

# CURRICULUM VITAE

**Name** Ding Xu

**Business Address** 3435 Main St.  
655 BRB  
University at Buffalo  
Buffalo, NY 14214  
e-mail: dingxu@buffalo.edu  
TEL: 716-829-3509  
Webpage: <https://www.xulab-heparan.org>

## **Education and Experience**

1995 – 1999 B.S. Biochemistry, Department of Biochemistry, Central China Normal University, Wuhan, China

2002 – 2007 Ph.D. Pharmaceutical Sciences, Division of Chemical Biology and Medicinal Chemistry, School of Pharmacy, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina

2007 – 2011 Postdoctoral Fellow, Department of Cellular and Molecular Medicine, School of Medicine, University of California San Diego, La Jolla, California

2011– 2014 Assistant Project scientist, Department of Cellular and Molecular Medicine, University of California, San Diego, La Jolla, California

2014– 2019 Assistant Professor, Department of Oral Biology, University at Buffalo, Buffalo, NY

2020-present Associate Professor, Department of Oral Biology, University at Buffalo, Buffalo, NY

## **Awards/Honors**

2005-2007 American Heart Association Predoctoral Fellowship

2008-2010 American Heart Association Postdoctoral Fellowship

2013-2014 American Heart Association Beginning Grant-in-Aid

April, 2012 The ASBMB 2012 Thematic Best Poster in Glycobiology, 2012 ASBMB Annual Meeting

July, 2012 Outstanding Poster Award at the Gordon Research Conference, Proteoglycans

Nov, 2012 JBC/Herbert Tabor Young Investigator Awards, Joint Meeting of the American Society for Matrix Biology and the Society for Glycobiology.

**Areas of Interest**

Bone biology, inflammation, Glycobiology, structural biology, mAb development

**Active Research Support**

**R01AR070179 NIH-NIAMS (08/01/2017-05/31/2022), *Awarded with 1% percentile***

**Xu, Ding (PI)**

**Heparan Sulfate–Osteoprotegerin Interactions in Bone Remodeling**

The goal of this study is to elucidate how HS interacts with osteoprotegerin and how HS–OPG interactions regulate osteoclastogenesis and bone remodeling.

**Total direct cost: \$1,100,000**

**2R01HL094463 NIH-NHLBI (09/01/2018-06/30/2022)**

**Xu, Ding (Co-PI)**

**In vitro Synthesis of Recombinant Heparan Sulfate**

The goal of this study is to investigate the role of heparan sulfate in sterile inflammation using structural defined heparan sulfate oligosaccharide

**Total direct cost: \$300,000**

**Buffalo Accelerator Funds (09/01/2020-12/31/2021)**

**Xu, Ding (PI)**

**Antibody-based therapeutic to target RAGE**

The goal of this study is to further develop our anti-RAGE mAb in potential treatment of osteoporosis and sepsis.

**Total direct cost: \$90,000**

**Pending Research Support**

**R01DE031273-01A1 NIH-NIDCR (07/01/2022-06/31/2027) *Percentile: 7%***

**Xu, Ding (PI)**

**The role of Heparan Sulfate in Cathepsin K Biology**

The goal of this study is to elucidate the biological significance of cathepsin K–heparan sulfate interaction in murine models, and to test the effectiveness of targeting the HS-binding site of cathepsin K as a novel strategy to selectively inhibit the collagenase activity of cathepsin K.

**Total direct cost: \$1,890,000**

**Completed Research Support**

**Beginning Grant-in-Aid (13BGIA14150008), AHA, Western States Affiliate**

**Ding Xu (PI)**

**01/01/13-12/31/14**

**RAGE – Heparan Sulfate Interactions in Vascular Inflammation**

The goal of this study is to understand the role of endothelial heparan sulfate in RAGE-mediated vascular inflammation using biophysical methods and cell culture systems.

**Total direct cost: \$140,000**

**Peer Reviewed Publications**

*2014-2021 (University at Buffalo)*

1. **Ding Xu** and Jeffrey D. Esko (2014). Demystifying Heparan sulfate-binding proteins. 2014;83:129-57. *Annual Review of Biochemistry*.
2. Weiss, R. J.; Gordts, P. L. S. M.; Le, D.; **Ding Xu**.; Esko, J. D.; Tor, Y. "Small molecule antagonists of cell-surface heparan sulfate and heparin–protein interactions" *Chem. Sci.* 2015, 6, 5984-5993
3. Durning SP, Preston-Hurlburt P, Clark PR, **Xu D**, Herold KC (2016). The Receptor for Advanced Glycation Endproducts Drives T Cell Survival and Inflammation in Type 1 Diabetes Mellitus. *J Immunol.* 197(8):3076-3085
4. Miaomiao Li, Shuying Yang, **Ding Xu\*** (2016). Heparan Sulfate Regulates the Structure and Function of Osteoprotegerin in Osteoclastogenesis. *J Biol Chem* 291 (46):24160-24171
5. **Xu D\***, Arnold K, Liu J\*. Using structurally defined oligosaccharides to understand the interactions between proteins and heparan sulfate. *Curr Opin Struct Biol.* 2018 Apr 20;50:155-161. doi: 10.1016. PMID: 29684759. (\*corresponding author)
6. Settem RP, Honma K, Shankar M, Li M, LaMonte M, **Xu D**, Genco RJ, Browne RW, Sharma A. Tannerella forsythia-produced methylglyoxal causes accumulation of advanced glycation endproducts to trigger cytokine secretion in human monocytes. *Mol Oral Microbiol.* 2018 Mar 23. doi: 10.1111/omi.12224. PMID: 29573211.
7. Andrew YH Ng, Chengjian Tu, Shichen Shen, **Ding Xu**, Merry J Oursler, Jun Qu, and Shuying Yang (2018). Comparative Characterization of Osteoclasts Derived From Murine Bone Marrow Macrophages and RAW 264.7 Cells Using Quantitative Proteomics. *JBMR Plus*, Vol. 2, No. 6, pp 328–340. PMID: 30460336.
8. Yiming Xiao, Miaomiao Li, Rinzhi Larocque, Fuming Zhang, Anju Malhotra, Jianle Chen, Robert J. Linhardt, Lars Konermann, and **Ding Xu** (2018). Dimerization Interface of Osteoprotegerin Revealed by Hydrogen-deuterium Exchange Mass Spectrometry. *J Biol Chem* 293 (45), 17523-17535.
9. Zhang X, Ong C, Su G, Liu J, **Xu D**. Characterization and Engineering of S100A12–Heparan sulfate interactions. *Glycobiology.* (2019) 30(7):463-473.
10. Katelyn Arnold, Yongmei Xu, Erica M. Sparkenbaugh, Miaomiao Li, Xiaorui Han, Xing Zhang, Ke Xia, Mark Piegore, Fuming Zhang, Xiaoxiao Zhang, Mike Henderson, Vijayakanth Pagadala, Guowei Su, Pyong Woo Park, R. Todd Stravitz, Nigel S. Key, Robert J. Linhardt, Rafal Pawlinski, **Ding Xu\***, and Jian Liu\* (2020). Design of an HMGB1-binding heparan sulfate to treat acetaminophen-induced acute liver failure. *Science Translational Medicine.* 2020 Mar 18;12(535):eaav8075. PMID 32188725. (\*corresponding author)

11. Sandoval DR, Toledo AG, Painter CD, Tota EM, Sheikh MO, West AMV, Frank MM, Wells L, **Xu D**, Bicknell R, Corbett KD, Esko JD (2020). Proteomics-based screening of the endothelial heparan sulfate interactome reveals that C-type lectin 14a (CLEC14A) is a heparin binding protein. *J Biol Chem* RA119.011639
12. Miaomiao Li & **Ding Xu** (2020). Antiresorptive activity of osteoprotegerin requires an intact heparan sulfate-binding site. *Proc Natl Acad Sci U S A*. 117 (29) 17187-17194. PMID: 32636266
13. Xiaoxiao Zhang, Xinyue Liu, Miaomiao Li, Guowei Su, Jian Liu, Chunyu Wang, and **Ding Xu** (2021) pH-Dependent and Dynamic Interactions of Cystatin C with Heparan Sulfate. *Communications Biology*. 2021 Feb 12;4(1):198. PMID:33580179
14. Shoib S Siddiqui , Chirag Dhar , Venkatasubramaniam Sundaramurthy , Aniruddha Sasmal , Hi Yu, Esther Bandala-Sanchez , Miaomiao Li , Xiaoxiao Zhang , Xi Chen , Leonard C. Harrison , **Ding Xu**, Ajit Varki (2021). Acidosis, Zinc and HMGB1 in Sepsis: A Common Connection Involving Sialoglycan Recognition. *Proc Natl Acad Sci U S A*. 118 (10) e2018090118. PMID: 33658363
15. Zhangjie Wang, Vijay M. Dhurandhare, Cressida A. Mahung, Katelyn Arnold, Jine Li, Guowei Su, **Ding Xu**, Rob Maile, and Jian Liu (2021). Improving the Sensitivity for Quantifying Heparan Sulfate from Biological Samples. *Anal. Chem*. 93, 11191-11199. PMID: 34355888
16. Miaomiao Li, Chihyeon Ong, Christophe Langouet Astrie, Lisi Tan, Ashwni Verma, Yimu Yang, Xiaoxiao Zhang, Dhaval K Shah, Eric P Schmidt and **Ding Xu** (2022). Heparan Sulfate-dependent RAGE oligomerization is indispensable for pathophysiological functions of RAGE *eLife*. 2022;11:e71403 DOI: 10.7554/eLife.71403.
17. Yin Luo, Miaomiao Li and **Ding Xu** (2021). A disease-causing human osteoprotegerin mutant exists in hyper-oligomerized forms. *Scientific Report*, under review.
18. **Zhang X**, Su G, Li M, Liu J, Pedersen LC, **Ding Xu** (2021). “Heparan sulfate inhibits the collagenase activity of cathepsin K by inducing its oligomerization”. *Molecular Cell*, in preparation.

2007-2014 (UC San Diego)

19. **Ding Xu** and Jeffrey D Esko (2009) A Golgi-on-a-chip for glycan synthesis. *Nat Chem Biol*. 5, 612-613. PMID: 19690535
20. **Ding Xu**, Mark Fuster, Roger Lawrence and Jeffrey D Esko (2010) Heparan sulfate regulates VEGF<sub>165</sub> and VEGF<sub>121</sub>-mediated vascular hyperpermeability. *J Biol Chem*. 286(1):737-45. PMID: 20974861
21. Xin Yin, Scott C. Johns, Roger Lawrence, **Ding Xu**, Krisanavane Reddi, Joseph R. Bishop, Judith A. Varner and Mark M. Fuster (2011) Lymphatic Heparan Sulfate Deficiency Results in Altered Growth Response to VEGF-C. *J Biol Chem*. 286(17):14952-62. PMID: 21343305
22. Yung-Chi Chang, Zhipeng Wang, Lindsay A. Flax, **Ding Xu**, Jeffrey D. Esko, Victor Nizet and Miriam J. Baron (2011) Glycosaminoglycan Binding Facilitates Entry of Group B *Streptococcus* into Central Nervous Systems. *PLoS Pathog*. 7(6): e1002082. PMID: 21731486.

23. Omai B. Garner, Kevin T. Bush, Kabir B. Nigam, Yu Yamaguchi, **Ding Xu**, Jeffrey D. Esko and Sanjay K Nigam (2011) Stage-dependent regulation of mammary ductal branching by heparan sulfate and HGF-cMet signaling. *Dev Biol.* 355(2):394-403. PMID: 21586278
24. **Ding Xu\***, Jeffrey H Young, Danyin Song and Jeffrey D. Esko\* (2011) Heparan sulfate is essential for high mobility group protein-1 (HMGB1) signaling by the receptor for advanced glycation end products (RAGE). *J Biol Chem.* 286(48):41736-44 (\*corresponding authors). PMID: 21990362.
25. Jakob Axelsson\*, **Ding Xu\***, Bit Na Kang, P. Sriramarao, Tracy M. Handel, and Klaus Ley and Jeffrey D. Esko (2012) :Inactivation of heparan sulfate 2-O-sulfotransferase accentuates neutrophil infiltration during acute inflammation in mice. *Blood.* 120(8):1742-51. (\*equal contribution). PMID: 22791291
26. **Ding Xu\*** Jeffrey H Young, Juno M. Krahn, Danyin Song, Kevin D. Corbett, Walter J Chazin, Lars C. Pedersen and Jeffrey D. Esko\* (2013) Stable RAGE-heparan sulfate complexes are essential for signal transduction. *ACS Chemical Biology.* 8 (7), pp 1611–1620 (\*corresponding author). PMID: 23679870
27. Bryan E. Thacker, **Ding Xu**, Roger Lawrence and Jeffrey D. Esko (2013). Heparan sulfate 3-O-sulfation: A rare modification in search of a function. *Matrix Biology.* Apr;35:60-72. PMID: 24361527
28. Mooij HL, Cabrales P, Bernelot Moens SJ, **Ding Xu**, Udayappan SD, Tsai AG, van der Sande MA, de Groot E, Intaglietta M, Kastelein JJ, Dallinga-Thie GM, Esko JD, Stroes ES, Nieuwdorp M (2014) *Journal of the American Heart Association* 3(6):e001274
29. **Ding Xu**, Olson J, Cole JN, van Wijk XM, Brinkmann V, Zychlinsky A, Nizet V, Esko JD, Chang YC. Heparan sulfate modulates neutrophil and endothelial function in antibacterial innate immunity. *Infect Immun.* 2015 Sep;83(9):3648-56.

2002-2006 (UNC Chapel Hill)

30. **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. PMID: 15303968
31. Eva Munoz, **Ding Xu**, Melissa Kemp, Fuming Zhang, Jian Liu, and Robert J. Linhardt (2006) Affinity, kinetic, and structural study of the interaction of 3-O-Sulfotransferase isoform 1 with heparan sulfate. *Biochemistry* 45, 5122-5128. PMID: 16618101
32. Eva Munoz, **Ding Xu**, Fikri Avci, Melissa Kemp, Jian Liu and Robert J. Linhardt (2006) Enzymatic synthesis of heparin related polysaccharides on sensorchips: Rapid screening of heparin–protein interactions. *Biochem Biophys Res Commun.* 339, 597-602. PMID: 16310167
33. Vaibhav Tiwari, Christian Clement, **Ding Xu**, Tibor Valyi-Nagy, Beatrice Y.J.T. Yue, Jian Liu, and Deepak Shukla (2006) A role for 3-O sulfated heparan sulfate as the receptor for herpes simplex virus type-1 entry into primary human corneal fibroblasts. *J Virol.* 80, 8970-8980. PMID: 16940509

34. **Ding Xu**, Danyin Song, Lars C. Pedersen and Jian Liu (2007) Mutational study of heparan sulfate 2-*O*-sulfotransferase and chondroitin sulfate 2-*O*-sulfotransferase. *J Biol Chem.* 282, 8356-8367. PMID: 17227754
35. Dongmei Lu, Lucila Garcia-Contreras, **Ding Xu**, Sherry L. Kurtz, Jian Liu, Miriam Braunstein, David N. McMurray and Anthony J. Hickey (2007) Poly (lactide-co-glycolide) microspheres in respirable sizes enhance an *in vitro* T cell response to recombinant *Mycobacterium tuberculosis* antigen 85B. *Pharm Res.* 24(10):1834-43. PMID: 17657598
36. **Ding Xu**, Andrea F. Moon, Danyin Song, Lars C. Pedersen and Jian Liu (2008) Engineering the sulfotransferases to modify heparan sulfate. *Nat Chem Biol.* 4, 200-202. PMID: 18223645
37. Heather N. Bethea, **Ding Xu**, Jian Liu, and Lars C. Pedersen (2008) Redirecting the substrate specificity of heparan sulfate 2-*O*-sulfotransferase by structurally guided mutagenesis. *Proc Natl Acad Sci U S A.* 105 (48), 18724-18729. PMID: 19022906
38. Dongmei Lu, Lucila Garcia-Contreras, Pavan Muttill, Danielle Padilla, **Ding Xu**, Jian Liu, Miriam Braunstein, David N. McMurray, and Anthony James Hickey (2010) Pulmonary Immunization Using Antigen 85-B Polymeric Microparticles to Boost Tuberculosis Immunity. *AAPS J.* 12(3):338-47. PMID: 20422340
39. Courtney L. Jones, Jian Liu and **Ding Xu** (2010) Structure, Biosynthesis and Function of Glycosaminoglycans. *Comprehensive Natural Products II: Chemistry and Biology.* Elsevier: Oxford, 2010; Vol. 6, pp 407-427

### **Patent**

1. U.S. provisional patent application (No. 62/928,884) was filed on October 31, 2019. The application describes antibody compositions, including B2, and fragments thereof as well as methods of treatment.
2. U.S. provisional patent application (No. 62/581,443) was filed on November 3, 2017. Sulfated oligosaccharides having anti-inflammatory activity.

### **Professional Services**

2017 Oct, *Ad hoc* reviewer, NIH ICI study section.

2019 Oct, *Ad hoc* reviewer, NIH MOSS study section.

2021 – present, Editorial Board member, Glycobiology

2021 – present, Chapter Editor, Essentials of Glycobiology

2021 – present, Editorial Board member, Frontiers in Molecular Biosciences

### **Teaching and mentoring**

2015– present, Mentor of postdoctoral scholar, Miaomiao Li. Department of Oral Biology

2018– present, Mentor of PhD student, Chiyeon Ong. Department of Oral Biology

2019– present, Mentor of PhD student, Yin Luo. Department of Oral Biology

2021– present, Mentor of PhD student, Huanmeng Hao. Department of Oral Biology  
2016– 2021, Mentor of PhD student, Xiaoxiao Zhang. Department of Oral Biology  
2016–2020, Mentor of dental research student, Rin Zhi Larocque, School of Dental Medicine.  
2018-2019, Mentor of visiting scholar, Dr. Lisi Tan from China Medical University.  
2016, Mediator of PPBS graduate course BMS 511, Jacobs School of Medicine and Biomedical Sciences  
2017-present, Course director of ORB500, School of Dental Medicine

### **School Services**

2015 – present, School of Dental Medicine dental student Summer Research committee.  
2015 – present, Oral Biology PhD student preliminary exam committee  
2015 – present, Oral Biology PhD student thesis defense committee.  
2016 – present, Department of Oral Biology graduate student admission committee.  
2017– 2021, School of Medicine PPBS PhD program admission committee.  
2017 Oct, *Ad hoc* reviewer, NIH ICI study section.  
2019 Oct, *Ad hoc* reviewer, NIH MOSS study section.  
2019, Oral biology faculty search committee.  
2019– present, School of Dental Medicine IT steering committee

### **Oral Presentation**

1. Gordon Research Conference, Vascular Cell Biology, Ventura, CA, March 8-13, 2009 *Heparan sulfate as a regulator of VEGF-induced vascular permeability.*
2. 2012 ASBMB Annual Meeting, San Diego, CA, April 21-25, 2012. *Inactivation of heparan sulfate 2-O-sulfotransferase accentuates neutrophil infiltration during acute inflammation in mice.*
3. Gordon Research Conference, Glycobiology, Ventura, CA, March 3-8, 2013 *Heparan Sulfate-Dependent Oligomerization of RAGE is essential for signal transduction*
4. Invited talk, Tucson, AZ, March 28, 2013 *Heparan Sulfate-Dependent Oligomerization of RAGE—a novel target for therapeutic intervention.*
5. Invited talk. Vasculata 2013 - North American Vascular Biology Organization, San Diego, CA, July 29 – August 1. *Heparan Sulfate-Dependent Oligomerization of RAGE is essential for signal transduction.*
6. Invited talk. Buffalo, NY 2014 - *Deciphering Heparan sulfate-protein interactions in inflammation*

7. Invited talk. Roswell Park Cancer Institute, Buffalo, 2015 - *Deciphering Heparan sulfate-protein interactions in human health and disease*
8. Invited talk. University of North Carolina at Chapel Hill, Chapel Hill, NC, 2017 - *Deciphering Heparan sulfate-protein interactions in Bone remodeling*
9. Invited talk. University at Buffalo, Department of Biochemistry, 2017 - *Deciphering Heparan sulfate-protein interactions in Bone remodeling*
10. Invited talk. Jiangnan University, Wuxi, China, 2018 - *Deciphering Heparan sulfate-protein interactions in Bone remodeling and inflammation*
11. Invited talk. Rensselaer Polytechnic Institute, Department of Chemistry and Chemical Biology 2018 - *Deciphering Heparan sulfate-protein interactions in Bone remodeling and inflammation.*
12. 2019 ASBMR Annual Meeting, Orlando, FL, Sep 19-23, 2019. *Heparan sulfate is required for the anti-osteoclastogenic activity of osteoprotegerin.*
13. Invited talk. 2020 ACS Annual Meeting, Philadelphia, PA. March 22-26, 2020. *Characterization and Engineering of S100A12–Heparan sulfate interactions.*
14. Invited talk. 2021 ACS Annual Meeting, Atlanta, GA. Aug 22, 2021. *Heparan sulfate inhibits the collagenase activity of cathepsin K by inducing its oligomerization*
15. Invited talk. University of Georgia, Complex Carbohydrate Research Center, Nov. 3, 2021, - *Heparan sulfate: the master regulator of bone remodeling.*
16. Invited talk. University at Buffalo, Community of Excellence, Nov. 22, 2021, - *Heparan sulfate in cathepsin K biology.*