

Jian Liu, Ph.D.

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SUMMARY

Dr. Jian Liu has been working with heparin for more than 25 years. His expertise is in structural characterization of heparin and heparan sulfate, biosynthetic mechanism of heparin and enzymatic synthesis of heparin. He has invented an enzyme-based method to prepare heparin and heparan sulfate from bacteria polysaccharides. His method could potentially manufacture heparin in a confined facility to improve the safety of heparin drug.

APPOINTMENT

- 2014-present** **John A. and Deborah S. McNeill, Jr. Distinguished Professor**, Eshelman School of Pharmacy, University of North Carolina at Chapel Hill, NC, USA
- 2013-present** **Founder and acting chief scientific officer**, Glycan Therapeutics, LLC, Chapel Hill, NC
- 2011-2013** **Professor** (with tenure) of Chemical Biology and Medicinal Chemistry, Eshelman School of Pharmacy, University of North Carolina at Chapel Hill, NC
- 2006-2011** **Associate Professor** (with tenure) of Medicinal Chemistry and Natural Products, Eshelman School of Pharmacy, University of North Carolina at Chapel Hill, Chapel Hill, NC
- 2009-2010** **Visiting Associate Professor**, Department of Chemistry and Chemical Biology, Rensselaer Polytechnic Institute, Troy, NY
- 2000-2006** **Assistant Professor** of Medicinal Chemistry and Natural Products, School of Pharmacy, University of North Carolina at Chapel Hill, Chapel Hill, NC
- 1999-2000** **Research Scientist**, Biology Department, Massachusetts Institute of Technology, Cambridge, MA
- 1998-2000** **Research Fellow**, Molecular Medicine Unit, Beth Israel Hospital, Boston, MA

TRAINING

- 1993-1999** **Postdoctoral Research Associate**
Department of Biology, Massachusetts Institute of Technology
Cambridge, MA 02139
- Mentor:* Professor Robert D. Rosenberg
- 1989-1993** **Ph.D. in Medicinal Chemistry and Natural Products**

College of Pharmacy, The University of Iowa, Iowa City, Iowa.
Thesis Advisor: Professor Robert J. Linhardt

1984-1987 **M.S. in Biochemistry**, Nankai University, Tianjin, China.

1980-1984 **B.S. in Chemistry**, Nankai University, Tianjin, China.

FUNDING

Active

- 1) National Heart, Lung and Blood Institute. 1R01HL094463-05, August 1 of 2013 to May 31 of 2017. Project title: “In vitro synthesis of recombinant heparan sulfate” (Principal Investigator, Jian Liu). Direct cost \$300,000/yr for 4 years, 12% effort.
- 2) National Institute of General Medical Sciences, 1U01GM102137-01A1, September 1 of 2013 to May 31 of 2017. Project Title: “Uncovering the controlling mechanisms in heparan sulfate biosynthesis” (Principal Investigator, Jian Liu). Direct cost \$245,000/yr for four years, 10%.
- 3) US Food and Drug Administration, U19FD004994-01, September 1 of 2013 to August 31 of 2018. Project title: “Probing the heparin structural elements for high risk of heparin-induced thrombocytopenia (HIT)” (Principal Investigator). Total cost \$255,000/yr, 9% efforts.
- 4) National Heart, Lung and Blood Institute. 2R01HL062244-09A1, January 1 of 2013 to December 31, 2016. Project title: “Synthetic Heparan Sulfate: Probing Biosynthesis to Prepare Defined Drugs” (Contact PI, Robert Linhardt). Direct cost \$75,000/yr for four years. Role in the project: one of three MPIs, 5%.
- 5) National Heart, Lung and Blood Institute. U01HL117659-01, August 15 of 2013 to May 31 of 2018. Project title: “Targeted anticoagulant therapy for sickle cell disease” (Principal Investigator, Ken Ataga). Role in the project: collaborator, 10% effort.
- 6) National Heart, Lung and Blood Institute. 1R01HL096972-01, August 1 of 2009 to April 30 of 2014. Project title: “Development of a Bioengineered Heparin from a Non-Animal Source” (Principal Investigator, Robert J Linhardt). Role in the project: Co-PI. Direct cost \$100,000/yr for Yr 1-Yr3 and \$75,000/yr for Yr4-Yr5, 5% effort.
- 7) National Institute of General Medical Sciences, 1R01GM072667-06, June 1 of 2010 to May 31 of 2014. Project title: “Chemoenzymatic synthesis of heparan sulfate oligosaccharides” (Principal Investigator, Xuefei Huang). Role in the project: Co-PI. Direct cost \$60,000/yr for four years, 4% effort.
- 8) National Science Foundation, CHE-1111550, July 1 of 2011 to June 30 of 2014. Project title: “Synthesis of homogeneous heparan sulfate proteoglycans” (Principal Investigator, Xuefei Huang). Role in the project: Co-PI. Direct cost \$29,000/yr for three years, 3% effort.

Completed

- 1) National Institute of Allergy/Infectious Diseases, R01 AI50050-01, July, 2001 to May, 2006. Project title: "Specificity of Heparan Sulfate for Herpes Infection". (Principal Investigator) direct cost \$625,000 for five years, 40% effort.
- 2) American Heart Association Mid-Atlantic Affiliate, grant-in-aid 0355800U, July 1 of 2003 to June 30 of 2005. Project title: "Understanding the biosynthesis of anticoagulant heparan sulfate". (Principal Investigator) direct cost \$120,000 for two years, 10% effort.
- 3) Pharmacy Foundation of North Carolina, seed grant, Feb. 1 to Dec. 31, 2004. Project title: "Investigation of the Molecular Mechanism of the Biosynthesis of Anticoagulant Heparan Sulfate". (Principal Investigator) direct cost \$9,500.
- 4) American Heart Association, MidAtlantic grant-in-aid 0855424E, July 1 of 2008 to June 30 of 2010. Project title: "Investigation of the substrate specificities of heparan sulfate biosynthetic enzymes" (Principal Investigator). Direct cost \$60,000/yr for two years, 5% effort.
- 5) Zacharon, Inc, June 1 of 2009 to May 31 of 2010. Project title: "Inhibition of heparan sulfate biosynthetic enzymes by small molecules" (Principal Investigator). Direct cost \$20,000.
- 6) National Institute of Allergy/Infectious Diseases, 2R01AI050050, July of 2001 to January of 2011. Project title: "Structural specificity of heparan sulfate for herpes infection" (Principal Investigator). Direct cost \$226,000/yr for five years, 15% effort.
- 7) National Institute of Allergy/Infectious Diseases, 3R01AI050050-07S1, February 1 of 2008 to January 31 of 2011. Project title: "Structural specificity of heparan sulfate for herpes infection" (Principal Investigator). Direct cost \$33,000/yr for three years. This grant is to support Ms. Courtney Jones' PhD studies.
- 8) National Institute of Allergy/Infectious Diseases, 1R21AI074775-01A2, August 1 of 2009 to July 31 of 2011. Project title: "Glycomics of Heparan Sulfate in Bacterial Pathogenesis" (Principal Investigator). Direct cost, \$150,000/yr1 and \$125,000/yr2, 10% effort.
- 9) National Institute of Allergy/Infectious Diseases, 3R01AI050050, September 18 of 2009 to August 31 of 2010. Project title: "Structural specificity of heparan sulfate for herpes infection" (Principal Investigator). Direct cost \$99,760. This grant is to purchase a LC/MS system.
- 10) National Institute of Allergy/Infectious Diseases, 3R01AI50050-9S1, May 17 of 2009 to September 30 of 2010. Project title: "Structural specificity of heparan sulfate for herpes infection" (Principal Investigator). Direct cost \$5,029. This grant is to support the summer research training for Mrinalini Ramanan.
- 11) National Heart, Lung and Blood Institute. 1R01HL094463-01, February 13 of 2009 to July 31 of 2013. Project title: "In vitro synthesis of recombinant heparan sulfate" (Principal Investigator). Direct cost \$280,000/yr for 4 years, 15% effort.
- 12) National Institute of General Medical Sciences, 1R01GM093131-01, May 1 of 2010 to April 30 of 2014. Project title: "STRUCTURE AND FUNCTION OF 3-O-SULFATION IN HEPARAN SULFATE" (Principal Investigator, Jeff Esko). Role in the project: Co-PI. Direct cost \$16,000/yr for two years, 3% effort.
- 13) National Institute of General Medical Sciences, 1R01GM090257-01, September 30 of 2009 to August 31 of 2011. Project title: "An artificial Golgi: Controlled GAG synthesis and screening" (Principal Investigator, Robert J Linhardt). Role in the project: Co-PI. Direct cost \$55,000/yr1 and \$65,000/yr 2, 3% effort.

Serve as a sponsor for graduate student fellowship

- 1) National Institute of Allergy/Infectious Diseases, R01 AI50050S1, June 2004 to May 2005. Project title: "Specificity of Heparan Sulfate for Herpes Infection". A supplement fellowship to support Tanya Scarlett. Direct cost \$25,048.
- 2) American Heart Association, MidAtlantic Affiliate, July 2005 to June 2007. Project title: "Understanding the substrate recognition mechanism of heparan sulfate 3-O-sulfotransferase". A predoctoral fellowship to support Ding Xu. Direct cost \$40,000.
- 3) National Institute of General Medical Sciences, F31GM090647, Jan 1 of 2010 to Dec 31 of 2012. Project title: "Investigation of the inhibitor of heparanase" (P.I. Sherket Peterson). Direct cost \$35,000/yr for three years.
- 4) National Institute on Aging, F31AG040927-01, September 1 of 2011 to August 31 of 2014. Project title: "Contribution of structural motifs to heparin clearance" (P.I. Elizabeth Pempe). Direct cost \$29,000/yr for three years.
- 5) National Heart, Lung and Blood Institute, F31HL120598-01, July 1 of 2013 to August 31 of 2016. Project title: "Chemical and enzymatic synthesis of multi-domain heparin mimetics" (P.I. Timothy O'Leary). Direct cost \$32,042/yr for three years.

HONORS AND AWARDS

- 2010** Distinguished Faculty Award from Chinese-American Chemistry & Chemical Biology Professor Association, presented to outstanding faculty members of Chinese ethnics in US and China. Four awards (two from US and two from China) are given each year.
- 1996-1998** Postdoctoral Fellowship from American Heart Association Massachusetts and Rhode Island Affiliates, presented to outstanding physicians and scientists engaging in cardiovascular research.
- 1991-1993** Predoctoral Fellowship from American Heart Association Iowa Affiliates, presented to outstanding M.D. and Ph.D. candidates engaging in cardiovascular research.

SERVICE

- Louisiana Board of Regents' Research Competitiveness Subprogram (2007)
- American Heart Association, Co-Chair and member for Region II Basic Cell Peer Review Committee 2 (2008 – 2009)
- American Heart Association, Chair for Region II Basic Cell Peer Review Committee (2010-2011)
- National Institutes of Health, Member for Drug Discovery and Development (DDD) study section (Nov, 2008 – 2009).
- National Science Foundation of China, Biochemistry Division (May, 2009)
- National Institutes of Health, Member for Shared Instrumentation study section (July, 2009)
- US Pharmacopeia, Member for "Unfractionated Heparins Expert Ad Hoc Advisory Panel" (November, 2009-August, 2012)
- March of Dimes Foundation, *ad hoc* grant reviewer (January, 2010).

National Science Foundation, neural system cluster *ad hoc* grant reviewer (April, 2010)
National Institute of General Medical Sciences sponsored workshop entitled “Expanding the chemical space for carbohydrates: Road map to automated synthesis” (March 2011).
National Institute of General Medical Sciences sponsored working group entitled “10K Glycan Array Working Group” (Sept 2011).
Heparin Symposium Organizer for American Chemical Society-Carbohydrate Chemistry Division, April 8 to 9, 2013, New Orleans, LA.
National Science Foundation, chemistry of life processes program, *ad hoc* grant reviewer (March, 2013)
Invited by American Society for Biochemistry and Molecular Biology (ASBMB) to speak at US congressional briefing about the impact of sequestration on scientific research, Capital Hill, Washington DC, November 13, 2013
US Food and Drug Administration, independent site visit reviewer to evaluate FDA research programs, March 12, 2014.
Israel Science Foundation, grant reviewer (March, 2014).

LIST OF PUBLICATIONS

Research Articles (* denotes corresponding author)

1. Chandarajoti, K., Xu, Y., Sparkenbaugh, E., Key, N.S., Pawlinski, R., and **Liu*, J.** (2014) *De novo* synthesis of a narrow size distribution low molecular weight heparin *Glycobiology* submitted.
2. Hsieh, P-H, Xu, Y., Keire, D.A., and **Liu*, J.** (2014) Chemoenzymatic synthesis and characterization of 2-O-sulfated glucuronic acid containing heparan sulfate hexasaccharides. *Glycobiology* submitted.
3. Liu, C., Sheng, J., Krahn, J.M., Perera, L., Xu, Y., Hsieh, P-H., Dou, W., **Liu*, J.** and Pedersen, L.C. (2014) Molecular mechanism of substrate specificity for heparan sulfate 2-O-sulfotransferase. *J. Biol. Chem.* In press.
4. Xu, Y, Cai, C., Chandarajoti, K, Li, L., Hsieh, P., Pham, T., Sparkenbaugh, E.M., Sheng, J., Key, N., Pawlinski, R., Harris, E., Linhardt*, R.J., and **Liu*, J.** (2014) Homogeneous and reversible low-molecular weight heparins with reversible anticoagulant activity. *Nat. Chem Biol.* In press.
5. Sterner, E., Li, L., Paul, P., Beaudet, J.M., **Liu, J.**, Linhardt, R.J. and Dordick*, J.S. (2013) Assays for determining heparan sulfate and heparin O-sulfotransferase activity and specificity. *Anal. Bioanal. Chem.* 406: 525-536.
6. Cai, C., Li, L., Harvey, C., **Liu, J.** and Linhardt*, J. (2013) Towards the chemoenzymatic synthesis of heparan sulfate oligosaccharides: Oxidative cleavage of p-nitrophenyl group with ceric ammonium salts. *Tetrahedron Lett* 54: 4471-4474.

7. Li G, Masuko S, Green DE, Xu Y, Li L, Zhang F, Xue C, **Liu J**, Deangelis PL, Linhardt* RJ. (2013) N-sulfotestosteronan, a novel substrate for heparan sulfate 6-O-sulfotransferases and its analysis by oxidative degradation. *Biopolymers* 99: 675-85.
8. Cai C, Edgar K, **Liu J**, Linhardt* RJ. (2013) Preparation and application of a 'clickable' acceptor for enzymatic synthesis of heparin oligosaccharides. *Carbohydr Res* 372:30-34
9. Huang, R., **Liu, J.** and Sharp*, J.S. (2013) An approach for separation and complete structural sequencing of heparin/heparan sulfate-like oligosaccharides. *Anal Chem* 85: 5787-95.
10. Kailemia, M.J., Li, L., Xu, Y., **Liu, J.**, Linhardt, R.J. and Amster*, I.J. (2013) Structurally informative tandem mass spectrometry of highly sulfated natural and chemo-enzymatically synthesized heparin and heparan sulfate glycosaminoglycans. *Mol. Cell. Proteomics* 12: 979-90.
11. Zhou, X., Li, L., Linhardt, R.J. and **Lu*, J.** (2013) Neutralizing the anticoagulant activity of ultra-low molecular weight heparins using *N*-acetylglucosamine 6-sulfatase. *FEBS J.* 280: 2523-32
12. O'Leary, T., Xu, Y. and **Liu*, J.** (2013) Investigation of the substrate specificity of K5 lyase. *Glycobiology* 23: 132-141.
13. Peterson, S and **Liu*, J.** (2012) Deciphering mode of action heparanase using structurally defined oligosaccharides. *J. Biol. Chem.* 287: 34836-34843.
14. Masuko, S., Bera, S., Green, D.E., Weiwer, M., **Liu, J.**, DeAngelis, P.L., Linhardt*, R.J. (2012) Chemoenzymatic synthesis of uridine diphosphate-GlcNAc and uridine diphosphate-GalNAc analogs for the preparation of unnatural glycosaminoglycans. *J. Org. Chem.* 77: 1449-1456.
15. Zhang, C., Liu L., Chen, J., **Liu, J.**, Li, J., Du, G., Chen*, J. (2012) Metabolic engineering of *Escherichia coli* for biosynthesis of heparosan, a bioengineered heparin precursor. *Metab. Eng.* 14: 521-527.
16. Sheng, J., Xu, Y., Dulaney, S., Huang*, X. and **Liu*, J.** (2012) Uncovering biphasic catalytic mode of C₅-epimerase in heparan sulfate biosynthesis. *J. Biol. Chem.* 287:20996-21002.
17. Yongmei Xu, Elizabeth H. Pempe, and **Jian Liu*** (2012) Chemoenzymatic synthesis of heparan sulfate oligosaccharides with anti-IIa activity. *J. Biol. Chem.* 287: 29054-29061.
18. Elizabeth H. Pempe, Tanya C. Burch, Courtney J. Law and **Jian Liu*** (2012) Substrate specificity of 6-*O*-endosulfatase 2 and its implications in synthesizing anticoagulant heparan sulfate. *Glycobiology* 22: 1353-1362.
19. Elizabeth H. Pempe, Yongmei Xu, Sandhya Gopalakrishnan, **Jian Liu**, Edward N. Harris* (2012) Probing the structural selectivity of synthetic heparin binding to stabilin receptors. *J. Biol. Chem.* 287: 20774-20783.

20. Joglekar, M.V., Quintana Diez, P.M., Marcus, S., Qi, R., Espinasse, B., Wiesner, M.R., Pempe, E.H., **Liu, J.**, Monroe, D.M., Arepally*, G.M. (2012) Disruption of PF4/H multimolecular complex formation with a minimally anticoagulant heparin (ODSH). *Thromb. Haemost.* 107: 717-725.
21. Moon, A., Xu, Y., Woody, S.M., Krahn, J.M., Linhardt, R.J., **Liu***, **J.** and Pedersen, L.C., (2012) Dissecting the substrate recognition of 3-*O*-sulfotransferase for the biosynthesis of anticoagulant heparin. *Proc. Natl. Acad. Sci. USA* 109: 5265-5270.
22. Xu, Y., Wang, Z., Liu, R., Arlene Bridges, Huang*, X., and **Liu, J.*** (2012) Directing the biological activities of heparan sulfate oligosaccharides using a chemoenzymatic approach. *Glycobiology* 22: 96-106.
23. Tiwari, V., **Liu, J.**, Valyi-Nagy, T., and Shukla*, D. (2011) Anti-heparan sulfate peptides that block herpes simplex virus infection *in vivo*. *J. Biol. Chem.* 286: 25406-25415.
24. Wang, Z., Yang, B., Zhang, Z., Ly, M., Takeiddin, M., Mousa, S., **Liu, J.**, Dordick, J.S., Linhardt*, R.J. (2011) Control of the heparosan *N*-deacetylation leads to an improved bioengineered heparin. *Appl. Microbiol. Biotechnol.* 91: 91-99.
25. Sheng, J., Liu, R., Xu, Y. and **Liu***, **J.** (2011) The dominating role of *N*-deacetylase/*N*-sulfotransferase 1 in forming domain structures in heparan sulfate. *J. Biol. Chem.* 286: 19768-19776.
26. Xu, Y., Masuko, S., Takiuddin, M., Xu, E., Liu, R., Jing, J., Mousa, S., Linhardt*, R.J. and **Liu***, **J.** (2011) Chemoenzymatic synthesis of structurally homogeneous ultra-low molecular weight heparins. *Science* 334: 498-501. (Perspective article by Turnbull, J.E. (2011) Getting the farm out of pharma for heparin production *Science* 334:462-463)
27. Liu, R. and **Liu***, **J.** (2011) Enzymatic placement of 6-*O*-sulfo groups in heparan sulfate. *Biochemistry* 50:4382-4391.
28. Zhou, X., Chandarajoti, K., Phar, T.Q., Liu, R. and **Liu, J.*** (2011) Expression of secreted forms of sulfotransferases in *Kluyveromyces lactisto* to synthesize heparin and heparan sulfate. *Glycobiology* 21: 771-780.
29. Wang Z, Xu, Y, Yang, G, Tiruchinapally, B. Sun, R. Liu, S. Dulaney, **J. Liu**, and X. Huang* (2010) Preactivation-based One-pot Combinatorial Synthesis of Heparin-like Hexasaccharides for the Analysis of Heparin-Protein Interactions *Chemistry* 16:8365-8375
30. Sherket Peterson and **Jian Liu*** (2010) Unraveling the specificity of heparanase utilizing synthetic substrates *J. Biol. Chem.* 285: 14504-14513.

31. Rengpeng Liu, Yongmei Xu, Miao Chen, Michel Weïwer, Xianxuan Zhou, Arlene S. Bridges, Paul L. DeAngelis, Qisheng Zhang, Robert J. Linhardt and **Jian Liu*** (2010) Chemoenzymatic design of heparan sulfate oligosaccharides *J. Biol. Chem.* 285:34240-34249.
32. Li, K., Bethea, HN, and **Liu, J.** (2010) Determining the activity of heparan sulfate C5-epimerase using engineered 2-*O*-sulfotransferase *J. Biol. Chem.* 285: 11106-11113.
33. Martin JG, Gupta M, Xu Y, Akella S, **Liu J**, Dordick JS, Linhardt RJ* (2009) Toward an artificial Golgi: Redesigning the biological activities of heparan sulfate on a digital microfluidic chip *J. Am. Chem. Soc.* 131: 11041-11048.
34. Zhang Z, Xie J, Liu H, **Liu J**, Linhardt RJ.* (2009) Quantification of heparan sulfate disaccharides using ion-pairing reversed-phase microflow high-performance liquid chromatography with electrospray ionization trap mass spectrometry *Anal. Chem.* 81: 4349-4355
35. Heather N. Bethea, Ding Xu, **Jian Liu***, and Lars Pedersen (2008) Redirecting the substrate specificity of heparan sulfate 2-*O*-sulfotransferase by structurally guided mutagenesis. *Proc. Natl. Acad. Sci. USA* 105: 18724-18729.
36. Michel Weïwer, Trevor Sherwood, Dixy E. Green, Paul L. DeAngelis, **Jian Liu**, Robert J. Linhardt* (2008) Synthesis of uridine 5'-diphosphoiduronic acid (UDP-IdoA) as a potential unnatural substrate of glucuronosyltransferases for the chemoenzymatic synthesis of heparin *J. Org. Chem.* 73: 7631-7637.
37. Zhenqing Zhang, Scott A. McCallum, Jin Xie, Lidia Nieto, Francisco Corzana, Jesús Jiménez-Barbero, Miao Chen, **Jian Liu**, Robert J. Linhardt* (2008) Solution structures of chemoenzymatically synthesized heparin and its precursors *J. Am. Chem. Soc.* 130: 12998-13007.
38. Ronald Copeland, Arun Balasubramaniam, Vaibhav Tiwari, Arleen Bridges, Robert J Linhardt, Deepak Shukla, and **Jian Liu*** (2008) Using a 3-*O*-sulfated heparin octasaccharide to inhibit the entry of herpes simplex virus 1 *Biochemistry* 47: 5774-5783.
39. Xu, D., Moon, A.F., Song, D., Pedersen, L.C. and **Liu*, J.** (2008) Engineering the sulfotransferases to modify heparan sulfate *Nat. Chem. Biol.* 4: 200-202.
40. Zhenqing Zhang. Jin Xie, **Jian Liu** and Robert Linhardt* (2008) Tandem MS can distinguish hyaluronic acid from *N*-acetylheparosan *J. Am. Soc Mass Spect.* 19: 82-90
41. Chen, J., Jones, C.L., and **Liu*, J.** (2007) An enzymatic combinatorial approach to identify novel anticoagulant heparan sulfate structures *Chemistry & Biology* 14: 986-993 (Commentary by Linhardt, R.J. and Kim, J.-H. (2007) *Chemistry & Biology* 14: 972-973)
42. Lu, D., Garcia-Contreras, L., Xu, D., Kurtz, S.L., **Liu, J.**, Braunstein, M., McMurray, D. and Hickey*, A.J. (2007) Poly (Lactide-co-Glycolide) Microspheres Can Enhance a T Cell

- Response to Recombinant Mycobacterium tuberculosis Antigen 85B. *Pharm Res.* 24: 1834-1843.
43. Lawrence, R., Yabe, T., HajMohammadi, S., Rhodes, J., McNeely, M., **Liu, J.**, Lamperti, E.D., Toselli, P.A., Lech, M., Spear, P.G., Rosenberg, R.D., and Shworak*, N.W. (2007) The principal neuronal gD-type 3-O-sulfotransferases and their products in central and peripheral nervous system tissues *Matrix Biology* 26: 442-455.
 44. Xu, D., Song, D., Pedersen, L. and **Liu***, **J.** (2007) Mutational study of heparan sulfate and chondroitin sulfate 2-O-sulfotransferases *J. Biol. Chem.* 282: 8356-8367.
 45. Tiwari, V., O'Donnell, C., Copeland, R.J., Scarlett, T., **Liu, J.** and Shukla* D. (2007) Soluble 3-O-sulfated heparan sulfate can trigger herpes simplex virus type 1 entry into resistant Chinese hamster ovary (CHO-K1) cells *J. Gen Virol.* 88: 1075-1079.
 46. Chen, M., Bridges, A. and **Liu***, **J.** (2006) Determination of the substrate specificities of N-acetyl-D-glucosaminyl transferase *Biochemistry* 45: 12358-12365.
 47. Vaibhav Tiwari, Christian Clement, Ding Xu, Perry M. Scanlan, Veeral Seth, Gary Chung, Devanand Kowlessur, Tibor Valyi-Nagy, Beatrice Y.J.T. Yue, **Jian Liu**, and Deepak Shukla* (2006) Entry of HSV-1 into primary cultures of corneal fibroblasts is mediated by HVEM and 3-O-S HS but not nectin-1. *J. Virol.* 80: 8970-8980.
 48. Muñoz, E., Xu, D., Kemp, M., Zhang, F., **Liu, J.**, Linhardt*, R.J. (2006) Affinity, kinetic and structural study of the interaction of 3-O-sulfotransferase isoform 1 with heparan sulfate *Biochemistry* 45: 5122-5128.
 49. McDowell, L.M., Frazier, B., Studelska, D.R., Giljum, K., Chen, J., **Liu, J.**, Yu, K., Ornitz, D.M., and Zhang, L.* (2006) Inhibition or activation of Apert syndrome FGFRs (S252W) signaling by specific glycosaminoglycans *J. Biol. Chem.* 281: 6924-6930.
 50. Duncan, M., Liu, M., Fox, C. and **Liu, J.*** (2006) Characterization of the N-Deacetylase Domain from the Heparan Sulfate N-Deacetylase/N-Sulfotransferase 2 *Biochem. Biophys. Res. Commun.* 339: 1232-1237.
 51. Eva Muñoz, Ding Xu, Fikri Avci, Melissa Kemp, **Jian Liu**, Robert J. Linhardt* (2006) Enzymatic synthesis of heparin related polysaccharide on sensor chips: Rapid screening of heparin-protein interactions *Biochem. Biophys. Res. Commun.* 339:597-602.
 52. Jinghua Chen, Fikri Y. Avci, Eva M. Muñoz, Lynda M. McDowel, Miao Chen, Lars C. Pedersen, Lijuan Zhang, Robert J. Linhardt, and **Jian Liu*** (2005) Enzymatic redesigning of biologically active heparan sulfate *J. Biol. Chem.* 280: 42817-42825.
 53. Gong, Y., Duvvuri, M., Duncan, M., **Liu, J.** and Krise, J.P.* (2006) Niemann-pick C1 protein facilitates the efflux of the anticancer drug duanorubicin from cells according to a novel vesicle-mediated pathway *J. Pharmacol. Exp. Ther.* 316: 242-247.

54. Jinghua Chen and **Jian Liu*** (2005) Characterization of the Structure of Antithrombin-binding Heparan Sulfate Generated by Heparan Sulfate 3-*O*-Sulfotransferase 5 *Biochim. Biophys. Acta* 1725:190-200.
55. Ding Xu, Vaibhav Tiwari, Guoqing Xia, Christian Clement, Deepak Shukla and **Jian Liu*** (2005) Characterization of heparan sulphate 3-*O*-sulphotransferase isoform 6 and the role in assisting the entry of herpes simplex virus, type 1. *Biochem. J.*385: 451-459.
56. Andrea Moon, Suzanne C. Edavettal, Joe M. Krahn, Eva M. Munoz, Masahiko Negishi, Robert J. Linhardt, **Jian Liu***, and Lars C. Pedersen (2004) Structural analysis of the sulfotransferase (3-OST-3) involved in the biosynthesis of an entry receptor of herpes simplex virus 1. *J. Biol. Chem.* 279: 45185-45193 (Cover of October 22 issue).
57. Atsuko Negishi, Jinghua Chen, Douglas McCarty, Jude Samulski, **Jian Liu***, and Richard Superfine* (2004) Analysis of the interaction of heparan sulfate and adeno-associated virus by atomic force microscopy. *Glycobiology* 14: 969-977.
58. Suzanne C. Edavettal, Karen A. Lee, Masahiko Negishi, Robert J. Linhardt, **Jian Liu***, and Lars C. Pedersen (2004) Crystal structure and mutational analysis of heparan sulfate 3-*O*-sulfotransferase isoform 1. *J. Biol. Chem.* 279: 25789-25797.
59. Suzanne C. Edavettal, Kevin Carrick, Ruchir Shah, Lars C. Pedersen, Alex Tropsha, R. Marshall Pope, and **Jian Liu*** (2004) A conformational change of heparan sulfate 3-*O*-sulfotransferase induced by binding to heparan sulfate. *Biochemistry* 43: 4680 - 4688.
60. Vaibhav Tiwari, Christain Clement, Michael B. Duncan, Jinghua Chen, **Jian Liu**, and Deepak Shukla* (2004) A role of 3-*O*-sulfated heparan sulfate in cell fusion induced by herpes simplex virus type-1. *J. Gen. Virol.* 85: 805-809.
61. Michael B. Duncan, Jinghua Chen, Jeffrey Krise and **Jian Liu*** (2004) The contribution of heparan sulfate 3-*O*-sulfotransferase isoform 5 to the biosynthesis of anticoagulant heparan sulfate. *Biochim. Biophys. Acta* 1671: 34-43.
62. Jinghua Chen, Michael B. Duncan, Kevin Carrick, R. Marshall Pope, and **Jian Liu*** (2003) Biosynthesis of 3-*O*-sulfated heparan sulfate: unique substrate specificity of heparan sulfate 3-*O*-sulfotransferase isoform 5. *Glycobiology* 13: 785-794.
63. Guoqing Xia, Jinghua Chen, Vaibhav Tiwari, Wujian Ju, Jing-pin Li, Anders Malmström, Deepak Shukla, **Jian Liu*** (2002) Heparan sulfate 3-*O*-sulfotransferase isoform 5 generates both an antithrombin-binding site and an entry receptor for herpes simplex virus-1. *J. Biol. Chem.* 277: 37912-37919.
64. **Jian Liu***, Zach Shriver, R. Marshall Pope, Suzanne C. Thorp, Michael B. Duncan, Ronald J. Copeland, Christina S. Raska, Keiichi Yoshida, Roselyn J. Eisenberg, Gary Cohen, Robert J. Linhardt, and Ram Sasisekharan (2002) Characterization of a heparan sulfate

- octasaccharide that binds to herpes simplex viral type 1 glycoprotein D. *J. Biol. Chem.* 277: 33456-3346.
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69. Deepak Shukla¶, **Jian Liu¶**, Peter Blaiklock, Nicholas W. Shworak, Xiaomei Bai, Jeffrey D. Esko, Gary H. Cohen, Roselyn J. Eisenberg, Robert D. Rosenberg and Patricia G. Spear (1999) A novel role for 3-O-sulfated heparan sulfate in herpes simplex virus 1 entry. *Cell* 99: 13-22.(¶Both authors contributed equally to this work.)
70. **Jian Liu**, Zach Shriver, Peter Blaiklock, Keiichi Yoshida, Ram Sasisekharan, and Robert D. Rosenberg (1999) Heparan sulfate D-glucosaminyl 3-O-sulfotransferase 3A sulfates N-unsubstituted glucosamine. *J. Biol. Chem.* 274: 38155-38162.
71. **Jian Liu**, Nicholas W. Shworak, Pierre Sinaÿ, John J. Schwartz, Lijuan Zhang, Linda M.S. Fritze and Robert D. Rosenberg (1999) Expression of heparan sulfate D-glucosaminyl 3-O-sulfotransferase isoforms reveals novel substrate specificities. *J. Biol. Chem.* 274: 5185-5192.
72. Nicholas W. Shworak, **Jian Liu**, Lorin M. Petros, Neal G. Copeland, Nancy A. Jenkins and Robert D. Rosenberg (1999) Diversity of the extensive heparan sulfate D-glucosaminyl 3-O-sulfotransferase (3-OST) multigene family. *J. Biol. Chem.* 274: 5170-5184.
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74. Masashi Kobayashi, Geetha Sugumaran, **Jian Liu**, Nicholas W. Shworak, Jeremiah E. Silbert, and Robert D. Rosenberg (1999) Molecular cloning and characterization of a human uronyl 2-sulfotransferase that sulfates iduronyl and glucuronyl residues in dermatan/chondroitin sulfate. *J. Biol. Chem.* 274: 10474-10480.

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77. **Jian Liu**, Nicholas W. Shworak, Linda M.S. Fritze, Jay M. Edelberg and Robert D. Rosenberg (1996) Purification of heparan sulfate D-glucosaminyl 3-*O*-sulfotransferase. *J. Biol. Chem.* 271: 27072-27082.
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80. **Jian Liu**, Umesh R. Desai, Xue-Jun Han, Toshihiko Toida and Robert J. Linhardt (1995) Strategy for the sequence analysis of heparin. *Glycobiology* 5: 765-774.
81. Sylvia Collic-Jouault, Nicholas W. Shworak, **Jian Liu**, Ariane I. De Agostini and Robert D. Rosenberg (1994) Characterization of a cell mutant specifically defective in the synthesis of anticoagulant active heparan sulfate. *J. Biol. Chem.* 271: 24953-24958.
82. Nicholas W. Shworak, Motoaki Shirakawa, Sylvia Collic-Jouault, **Jian Liu**, Richard C. Mulligan, Louis K. Birinyi and Robert D. Rosenberg (1994) Pathway-specific regulation of the biosynthesis of anticoagulant active heparan sulfate. *J. Biol. Chem.* 269: 24941-24952.
83. Y. S. Kim, **J. Liu**, X.J. Han, A. Pervin and R. J. Linhardt (1994) Analysis of fluorescently labeled sugars by reversed-phase ion-pairing high performance liquid chromatography. *J. Chromatogr. Sci.* 33: 162-167.
84. **Jian Liu**, Azra Pervin, Cindy M. Gallo, Umesh R. Desai, Case VanGorp and Robert J. Linhardt (1994) New approaches for the preparation of hydrophobic heparin. *J. Pharmaceut. Sci.* 83: 1034-1039.
85. Robert J. Linhardt, Umesh Desai, **Jian Liu**, Debra Hoppensteadt and Jawed Fareed (1994) Low molecular weight dermatan sulfate as an antithrombotic agent: Structure activity relationship studies. *Biochem. Pharmacol.* 47: 1241-1252.

86. Kenan Gu, **Jian Liu**, Azra Pervin and Robert J. Linhardt (1993) Comparison of the activity of two chondroitin AC lyases on dermatan sulfate. *Carbohydr. Res.* 244: 369-377.
87. Robert J. Linhardt, Ali Al-Hakim, **Jian Liu**, Debra Hoppensteadt, Jawed Fareed, Guiseppe Mascellani, and Pietro Bianchini (1991) Structure features of dermatan sulfates and their relationship to anticoagulant and antithrombotic activities. *Biochem. Pharmacol.* 42: 1609-1619.
88. Youhan Xu, **Jian Liu**, Suipo Zhang and Lisheng Liu (1987) The effect of berbamine derivatives on activated Ca^{2+} -stimulated Mg^{2+} -dependent ATPase in erythrocyte membranes. *Biochem. J.* 248: 985-988.
89. Fayi Zhang, Yibao Zhang, **Jian Liu** and Xuezhuang Zhao (1986) Ascorbic acid oxidation reaction-kinetics of oxidation by molecular oxygen. *WuliHuaxue Xuebao* 2: 335-341 (in Chinese).

Peer-reviewed review articles

90. DeAngelis*, P.L., **Liu, J.** and Linhardt, R.J. (2013) Chemoenzymatic synthesis of glycosaminoglycans: Re-creating, re-modeling, and re-designing nature's longest or most complex carbohydrate chains. *Glycobiology* 23: 764-777.
91. Peterson, S.B. and **Liu*, J.** (2013) Multi-faceted substrate specificity of heparanase. *Matrix Biol.* 32: 223-227.
92. Chappell, E.P and **Liu*, J.** (2013) Use of biosynthetic enzymes in heparin and heparan sulfate synthesis. *Bioorg. Med. Chem.* 21: 4786-4792.
93. Paul, P., Suwan, J., **Liu, J.**, Dordick, J.S. and Linhardt*, R.J. (2012) Recent advances in sulfotransferase enzyme activity assays. *Anal Bioanal Chem* 403: 1491-1500.
94. **Liu, J.**, Moon, A.F., Sheng, J. and Pedersen*, L.C. (2012) Understanding the substrate specificity of the heparan sulfate sulfotransferases by a combined synthetic crystallographic approach. *Curr Opin Struct Biol* 22: 550-557.
95. Li, P., Sheng, J., Liu, Y., Li, J., **Liu*, J.** and Wang*, F. (2013) Heprosan-derived heparan sulfate/heparin-like compounds: One kind of potential therapeutic agents *Med. Res. Rev.* 33:665-692.
96. Linhardt*, R.J. and **Liu, J.** (2012) Synthetic heparin *Curr Opin Pharmacol.* 12:217-219.
97. Zhou, X., O'Leary, T., Xu, Y., Sheng, J. and **Liu*, J.** (2012) Chemoenzymatic synthesis of heparin and heparan sulfate. *Biocatalys. Biotransf.* 30:296-308.
98. Laremore TN, Zhang F, Dordick JS, **Liu J**, Linhardt RJ.* (2009) Recent progress and applications in glycosaminoglycan and heparin research *Curr Opin Chem Biol* 13:633-40.

99. Sherket Peterson, Amber Frick, **Jian Liu*** (2009) Designing of biologically active heparan sulfate and heparin using an enzyme-based approach *Nat. Prod. Rep.* 26: 610-627.
100. Chen, Y., Götte, M., **Liu, J.**, and Park, P.W. (2008) Microbial subversion of heparan sulfate proteoglycans *Mol Cells* 26: 415-426.
101. Robert J Linhardt*, Jonathan S. Dordick, Paul DeAngelis, **Jian Liu** (2007) Enzymatic synthesis of glycosaminoglycan heparin *Semin. Thromb. Hemost.* 33: 453-465.
102. **Jian Liu*** and Lars C. Pedersen (2007) Anticoagulant heparan sulfate: Structural specificity and biosynthesis. *Appl. Microbiol. Biotechnol.* 74:263-272.
103. **Jian Liu*** and Suzanne C. Thorp (2001) Cell surface heparan sulfate and the roles in assisting viral infections. *Med. Res. Rev.* 22:1-25.
104. Robert D. Rosenberg*, Nicholas W. Shworak, **Jian Liu**, John J. Schwartz, and Lijuan Zhang (1997) Heparan sulfate proteoglycans of the cardiovascular system: specific structures emerge but how is synthesis regulated? *J. Clin. Invest.* 99: 2062-2070.
105. Robert J. Linhardt*, **Jian Liu** and Xue-jun Han (1993) Mapping and sequencing of oligosaccharides by electrophoresis. *Trends Glycosci. Glycotechnol.* 5: 181-192.

Refereed book chapters

106. Tim O'Leary and **Jian Liu*** (2012) Uronyl 2-*O*-sulfotransferase in *Handbook of Glycosyltransferases and Their Related Genes* (N. Taniguchi and M. Fukuda Eds.) Springer-Verlag, Tokyo, in press.
107. Tim O'Leary and **Jian Liu*** (2012) Heparan sulfate D-glucosaminyl 3-*O*-sulfotransferase in *Handbook of Glycosyltransferases and Their Related Genes* (N. Taniguchi and M. Fukuda Eds.) Springer-Verlag, Tokyo, in press
108. Rengeng Liu and **Jian Liu*** (2010) Enzymatic synthesis of heparin, in *Sustainable Biotechnology-Sources of Renewable Energy* (O.V. Sigh and S.P. Harrey Eds.), in press.
109. Courtney L. Jones, Ding Xu and **Jian Liu*** (2010) Structure, Biosynthesis and Function of Glycosaminoglycans, in "Carbohydrates, Nucleosides, & Nucleic Acids" (C.H. Wong and G.P. Wang, eds), *Comprehensive Natural Products Chemistry II* series (L. Mendor and H.-W. Liu, editor in-chief) Vol 6, in press.
110. Fikri Y. Avci, Paul L. DeAngelis, **Jian Liu**, and Robert J. Linhardt* (2007) Enzymatic synthesis of glycosaminoglycans: improving on nature, in *Frontiers in Carbohydrate Chemistry*, pp 253-284.

111. **Jian Liu*** and Robert D. Rosenberg (2001) Heparan sulfate D-glucosaminyl 3-*O*-sulfotransferase, in *Handbook of Glycosyltransferases and Their Related Genes* (N. Taniguchi and M. Fukuda Eds.) Springer-Verlag, Tokyo pp 475-483. (Book Chapter)
112. Robert J. Linhardt*, Ali Al-Hakim and **Jian Liu** (1991) Acidic polysaccharides: Their modification and potential uses, in *Biotechnology and Polymers* (C. G. Gebelein Ed.) Plenum Press, New York, 155-165. (Book Chapter)

Patents:

1. Robert D. Rosenberg, Nicolas W. Shworak, **Jian Liu**, Linda M.S. Fritze, John J. Schwartz, and Lijuan Zhang Heparan sulfate D-glucosaminyl 3-*O*-sulfotransferases, and uses therefor, **US Patent 6,861,254 B1**.
2. **Jian Liu**, Guoqing Xia, Jinghua Chen, , Mike Duncan, Anders Mamlström, Deepak Shukla, Vaibhav Tiwari Heparan sulfate 3-*O*-sulfotransferase Isoform 5 generates both an antithrombin-binding site and an entry receptor for herpes simplex virus-1, US patent **20060165673 (7,531,338)**.
3. **Jian Liu**, Jinghua Chen, Robert J. Linhardt, Fikri Y. Avci, and Eva M. Munoz Enzymatic synthesis of sulfated polysaccharides, US Patent **20090197308 (US patent serial #11/920,319)**.
4. **Jian Liu**, Jinghua Chen, Courtney Jones, Yongmei Xu Enzymatic synthesis of sulfated polysaccharides without iduronic acid residues, US Patent **20090035787. (US patent serial # 12/178,434)**
5. **Jian Liu** and Yongmei Xu Chemoenzymatic synthesis of homogeneous ultra-low molecular weight heparins, **US patent serial # 61/426,921**.
6. Stavros Garantziotis, John W. Hollingsworth, Bryan P. Toole, and **Jian Liu** Use of antagonists of hyaluronan signaling inflammation and hyperresponsiveness, US2013/029776 (**serial # 61/647,101**).
7. **Jian Liu**, Yongmei Xu, Edward Harris and Robert Linhardt Design of homogeneous and reversible low-molecular weight heparins, US Provisional.

INVITED LECTURES

1. 21st Symposium on glycosaminoglycans, Lovenno, Lake Como, Italy, September 2013. "Design of homogeneous low-molecular heparin with reversible anticoagulant activity".
2. The 17th European Carbohydrate Symposium, Tel-Aviv, Israel, July 7-11, 2013. Title: "Rationale Design of Homogeneous Low-molecular Weight Heparin".
3. 2013 International Symposium on Chemical Glycobiology, Shanghai, China, June 29th to July 1st, 2013. "Rationale design of homogeneous low molecular weight heparins".

4. Glyco22, Dalian, China, June 22nd to 28th, 2013. “Enzymatic synthesis of heparin and heparan sulfate”.
5. 20th Symposium on glycosaminoglycans, Lovenno, Lake Como, Italy, September 2012. “Uncovering the control mechanism for the enzymatic synthesis of heparin”.
6. Ocean University of China, Qingdao, China, June 2012. Title: “Chemoenzymatic synthesis of heparin”.
7. Georgia State University, Atlanta, GA, November 2011. Title: “An enzymatic approach to synthesize heparan sulfate glycome”.
8. 19th Symposium on Glycosaminoglycans, Lovenno, Lake Como, Italy, September 2011. Title: “Enzymatic synthesis of heparin and heparan sulfate”.
9. 7th Canadian National Carbohydrate Symposium, Banff, Canada, May 2011. Title: “Enzymatic synthesis of heparin and ultra-low molecular weight heparins”.
10. 9th Carbohydrate Bioengineering Meeting (Keynote speaker), Lisbon, Portugal, May, 2011. “Enzymatic synthesis of heparin and ultra-low molecular weight heparins”.
11. University of Alabama, Birmingham, AL, January 2011. Title: “Developing a chemoenzymatic approach to synthesize heparan sulfate”.
12. Academia Sinica, Taiwan, December 2010. Title: “Enzymatic synthesis of heparin and heparan sulfate”.
13. American Chemical Society/Carbohydrate Chemistry Division annual meeting, Boston, MA, August 2010. Title: “Developing an enzymatic approach to synthesize heparan sulfate”.
14. International Carbohydrate Symposium Satellite meeting, Taipei, Taiwan, July 2010. Title: “Developing an enzymatic approach to synthesize heparan sulfate oligosaccharides”.
15. Shandong University, Jinan, China, September, 2009. Title: “An enzymatic approach to synthesize heparin”.
16. Jiangnan University, Wuxi, China, April 2009. Title: “Developing an enzymatic approach to synthesize polysaccharide-based therapeutics”.
17. University of Georgia, Athens, GA, September, 2008. Title: “Enzymatic synthesis of heparan sulfate”.
18. Chinese Glycobiology conference, Jinan, China, July, 2008. Title: “Developing an enzymatic approach to synthesize heparin-based drugs”. (Keynote speaker)
19. University of California at Davis, Davis, CA, April, 2008. Title: “An enzymatic approach to design polysaccharides drugs”.
20. University of Toledo, Toledo, OH, March, 2008. Title: “Using a glycomics approach to develop polysaccharide-based drugs”.
21. National Institute of Environmental Health Sciences, LSB retreat, September, 2007. Title: “Using a glycomics approach to develop polysaccharide-based drugs”.
22. Tsin Hua University, Taiwan, April, 2007. Title: “An enzymatic approach to synthesize heparan sulfate with specific functions”.
23. Ohio State University, Columbus, Ohio, October 2006. Title: “Enzymatic synthesis of anticoagulant heparan sulfate”.
24. University of Illinois at Chicago, Chicago, Illinois, September 2006. Title: “Heparan sulfate: The roles in regulating blood coagulation and assisting viral infections”.
25. University of Iowa, Iowa City, IA, February 2006. Title: “Enzymatic synthesis of anticoagulant drugs”.
26. University of Illinois at Chicago, Chicago, Illinois, September 2004. Title: “Investigation of the structural and functional relationship of heparan sulfate”.

27. University of Arkansas, Little Rock, Arkansas, April 2004. Title: “The biological functions and the fine structures of heparan sulfate”.
28. Rensselaer Polytechnic Institute, Troy, New York, October 2003. Title: “Heparan sulfate: from an anticoagulant to a viral receptor”.
29. Georgia State University, Atlanta, Georgia, October 2003. Title: “Cell surface heparan sulfate: from an anticoagulant to a viral receptor.”
30. Virginia Commonwealth University, Richmond, Virginia, May 2002. Title “Specificity of heparan sulfate in assisting herpes simplex viral infection”.
31. American Association for Pharmaceutical Sciences, Denver, Colorado, October 2001. Title “Heparan sulfate: a potential new receptor for gene delivery”.
32. National Institute of Environmental Health Science, Research Triangle Park, April 2001. Title “The role of heparan sulfate in assisting viral infections”.

Oral Presentations at Professional Meetings

1. 244th American Chemical Society National Meeting, Philadelphia, PA, Aug 2012. Title: “Uncovering a biphasic catalytic mode of C₅-epimerase for the biosynthesis of heparan sulfate”.
2. US Pharmacopeia 5th Workshop on the characterization of heparin products, Rockville, MD, Aug 2012. Title: “Chemoenzymatic synthesis of homogeneous ultra-low molecular weight heparins”.
3. Annual meeting for the Society for Industrial Microbiology, Washington, DC, Aug 2012. Title: “Chemoenzymatic synthesis of homogeneous ultra-low and low molecular weight heparins”.
4. Proteoglycan Gordon Conference, Andover, NH, July 2012. Title: Understanding the control mechanism for the enzymatic synthesis of heparin.
5. 2nd International Conference on Drug Discovery & Therapy, Dubai, UAE, February, 2010. Title: “An enzymatic approach to synthesize heparin”.
6. Carbohydrates Gordon Conference, Tilton, NH, June 2009. Title: “Enzymatic synthesis of heparan sulfate and heparin”.
7. 67th Harden Conference, Cambridge, UK, March 2009. Title: “Developing an enzymatic approach to synthesize heparan sulfate”.
8. Glycobiology Gordon Conference, Ventura, CA, January 2009. Title: “Engineering sulfotransferases to modify heparan sulfate”.
9. Ehrlich II International Conference, Nuremberg, Germany, October 2008. Title: An enzymatic approach for developing heparan sulfate-based drugs”.
10. Rensselaer Nanotechnology in Glycomics Symposium, Troy, NY, July 2008. Title: “Enzymatic synthesis of heparan sulfate and heparin”.
11. Carbohydrate Gordon Conference, Tilton, NH, July 2007. Title: “Engineering the specificity of sulfotransferases to synthesize specific heparan sulfate structures”.
12. Rensselaer Glycomics Symposium, Albany, NY, July 2006. Title: “Enzymatic synthesis of heparan sulfate.”
13. International Carbohydrate Symposium, Whistler, BC, July 2006. Title: “Enzymatically redesigning of biologically active heparan sulfate.”
14. Proteoglycan Gordon Conference, Andover, NH, July 2004. Title: “Crystal structure and mutational analysis of heparan sulfate 3-*O*-sulfotransferase isoform 1”.

15. Proteoglycan Gordon Conference, Andover, NH, July 2002. Title: “Heparan sulfate 3-*O*-sulfotransferase isoform 5 generates both an antithrombin-binding site and an entry receptor for herpes simplex virus-1”.

Previous and Current Fellows/Trainees

Total number of pre-doctoral and post-doctoral individuals sponsored *in the past* = 14

1. **J. Chen, PhD** (postdoctoral fellow, 2001-2005) is now a professor at Jiangnan University, China.
2. **S. C. Edavettal, PhD** (PhD graduate student, 2000-2004) is now a senior scientist at Merck Inc., West Point, PA.
3. **M.B. Duncan, PhD** (PhD graduate student, 2001-2006) is now an assistant professor of medicine at the Medical College of Georgia, Augusta, GA.
4. **R. Copeland, PhD** (PhD graduate student, 2001-2006) is now a postdoc at Johns Hopkins University, Baltimore, MD.
5. **D. Xu, PhD** (PhD graduate student, 2002– 2006) is now a senior research scientist at University of California at San Diego, San Diego, CA. Dr. Xu was supported by a predoctoral fellowship from American Heart Association, MidAtlantic Affiliate.
6. **M. Chen, PhD** (PhD graduate student, 2003-2008) is now a graduate student in biostatistics program at Harvard University, Boston, MA.
7. **T. Burch, PhD** (PhD graduate student, 2002-2008).
8. **Renpeng Liu, PhD** (PhD graduate student, 2004 -2010) is a postdoctoral fellow at Emory University, Atlanta, GA.
9. **Heather Bethea, PhD** (PhD graduate student, 2004-2010) is now a postdoctoral fellow at the University of North Carolina.
10. **Courtney Jones** (PhD graduate student, 2004 to 2011) is now a postdoctoral fellow at North Carolina Central University.
11. **Sherket Peterson** (PhD graduate student, 2007 to 2012) is now a postdoctoral fellow at Johns Hopkins University. Dr. Peterson was supported by predoctoral fellowship of Ruth L. Kirschstein Individual National Research Service Award from National Institutes of Health (F31GM090647).
12. **Kai Li** (Post-doctoral fellow, 2009 to 2011) is now a scientist at North Carolina State University.
13. **Xianxuan Zhou** (Post-doctoral fellow, 2009 to 2012) is a professor in the College of Biotechnology and Food Engineering, Hefei University of Technology, China
14. **Juzheng Sheng** (Post-doctoral fellow, 2009 to 2012) is an associate professor in the College of Pharmacy, Shandong University, China.

Total number lab members *currently* supported = 11

1. **Ryan Bullis** (PhD student, 2008 to present) is supported by a NIH minority supplement (1R01HL096972-01S1, PI Robert Linhardt) predoctoral fellowship till Aug of 2013.
2. **Kasemsiri Chandarajoti** (PhD student, 2009 to present) is supported by a predoctoral fellowship from Thai government till 2014.
3. **Elizabeth Pempe** (PhD student, 2009 to present) is supported by predoctoral fellowship of Ruth L. Kirschstein Individual National Research Service Award from National Institutes of Health grant (F31AG040927-01) till 2014.
4. **Tim O’Leary** (PhD student, 2010-present) is supported by teaching assistantship.

5. **Yongmei Xu, PhD** (Post-doctoral fellow, 2007 to present) is supported by NIH grant (1R01GM072667-06 ; PI, Xuefei Huang and a grant from Vesta Therapeutics).
6. **Po-Hung Hsieh** (graduate student, 2011 to present) is supported by a NIH grant (R01HL094463; PI, Jian Liu).
7. **Truong Quang Pham** (Technician, 2009 to present) is supported by a NIH grant (R01HL096972; PI, Robert Linhardt).
8. **Chunhui Liu, PhD** (Visiting Scholar, 2011 to present) is supported by a fellowship from Chinese Research Council.
9. **Ana Rita Xavier deJesus** (Visiting Scholar, 2012 to present) is supported by a fellowship from Portuguese government.
10. **Wen Zhou, PhD** (Visiting Scholar, 2013) is supported by a fellowship from Chinese Research Council.
11. **Susan Woody** (Pharm D/PhD student, 2011-present) is current enrolled in pharmacy curriculum. She is not supported.