

Curriculum Vitae

Rihe Liu, Ph.D.

Mailing Address: 125 Mason Farm Road, Marsico Hall, Room 3111, CB#7363, University of North Carolina at Chapel Hill, NC 27599-7363

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Education and Training:

B.Sc. in Polymer Physics, 07/1988, University of Science and Technology of China, Hefei, China

M.Sc. in Biochemistry, 05/1995, University of California at San Diego/Salk Institute for Biological Studies

Ph.D. in Biochemistry, 12/1996, University of California at San Diego/Salk Institute for Biological Studies (Ph.D.

Advisor: Leslie E. Orgel)

Postdoctoral Fellow in Molecular Biology & Genetics, 02/1997-12/2001, Harvard Medical School,

Massachusetts General Hospital, & Howard Hughes Medical Institute (Postdoctoral Advisor: Jack W. Szostak)

Positions and Employment:

Associate Professor, Eshelman School of Pharmacy, University of North Carolina at Chapel Hill (12/2008-)

Associate Professor, Carolina Center for Genome Sciences, University of North Carolina at Chapel Hill

(12/2008-)

Assistant Professor, School of Pharmacy, University of North Carolina at Chapel Hill (12/2001-2008)

Assistant Professor, Carolina Center for Genome Sciences, University of North Carolina at Chapel Hill

(12/2001-2008)

Research Associate with Professor Jack W. Szostak, Howard Hughes Medical Institute, Harvard Medical School & Massachusetts General Hospital (03/2000-12/2001)

Postdoctoral Fellow with Professor Jack W. Szostak, Harvard Medical School and Massachusetts General Hospital (02/1997-02/2000)

Graduate Student (Ph.D. Program in Biochemistry) with Professor Leslie E. Orgel, The Salk Institute for Biological Studies and University of California at San Diego (1992-1996)

Peer-reviewed Publications (* Corresponding Author)

1. Liu, R.* and Visscher, J. (1994) "A novel preparation of nicotinamide mononucleotide"; *Nucleosides & Nucleotides*, **13**, 1215-1216.

2. Liu, R. and Orgel, L.* (1995) "Enzymatic synthesis of polymers containing nicotinamide mononucleotide"; *Nucleic Acids Research*, **23**, 3742-3749.

3. Ferris, J., Hill A., Liu, R., and Orgel, L.* (1996) "Synthesis of long prebiotic oligomers on mineral surfaces"; *Nature*, **381**, 59-61.

4. Liu, R. and Orgel, L.* (1997) "Efficient oligomerization of negatively charged α -amino acids at -20 °C"; *Journal of the American Chemical Society*, **119**, 4791-4792.

5. Liu, R. and Orgel, L.* (1997) "Oxidative acylation using thioacids"; *Nature*, **389**, 52-54.

6. Liu, R. and Orgel, L.* (1998) "Polymerization of β -amino acids in aqueous solution", *Orig Life Evol Biosph.*, **28**, 47-60.

7. Liu, R. and Orgel, L.* (1998) "Polymerization on the rocks: β -amino acids and arginine", *Orig Life Evol Biosph.*, **28**, 245-57.

8. Liu, R., Barrick, J., Szostak, J., and Roberts, R. (2000) "Optimized synthesis of RNA-protein fusions for *in vitro* protein selection"; *Methods in Enzymology*; **318**, 268-293.
9. Cho, G.†, Keefe, A.†, Liu, R.†, Wilson, D.†, and Szostak, J.* (2000). "Constructing high complexity synthetic libraries of long ORFs using *in vitro* selection"; *Journal of Molecular Biology*, **297**, 309-319. †Contributed equally.
10. Baggio, R., Burgstaller, P., Hale, S., Putney, A., Lane, M., Lipovsek, D., Wright, M., Roberts, R., Liu, R., Szostak, J., and Wagner, R.* (2002) "Identification of epitope-like consensus motifs using mRNA display". *Journal of Molecular Recognition* 15:126-34.
11. Shen, X., Valencia, C. A., Szostak, J. W., Dong, B., and Liu, R.* (2005) "Scanning the Human Proteome for Calmodulin-binding Proteins"; *Proceedings of the National Academy of Sciences of US*, **102**, 5969-5974. PMID: 15840729.
12. Kim, J. S., Valencia, C. A., Liu, R.*, and Lin, W.* (2007) "Highly-Efficient Purification of Native Polyhistidine-Tagged Proteins by Multivalent NTA-Modified Magnetic Nanoparticles", *Bioconjugate Chemistry*, **18** (2), 333-341. PMID: 17311440.
13. Dong, B., Valencia, C. A., and Liu, R.* (2007) "Ca²⁺/CaM Directly Interacts with the PH Domain of AKT1"; *Journal of Biological Chemistry*, **282** (34), 25131-25140. PMID: 17580302.
14. Huang, B. and Liu, R.* (2007) "Comparison of mRNA-Display Based Selections Using Synthetic Peptide and Natural Protein Libraries", *Biochemistry*, **46** (35), 10102-10112. PMID: 17685586.
15. Ju, W., Valencia, C. A., Pang, H., Ke, Y., Gao, W., Dong, B., and Liu, R.* (2007) "Proteome-wide Identification of Member-specific Natural Substrate Repertoire of Caspases"; *Proceedings of the National Academy of Sciences of US*, **104**, 14294-14299. PMID: 17728405.
16. Valencia, C. A., Ju, W., and Liu, R.* (2007) "Matrin 3 is a Ca²⁺/Calmodulin-binding Protein Cleaved by Caspases", *Biochemical and Biophysical Research Communications*, **361** (2), 281-286. PMID: 17658460.
17. Valencia, C. A., Bailey, C., and Liu, R.* (2007) "Novel Zebrafish Caspase-3 Substrates", *Biochemical and Biophysical Research Communications*, **361** (2), 311-316. PMID: 17643392.
18. Shen, X., Valencia, C. A., Gao, W., Cotten, S.W., Dong, B., Huang, B., and Liu, R.* (2008) "Ca²⁺/calmodulin-binding Proteins from the *C. elegans* Proteome"; *Cell Calcium*, **43** (5), 444-456. PMID: 17854888.
19. Duan, J., Wu, J., Valencia, C. A., and Liu, R.* (2007) "Fibronectin Type III Domain Based Monobody with High Avidity", *Biochemistry*, **46** (44), 12656-12664. PMID: 17929945.
20. Valencia, C. A., Cotten, S. W., and Liu, R.* (2007) "Cleavage of BNIP-2 and BNIP-XL by Caspases", *Biochemical and Biophysical Research Communications*, **364** (3), 495-501. PMID: 17961507.
21. Valencia, C. A., Cotten, S. W., Duan, J., and Liu, R.* (2008) "Modulation of Nucleobindin-1 and Nucleobindin-2 by Caspases", *FEBS Letters*, **582** (2), 286-290. PMID: 18154733.
22. Dong, B. and Liu, R.* (2008) "Characterization of Endogenous and Recombinant Human Calpain-10", *Biochimie*, **90** (9), 1362-1371. PMID: 18452715.
23. Valencia, C.A., Cotten, S. W., and Liu, R.* (2008) "mRNA Display-Based Selections for Proteins with Desired Functions: A Protease-Substrate Case Study" (Review), *Biotechnology Progress*, **24** (3), 561-569. PMID: 18471027.

24. Liu, R.* , Kay, B.K., Jiang, S., and Chen S. (2009) "Smart Molecules for Nanoparticle Delivery: Targeting and Nonspecific Binding" (Review), *MRS Bulletin*, **34** (6), 432-440.
25. Park, K., Liu, R.* , and Kohn, H.*. (2009) "Useful Tools for Biomolecule Isolation, Detection, and Identification: Acylhydrazone-Based Cleavable Linkers", *Chemistry & Biology*, **16** (7), 763-772. PMID: 19635413.
26. Chen, N., Huang, Y., Yang, L., Liu, R., and Yang, A.J.* (2009) "Designing Caspase-3 Sensors for Imaging of Apoptosis in Living Cells", *Chemistry*. **15** (37), 9311-9314. PMID: 19655355.
27. Park, K., Morieux, P., Salomé, C., Cotten, S.W., Reamtong, O., Evers, C., Gaskell, S.J., Stables, J.P., Liu, R.* , and Kohn, H.* (2009) "Lacosamide Isothiocyanate-based Agents: Novel Agents to Target and Identify Lacosamide Receptors", *Journal of Medicinal Chemistry*. **52** (21):6897-6911. PMID: 19795888.
28. Simnick, A.J., Valencia, C.A., Liu, R., Chilkoti, A.* (2010) "Morphing Low-Affinity Ligands into High-Avidity Nanoparticles by Thermally Triggered Self-Assembly of a Genetically Encoded Polymer", *ACS Nano*. **4**(4):2217-27. PMID: 20334355.
29. Park, K., Stables, J.P., Liu, R.* , and Kohn, H.* (2010) "Proteomic searches comparing two (R)-lacosamide affinity baits: An electrophilic arylisothiocyanate and a photoactivated arylazide group", *Organic and Biomolecular Chemistry*. **8** (12): 2803-2813. PMID: 20405068.
30. Cotten, S.W., Zou, J., Valencia, C.A., and Liu, R.* (2011) "Selection of Proteins with Desired Properties from Natural Proteome Libraries Using mRNA Display", *Nature Protocols*, **6**, 1163-1182. PMID: 21799486.
31. Wang, H. and Liu, R.* (2011) "Advantages of mRNA Display Selections Over Other Selection Techniques for Investigation of Protein-Protein Interactions", *Expert Reviews of Proteomics*, **8** (3), 335-346. PMID: 21679115.
32. Wang, Y., Park, K.D., Salome, C., Wilson, S.M., Stables, J.P., Liu, R., Khanna, R., and Kohn, H.* (2011) "Development and Characterization of Novel Derivatives of the Antiepileptic Drug Lacosamide that Exhibit Far Greater Enhancement in Slow Inactivation of Voltage-gated Sodium Channels", *ACS Chem Neurosci*, **2** (2): 90-106. PMID: 21532923.
33. Park, K.D., Kim, D.K., Reamtong, O., Evers, C., Gaskell, S., Liu, R.* , Kohn, H* (2011) "Identification of a Lacosamide Binding Protein Using an Affinity Bait and Chemical Reporter Strategy: 14-3-3 ζ ", *Journal of American Chemical Society*, 2011, **133**(29), 11320-11330. PMID: 21692503.
34. Wang, R., Cotten, S.W., and Liu, R.* (2012) "mRNA Display Using Covalent Coupling of mRNA to Translated Proteins", *Methods in Molecular Biology*, **805**, 87-100.
35. Cotten, S.W., Zou, J., Wang, R., Huang, B.C., and Liu, R.* (2012) "mRNA Display Based Selections Using Synthetic Peptide and Natural Protein Libraries", *Methods in Molecular Biology*, **805**, 287-297.
36. Hassouneh, W., Fischer, K., MacEwan, S.R., Branscheid, R., Fu, C.L., Liu, R., Schmidt, M., and Chilkoti, A.* (2012) "Unexpected multivalent display of proteins by temperature triggered self-assembly of elastin-like polypeptide block copolymers", *Biomacromolecules*, **13**(5), 1598-1605. PMCID: PMC3371654.
37. Benhabbour, S.R., Luft, J.C., Kim, D., Jain, A., Wadhwa, S., Parrott, M.C., Liu, R., DeSimone, J.M., and Mumper, R.J.* (2012) "In vitro and in vivo assessment of targeting lipid-based nanoparticles to the epidermal growth factor-receptor (EGFR) using a novel Heptameric ZEGFR domain", *J Control Release*, **158**(1), 63-71. PMCID: PMC3294062.

38. Kim, D.K., Yan, Y., and Liu, R.* (2012) "Heptameric Targeting Ligands against EGFR and HER2 with High Stability and Avidity", *PLOS ONE*, 2012;7(8):e43077. Epub 2012 Aug 9.
39. Friedman, A.D., Claypool, S.E., and Liu, R.* (2013) "The Smart Targeting of Nanoparticles", *Current Pharmaceutical Design*, 2013; **19**(35): 6315-29. PMID: 23470005.
40. Fu, C., Zheng, X., Jiang, Y., Liu, Y., Xu, P., Zeng, Z., Liu, R., and Zhao, Y.* (2013) "A Universal and Multiplex Kinase Assay Using γ -[$^{18}\text{O}_4$]-ATP", *Chemical Communications*, **49**(27):2795-7. PMID: 23439932.
41. Liu, R. (2013) "In vitro Protein Selection", *Methods*, 2013 March 15, **60**(1):1-2. PMID: 23651871.
42. Valencia, C.A., Zou, J., and Liu, R.* (2013) "In vitro selection of proteins with desired characteristics using mRNA-display", *Methods*, 2013; **60**(1): 55-69. PMID: 23201412.
43. Kim, D.W., Kim, S.K, Valencia, C.A., and Liu, R.* (2013) "Tribody: Robust Self-assembled Trimeric Targeting Ligands with High Stability and Significantly Improved Target-binding Strength", *Biochemistry*, **52**(41), 7283-7294. PMID: 24050811.
44. Kim, D.W., Friedman, A.D., and Liu, R.* (2014) "Tetraspecific ligand for tumor-targeted delivery of nanomaterials", *Biomaterials*, 2014, **35**(23): 6026-6036. PMID: 24786763.
45. Friedman, A.D., Kim, D.W., and Liu, R.* (2014) "Highly stable aptamers selected from a 2'-fully modified fGmH RNA library for targeting biomaterials", *Biomaterials*, 2014, **36**(1): 110-123. PMID:25443790.
46. Reuter, K.G., Perry, J.L., Kim, D., Luft, J.C., Liu, R., DeSimone, J.M.* (2015) "Targeted PRINT Hydrogels: The Role of Nanoparticle Size and Ligand Density on Cell Association, Biodistribution, and Tumor Accumulation", *Nano Letters*, **15**(10): 6371-8. PMID: 26389971.
47. Wang, H., Vilela, M., Winkler, A., Tarnawski, M., Hartmann, E., Schlichting, I., Yumerefendi, H., Kuhlman, B., Liu, R.*, Danuser, G.*, Hahn, K.* (2016) "LOVTRAP, A Versatile Optogenetic System, Reveals Resonator Motifs in Mammalian Mechano-chemical Signaling Pathways", *Nature Methods*, Sep. 2016; **13**(9): 755-758. PMID: 27427858.
48. Goodwin, T., Zhou, Y., Musetti, S., Liu, R.*, Huang, L.* (2016) "Local and Transient Gene Expression Primes the Liver to Resist Colorectal cancer metastasis", *Science Translational Medicine*, Nov. 9 2016; **8**(364): 364ra153. PMID: 27831902.
49. Miao, L., Li, J., Liu, Q., Feng, R., Das, M.C., Lin, M., Goodwin, T., Dorosheva, O., Liu, R.*, Huang, L.* (2017) "Transient and Local Expression of Chemokine and Immune Checkpoint Traps to Treat Pancreatic Cancer", *ACS Nano*, 2017 Sep 26; **11**(9):8690-8706. PMID: 28809532.
50. Goodwin, T.J., Shen, L., Hu, M., Li, J., Feng, R., Dorosheva, O., Liu, R.*, Huang, L.* (2017) "Liver specific gene immunotherapies resolve immune suppressive ectopic lymphoid structures of liver metastases and prolong survival", *Biomaterials*, 2017 Oct; **141**:260-271. PMID: 28700955.
51. Brantley, S.J., Cotten, S.W., Lamson, D.R., Smith, G.R., Liu, R.*, Williams, K.P.* (2017) "Discovery of small molecule inhibitors for the *C. elegans* caspase CED-3 by high-throughput screening", *Biochem Biophys Res Commun*. 2017 Sep 23; **491**(3):773-779. doi: 10.1016/j.bbrc.2017.07.100. Epub 2017 Jul 18. PMID: 28733033.
52. Zhou, J., Liu, M., Sun, H., Feng, Y., Xu, L., Chan, A.W.H., Tong, J.H., Wong, J., Chong, C.C.N., Lai, P.B.S., Wang, H.K., Tsang, S.W., Goodwin, T., Liu, R., Huang, L., Chen, Z., Sung, J.J., Chow, K.L., To, K.F., Cheng, A.S.* (2017) "Hepatoma-intrinsic CCRK inhibition diminishes myeloid-derived suppressor cell

immunosuppression and enhances immune-checkpoint blockade efficacy." *Gut*, 2017 Sep 22. pii: gutjnl-2017-314032. doi: 10.1136/gutjnl-2017-314032. [Epub ahead of print] PMID: 28939663.

53. Liu, Q., Zhu, H., Tiruthani, K., Shen, L., Chen, F., Gao, K., Zhang, X., Hou, L., Wang, D., Liu, R.* , Huang, L.* (2018) "Nanoparticle-Mediated Trapping of Wnt Family Member 5A in Tumor Microenvironments Enhances Immunotherapy for B-Raf Proto-Oncogene Mutant Melanoma", *ACS Nano*, 2018 Feb 27;12(2):1250-1261. doi: 10.1021/acsnano.7b07384. PMID: 29370526.

54. Wang, H., Zhang, Y., Yang, H., Qin, M., Ding, X., Liu, R.* , Jiang, Y.* (2018) "In Vivo SELEX of an Inhibitory NSCLC-Specific RNA Aptamer from PEGylated RNA Library", *Molecular Therapy Nucleic Acids*, 2018 Mar 2;10:187-198. doi: 10.1016/j.omtn.2017.12.003. Epub 2017 Dec 9. PMID: 29499932.

55. Song, W., Shen, L., Goodwin, T., Liu, Q., Li, J., Dorosheva, O., Liu, T., Wang, Y., Das, M., Liu, R.* , Huang, L.* (2018) "Synergistic and Low Adverse Effect Cancer Immunotherapy by Immunogenic Chemotherapy and Locally Expressed PD-L1 Trap", *Nature Communications*, 2018 Jun 8;9(1):2237. doi: 10.1038/s41467-018-04605-x. PMID: 29884866.

56. Shen, L., Li, J., Liu, Q., Song, W., Zhang, X., Tiruthani, K., Hu, H., Das, M., Goodwin, T.J., Liu, R.* , Huang, L.* (2018) "Local Blockade of Interleukin 10 and C-X-C Motif Chemokine Ligand 12 with Nano-Delivery Promotes Antitumor Response in Murine Cancers", *ACS Nano*. 2018 Sep 28. doi: 10.1021/acsnano.8b00967. [Epub ahead of print] PMID: 30253648.

57. Wang, Y., Song, W., Hu, M., An, S., Xu, L., Li, J., Kinghorn, K. A., Liu, R.* , Huang, L.* (2018) "Nanoparticle-mediated HMGA1 Silencing Promotes Lymphocyte Infiltration and Boosts Checkpoint Blockade Therapy for Cancer", *Advanced Functional Materials*, 2018, July 24; 28 (36). <https://doi.org/10.1002/adfm.201802847>.

58. Song, W., Tiruthani, K., Wang, Y., Shen, L., Hu, M., Dorosheva, O., Qiu, K., Kinghorn, K., Liu, R.* , Huang, L.* (2018) "Trapping Lipopolysaccharide to Promote Immunotherapy against Colorectal Cancer and Attenuate Liver Metastasis", *Advanced Materials*, 2018 Nov 2:e1805007. doi: 10.1002/adma.201805007. [Epub ahead of print] PMID:30387230.

59. Ahn, S., Li, J., Sun, C., Gao, K., Li, H., Savoldo, B., Liu, R.* , Dotti, G.* (2018) "T cells Redirected with Biepitopic and Bispecific Antibody Mimic Receptors for Cancer Immunotherapy", *Cancer Immunology Research*, *Minor revision*.

60. Sun, H., Yang, W., Tian, Y., Zeng, X., Zhou, J., Mok, M., Tang, W., Feng, Y., Xu, L., Chan, A., Tong, J., Cheung, Y., Lai, P., Wang H., Tsang, S., Chow, K., Hu, M., Liu, R., Huang, L., Yang, B., Yang, P., To, K., Sung, J., Wong, G., Wong, V., Cheng, A.* (2018) "An inflammatory-CCRK circuitry drives mTORC1-dependent metabolic and immunosuppressive reprogramming in obesity-associated hepatocellular carcinoma", *Nature Communications*, 2018 Dec 6;9(1):5214. PMID:30523261.

61. An, S., Tiruthani, K., Wang, Y., Xu, L., Hu, M., Li, J., Song, W., Jiang, H., Sun, J., Liu, R.* , Huang, L.* (2018) "Locally Trapping the C-C Chemokine Receptor Type 7 by Gene Delivery Nanoparticle Inhibits Lymphatic Metastasis Prior to Tumor Resection", *Small*, In Press.

62. Du, H., Hirabayashi, K., Ahn, S., Kren, N.P., Montgomery, S.A., Wang, X., Tiruthani, K., Mirlekar, R., Michaud, D., Greene, K., Herrera, S.G., Sun, C., Chen, Y., Xu, Y., Ma, X., Ferrone, C.R., Pylayeva-Gupta, Y., Yeh, J.J., Liu, R., Savoldo, B., Ferrone, S., Dotti, G.* (2018) "Antitumor Responses in the Absence of Toxicity in Solid Tumors by Targeting B7-H3 via Chimeric Antigen Receptor T Cells", *Cancer Cell*, In press.

Patents:

1. Liu, R., Tiruthani, K., Li, J., Song, W., Huang L., US Provisional Patent Application; "Novel LPS Neutralizing Protein Molecules with Trivalency"
2. Liu, R., Dotti, G., Li, J., Ahn, S., US Provisional Patent Application; "Highly Modular Biepitopic and Bispecific CAR-T Cells for Cancer Immunotherapy"
3. Huang, L., Liu, R., Shen, L., Li, J. US Provisional Application; "CXCL13 Traps And Their Uses To Modulate Tumor Microenvironments"
4. Liu, R. ; Huang, L., Goodwin, T., Miao, L. PCT U.S. Application No. 62/232,169; "Methods and Compositions for Reducing Metastases"
5. Wang, H., Liu, R., Jiang, Y. WO/2017/162185; "Ribonucleic Acid Aptamer Having Inhibitory Effect on Non-Small Cell Lung Cancer, and Pharmaceutical Composition Comprising Same".
6. Liu, R. WO 2012/162426 A1; US20140086835 ; "Methods and Compositions for Heptameric Targeting Ligands".
7. Liu, R. PCT/US2014/058257 and WO/2015/048724; "Methods and Compositions for Self-assembly System of Nanoparticles and Microparticles for Multi-targeting specificity".
8. Liu, R. EP3052090; "Methods and Compositions for Self-assembly System of Nanoparticles and Microparticles for Multi-targeting specificity".
9. Liu, R. WO 2012/162418 A1; PCT/US2012/039187 ; "Methods and Compositions for Heterodimeric Targeting Ligands".
10. Szostak, J., Roberts, R., and Liu, R. ES2373110 (2012); "Seleccion De Proteinas Usando Fusiones De Arn-Proteina".
11. Szostak, J., Roberts, R., and Liu, R. IN158/DEL/1998 (2010); "A Method for the Manufacture of a Protein".
12. Szostak, J., Roberts, R., and Liu, R. US20080058217 (2008); "Selection of proteins using RNA-protein fusions".
13. Szostak, J., Roberts, R., and Liu, R. EP1712623 (2006) ; "Selection of proteins using RNA-protein fusions".
14. Szostak, J., Roberts, R., and Liu, R. CN1251593 (2006) ; "Selection of proteins using RNA-protein fusions".
15. Szostak, J., Roberts, R., and Liu, R. U. S. Patent 6,281,344 (2001) ; "Nucleic acid-protein fusion molecules and libraries".
16. Szostak, J., Roberts, R., and Liu, R. U. S. Patent 6,261,804 (2001) ; "Selection of proteins using RNA-protein fusions".
17. Szostak, J., Roberts, R., and Liu, R. U. S. Patent 6,258,558 (2001); "Method for selection of proteins using RNA-protein fusions".
18. Szostak, J., Roberts, R., and Liu, R. U. S. Patent 6,214,553 (2001) ; "Libraries of protein encoding RNA-protein fusions".
19. Szostak, J., Roberts, R., and Liu, R. U. S. Patent 6,207,446 (2001) ; "Selection of proteins using RNA-protein fusions".

20. Szostak, J., Roberts, R., and Liu, R. WO/1998/031700 (1998) ; "Selection of proteins using RNA-protein fusions".

21. Szostak, J., Roberts, R., and Liu, R. " WO/2000/047775 (2000) ; "Selection of proteins using RNA-protein fusions.

Invited Talks:

University of North Carolina at Chapel Hill, Department of Pharmacology, October, 2002, Invited, "Scanning the Human Proteome for Protein-Protein Interactions Using mRNA-display"

American Chemical Society National Meeting, New York, NY. September 8, 2003, Invited, Division of Professional Relations, "Pursuing a Career in Protein Recognition"

VivoQuest, Inc. Valley Cottage, NY, October 31, 2003, Invited, "Functional Molecules from Libraries"

University of North Carolina at Chapel Hill, Department of Pharmacology, Macromolecular Therapeutics PPG, March 2, 2005, Invited, "Scanning the Human Proteome for Protein-Protein and Protease-Substrate Interactions"

Gordon Research Conferences on Proteolytic Enzyme and Their Inhibitors, New London, NH, July 06, 2006. "Scanning the Human Proteome for Caspase Substrates using mRNA-display"

North Carolina Center University, Durham, NC, BRITE Center, April 12, 2007, Invited, "Caspases and Granzyme-B as Drug Targets"

University of Maryland, Baltimore, MD, Center of Marine Biotechnology, April 23, 2007, Invited, "Proteome-wide Identification of Functional Proteins Using mRNA-display"

Georgia State University, Atlanta, GA. Department of Chemistry, June 26, Invited, "Proteome-wide Identification of Proteins with Desired Functions"

University of California at Irvine, Irvine, CA. Comprehensive Cancer Center, June 29, Invited, "Proteome-wide Identification of Proteins with Desired Functions"

Northwestern University, Chicago, IL, Children's Memorial Research Center, July 12, 2007, Invited, "Scanning the Proteomes of Human and Model Organisms for Functional Proteins"

American Chemical Society National Meeting, Boston, MA. August 22, 2007, Division of Biochemical Technology, "Proteome-wide Identification of Member-specific Natural Substrate Repertoire of Caspases and Other Proteases"

Arizona State University, Tempe, AZ, Department of Chemistry and Biochemistry, September 14, 2007, Invited, "Identification of Proteins with Desired Functions from the Proteome of Human and Model Organisms"

5th General Meeting of the International Proteolysis Society, Patras, Greece, October 21, 2007, Invited, "Identification of Member-specific Natural Substrate Repertoire of Caspases and Caspase-like Proteases from the Human and *C. elegans* Proteomes"

"Proteins with Desired Functions from the Proteomes of Human and Model Organisms", April 17, 2009, Invited, Department of Biochemistry, Duke University

"Identification of drug targets through a combination of proteomic and chemical biology approaches", December

09, 2009, Invited, Department of Pharmaceutical Sciences, University of Maryland

“Novel methods for the development of cancer biomarker-binding targeting ligands”, May, 2009, Invited, Suzhou Biopharmaceutical Center, Peking Union Medical College

“Combinatorial Biochemical Approaches to Identify Proteins with Desired Functions”, June, 2010, Invited, Chinese Chemical Society National Meeting, Xiamen, China.

“Novel Targeting Ligands for Nanoparticles”, December 01, 2010, Invited, 2010 MRS Fall Meeting, Boston, MA.

“Targeting Ligands for Nanoparticles”, September 22, 2011, Invited, The Annual NCI Alliance for Nanotechnology in Cancer Investigators’ Meeting, Boston, MA.

“Novel Theranostic Molecules and Their Applications”, April 15, 2012, Invited, Chinese Academy of Medical Sciences, China.

“Targeting Ligands for Theranostic Applications and Cancer Biomarker Identification”, Invited, November 16, 2012, The Annual NCI Alliance for Nanotechnology in Cancer Investigators’ Meeting, Houston, TX.

“mRNA Display for the Discovery of Novel Cancer Biomarkers”, Invited, Discuss and evaluation workshop for biological agents with great applications, August 15, 2012, China National Center for Biotechnology Development, Beijing, China.

“Federal and State Funding Opportunities”, Panel Co-Chair, Carolina Institute for Nanomedicine and UNC/NCSU Biomedical Engineering Discussion Forum, December 11, 2012, NC Biotech Center, RTP.

“Search Natural Proteome for Functional Proteins and Select Novel Targeting Ligands for Imaging and Theranostic Applications”, Invited, Chemical Biology Symposium, April 26, 2013, Virginia Commonwealth University.

“Development of Novel Targeting Ligands for Imaging and Theranostic Applications”, April 29, 2013, University of North Carolina at Charlotte.

“Highly Stable Aptamers Directly Selected from a 2’-Fully Modified RNA Library”, June 24, 2016, Aptamers in Bordeaux, France.

“Directed Evolution of a LOV-Trap for Deciphering Intracellular Signaling Pathways”, July 17, 2016; The Protein Society 30th Anniversary Symposium in Baltimore, MD.

“Revoke Immunosuppression of Tumor Microenvironment Using Engineered Molecular Traps”, March 21, 2018, ACS National Meeting, New Orleans

“Therapeutic Aptamer Based on 2’-Fully Modified RNAs and Novel Selection Strategies”, August 3, 2018, Aptamers in Boulder Symposium

Trainees: Graduate Students, Postdocs, and Others

Current lab members:

Alex Dorosheva, Current Graduate Student

Ying, Wang, Ph.D., Current Postdoc

Jingjing Li, Ph.D., Current Postdoc

Ellie McCabe, Ph.D., Current Postdoc

Sourav Roy, Ph.D., Current Postdoc

Wentao, He, Lab technician

Yixin Hu, Undergraduate Student

Previous lab members since 2008
Karthik Tiruthani, Ph.D., Former Postdoc
Keliang Gao, Ph.D., Former Postdoc
Kripa Raj Ahuja, Undergraduate Student
Sophia Luo, High School Student
Yingqiu Rachel Zhou, Former Graduate Student
Sarah Claypool, Former Graduate Student
Adam Friedman, Former Graduate Student
Jianwei Zou, Former Postdoc
Yuenmu Chen, Former Postdoc
Dongwook Kim, Former Postdoc, Current Research Assistant Professor at Purdue University
Hui William Chen, Former Postdoc, Currently Senior Scientist at Novartis
Steve Cotten, Former Graduate student, Current Assistant Professor at Ohio State University
Biao Dong, Former Postdoc, Current Professor at Sichuan University, China
C. Alexander Valencia, Postdoc, Currently Assistant Professor at Cincinnati Children's Hospital
Xin Chen, M.D., Former Visiting Scholar
Nick Empey, Former Graduate student, Current Pharm.D. student at ESOP
Yitang Yan, Currently Research Staff at NIEHS/NIH

Service Appointments:

Division and School (does not include SAC)

1. Coordinator CBMC Cumulative Examination Committee (2004-present)
2. Member of the CBMC Graduate Program Admission Committee (2011-present)
3. Member of the ESOP Conflicts of Interest Committee (Sept. 2012-present)
4. Member of the ESOP Scholarship Committee (2015-present)
5. Member of the Curriculum Committee at CBMC (2012)
6. Mentor for all the First Year BBSP Students interested in the Pharmaceutical Sciences Program (July 2012-2015)
7. Member of the Committee for Internationalization (2011-Sept. 2012)
8. Member of the Organization Committee for Chapel Hill PharmSci 2015
9. Member of the Search Committee for the Chair of MOPH (2015-2016)

University

Member Laboratory and Chemical Safety Committee (2008-present)
Member of the BBSP Program Quantitative Admission Committee (2011-2014)
Member of Linberger Cancer Center "Out of the Box" committee for Year 2020-2025 strategic planning

Profession

Peer reviewer for scholarly journals: Nature Chemical Biology, Nature Communications, Science Translational Medicine, PNAS, Cell Chemical Biology, JACS, Nucleic Acids Research, Chemistry and Biology, Nano Today, Journal of Biological Chemistry, Oncogene; Biotechnology and Bioengineering, ChemBioChem; FEBS Letters; Molecular Systems Biology; Journal of Controlled Release; Methods; Trends in Biotechnology; Journal of Nucleic Acids, Critical Reviews in Biotechnology, Current Cancer Drug Targets, Biochemistry, Theranostics, etc..

Grants reviewer for: Ad Hoc reviewer for NIH Study Sections, National Science Foundation, European Research Council, Singapore Agency for Science, Technology & Research, Research Grants Council of Hong Kong, Chinese National Science Foundation.

Guest Editor for *Methods* Journal; Special Issue "In Vitro Protein Selection", published in June 2013.

Ph.D. Thesis Committee

Since 2010

Pierre Morieux (CBMC)
 Steven Cotten (CBMC)
 Amber King (CBMC)
 Rima Hajjo (CBMC)
 Saurabh Wadhwa (MOPH)
 Joana Soares (CBMC)
 Oana Lungu (Pharmacology)
 Yang Liu (MOPH)
 Morgan Chapman (CBMC)
 Adam Friedman (BBSP and CBMC)
 Sarah Claypool (CBMC)
 Rachel Zhou (CBMC)
 Colin O'Banion (BBSP and CBMC)
 Paul Michael Himes (CBMC)
 Oleksandra Dorosheva (CBMC)
 Tyler Jay Goodwin (MOPH)
 Tejash Vijay Patel (MOPH)
 Qi Liu (MOPH)
 Christina Parker (MOPH)
 Steven Fleming (CBMC)
 Manisit Das (MOPH)
 Jimmy Fay (MOPH)
 Sarah Ahn (Immunology)
 Mengzhe Wang (Bioengineering)
 Jacob Larson (CBMC)

Co-founder:

OncoTrap, Inc (Co-founder and Scientific Board)
 AccuNovo Biotechnologies, Inc (Co-founder and Scientific Board)
 Panacise Bio, Inc (Founder)

OTHER SUPPORT

ACTIVE

1R01GM120291-03 (MPI: Sonddek/Liu)	9/1/16 – 8/31/20	1.5 Cal Months
NIH/NIGMS	\$100,714 Direct Cost/Year to Liu Lab	

Inhibition of GTPases and G proteins to treat human disease

We propose to integrate several developing technologies to potently and selectively target constitutively active GTPases in cancers.

RX03812125 (PI: Liu)	6/01/18 – 5/31/20	1.2 Cal Months
Eshelman Institute for Innovation (Intramural)	\$250,000 Direct Cost/Year	

A Wholly Protein-Based Self-Assembly Nanoplatfom for Tunable Cancer Immunotherapy

We propose to develop an innovative nanomedicine that is wholly composed of proteins and ideal for tunable combination immunotherapy.

RX03712112 (PI: Liu)	6/01/17 – 5/31/19	0.24 Cal. Months
Eshelman Institute for Innovation (Intramural)	\$100,000 Direct Cost/Year	

Biepitopic and Bispecific Chimeric Antigen Receptors for T-Cell Therapy

Chimeric Antigen Receptor (CAR)-T cell therapy is a cell-based treatment that uses engineered T cells to recognize and drastically kill cancer cells.

RX03612118 (PI: Liu)	6/01/16 – 11/30/18	0 Cal. Months
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Eshelman Institute for Innovation (Intramural) \$100,000 Direct Cost/Year
Novel Single Domain Antibody Mimics for Targeted Cancer Therapy
This project focuses on developing novel targeting ligands that can be integrated with Chemo/cytokine traps for precise immunotherapies against malignant tumors.

Contract Project 4/01/2018 – 3/31/2020 .6 Cal Mos
OncoTrap, Inc. (MPI: Li/Liu; Contact PI: Li); \$121,407 Direct Cost/Year

Evaluation of OncoTrap's lead drugs in tumor bearing mouse model

This proposal seeks to establish in vivo drug evaluation platform in Marsico Hall animal facility. The platform is focusing on, but not limited to, the evaluation of the pharmacodynamics, pharmacokinetics, toxicities, immunogenicity and pharmacological properties, of the lead drugs in OncoTrap.

MCC078RHL1 (PI: Liu) 8/01/18 – 7/31/19 0 Cal. Months
Carolina CCNE (Intramural) \$50,000 Direct Cost/Year

Nano-delivery of the mRNA of an evolved Gαq-inhibitory decoy protein for the treatment of liver metastasis of uveal melanoma

This project is aimed at delivering the mRNA of an evolved Gαq-inhibitory protein therapeutics to a liver metastatic uveal melanoma mouse model.

NCI STTR Subcontract (PI: Liu) 5/01/18 – 4/30/189 0.96 Cal. Months
NIH and Panacise Bio, Inc \$111,553 Direct Cost/Year

Innovative TME-specific Pro-CAR T-cells for Immunotherapy of Solid Tumors

This STTR subcontract aims to characterize the pro-CAR T-cells, an innovative type of engineered T-cells that are inactive in normal tissues but get activated in tumor microenvironment, that are developed at the Panacise Bio Inc. at the molecular and the cellular levels.

5U01CA198910-04 (MPI: Kabanov/Liu/Bronich) 8/14/15 – 7/31/20 1.0 Cal Months
NIH/NCI \$41,828 Direct Cost/Year to Liu Lab

Targeted Core Shell Nanogels for Triple Negative Breast Cancer

This project proposes to use biodegradable nanogels that carry potent chemotherapeutic agents and are decorated with novel polypeptide antagonists to EGFR and HER3 receptors displayed in the TNBC. The softness of the nanogels is adjusted in an attempt to maximize the penetration of the nanogels deeply into tumor, which is one of the major barriers to targeted nanotherapeutics, and such soft targeted nanogels can deliver and release their therapeutic cargo to the TNBC tumors.

5U54CA198999-02 (MPI: Huang/Tepper) 9/01/15 – 7/31/20 0.6 Cal Months
NIH (Role: Co-Investigator -Project 1)

Nano Approaches to Modulate Host Cell Response for Cancer Therapy

The goal of this proposal is to develop targeted methods for the delivery of biologics, immunologic- modifiers and chemotherapies against melanoma and non-small cell lung cancers, utilizing innovative nanotechnologies developed at UNC-Chapel Hill.

R01EB022596-01A1 (PI: Jin Xie; Role: Co-I) 4/1/17-3/31/22 0.5 Cal Months
University of Georgia/NIH

Nanoscintillator-based X-ray sensitizers to enable efficient non-small cell lung cancer treatment with X-ray

We will integrate EGFR PET and FLT/FMISO PET with X-PDT treatment of lung cancer.

OVERLAP: None.

Completed:

R01CA157738 PI: Liu 12/01/11-11/30/17
NIH/NCI

Novel Single Domain Antibodies with Multivalency and Multispecificity

The overall goal of this project addresses a critical need for developing cost-effective targeting ligands that recognize and bind HER family members with desired avidity and multispecificity.

Total direct costs: \$1,037,500

RX03512418 PI: Huang/Liu 10/01/15-03/30/18

Eshelman Institute for Innovation; Tier 3; Role: Co-Innovator

Priming the Liver to Resist Cancer Metastasis

Total direct costs: \$630,000

No Number (PI: Cartier; Role: Co-Investigator) 3/01/16 – 11/30/18

The Foundation For Applied Molecular Evolution (FfAME)

Templated Cross Catalysis by Oligopeptides and Oligonucleotides

R01 NS047650 PI: Liu 01/01/04-12/31/09

NIH/NINDS

Identification of caspase substrates from human proteome

Total direct costs: \$1,040,625

R21 DK067480 PI: Liu 04/01/04-03/31/07

NIH/NIDDK

Identifying calpain-10 substrates from human proteome

Total direct costs: \$193,796

U54 CA119343 PI: Liu 09/30/05-08/31/10

NIH/NCI

The Combinatorial Library Research Core of the Carolina Center of Cancer Nanotechnology Excellence

Total direct costs: \$500,000

U54 CA151652 PI: Liu 09/01/10-08/31/16

NIH/NCI

The Targeting Ligand Core of the Carolina Center of Cancer Nanotechnology Excellence (C-CCNE)

Total direct costs: \$400,000

ACS RSG-TBE-110472 PI: Liu 01/01/06-12/31/10

American Cancer Society

Novel calmodulin-binding proteins in regulating ubiquitin-proteasome system

Total direct costs: \$600,000

R01 NS054112 PI: Kohn 07/01/06-06/30/11

NIH/NINDS

Methods to identify targets of the neurological agent (R)-lacosamide

Role: Co-PI

Total direct costs: \$900,000

R21 DA025702 PI: Liu 09/20/08-01/31/12

NIH/NIDA

Identification of the Interactom of Methylated Histones from Human Proteome

Total direct costs: \$400,000

R21 AI092228 PI: Liu 12/01/10-11/30/13

NIH/NIAID

Novel Anti-allergic Single-domain Antibody Against IgE

Total direct costs: \$275,000

RX03512111

PI: Liu

10/01/15-09/30/16

Eshelman Institute for Innovation; Tier 1; Role: Innovator

Decipher a Highly Specific Biomarker for Targeted Treatment of Pancreatic Cancer

Total direct costs: \$50,000