou, I.M; Attia A.M.E. and **S.E. Patterson**, "The First Direct Ammonolysis of 2-Thiouracil Nucleosides to 2-Thiosytosine Nucleosides," *Tetrahedron Letters* **2000** *41*, 4757-61.

• Pankiewicz, K.W; Lesiak-Watanabe, K.B; Watanabe, K.A; **Patterson**, S; Jayaram, H.N; Yalowitz, J; Miller, M.D; Seidman, M; Majumdar, A; Prehna, G and B.M. Goldstein, "Novel Mycophenolic Adenine Bis(phosphonate) Analogues as Potential Differentiation Agents Human Leukemia," *J.Med.Chem.* **2002,** *45*, 703-12.

• Yalowitz, J; Pankiewicz, K; **Patterson**, **S.E.** and H.N. Jayaram M.D. "Cytotoxicity and Cellular Differentiation Activity of Methylenebis(phosphonate) Analogs of Tiazofurin and Mycophenolic Acid Adenine Dinucleotide in Human Cell Lines," *Cancer Lett.* **2002** *181*, 31-38.

• Clark, J.L; **Patterson**, **S.E;** Mason, J.C; Otto, M.J; Schinazi, R.F; Watanabe, K.A; Risal, K.A; Goldstein B.M. and K. Pankiewicz. "Novel Inhibitors of Inosine Monophosphate Dehydrogenase,"*Coll.Czech.Chem. Comm.Symp.Ser.* **2002,** *5*, 256-60.

• Stuyver, L.J.; Lostia, S.; **Patterson**, **S.E;** Watanabe, K.A.; Otto M.J. and K.W. Pankiewicz. "Inhibitors of the IMPDH enzyme as potential anti-bovine viral diarrhoea virus agents," *Antiviral Chemistry and Chemotherapy* **2002**, *13*, 345-352.

• Pankiewicz, K. W.; **Patterson, S. E.**; Black, P. L.; Jayaram, H. N.; Risal, D. et al. Cofactor mimics as selective inhibitors of NAD-dependent inosine monophosphate dehydrogenase (IMPDH)--the major therapeutic target. *Curr Med Chem* **2004**, *11*, 887-900

• Hollecker L, Du J, Hassan A, Shi J, Wang P, **Patterson SE**, Khan N, Hobs A, Clark J, Rachakonda S, Chun BK, Pinar I, Lostia S, McBrayer T, Stuyver LJ, Otto MJ, Pankiewicz KW. "Synthesis and antiviral activity of a mutagenic N^4-hydoxycytidine and its analogues." *Developments in Nucleic Acids*, Schinazi RF, Liotta D. eds. . IHL Press, **2004**

• **Patterson SE**, Clark JL, Mason JC, Pankiewicz KW "The reaction of alcohols and nucleosides with methylenebis(phosphonic acid dichloride): Facile synthesis of methylenebis-(phosphonic acid) monoesters." *Frontiers in Nucleosides and Nucleic Acids*, Schinazi RF, Liotta D. eds. IHL Press, **2004**

• **Patterson SE**, Black PL, Clark JL, Risal D, Goldstein BM, Jayaram HN, Schinazi, RF, Pankiewicz KW. "The mechanism of action and antileukemic activity of bis(phosphonate) analogue of mycophenolic adenine dinucleotide (C2-MAD); An alternative for tiazofurin." *Frontiers in Nucleosides and Nucleic Acids*, Schinazi RF, Liotta D. eds. IHL Press, **2004**

• Pankiewicz KW, **Patterson SE**, Black PL, Jayaram HN, Risal D, Goldstein BM, Stuyver LJ, Schinazi RF., Cofactor Mimics as Selective Inhibitors of NAD-dependent Inosine Monophosphate Dehydrogenase (IMPDH) *Curr. Med. Chem*., **2004**, 11, 887-900.

• Du J**, Patterson S,** Shi J, Chun BK, Stuyver LJ, Watanabe KA., "Synthesis of 5'-C-methyl-1',3'-dioxolan-4'-yl nucleosides" *Bioorg Med Chem Lett*. **2004,** 14,1243-5

• L. Strekowski, A.N. Parker, M. Hojjat, M. Say, O. Zegrocka-Stendel, **S.E. Patterson**, F.A. Tanious and W.D. Wilson, "Triple-Helix DNA Selective 2-(2-Naphthyl)Quinoline Intercalators" *Acta.Pol.Pharm.***2004**, 61 Suppl, 70-2.

• Wang, P.; Hollecker, L.; Pankiewicz, K. W.; **Patterson, S. E**.; Whitaker, T. et al. "Synthesis of N3,5'-Cyclo-4-(beta-D-ribofuranosyl)-vic-triazolo[4,5-b]pyridin-5-one, a Novel Compound with Anti-Hepatitis C Virus Activity." *J Med Chem* **2004**, *47*, 6100-6103

• Chun, B.-K.; Clark, J. L.; Du, J.; Furman, P. A.; Hassan, A. E.; Hollecker, L.; McBrayer, T.; Otto, M. E.; Pankiewicz, K. W.; **Patterson, S. E.**; et al "5',9-Anhydro-3-(β-D-ribofuranosyl) purine nucleoside analogues as potential anti-HCV agents." *Collection Symposium Series* **2005**, *7(Chemistry of Nucleic Acid Components)*, 319-327.

• Clark, J.L.; Hollecker, L.; Mason, J.C.; Stuyver, L.J.; Tharnish, P.M.; Lostia, S.; McBrayer, T.R.; Schinazi, R.F.; Watanabe, K.A.; Otto, M.J.; Furman, P.A.; Stec, W.J.; **Patterson, S.E.;** Pankiewicz, K.W. "Design, Synthesis, and Antiviral Activity of 2'-Deoxy-2'-fluoro-2'-C-methyl-cytidine, a Potent Inhibitor of Hepatitis C Virus Replication." *J Med Chem* **2005**, *48*, 5504-5508.

• Shi, J.; Du, J.; Ma, T.; Pankiewicz, K. W.; **Patterson, S. E.** et al. Synthesis and anti-viral activity of a series of D- and L-2'-deoxy-2'-fluororibonucleosides in the subgenomic HCV replicon system. *Bioorg Med Chem* **2005**, *13*, 1641-1652.

• Wang, P.; Hollecker, L.; Pankiewicz, K. W.; **Patterson, S. E**.; Whitaker, T.; McBrayer, T R.; Tharnish, P M.; Stuyver, L J.; Schinazi, R F.; Otto, M J "Synthesis of N3,5'-cyclo-4-(beta-D-ribofuranosyl)-vic-triazolo[4,5-b]pyridin-5-one and its 3'-deoxysugar analogue as potential anti-hepatitis C virus agents." *Nucleosides Nucleotides Nucleic Acids* **2005**, *24*, 957-960.

• Shi, J.; Du, J.; Ma, T.; Pankiewicz, K. W.; **Patterson, S. E.** Hassan, Abdalla E. A.; Tharnish, Phillip M.; McBrayer, Tamara R.; Lostia, Stefania; Stuyver, Lieven J.; et al "Synthesis and in vitro anti-HCV activity of beta-D- and 1-2'-deoxy-2'-fluororibonucleosides." *Nucleosides Nucleotides Nucleic Acids* **2005**, *24*, 875-879.

• Shi, J.; Du, J.; Ma, T.; Pankiewicz, K. W.; **Patterson, S. E. ;** Phillip PM.; McBrayer, TR.; Stuyver, LJ.; Otto, MJ.; Chu, CK.; et al "Synthesis and anti-viral activity of a series of d- and l-2'-deoxy-2'-fluororibonucleosides in the subgenomic HCV replicon system." *Bioorg Med Chem* **2005**, *13*, 1641-1652.

• Rejman D, Olesiak M Chen L **Patterson SE**, Wilson D, Jayaram HN, Hedstrom L, Pankiewicz KW. "Novel methylenephosphophosphonate analogues of mycophenolic adenine dinucleotide Inhibition of Inosine Monophosphate Dehydrogenase." *J. Med. Chem.*, **2006**, *49*, 5018-22

• Pankiewicz KW; Gao G; **Patterson S E** "Synthesis of methylenebis(phosphonate) analogs of dinucleotide pyrophosphates" *Curr Protocol Nuc Acid.*, **2006**, *DOI: 10.1002/0471142700.NC1305S24*

• Chen L; Rejman D; Bonnac L; Pankiewicz K W; **Patterson S E** "Nucleoside-5'-phosphoimidazolides: reagents for facile synthesis of dinucleoside pyrophosphates" *Curr Protocol Nuc Acid.*, **2006**, *DOI: 10.1002/0471142700.NC1304S23*

• Paliakov, E; Henary, M; Say, M. **Patterson SE;** Parker, A, Manzel, L; Macfarlane, DE; Bojarski, AJ and Strekowski, L. "Fujita-Ban QSAR analysis and CoMFA study of quinoline antagonists of immunostimulatory CpG-oligonucleotides" *Bioorg Med Chem* **2007**, 324-332

• Bonnac, L; Chen, L; Pathak, R; Gao, G; Ming, Q; Bennett, E; Felczak, F; Kullberg, M; **Patterson SE**, Magni, G and Pankiewicz, KW. "Probing binding requirements of NAD kinase with modified substrate (NAD) analogues." *Bioorg Med Chem Lett* **2007**, *17*, 1512-1515.

• Suk, D-H; Bonnac, L; Dykstra, CC; Pankiewicz, KW and **Steven E. Patterson** "Rational Design and Synthesis of Novel Nucleotide Anti-Giardia Agents" *Bioorg Med Chem Lett **2007**, 2064-2067.*

• Suk, D-H; Rejman, D; Dykstra, CC; Pankiewicz, KW and **Patterson, SE "**Phosphonoxins: Rational Design and Discovery of a Potent Nucleoside anti-Giardia Agent". *Bioorg Med Chem Lett **2007,** 17, 2811-2816.*

• Crankshaw, D. L.; Goon, D. J. W.; Briggs, J. E.; DeLong, D.; Kuskowski, M.; **Patterson, S. E**.; Nagasawa, H. T. A Novel Paradigm for Assessing Efficacies of Potential Antidotes against Neurotoxins in Mice. *Toxicol Lett* **2007,** 174, 111-117.

• Nagasawa, H. T.; Goon, D. J. W.; L.Crankshaw, D.; Vince, R.; **Patterson, S. E**. "Novel, Orally Effective Cyanide Antidotes." *J Med Chem* **2007,** 50, 6462-4

• Zhou, D.; Staake, M.; and **Patterson, S.E.** "Phosphonoxins II: Diastereoselective synthesis of phosphonic acid analogs of polyoxins"*Org Lett* **2008**, 10, 2179.

• Michael J. Dapp, Christine L. Clouser, **Steven Patterson**, and Louis M. Mansky "5-Azacytidine Can Induce Human Immunodificiency Virus Type 1 Lethal Mutagenesis" *J. Virol.* **2009**, 83, 11950

• Wattenberg LW, **Patterson S**, Antonides JD. "Chitin or chitin-like glycans as targets for late-term cancer chemoprevention." *Cancer Prev Res (Phila).* **2010**, *3*,1519-22.

• M. Brenner, S. B. Mahon, J. G. Kim, J. Lee, D. Mukai, K.A Kreuter, W Blackledge, **S. Patterson**, H. Singh, and G. Boss "Intramuscular Cobinamide Sulfite in a Rabbit Model of Sublethal Cyanide Toxicity" *Ann Emg Med* **2010**, *55*, 352-63.

• Brenner, M; Kim, JG; Lee, J; Mahon, SB; Lemor, D; Ahdout, R; Boss, GR; Nagasawa, H; and **Patterson SE.** "Sulfanegen Sodium Treatment in a Rabbit Model of Sub-Lethal Cyanide Toxicity" *J Pharmacol Toxicol* **2010,** *248*, 269-76.

• Christine L. Clouser, **Steven E. Patterson**, Irene J. Dorweiler and Louis M. Mansky "Exploiting Drug Repositioning for the Discovery of a Novel Combination Therapy That Inhibits Human Immunodeficiency Virus Type 1 Replication" *J Virol* **2010,** *84*, 9301-9.

• Michael Staake, Ding Zhou, Aaron Shanker, Atasi De Chatterjee, Siddhartha Das, and **Steven E. Patterson** "Phosphonoxins III: Synthesis of α-Aminophosphonate Analogs of Antifungal Polyoxins," *Org Lett.* **2010,** *12*, 4596-9.

• Jay Chauhan, Alexandre R. Monteil, **Steven E. Patterson** "Synthesis of novel benzo[*b*]furans and benzo[*b*]thiophenes: analogs of combretastatin and resveratrol." *Heterocyclic Communications* **2010**, *16*, 241–244.

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