Training the Next Generation of Radiochemists at the University of Missouri

Silvia S. Jurisson, J. David Robertson, Susan Z. Lever, Timothy J. Hoffman
Facilities Supporting Radiochemistry

- University of Missouri Research Reactor (MURR; 10 MW) and Cyclotron (16.8 MeV PetTrace)
- Chemistry Department
- Radiopharmaceutical Science Institute (RSI)
- Nuclear Science and Engineering Institute
Chemistry Department
Radiochemistry Program

➢ Chemistry Faculty
  • Silvia Jurisson—inorganic/radiochemistry
  • Susan Lever—organic/radiopharmaceutical chemistry
  • Dave Robertson—radioanalytical/nuclear chemistry
  • Justin Walensky—actinide chemistry

➢ Joint Appointments
  • Tim Hoffman (Internal Medicine)
  • Wynn Volkert (Emeritus; Radiology)
Jurisson Group Research

- Radiopharmaceutical Chemistry
  - Inorganic Chemistry
    - Tc, Re, Rh, Au, Ln, Ga, In, Cu
  - Ligand design
  - Radiochemistry
  - Biochemistry/Biology

- Radioenvironmental Chemistry
  - Tc-99
Lever Group Research

Design, synthesis and evaluation of novel biological targets for diagnosis and therapy

• Small metal complexes containing relevant radiometals (Tc, Re, Rh, Lu)
• Small molecules labelled with I-125 or I-123
• Peptides or antibodies containing bifunctional chelates for stable metal complexation
Robertson Group Research

- **Materials Science**
  - Use of boron neutron capture to create high surface area carbon materials for hydrogen storage.
  - Development of liquid semiconductor nuclear batteries for MEMS systems.

- **Metals in Biological Systems**
  - Role of trace nutrients in insect development and insect immune response.
  - The role of copper transporters and the effectiveness of platinum cancer agents.

- **Radioisotope Production**
  - $^{64}\text{Cu}$ for PET imaging
  - $^{147}\text{Pm}$ for nuclear batteries
Hoffman Group Research

- **Receptor Targeting Radiopharmaceuticals**
  - Use diagnostic ($^{99m}$Tc-, $^{111}$In-, $^{67/68}$Ga, $^{64}$Cu, $^{18}$F) isotopes to develop peptide based SPECT/PET imaging agents.
  - Develop tumor targeting beta emitting peptides ($^{177}$Lu, $^{90}$Y, and $^{188}$Re) to treat prostate and breast cancers.
  - Evaluate pre-clinical multi-modal combination targeted radiation/chemotherapy treatment strategies

- **Molecular Imaging Research**
  - Develop molecular PET/SPECT imaging techniques for use in nuclear oncology drug development
Objective: Synthesize molecular actinide compounds in order to model macroscopic issues (nuclear fuel cycle intermediates, actinide alloys) while advancing the fundamental structure, bonding, and reactivity.

Actinide-gallium alloys, i.e. PuGa, are components in nuclear weapons.

Small molecule activation

Spectroscopy and further reactivity

Gallium nitride is a semiconductor, uranium nitride is a potential nuclear fuel.
Radiopharmaceutical Sciences Institute (RSI)

- **Faculty**
  - Wynn Volkert
  - Cathy Cutler
  - Sue Deutscher
  - Gary Ehrhardt
  - Tim Hoffman
  - Silvia Jurisson
  - Michael Lewis
  - Kattesh Katti
  - Alan Ketrion
  - John Lever
  - Susan Lever
  - Tom Quinn
  - Jeff Smith

- **Department**
  - Radiology
  - MURR
  - Biochemistry
  - MURR
  - Internal Medicine
  - Chemistry
  - Veterinary Medicine
  - Radiology
  - MURR
  - Radiology
  - Chemistry
  - Biochemistry
VA Biomolecular Imaging Center

- Imaging Center (Tim Hoffman, Director):
  - Multimodality PET/SPECT/CT
  - MicroMRI
  - Optical Imaging
Micro-MRI - 7 Tesla

In Vivo Fluorescence/ Bioluminescence Imaging
Radiochemistry Program

- PhD degrees specializing in radiochemistry
- NIBIB Pre-doctoral Training Grant in Radiopharmaceutical Chemistry (2007-2012)
- DOE Radiochemistry Research Projects of Excellence Research and Training Grant (2009-2012)
- NSF IGERT in Radiochemistry (sub-award; 2010-2015)
Chemistry PhD

- **Courses**
  - Radiation Detection and Lab
  - Advanced Radiochemistry
  - Nuclear Chemistry
  - Radiopharmaceutical Chemistry
  - Radiopharmaceuticals in Nuclear Medicine
  - Radiation Biology

- **Cumulative Exams in Area**
- **Oral Comprehensive Exam**
- **Dissertation**
University of Missouri MS and PhD Radiochemistry Graduates (1995-2010)

- 35 PhD Graduates in Radiochemistry
  - 16 US Citizens

- Now in Academia, Industry and National Labs

- 10 MS Graduates in Radiochemistry
  - 5 US Citizens

- Primarily in Industry
Current Radiochemistry Graduate Students (2010)

- 15 radiochemistry graduate students
- 11/15 US citizens
NIBIB Graduate Training in Radiopharmaceutical Chemistry at University of Missouri (2007-2012)

Silvia Jurisson (PI)
Susan Lever (Co-PI)

Martin Brechbiel (site PI)

Internships at the NCI or BNL

Chemistry Department
University of Missouri
Anticipated Timeline to Degree

- Select advisor
- Begin Cumes

- Complete Oral Comprehensive

- Finish cumes
- Research

- PhD Defense

- ~3 months internship (NCI or BNL) synergistic with research topic
- 2 years training grant support

- Enter graduate program

- Year 1
- Year 2
- Year 3
- Year 4

- Graduate
Trainees

- **Trainee**
  - Stephanie Lane, PhD
    - Internship at NCI
  - Brienne Bottenus, PhD
    - Internship at BNL
  - Valerie Carroll
    - Internship at BNL
  - Roderick Pomfrey
  - Peter Chen
  - Dustin Demoin
  - Andy Mossine

- **Status**
  - PNNL
  - PNNL
  - 4th year PhD student
  - MS anticipated, 12/10
  - MS, 12/09
  - 2nd year PhD student
  - 2nd year PhD student
DOE Radiochemistry Research and Education Award

- Research Projects for the Interrogation of Biological Systems: Training for the Development of Novel Radiotracers
- Interdisciplinary projects between Chemistry, MURR, Biochemistry, Plant Biology Group, Radiopharmaceutical Sciences Institute
- 3 pre-doctoral and 1 post-doctoral training slots
  - Lihui Song, Rui Sun, Patrick Cavins, Dr. Vikram Gaddam
- Radiochemistry curriculum for all trainees
NSF IGERT Award in Radiochemistry

- **Multi-institutional training grant**
  - Hunter College*/Queens College (CUNY), Memorial Sloan Kettering Cancer Center, Albert Einstein University
  - University of Missouri (subcontract)
  - University of Nevada-Las Vegas (subcontract)

- **Pre-doctoral training slots**
  - 8 at Hunter/Queens Colleges/Sloan Kettering/Albert Einstein
  - 2 at University of Missouri
  - 2 at University of Nevada-Las Vegas

- **National Laboratory involvement**
  - Argonne National Laboratory, Oak Ridge National Laboratory

- **Industry (GE Healthcare)**

- **Internships for students at non-home institution(s) for cross training**
Individual Fellowships

- Joshua McCormick  NF Predoctoral Fellowship (DHS/DOE)
- Richard Clark  NF Predoctoral Fellowship (DHS/DOE)
- Mark McLaughlin  DOE NE Predoctoral Fellowship
- Valerie Carroll  DOD Predoctoral Fellowship*
Acknowledgments

- NIBIB – T32 Predoctoral Training Grant
- DOE – Research and Training Grants and Fellowships
- DHS – Individual Predoctoral Fellowships
- NSF – IGERT Radiochemistry Predoctoral Training Grant
- MURR and Chemistry Department at MU