BIOGRAPHICAL SKETCH

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NAME: **Jai Woong Seo**

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POSITION TITLE: Senior Research Scientist

EDUCATION/TRAINING

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
Inha University, Incheon, South Korea	B.S.	02/2001	Chemistry
Inha University, Incheon, South Korea	M.S.	02/2003	Organic and medicinal Chemistry
Inha University, Incheon, South Korea/ University of Illinois, Urbana-Champaign (visiting)	Ph.D.	02/2007	Medicinal and Radiochemistry

A. Personal Statement

My research has focused on organic, medicinal chemistry and radiolabeling of small molecules and nanoparticles to evaluate the PK of those molecules. I received a B.S. (2001), M.S. (2003), and Ph.D. degrees (2007) in chemistry from Inha University in Korea. During my B.S. studies, I focused on the preparation of ionic liquids; during my MS degree I focused on the synthesis of nitric oxide suppressors. During my Ph.D. degree, I studied estrogen receptor imaging for breast cancer detection with F-18 labeled cyclofenil derivatives at the University of Illinois at Urbana-Champaign as a visiting graduate student (2003-2004). After returning to Inha University, I developed facile F-18 labeling methods for small molecule labeling (2004-2007). My research after my Ph.D. studies has focused on establishing methods for radiolabeling nanoparticles and macromolecules, evaluating the pharmacological properties of those molecules, and visualizing cancer and atherosclerotic plaques in a rodent model using PET/MR or PET/CT. I joined Professor Katherine Ferrara's laboratory at the University of California, Davis (2007) and expanded my research career in the radiolabeling of macromolecules and nanoparticles with Cu-64, F-18, and Zr-89 for tracking dendrimers, solid lipid nanoparticles, liposomes, and micelles. From 2015-2016, I was a senior researcher at the Korea Institute of Radiological and Medical Sciences, Seoul, Korea where I led the development of a GMP radiochemistry facility. Currently I am a Research Associate at Stanford University in the Department of Radiology. I have successfully collaborated on many projects including atherosclerotic plaque identification in mice with Professor Erkki Ruoslahti at UC Santa Barbara, a PET study of novel 20-nm micelles with Professor Ting Xu at UC Berkeley, and evaluation of the pharmacokinetics of radiolabeled-miRNA and dendrimers in an atherosclerosis mouse model with Professor Hanjoong Jo at Emory University. I also joined a collaborative research project with Dr. John R Forsayeth at UCSF, investigating glioblastoma in the rat brain with PET. During my 8 years of experience with Dr. Ferrara's group, I have mentored many visiting scholars, postdocs and graduate students in the biomedical engineering department. The four papers below provide an overview of projects in which I have led the imaging design or applied probes to evaluate important aspects of drug and gene delivery.

1. **Seo JW**, Comninos JS, Chi DY, Kim DW, Carlson KE, Katzenellenbogen JA. Fluorine-substituted cyclofenil derivatives as estrogen receptor ligands: Synthesis and structure-affinity relationship study of potential positron emission tomography agents for Imaging estrogen receptors in breast cancer. Journal of Medicinal Chemistry. 2006;49(8):2496-511. PubMed PMID: ISI:000236979100015.
2. **Seo JW**, Mahakian LM, Silvestrini MT, Tam S, Ingham ES, Salazar FB, Borowsky AD, Wu AM, and Ferrara KW, CD8 T-cell density imaging with 64Cu-labeled cys-diabody informs immunotherapy-related protocols,

Clin Cancer Res. 2018 Jul 2. pii: clincanres.0261.2018. doi: 10.1158/1078-0432.CCR-18-0261.
3. Son, D., Kumar S, Takabe W, Kim C, Ni CW, Alberts-Grill N, Jang I, Kim So, Kim WK, Kang SW, Baker AH, **Seo JW**, Ferrara KW, Jo H. (2013) Inhibition of mechanosensitive microRNA, miR-712, atypical microRNA derived from pre-ribosomal RNA, decreases endothelial inflammation and atherosclerosis. Nature Communications, 2013;4:3000. doi: 10.1038/ncomms4000. PMC3923891.
4. **Seo JW**, Zhang H, Kukis DL, Meares CF, Ferrara KW. A Novel Method to Label Preformed Liposomes with ^{64}Cu Positron Emission Tomography (PET) Imaging. Bioconjugate Chemistry. 2008;19(12):2577-84. doi: 10.1021/bc8002937. PMC2756669.

B. Positions and Honors

Positions and Employment

2003- 2004 Visiting Scholar, Department of Chemistry, University of Illinois at Urbana-Champaign, IL
2007- 2009 Postdoctoral Scholar, Department of Biomedical Engineering, University of California, Davis, CA
2009- 2015 Assistant Project Scientist, Department of Biomedical Engineering, University of California, Davis, CA
2015- 2016 Senior Researcher, Korea Institute of Radiological and Medical Sciences, Seoul, Korea
2017- present Associate Project Scientist, Department of Biomedical Engineering, University of California, Davis, CA (I retain a 10% appointment at UC Davis)
2018 - present Senior Research Scientist, Radiology, School of Medicine, Stanford University (This is a 90% appointment)

Selected Experience and Professional Memberships

2011, 2017 UC Davis representative, KOrean LIfe Scientists in the Bay Area (KOLIS)
2014- 2015 Sacramento Chapter Executive director, Korean-American Scientists and Engineers Association
2016- 2017 Board member, Korean Society of Radiopharmaceuticals and Molecular Probes
2017 Editorial Board, Journal of Radiopharmaceuticals and Molecular Probes

C. Contributions to Science

Synthesis of NO production regulators

In early my work, I focused on synthesis of NO production regulators. Several compounds showed a protective effect in brain disease models such as Parkinson's and neuroinflamatory disease. Those compounds are now investigated in large animals.

5. **Seo JW**, Srisook E, Son HJ, Hwang O, Cha YN, Chi DY. Syntheses of NAMDA derivatives inhibiting NO production in BV-2 cells stimulated with lipopolysaccharide. Bioorganic & Medicinal Chemistry Letters. 2005;15(14):3369-73. PubMed PMID: ISI:000230337100010.
6. **Seo JW**, Srisook E, Son HJ, Hwang O, Cha YN, Chi DY. Syntheses of tetrahydroisoquinoline derivatives that inhibit NO production in activated BV-2 microglial cells. European Journal of Medicinal Chemistry. 2008;43(6):1160-70. PubMed PMID: ISI:000257261500003.
7. Son HJ, Lee JA, Shin N, Choi JH, **Seo JW**, Chi DY, Lee CS, Kim EM, Choe H, Hwang O. A novel compound PTIQ protects the nigral dopaminergic neurones in an animal model of Parkinson's disease induced by MPTP. Brit J Pharmacol. 2012;165(7):2213-27. doi: Doi 10.1111/J.1476-5381.2011.01692.X. PMC3413858.
8. Son HJ, Han SH, Lee JA, Lee CS, **Seo JW**, Chi DY, Hwang O. 2-Acetyl-7-hydroxy-6-methoxy-1-methyl-1,2,3,4,-tetrahydroisoquinoline exhibits anti-inflammatory properties and protects the nigral dopaminergic neurons. Eur J Pharmacol. 2016;771:152-61. doi: 10.1016/j.ejphar.2015.12.009. PubMed PMID: 26687634.

Liposomes: Design and stability

I have created and applied several methods to label liposomes with positron emitters such as Cu-64 and Zr-89. In 2008, I first synthesized chelator-lipid conjugates for Cu-64 labeling of liposomes enabling evaluation of liposomal stability and trafficking. Next, I developed a novel labeling approach using a bifunctional chelator and demonstrated that the clearance of Cu-64 chelators from the liver is not related to the stability of chelator and Cu-64 complex. Further, I developed dual labeling methods for liposomes with Cu-64 on the lipid shell and near-IR dye for the cargo and generated an imaging-driven PK model for liposomal stability.

9. **Seo JW**, Mahakian LM, Kheirolomoom A, Zhang H, Meares CF, Ferdani R, Anderson CJ, Ferrara KW. Liposomal Cu-64 labeling method using bifunctional chelators: poly(ethylene glycol) spacer and chelator effects. Bioconjugate Chemistry. 2010;21(7):1206-15. PMC2943334.
10. Qin SP, **Seo JW**, Zhang H, Qi J, Curry FRE, Ferrara KW. An Imaging-Driven Model for Liposomal Stability and Circulation. Mol Pharmaceut. 2010;7(1):12-21. PMC2867051.
11. **Seo JW**, Mahakian LM, Tam S, Qin S, Ingham ES, Meares CF, Ferrara KW. The pharmacokinetics of Zr-89 labeled liposomes over extended periods in a murine tumor model. Nucl Med Biol. 2015;42(2):155-63. doi: 10.1016/j.nucmedbio.2014.09.001. PubMed PMID: 25451215; PMCID: PMC4281498.
12. Zhang H, Kusunose J, Kheirolomoom A, **Seo JW**, Qi J, Watson KD, Lindfors HA, Ruoslahti E, Sutcliffe JL, Ferrara KW. Dynamic imaging of arginine-rich heart-targeted vehicles in a mouse model. Biomaterials. 2008; 29:1976-88. PMC2475513.

Alternative carriers

I have applied a subset of these techniques to study alternative carriers including three helix bundle forming micelles and solid lipid nanoparticles. Very stable 20 nm nanoparticle engineered by the Xu laboratory were evaluated with a Cu-64 chelator conjugated to an □-helical amphiphile after the formation of a 3-helix bundle. With a goal of developing a 20 nm vehicle for the delivery of peptides and small molecule therapeutics, we confirmed the substantial advantages of using 20 nm micelles in glioblastoma. In several papers with the Xu laboratory, we devised a strategy to enhance the helical micelle stability based on PET image analysis.

13. Andreozzi E, **Seo JW**, Ferrara K, Louie A. Novel Method to Label Solid Lipid Nanoparticles with (64)Cu for Positron Emission Tomography Imaging. Bioconjugate Chemistry. 2011;22(4):808-18. doi: Doi 10.1021/Bc100478k. PMC3086097.
14. Dong H, Dube N, Shu JY, **Seo JW**, Mahakian LM, Ferrara KW, Xu T. Long-Circulating 15 nm Micelles Based on Amphiphilic 3-Helix Peptide-PEG Conjugates. Acs Nano. 2012;6(6):5320-9. doi: Doi 10.1021/Nn301142r. PMC3531550.
15. Dube N, **Seo JW**, Dong H, Shu JY, Lund R, Mahakian LM, Ferrara KW, Xu T. Effect of alkyl length of Peptide-polymer amphiphile on cargo encapsulation stability and pharmacokinetics of 3-helix micelles. Biomacromolecules. 2014;15(8):2963-70. doi: 10.1021/bm5005788. PMC4130244.
16. **Seo JW**, Ang J, Mahakian LM, Tam S, Fite B, Ingham ES, Beyer J, Forsayeth J, Bankiewicz KS, Xu T, Ferrara KW. Self-assembled 20-nm (64)Cu-micelles enhance accumulation in rat glioblastoma. J Control Release. 2015;220(Pt A):51-60. doi: 10.1016/j.jconrel.2015.09.057. PMC4688122.

Peptides, peptide dendrimers, albumin, and small molecule probes

I have also developed and applied methods to label peptides, dendrimers, albumin and small molecule probes. In atherosclerotic plaque imaging projects with collaborators (Ruoslahti laboratory at UC Santa Barbara), we visualized p32 in macrophage abundant in atherosclerotic plaque by monopeptide or dendrimer. Further, we quantitatively evaluated tumor permeability using radiolabeling liposomes and albumin. Finally, we applied a set of small and large molecule PET and MR probes to evaluate vascular permeability in brain metastases.

17. Hamzah J, Kotamraju VR, **Seo JW**, Agemy L, Fogal V, Mahakian LM, Peters D, Roth L, Gagnon MKJ, Ferrara KW, Ruoslahti E. Specific penetration and accumulation of a homing peptide within atherosclerotic plaques of apolipoprotein E-deficient mice. P Natl Acad Sci USA. 2011;108(17):7154-9. PMC3084060.
18. **Seo JW**, Baek H, Mahakian LM, Kusunose J, Hamzah J, Ruoslahti E, Ferrara KW. (64)Cu-labeled LyP-1-dendrimer for PET-CT imaging of atherosclerotic plaque. Bioconjug Chem. 2014;25(2):231-9. PMC4311647.
19. Rygh CB, Qin SP, **Seo JW,** Mahakian LM, Zhang H, Adamson R, Chen JQ, Borowsky AD, Cardiff RD, Reed RK, Curry FRE, Ferrara KW. Longitudinal Investigation of Permeability and Distribution of Macromolecules in Mouse Malignant Transformation Using PET. Clinical Cancer Research. 2011; 17, 550-559. PMC3107124.
20. Thorsen F, Fite B, Mahakian LM, **Seo JW,** Qin S, Harrison V, Johnson S, Ingham E, Caskey C, Sundstrøm T, Meade TJ, Harter PN, Skaftnesmo KO, Ferrara KW. Multimodal imaging enables early detection and characterization of changes in tumor permeability of brain metastases. J Control Release. 2013 Dec 28;172(3):812-22. PMC3922207. (2013 outstanding paper award)

Complete List of Published Work in MyBibliography: https://www.ncbi.nlm.nih.gov/sites/myncbi/1t7opWJb-n9km/bibliography/40378355/public/?sort=date&direction=ascending

I also have a Google Scholar page that is complete and can be accessed from:
https://scholar.google.com/citations?hl=en&user=vbeQY88AAAAJ&view_op=list_works&sortby=pubdate

D. Research Support

Ongoing Research Support

R01 CA112356 (PI: Ferrara) 07/01/18 – 06/30/23
NIH/NCI
Insonation of Ultrasound Microbubbles at low frequency to enhance image-guided therapy
The objective of this project is to create sensitive and specific ultrasound strategies capable of detecting small tumors using ultrasound and targeted microbubbles.
Role: Co-investigator

R01 CA227687 (PI: Butts-Pauly) 03/01/18 – 02/28/23
NIH
The Impact of FUS-Mediated Brain Cancer Therapy on BBB Transport, Cytokines, and Immunocyte Trafficking
The goal is to assess the safety and efficacy of BBB transport as a function of ultrasound parameters.
Role on project: Co-investigator

R01 EB028646 (PI: Ferrara) 07/01/19 – 06/30/24
NIH
In Vivo PET Imaging of Novel Engineered AAVs Informs Capsid Design
The goal is to gain insight into the impact of novel capsid structure by validating and applying PET and optical imaging of AAVs across organ systems and species. Novel PET imaging of AAVs translates the therapies to large animals and, in the future, to human medicine.
Role: Co-investigator

Completed Research Support (past 3 years)

Pilot Funding (Jai Woong Seo) 03/01/17 – 2/28/18
UC Davis CMGI
“Monitoring CD8+ T cells in a mouse tumor with immunotherapeutic treatment”
Role: PI