

Department of Chemistry and Biochemistry Faculty Research Areas

Poop! There it is! Prophylaxis and Biological Variables Affecting Intestinal Bacterial Infections

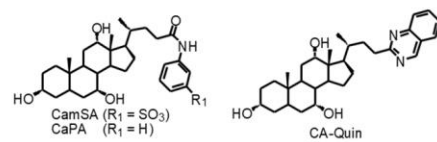
- **Dr. Ernesto Abel-Santos**
- Professor
- Department of Chemistry & Biochemistry
- Email: ernesto.abelsantos@unlv.edu
- Website: <https://abelsantos.faculty.unlv.edu/>

Expertise

- Bioorganic chemistry
- Enzymology
- Bacterial Spore Germination
- Bioterrorism

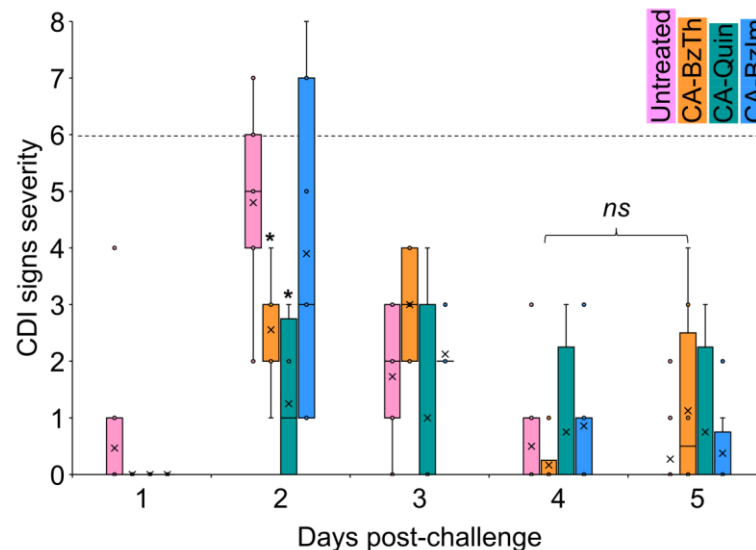


Inhibition of *C. difficile* spore germination protects mice from infection

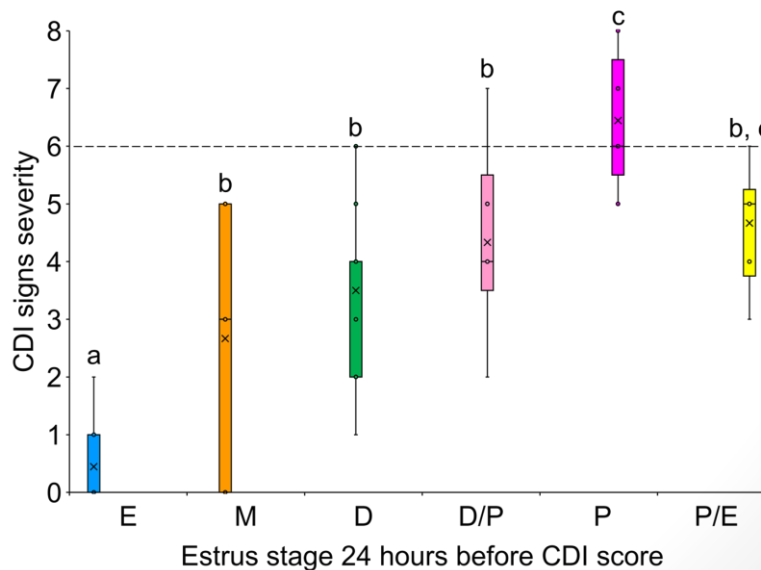
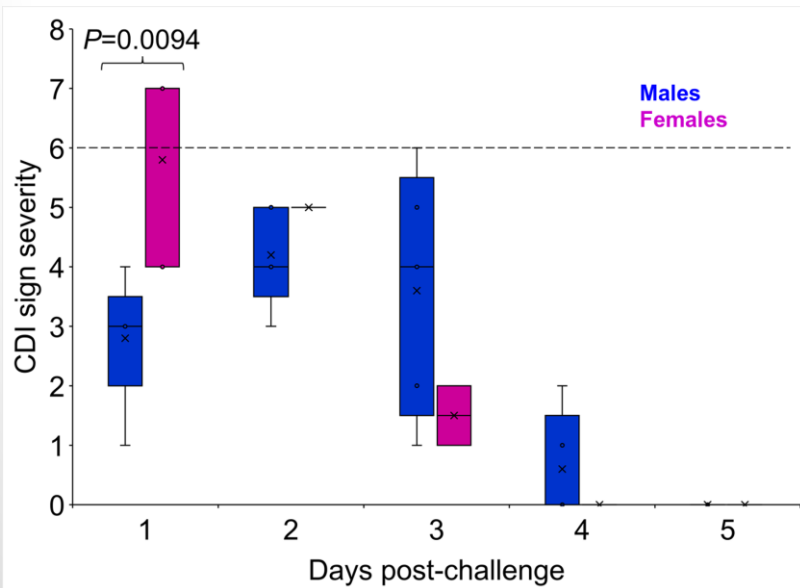


CA-BzIm ($X = \text{NH}$, $R_2 = \text{OH}$); DCA-BzIm ($X = \text{NH}$, $R_2 = \text{H}$)
CA-BzTh ($X = \text{S}$, $R_2 = \text{OH}$); DCA-BzTh ($X = \text{S}$, $R_2 = \text{H}$)
CA-BzOx ($X = \text{O}$, $R_2 = \text{OH}$); DCA-BzOx ($X = \text{O}$, $R_2 = \text{H}$)

Table 1. NHBS-mediated germination inhibition of <i>C. difficile</i> strain R20291 spores	
Name	IC ₅₀ (μM)
CA-Quin	21.6 ± 2.6
CA-BzIm	4.4 ± 0.3
DCA-BzIm	5.6 ± 1.2
CA-BzTh	5.9 ± 3.5
DCA-BzTh	Inactive
CA-BzOx	5.8 ± 2.8
DCA-BzOx	Inactive



C. difficile infection severity in mice is affected by their estrus cycle



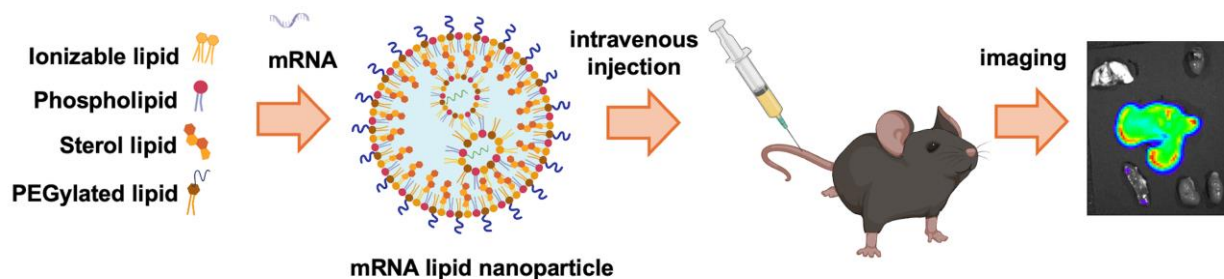
mRNA medicine

- **Dr. Chandrabali Bhattacharya**
- Assistant Professor
- Department of Chemistry and Biochemistry
- Email: chandra.bhattacharya@unlv.edu
- Website: <https://bhattacharya-lab.faculty.unlv.edu/>



Expertise

- Biomaterials
- Drug and Gene Delivery
- Chemical Biology
- Medicinal Chemistry



Our interests focus on organic and polymer synthesis in general. More specifically, we are interested in developing novel light-emitting and liquid-crystalline polymers for their multitude applications in modern technology, including biosensors.

In another project, we are developing ionic liquids and ionic liquid crystals for their better ionic conductivities as electrolytes for next generation batteries. Significant efforts are concentrated on the development organic ionic plastic crystals for the solid state batteries.

Carbon nanotube-based composite materials based on ionic polymers are of significant interest in our group. In recent years, we are also actively pursuing the development of cisplatin analogs for cancer therapy.



Colorful Pyrylium Salts



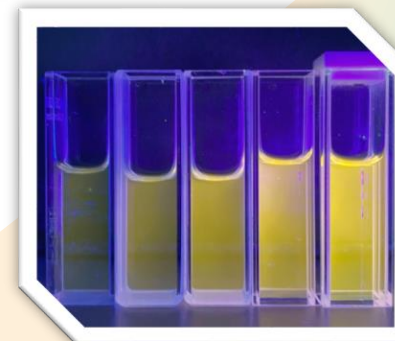
Liquid Crystalline Texture



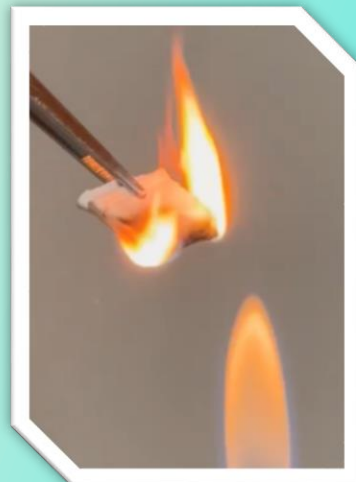
Fluorescent Pyrylium Solution

Current Research Interests

- Thermotropic and Lyotropic Liquid Crystalline Polymers
- Polyesters, Viologen Polymers, Poly(pyridinium salt)s
- Fire Retardant Polymers
- Light-Emitting Properties of Polymers
- Photo-responsive Polymers
- Proton and Anion Exchange Membranes
- Oxidation of Carbohydrates by Viologens
- Ionic Liquids, Liquid Crystals, and Plastic Crystals
- Novel Light-Harvesters for Solar Energy Storage
- Fluorescent Molecules for Cell Imaging
- Pyrylium Salt Chemistry
- Lasing Properties in Organic Solvents and Water
- Two Photon Induced Absorption Fluorescent Properties
- Piezochromic Materials
- Magnetic Materials
- Cisplatin Analogues for Cancer Therapy



Polymer
Flame
Testing



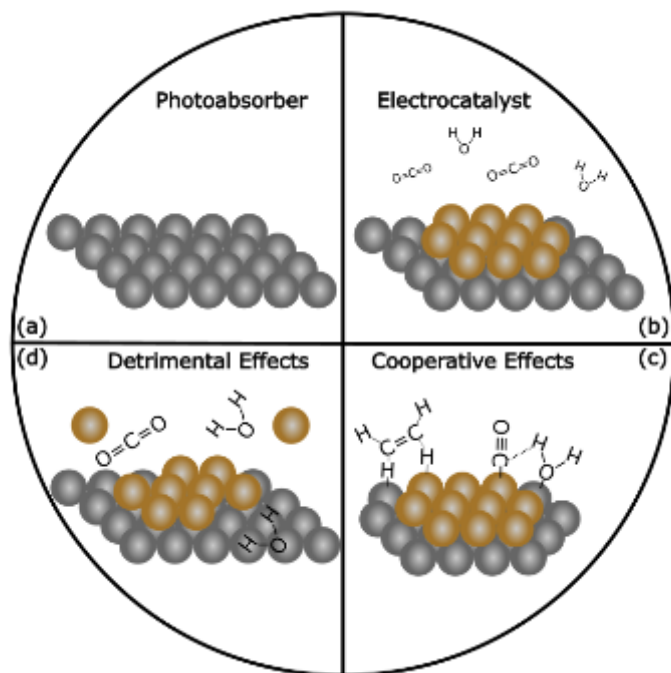
Interfacial Photochemistry

- **Dr. Jared P. Bruce**
- Assistant Professor
- Department of Chemistry and Biochemistry
- Email: jared.bruce@unlv.edu
- Website: jpbruce.faculty.unlv.edu

Expertise

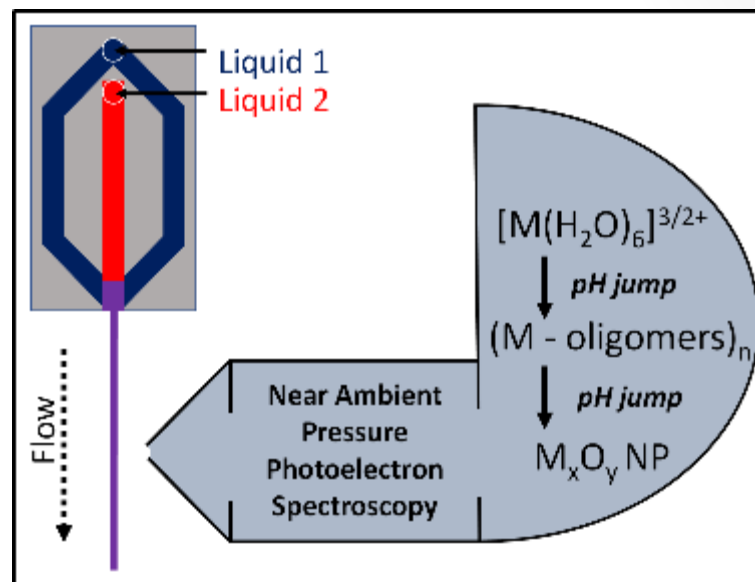
- Heterogeneous Photochemistry
- Electrocatalysis
- Photocatalysis
- Atmospheric Chemistry
- Surface Chemistry and Interfacial Characterization
- Near Ambient Pressure Photoelectron Spectroscopy

Hybrid Co-Catalyst/Photoabsorber Photochemical Interfaces



- Metals often make good electrocatalysts
- Semiconductors make good photoabsorbers
- The combination of the two create a new, complex interface that can be leveraged to increase the efficiency of co-catalyst/photoabsorber devices

Mixing Liquid Jet Photoelectron Spectroscopy

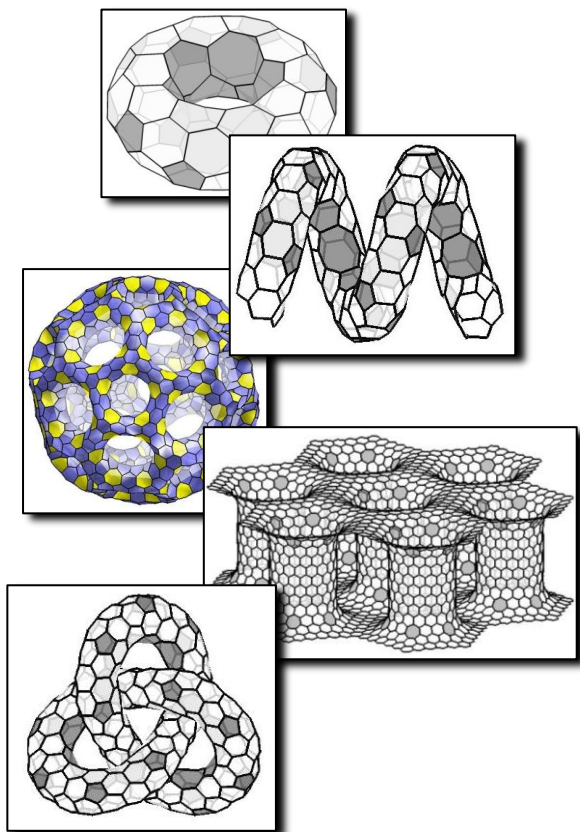


- Dynamic processes are tricky to study at the liquid surface
- A small liquid jet (20 μ m dia.) is used to investigate the liquid surface
- Microfluidic chips provide mixing chamber to induce chemical reactions

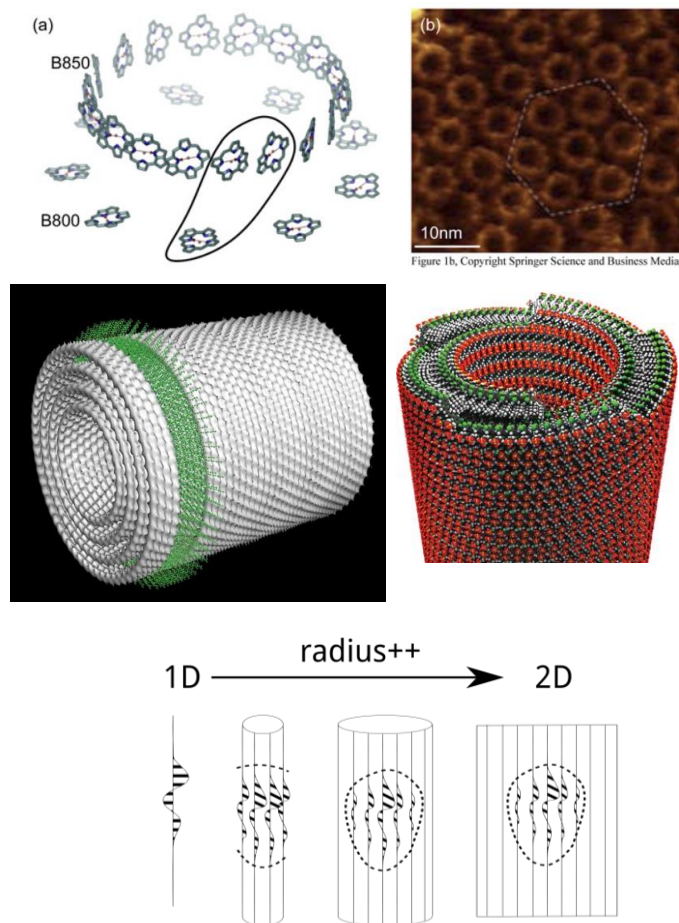
Theoretical chemical physics

- Dr. Chern Chuang,
- Assistant Professor, Department of Chemistry and Biochemistry
- Email: chern.chuang@unlv.edu
- Website: <http://cchuang.faculty.unlv.edu/Home.html>
- Expertise
 - Open quantum system dynamics and spectroscopy
 - Photophysics and photochemistry of materials
 - Quantum transport
 - Quantum effects in biology
 - Exotic geometries and topologies of low dimensional materials

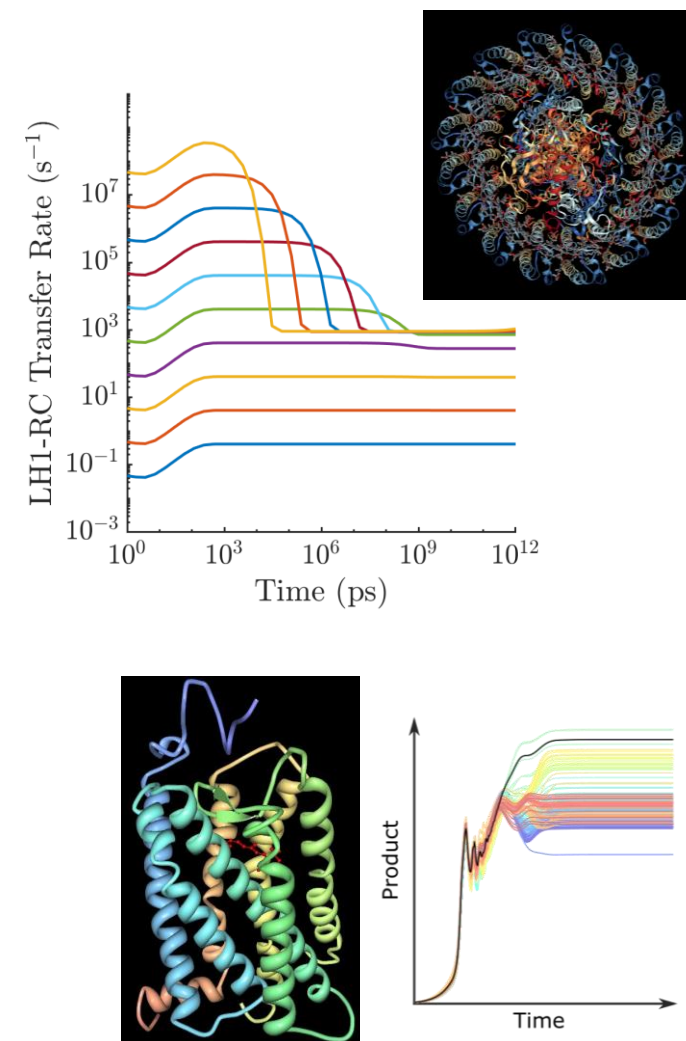
Theoretical chemical physics



Exotic low-dimensional materials



Photophysics of organic materials



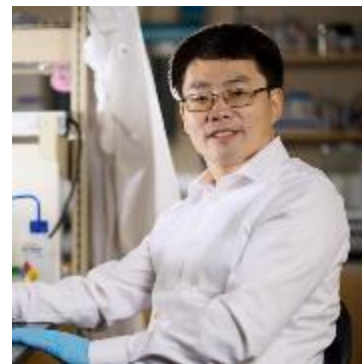
Photochemistry under environmental control

Electrochemistry for Energy Storage, Environmental Remediation, and Biomedical Applications

- **Dr. Zhange Feng**
- Assistant Professor
- Department of Chemistry & Biochemistry
- Email: zhange.feng@unlv.edu
- Website: <https://zfeng.faculty.unlv.edu/>

Expertise

- Water and soil remediation
- Rechargeable batteries
- Electrocatalysis
- Electrosynthesis
- Electrochemical Manufacturing
- Electrical neural stimulation



A combination of electrochemistry, *in situ* spectroscopy, and theoretical calculations to study electrified interfaces

Radiochemistry

Paul M. Forster

Department of Chemistry and Biochemistry

Radiochemistry

Expertise:

-Structure determination (X-ray and neutron diffraction, total scattering)

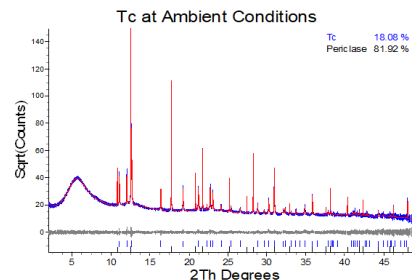
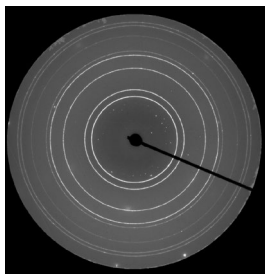
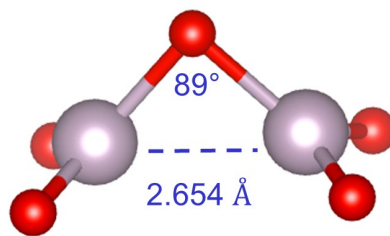
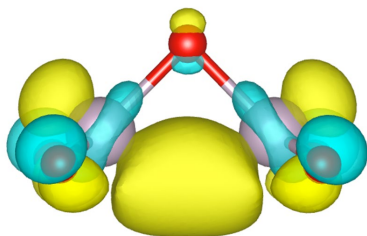


Figure 1 One-hour XRD of technetium metal and magnesium oxide.

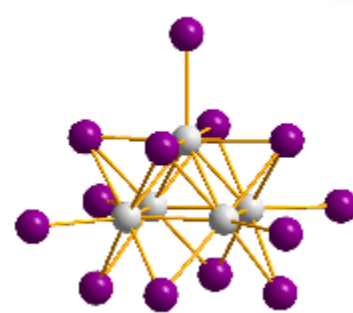
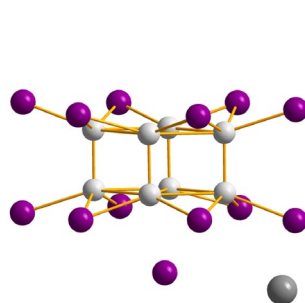
-Structure-property relationships, integrated simulation



Probable identification of a gas phase technetium oxide molecule

-Hydro/solvothermal synthesis

Technetium iodide compounds prepared solvothermally



Paul M. Forster

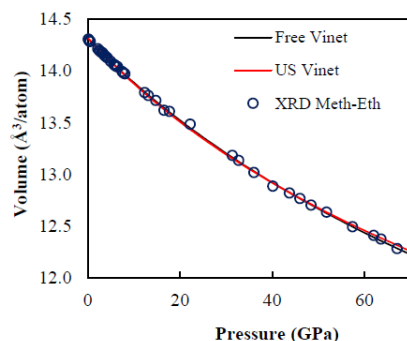
Department of Chemistry and Biochemistry

Radiochemistry

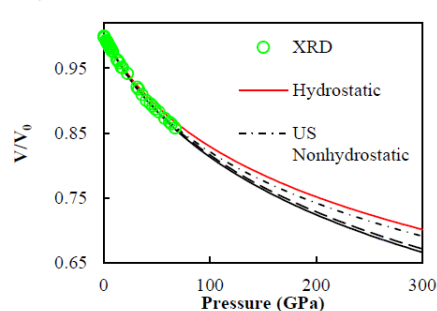
Relevant projects:

First diffraction-based equation of state for elemental Tc

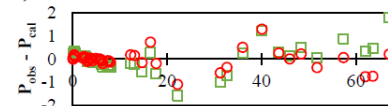
a) EOS of technetium



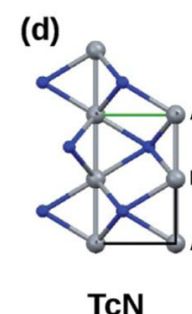
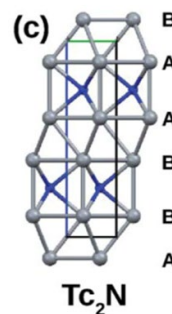
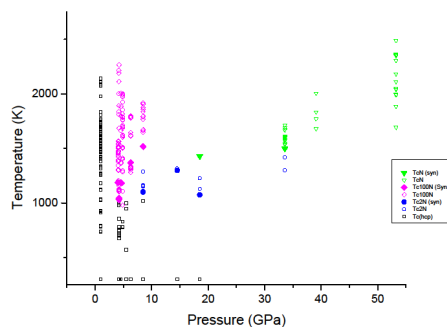
b) EOS of technetium



c) Pressure Difference



Discovery of new binary Tc nitrides



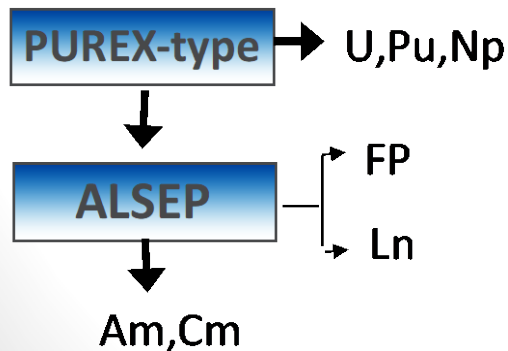
Art Gelis

Director, Radiochemistry Program

Actinide Separations and Recovery

Design and Testing of Advanced Separation Processes using Additive Manufacturing

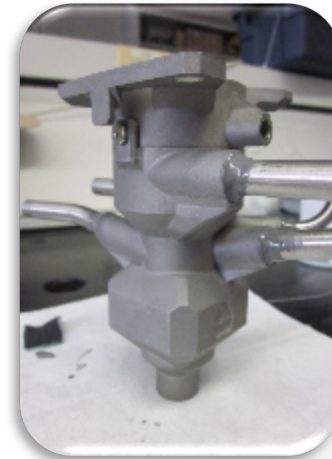
- Liquid-Liquid Extraction and Separation of Plutonium, Uranium, Minor Actinides, Lanthanides and Fission Products
- Twenty-seven 3D-printed acrylic centrifugal contactors (CC), fabricated at Argonne National Lab are available at UNLV
- Contactors can be 3D-printed in stainless steel or any alloy
- Solvent extraction separations can be tailored to a specific goal
- Example: **A**ctinide **L**anthanide **SEP**aration process - **ALSEP**, designed and tested for DOE-NE



10+1 acrylic CC

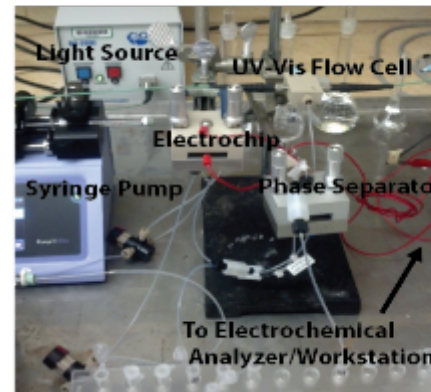
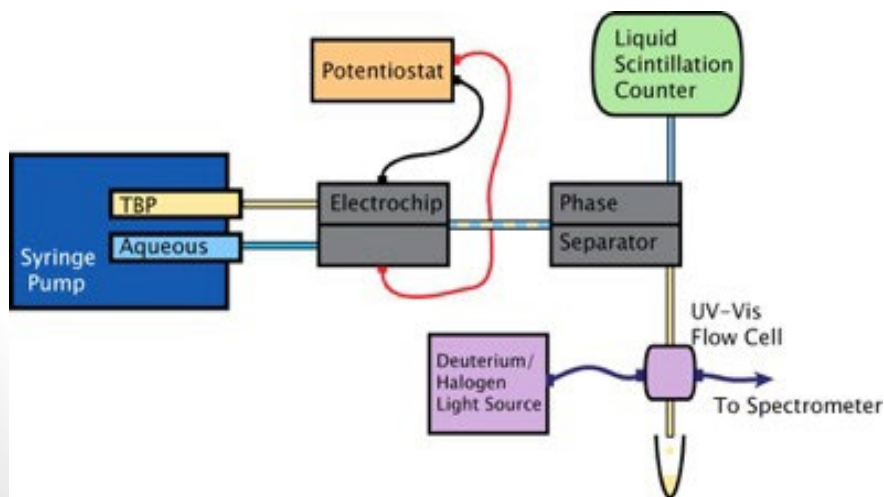
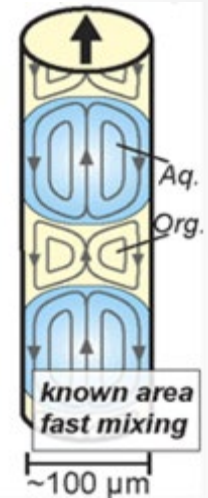


Steel CC

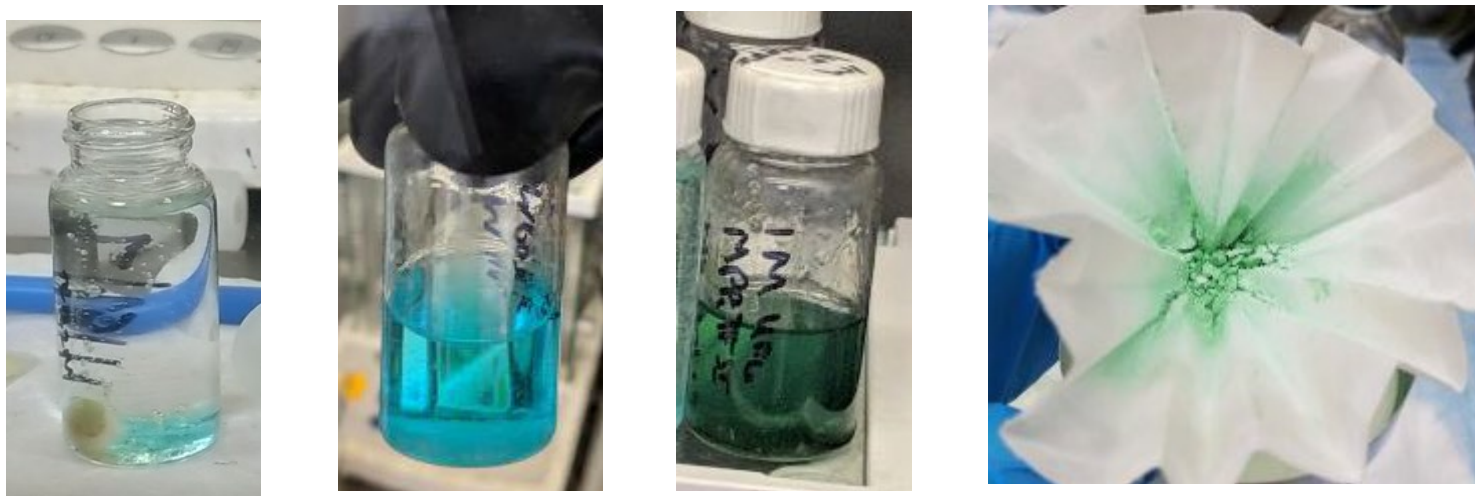


Microfluidic Systems for Rapid Radionuclide Separation and Detection

- Microfluidic device to combine aqueous and organic phases, rapidly mix, then separate phases, following by analysis
- Selective Extraction of radionuclides on a very small scale
- Can be implemented either as a bench-top setup or as a portable detector
- Potential applications: rapid Pu separation and detection from Uranium and FP for safeguards; "dirty bomb" analysis



Strategic Materials Analysis and Recovery – David Hatchett and Ken Czerwinski

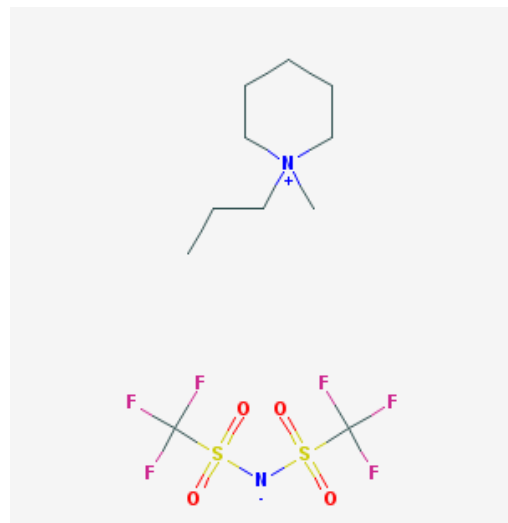


Dissolution of UF_6 into IL at 0 hours, 24 hours, 30 days, and the recovery of UF_6 salt.

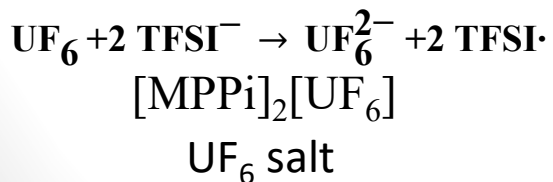
Expertise:

- Actinide, Lanthanide, and Li materials recovery from Ionic Liquids (ILs).
- Electrochemical, Spectroscopic, and thermal analysis of Radioactive materials.
- Radiochemistry and Analytical Chemistry.

Strategic Materials Analysis and Recovery – David Hatchett and Ken Czerwinski



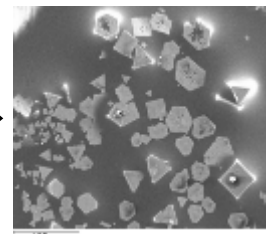
1-methyl-1-propyl piperidinium
bis(trifluoromethylsulfonyl)imide
[MPPi][TFSI]



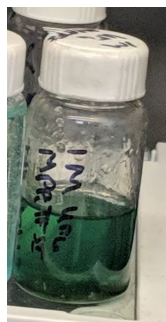
Electrochemistry



Low Concentration
0.1 M

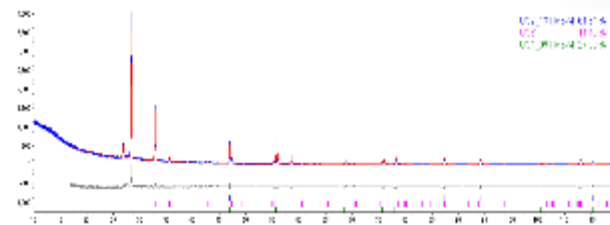


U metal
Crystallites

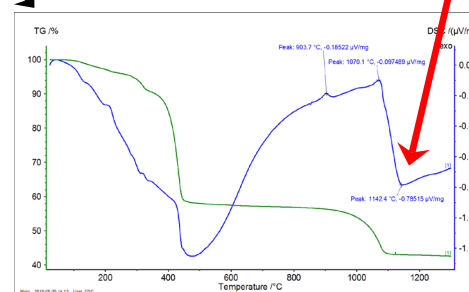


High
Concentration
0.95 M

UF₆ salt



Air
U metal



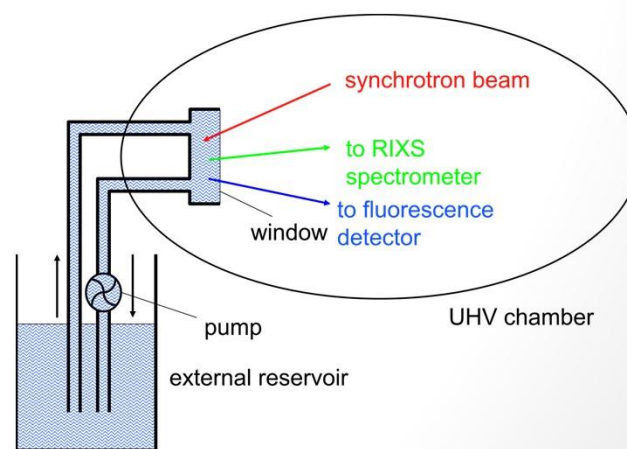
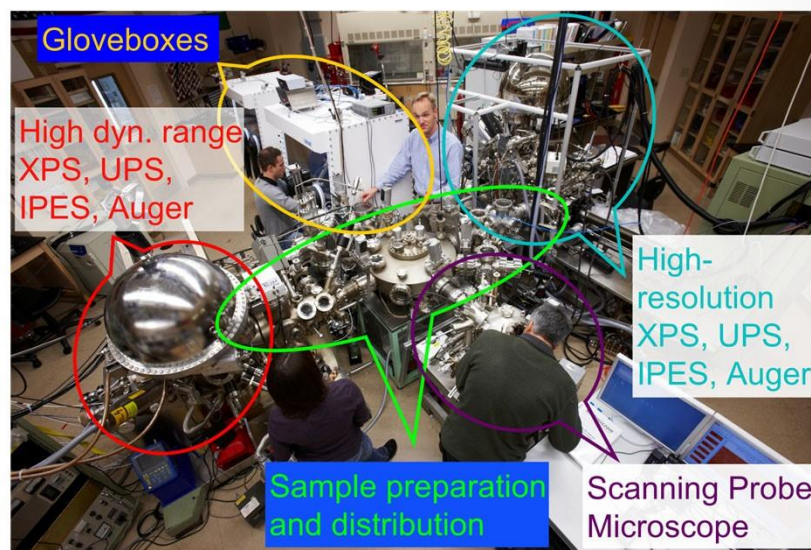
Paths to U recovery from UF₆ dissolved in IL

Surface and Interface Characterization of Materials for Energy Conversion

- **Dr. Clemens Heske**
- Professor
- Department of Chemistry and Biochemistry
- Email: heske@unlv.nevada.edu
- Website: <https://heske.faculty.unlv.edu//>

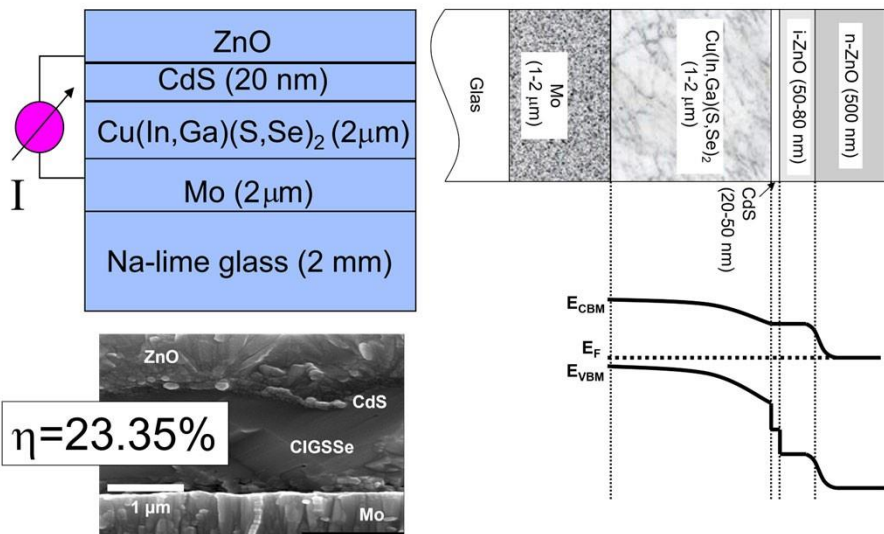
Expertise

- Electronic and Chemical Structure of Energy-Conversion Materials
- Surface and Interface Characterization
- Soft x-ray and Electron Spectroscopy
- Scanning Probe Microscopy
- Synchrotron Radiation

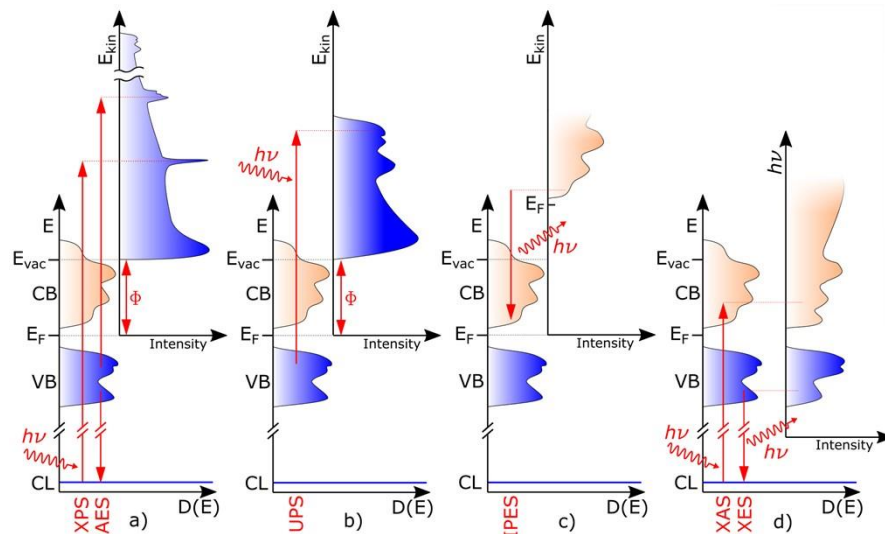


Surface and Interface Characterization of Materials for Energy Conversion

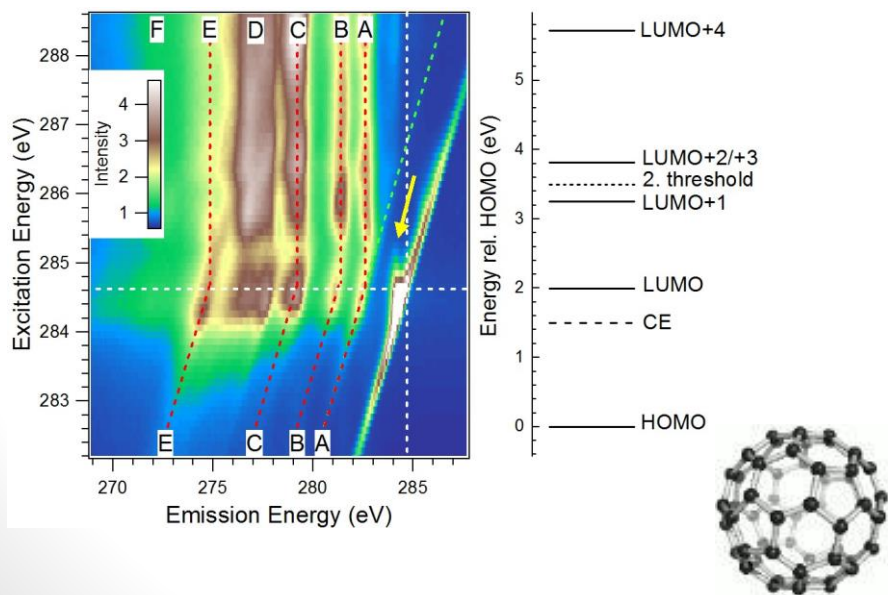
Cu(In,Ga)(S,Se)₂ Thin-Film PV Device



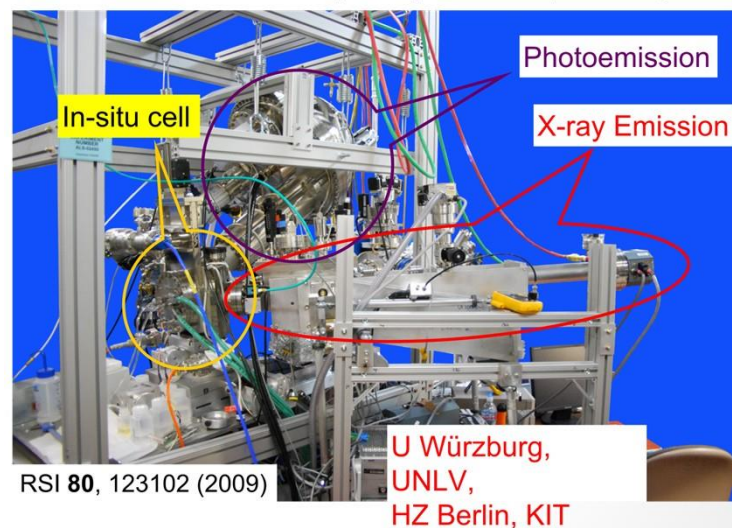
Method development



Electronic structure of C₆₀



SALSA: Solid And Liquid Spectroscopic Analysis



Main-Group and Organometallic Chemistry

- **Dr. Arumugam Jayaraman**
- Assistant Professor, Inorganic Chemistry
- Department of Chemistry and Biochemistry
- Email: arumugam.jayaraman@unlv.edu
- Website: <https://jayaramangroup.faculty.unlv.edu/>



Expertise

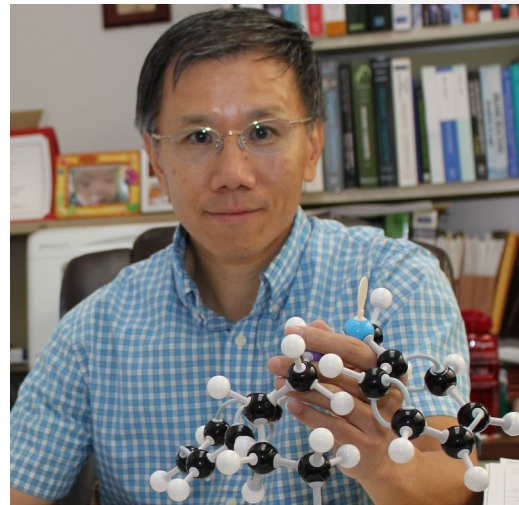
- Chemistry of Low-valent Boron, Carbon and Phosphorus Compounds
- Antiaromatic and Aromatic Main-Group Heterocyclic Materials
- Sustainable Transformation of Burnt Fossil Fuels to Chemical Feedstock
- Green Catalysis and Technology Transfer to Fine-Chemical Industry
- Synthetic Inorganic Antibiotics
- Computational Organometallic Chemistry of *p*- and *d*-block compounds
- Single-Crystal X-ray Crystallography

Selected Publications

- 1) *Olefin π -coordination chemistry at low-oxidation-state boron*, M. Michel, M. Weber, A. Jayaraman, R. D. Dewhurst, I. Krummenacher, C. Voigt, M. Härterich, A. Vargas, H. Braunschweig, [Nature Chem.](#), 2025, in press.
- 2) *Formation and metallomimetic reactivity of a transient dicoordinate alkylborylene*, Y. Konrad, A. Jayaraman, I. Krummenacher, H. Braunschweig, [Angew. Chem. Int. Ed.](#), 2025, e202423669
- 3) *Straightforward formation of borirenes from boroles and dialkynes*, P. H. R. Oliveira, M. O. Rodrigues, C. D. G. Da Silva, J. L. Bohlen, M. Arrowsmith, A. Jayaraman, L. Lubczyk, F. Fantuzzi, E. N. da Silva Júnior, H. Braunschweig, [Angew. Chem. Int. Ed.](#), 2025, e202423391
- 4) *Intermolecular 1,2-aminoboration of alkynes and the critical role of electron-rich alkynes*, S. Dotzauer, A. Jayaraman, D. Reinhart, H. Braunschweig, [Angew. Chem. Int. Ed.](#), 2024, 63, e202413370
- 5) *Experimental observation of a terminal borylene-dinitrogen adduct via cleavage of a 1,2,3,4,5-diboratriazoline* A. Jayaraman, B. Ritschel, M. Arrowsmith, C. Markl, M. Jürgensen, A. Halkić, Y. Konrad, A. Stoy, K. Radacki, H. Braunschweig, [Angew. Chem. Int. Ed.](#), 2024, 63, e202412307
- 6) *Full electron delocalization across the cluster in 1,12-bis BMes₂-p-carborane radical anion*, L. Wu, X. Zhang, M. Moos, I. Krummenacher, M. Dietz, A. Jayaraman, R. Bertermann, Q. Ye, M. Finze, C. Lambert, H. Braunschweig, L. Ji, [J. Am. Chem. Soc.](#), 2024, 146, 17956–17963
- 7) *An unsymmetrical, cyclic diborene based on a chelating CAAC ligand and its small-molecule activation and rearrangement chemistry*, W. Lu, A. Jayaraman, F. Fantuzzi, R. D. Dewhurst, M. Härterich, M. Dietz, S. Hagspiel, I. Krummenacher, K. Hammond, J. Cui and H. Braunschweig, [Angew. Chem. Int. Ed.](#), 2022, 61, e202113947
- 8) *Palladium-catalyzed homocoupling of highly fluorinated arylboronates: studies of the influence of strongly vs weakly coordinating solvents on the reductive elimination process* Y. Budiman, A. Jayaraman, A. Friedrich, F. Kerner, U. Radius, T. B. Marder [J. Am. Chem. Soc.](#), 2020, 142, 6036–6050
- 9) *Practical and scalable synthesis of borylated heterocycles using stable precursor of metal-free Lewis pair catalysts*, A. Jayaraman, L. C. Misal Castro, F.-G. Fontaine, [Org. Process Res. Dev.](#), 2018, 22 (11), 1489–1499
- 10) *Metal-free borylation of heteroarenes using ambiphilic aminoboranes: on the importance of sterics in frustrated Lewis pair C-H bond activation*, J. L. Lavergne, A. Jayaraman, L. C. Misal Castro, É. Rochette, F.-G. Fontaine, [J. Am. Chem. Soc.](#), 2017, 139 (41), 14714-14723
- 11) *A potent synthetic inorganic antibiotic with activity against drug-resistant pathogens*, S. Hubick, A. Jayaraman, S. Reid, J. Alcorn, J. Stavrinides, B. T. Sterenberg, [Sci. Rep. \(Nature\)](#), 2017, 7, 41999

Jun Yong Kang

- Assistant Professor, Department of Chemistry and Biochemistry
- Ph.D., Chemistry, Texas A&M University, College Station, TX
- CHE 217B, junyong.kang@unlv.edu
- http://jkang.faculty.unlv.edu/?page_id=110



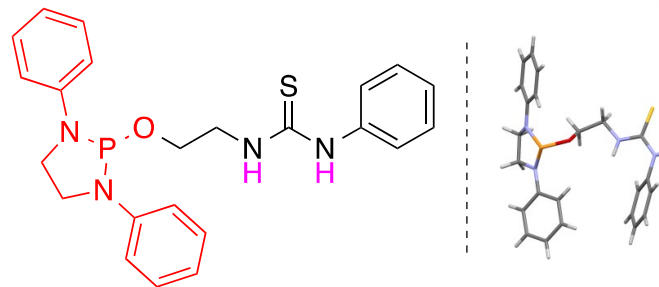
Areas of Expertise

- Synthetic organic chemistry
- Development of new synthetic methodology
- Asymmetric organocatalysis
- Organophosphorus chemistry
- Synthesis of bioactive small molecules

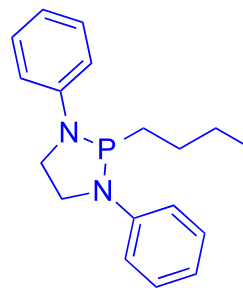
Research Summary:

The development of new synthetic methodologies plays a key role in medicinal chemistry, biochemistry, and materials chemistry. Professor Kang and his group have been developing novel synthetic transformation and new chemical reagents such as commercially available NHP-thiourea and NHP-butane to apply for pharmaceuticals and bioactive molecules.

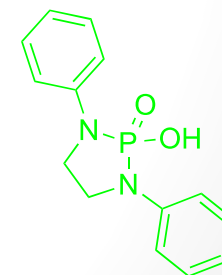
Kang's reagents-commercially available at Kerafast



NHP-thiourea
(phosphonylation reagent)



NHP-butane
(organocatalyst)



NHPA
(organocatalyst)

Ubiquitin-mediated protein degradation

Dr. Gary Kleiger

Professor and department Chair

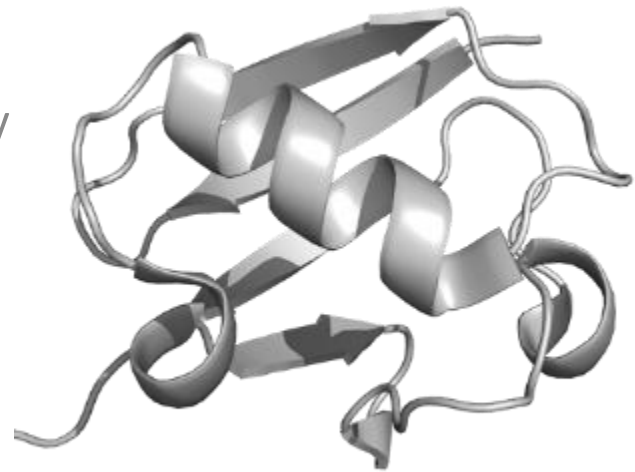
Department of Chemistry and Biochemistry

gary.kleiger@unlv.edu

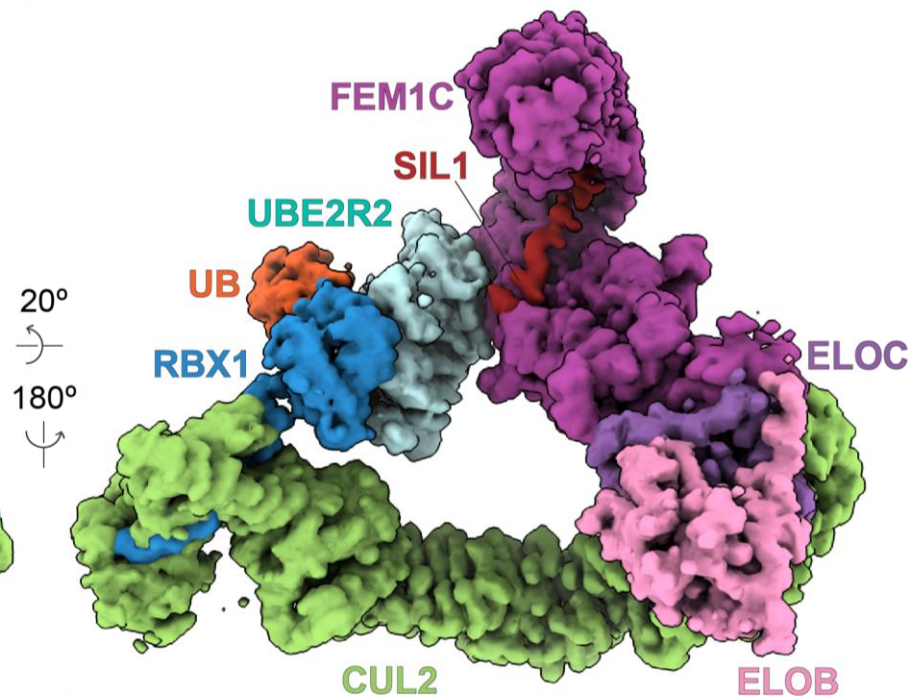
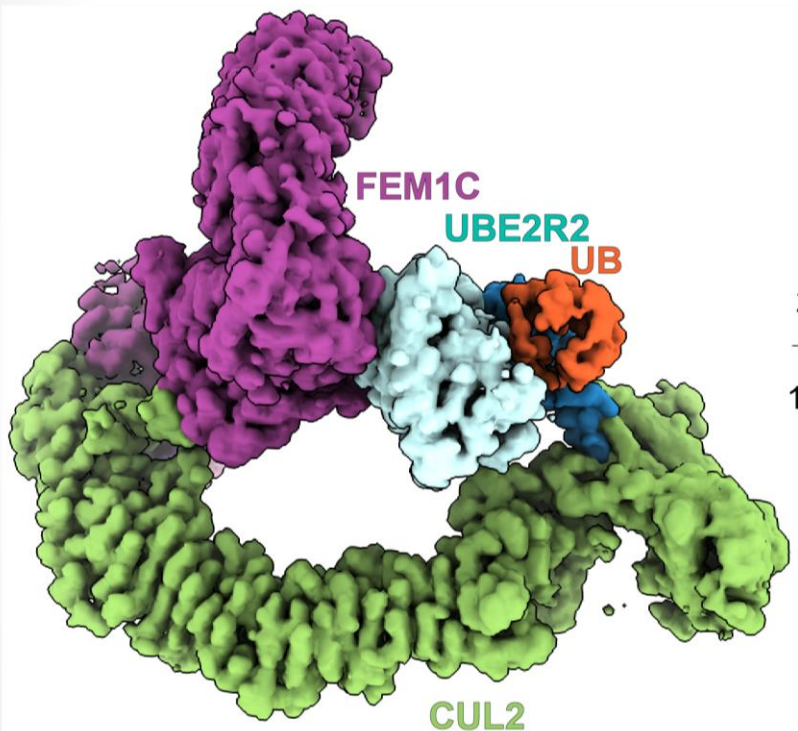
<https://kleiger.faculty.unlv.edu>

Expertise

- Structural biology
- Proteomics
- Enzyme kinetics and biophysical assays
- Cell biology

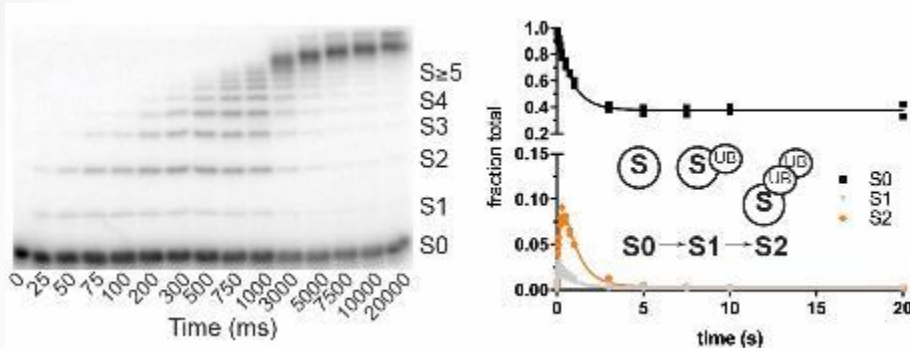


Determining the structures of enzymes that promote protein degradation by cryo-EM.

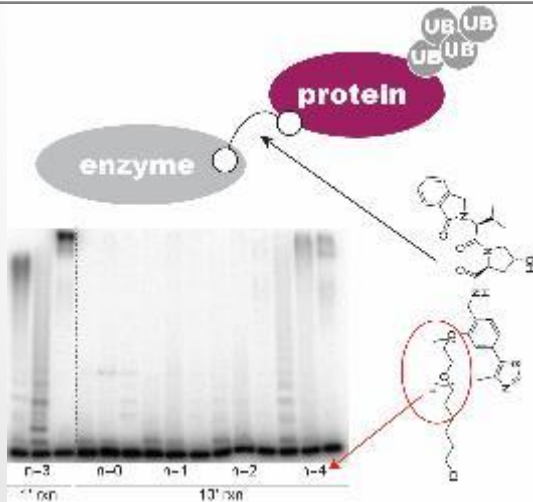
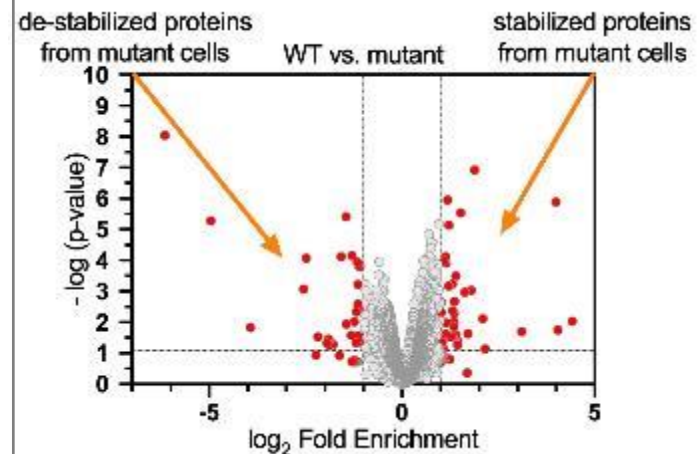


Uncovering how the enzymes that promote protein degradation function in human cells.

Kinetics help us understand how enzymes select protein targets for modification with ubiquitin.



High-resolution mass-spectrometry tells us how mutations in enzymes that lead to human disease affect the stabilities of key human cellular proteins.



Small molecule inducers of protein degradation can be used to treat human disease. We study the mechanism of how they function both in test tubes and cells.

Organic Materials Chemistry

Dong-Chan Lee, Ph.D.

Associate Professor

Department of Chemistry & Biochemistry

Phone: 702-895-1486

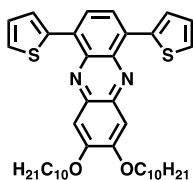
Email: dong-chan.lee@unlv.edu

Expertise

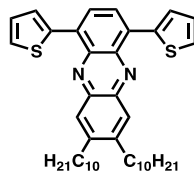
- Organic semiconductors with tunable electronic properties
- Self-assembly (nanomaterials, organogels, etc.)
- All organic room-temperature phosphors
- Materials development for solid-state emission with high quantum yield

Electronic-Property Tuning with Smart Molecular Design

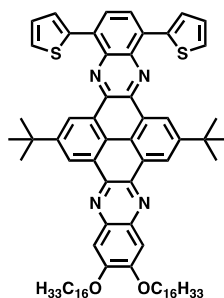
E_{LUMO} -3.16 eV



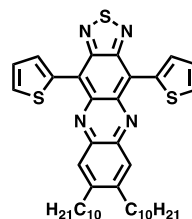
-3.26 eV



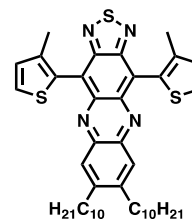
-3.22 eV



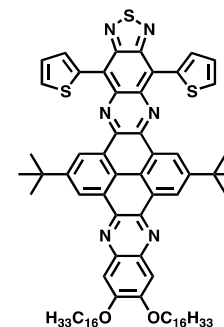
-3.89 eV



-3.80 eV



-3.84 eV



E_{HOMO} -5.43 eV



-5.45 eV



-5.49 eV



-5.32 eV



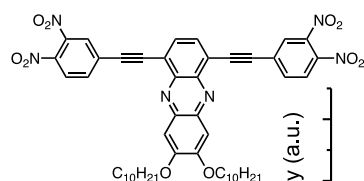
-5.51 eV



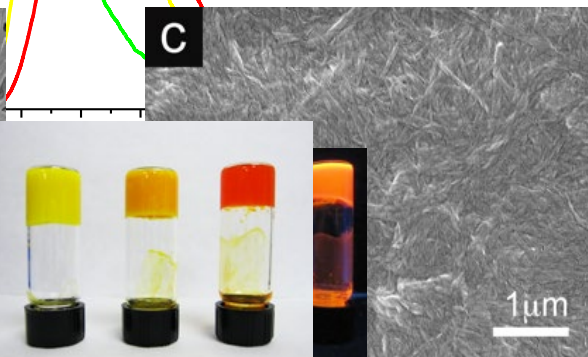
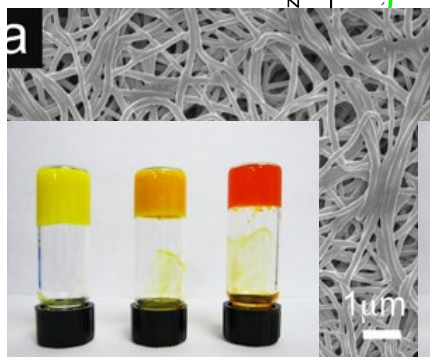
-5.40 eV



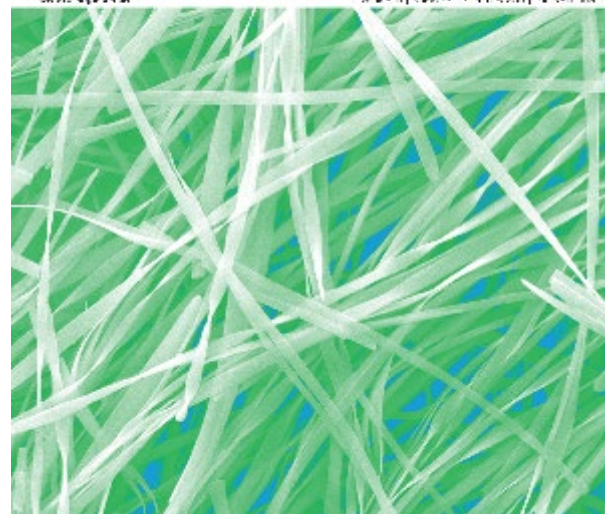
Solvent-Dependent Morphology Control through Organogelation



Normalized FL Intensity (a.u.)



Journal of Materials Chemistry



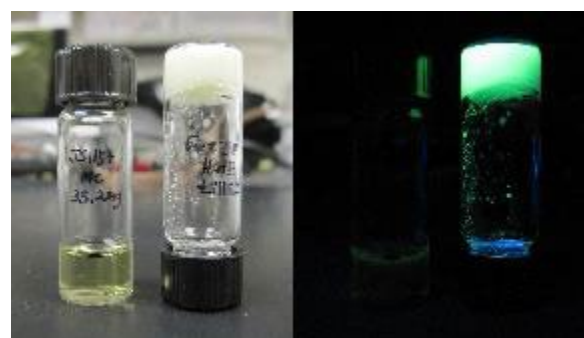
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Solid-State
Emission with
High
Quantum
Yield



Gel-Induced
Room
Temperature
Phosphorescence

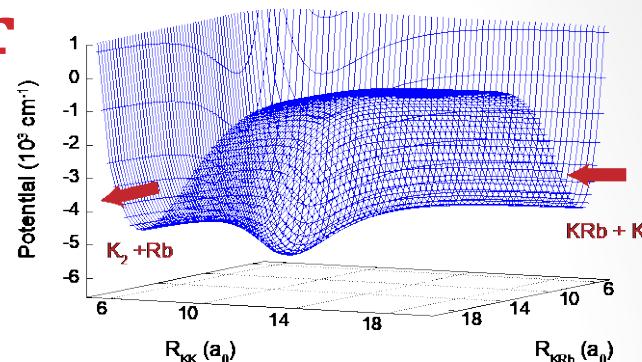
Quantum Information and Quantum Control of Chemical Reactions

Balakrishnan Naduvalath

Department of Chemistry & Biochemistry,
UNLV

Areas of Expertise

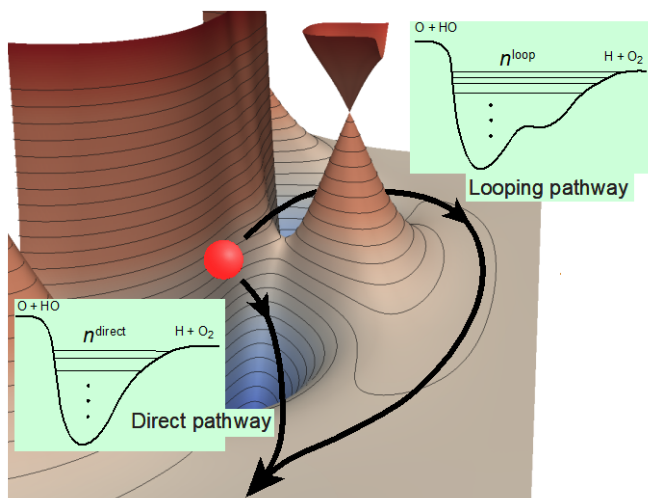
- Ultracold Molecules
- Ultracold Quantum Engineered Chemistry
- Quantum control of chemical reactions
- Geometric phase effect in chemistry
- Stereodynamic control of chemical reactions



Chemical reaction pathway in ultracold $K + KRb$ collisions. Quantum engineered KRb molecules have been prepared at 300 nK. Ultracold polar molecules such as KRb are potential candidates for quantum computing and quantum information processing.

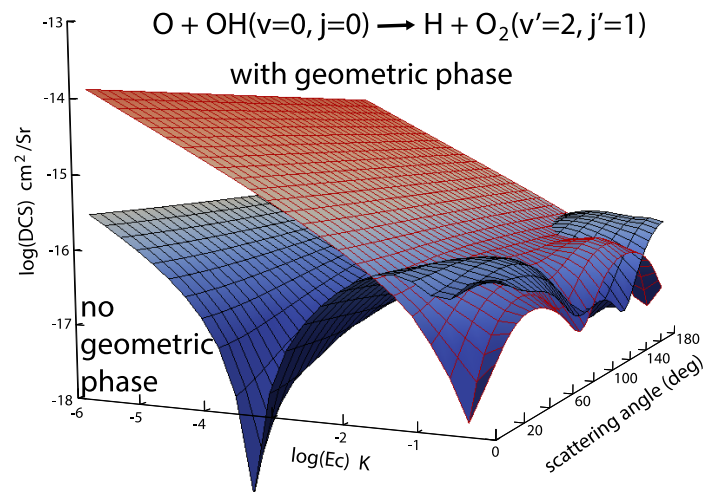
\$\$\$: NSF, DOD, NASA

Controlling reaction outcome through quantum interference



Left panel: Two paths for a chemical reaction. These two paths can interfere constructively or destructively, maximizing or minimizing the reaction rate. This quantum effect becomes magnified in the ultracold regime (Kendrick, Hazra, and Balakrishnan, *Nature Comm.* **6**, 7918 (2015)).

Right panel: The nature of the interference can be controlled by including “geometric phase”. In the image on the right, inclusion of the geometric phase enhances the reactivity. The geometric phase (that correctly describes the sign of the wave function near a conical intersection with an excited electronic state) acts as a “quantum switch” (Hazra, Balakrishnan, and Kendrick, *J. Phys. A* **119**, 12291 (2015))



References

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- J. F. E. Croft and N. Balakrishnan, Controlling rotational quenching rates in cold molecular collisions, *J. Chem. Phys.* **150**, 164302 (2019).
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- J. F. E. Croft, N. Balakrishnan, M. Huang, and H. Guo, Unrevealing the stereodynamics of cold controlled HD-H₂ collisions, *Phys. Rev. Lett.* **121**, 113401 (2018). (**Editor's choice**).
- J. F. E. Croft, C. Makrides, M. Li, A. Petrov, B. K. Kendrick, N. Balakrishnan, and S. Kotochigova, Universality and chaoticity in ultracold K+KRb chemical reactions, *Nature Comm.* **8**, 15897 (2017).
- N. Balakrishnan, Perspective: Ultracold molecules and the dawn of cold controlled chemistry, *J. Chem. Phys.* **145**, 150901 (2016).
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- B. K. Kendrick, J. Hazra, and N. Balakrishnan, The Geometric Phase Controls Ultracold Chemistry, *Nature Communications* **6**, 7918 (2015).

MaryKay Orgill

Professor

Department of Chemistry and Biochemistry

- Ph.D., Chemistry, Purdue University
- Fellow, Royal Society of Chemistry
- Fellow, American Chemical Society
- Former Chair, ACS Division of Chemical Education
- Email: MaryKay.Orgill@unlv.edu
- <https://www.unlv.edu/people/marykay-orgill>

Areas of Expertise

- Chemistry Education
- Biochemistry Education

Research Summary:

I am interested in using qualitative research techniques to examine and improve undergraduate chemistry teaching and learning. Currently, this involves looking at how students understand concepts and solve problems in chemistry classes, how they visualize different chemical concepts, how they use language to make sense of chemical concepts, and how a systems thinking approach to chemistry teaching might be used to help students learn chemistry more meaningfully. I have also been involved in a number of projects that provide professional development opportunities to faculty and K-12 teachers.



Postsecondary Underrepresented Minority STEM Students' Perceptions of Their Science Identity

Schetema Nealy MaryKay Orgill Charles R. Drew University of Medicine and Science
University of Nevada, Las Vegas

JOURNAL OF
CHEMICAL EDUCATION

Cite This: J. Chem. Educ. 2019, 96, 2720–2729

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Introduction to Systems Thinking for the Chemistry Education Community

MaryKay Orgill,^{*,†} Sarah York,[†] and Jennifer MacKellar[‡]

[†]Department of Chemistry and Biochemistry, University of Nevada, Las Vegas, Las Vegas, Nevada 89154, United States

[‡]ACS Green Chemistry Institute, American Chemical Society, Washington, D.C. 20036, United States



Supporting English Language Learners in College Science Classrooms Insights from Chemistry Students

Eshani N. Lee, MaryKay Orgill, & CarolAnne Kardash

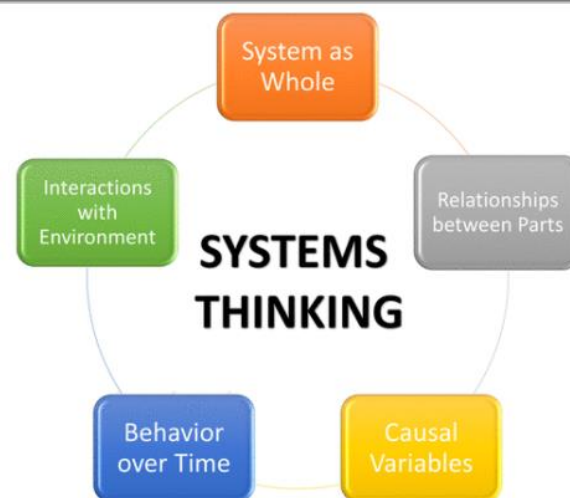
THEORETICAL
FRAMEWORKS
for RESEARCH in
CHEMISTRY/SCIENCE
EDUCATION

GEORGE M. BODNER
MARYKAY ORGILL

RESEARCH REPORT

Faculty Perceptions of the Factors Influencing Success in STEM fields

Eshani Gandhi-Lee¹, Heather Skaza, Erica Marti, PG Schrader, MaryKay Orgill
University of Nevada, Las Vegas, USA



DOI: [10.1039/C4RP00256C](https://doi.org/10.1039/C4RP00256C) (Paper) *Chem. Educ. Res. Pract.*, 2015, **16**, 731-746

Biochemistry instructors' perceptions of analogies and their classroom use

MaryKay Orgill ^a, Thomas J. Bussey ^b and George M. Bodner ^c

^aDepartment of Chemistry and Biochemistry, University of Nevada, Las Vegas, USA. E-mail: marykay.orgill@unlv.edu

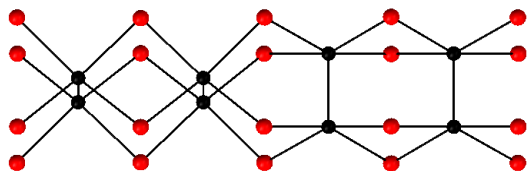
^bDepartment of Chemistry and Biochemistry, University of California, San Diego, USA

^cDepartment of Chemistry, Purdue University, USA

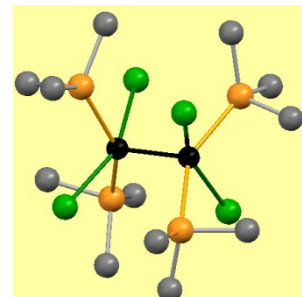
→ Synthetic and coordination chemistry

Technetium binary and ternary halide compounds

Compounds with multiple metal-metal bonds



TcCl_2 : a unique structure-type



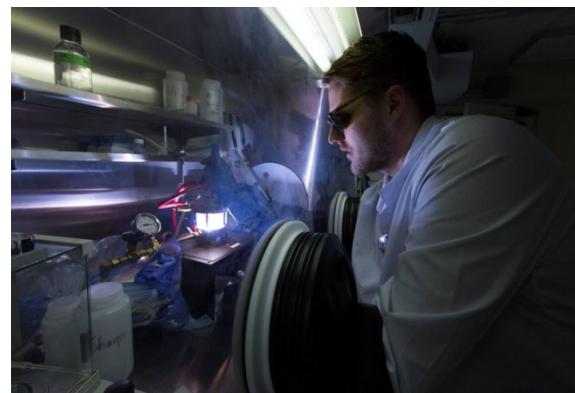
$\text{Tc}_2\text{Cl}_4(\text{PMe}_3)_4$

→ Chemistry relevant to remediation and fuel cycle applications

Separation, vitrification, and waste forms (alloys)



Demonstration of the separation of uranium from technetium for fuel cycle application

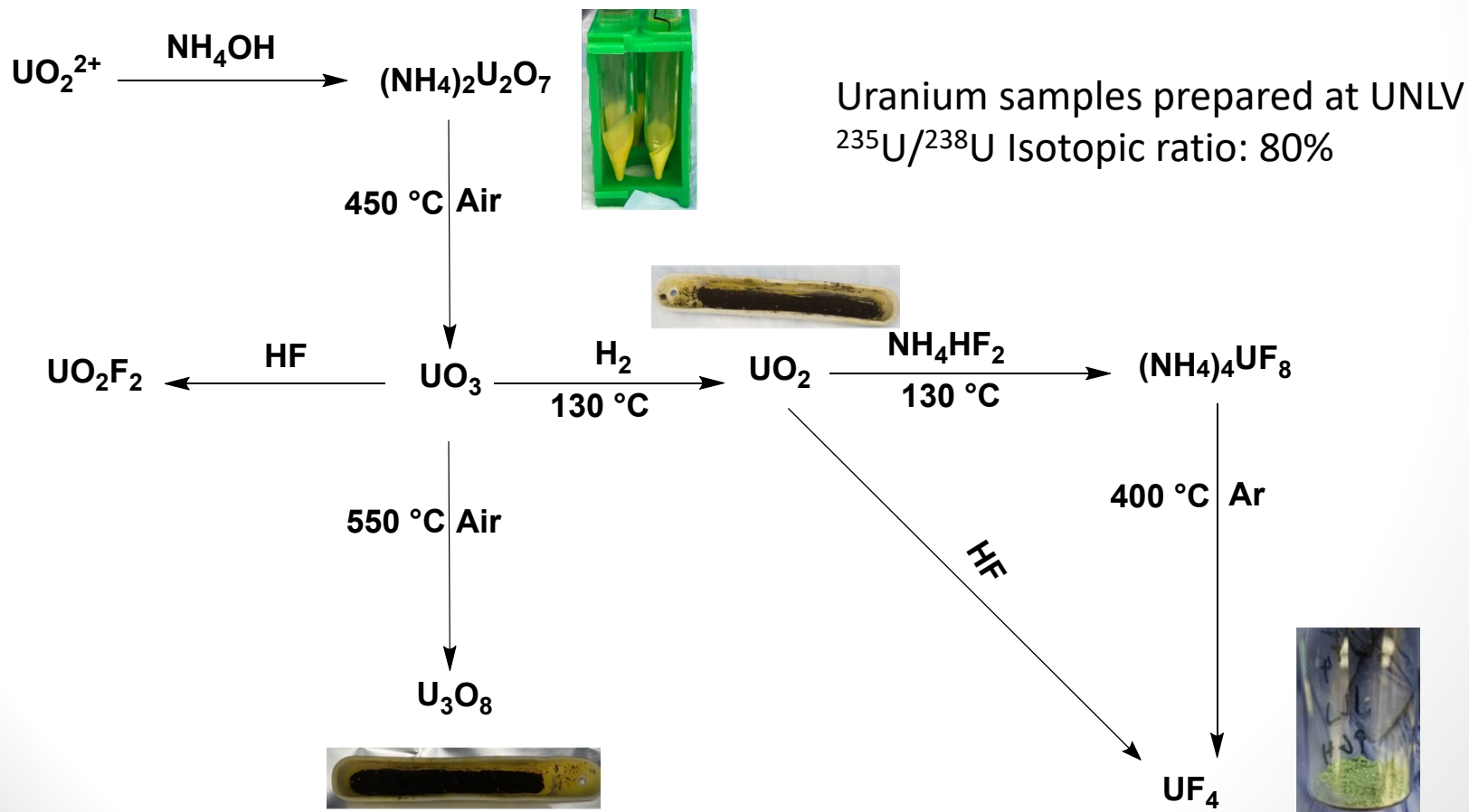


Preparation of U-Tc alloys by arc melting

→ Collaborative work relevant to nuclear forensics

Analysis of Uranium Isotopic Ratios by Thermal Ionization Mass Spectrometry (TIMS)

- Uranium compounds found throughout the fuel cycle (UO_2 , U_3O_8 , UF_4) prepared at UNLV
- $^{235}\text{U}/^{238}\text{U}$ isotopic ratio measurements using TIMS at LANL



Colloidal Quantum Dots: Single-Photon Emitters & Sensor Materials

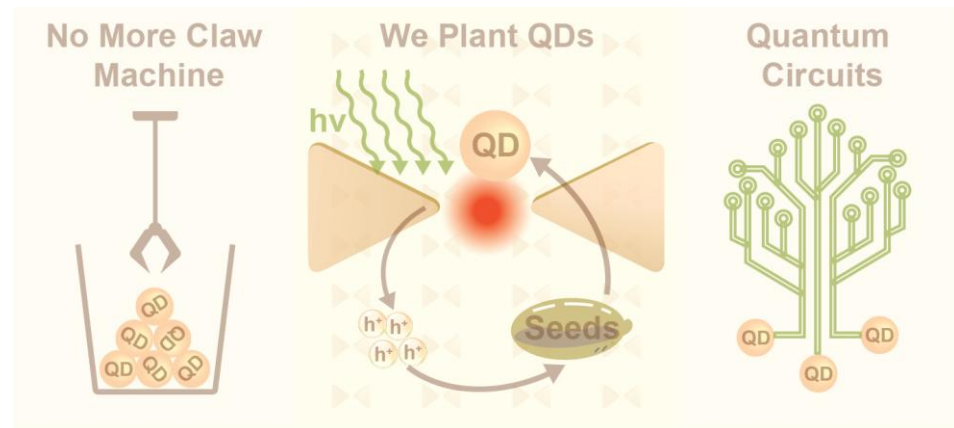
SWIR colloidal quantum dots for LIDAR

- **Dr. Tian Qiao**
- Assistant Professor
- Department of Chemistry and Biochemistry
- Email: tian.qiao@unlv.edu
- Website: qtlab.sites.unlv.edu/

Expertise

- Synthesis of Colloidal Quantum Dots
- Optical Spectroscopy
- Single Photon Emitters
- Shortwave IR Emitters

On-demand synthesis of colloidal quantum dots



Measuring student motivation in chemistry classrooms

- **Dr. Guizella A. Rocabado**
- Assistant Professor of Chemistry
- Department of Chemistry and Biochemistry
- Email: guizella.rocabado@unlv.edu



Expertise

My expertise lies in chemistry education research, with a particular focus on the development of instruments and the application of advanced measurement and statistical techniques to evaluate the effectiveness of evidence-based instructional practices. A central passion and area of expertise is understanding and measuring student attitudes and motivation, particularly as they relate to engagement and success in chemistry learning environments. I specialize in designing tools that capture meaningful learning outcomes, affective dimensions, and instructional impacts. In addition to my methodological strengths, I bring experience in science communication, translating complex scientific ideas into accessible language for diverse audiences. I also have expertise in program evaluation, using data-driven approaches to assess and improve the design, implementation, and outcomes of educational initiatives in STEM fields.

Biochemistry – Interrogate Cell Signaling Pathways by Molecular, Genetic and Proteomic Approaches

Dr. Hong Sun

Associate Professor

Department of Chemistry and Biochemistry

Telephone: (702) 774-1485

Email: hong.sun@unlv.edu

Expertise

Cell signaling

Cancer cell biology

Stem cell biology

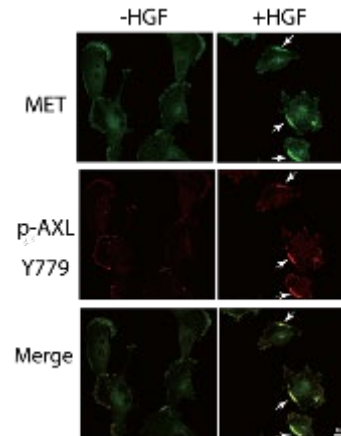
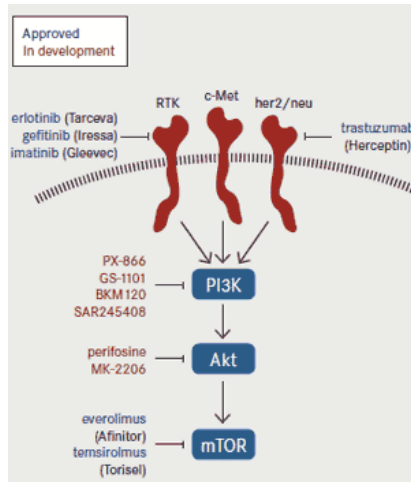
Mouse conditional knockout models

Regulation of cell surface receptor RTKs localization and activation

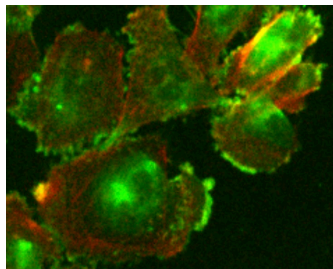
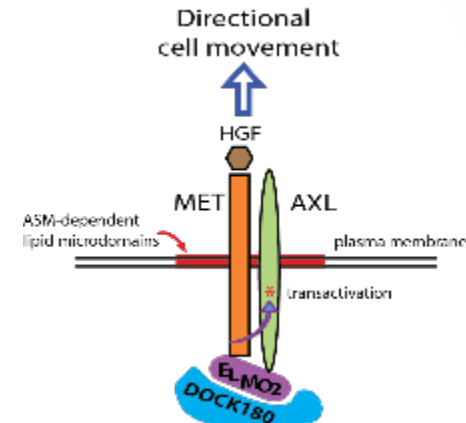
Problem: cancer cells often have multiple receptors (RTKs) activated on cell surface, making targeting inefficient

Co-activation of AXL-MET RTKs: HGF (ligand for MET) also activates AXL, detected by antibodies for p-AXL-Y779

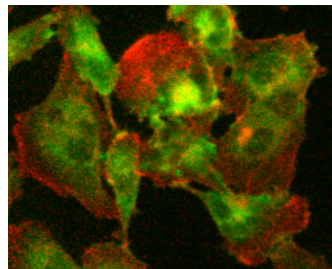
A novel mechanism discovered for RTK-Co-activation and signaling for cancer cell migration and invasion



Li et al., J. Biol. Chem. (2018) 293:15397-15418.



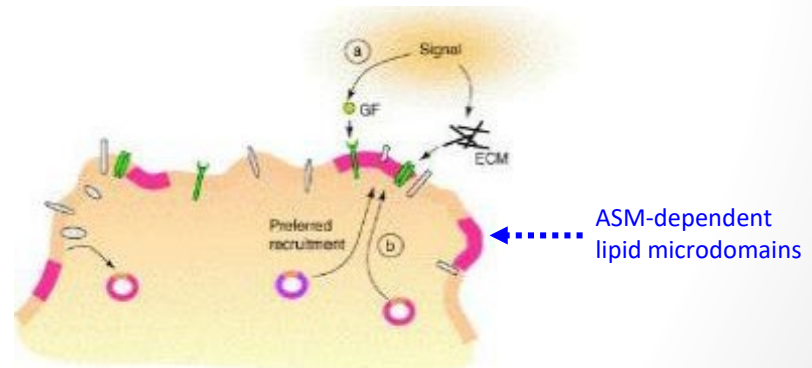
Vehicle



ASM Inhibitor

ASM inhibition prevents the MET RTK to be transported to the cell surface, as revealed by immunostaining (MET, green label; and a control cell surface protein, red label).

Zhu et al, J. Cell Science (2016) 129, 4238-4251.

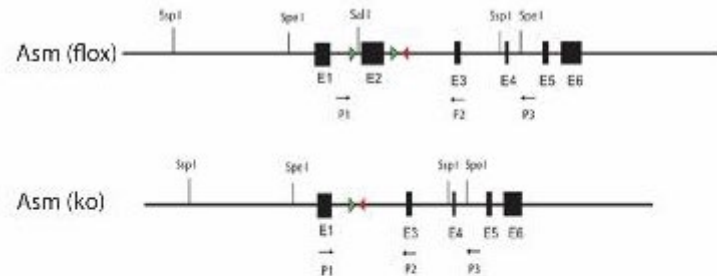


Mass-Spectrometry analyses revealed that the ASM-regulated local lipid microdomains were enriched with many signaling molecules.

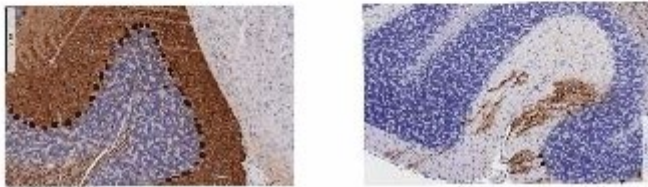
Xiong et al. Biol. Open (2019) 8, bio040311.

Regulation of stem cell maintenance: insights from the genetic studies in novel mouse knockout models

A. Gene locus



B. Loss of Purkinje neurons in cerebellum



Purkinje neurons immunostained with D28K antibody.

D. ASM mutant MSCs failed to become bone-forming cells

Wild-type MSCs

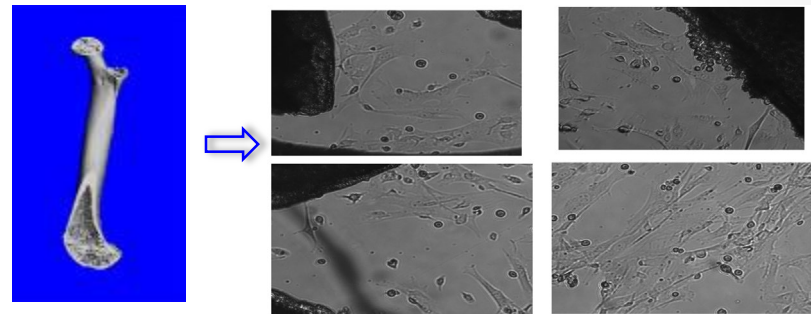


ASM mutant MSCs

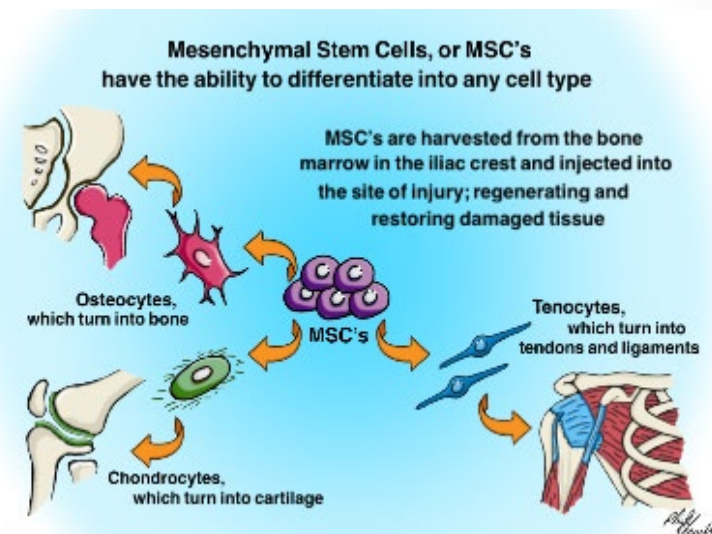


(*in vitro* differentiation assay, then stained with alizarin red)

C. Mesenchymal stem cells (MSCs) cultured from bones

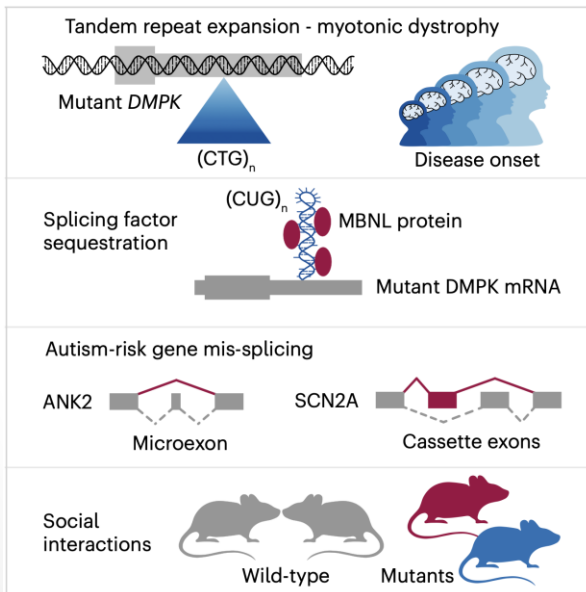


E. Potentials of MSCs for tissue repair



Neurogenetics

- **Dr. Łukasz J Sznajder**
- Assistant Professor
- Department of Chemistry and Biochemistry
- Email: lukasz.sznajder@unlv.edu



Expertise

- Neurodevelopmental and neuromuscular disorders
- Genetics, RNA biology, and bioinformatics
- Disease mechanisms and gene therapy

Stem Cells, Genetic and Epigenetic Inheritance, Cancer

Dr. Hui Zhang

Associate Professor

Department of Chemistry and Biochemistry

Phone: (702)774-1489

Email: hui.zhang@unlv.edu

Expertise:

- Biochemistry and developmental regulation of pluripotent embryonic stem cells, adult stem cells, and related diseases
- Regulation of chromatin structure, epigenetics, and transcription by protein methylation and ubiquitin enzymes
- DNA replication, DNA repair, cell cycle, genome instability, and cancer
- Targeting the vulnerability of human cancers

Current research areas in Zhang Laboratory:

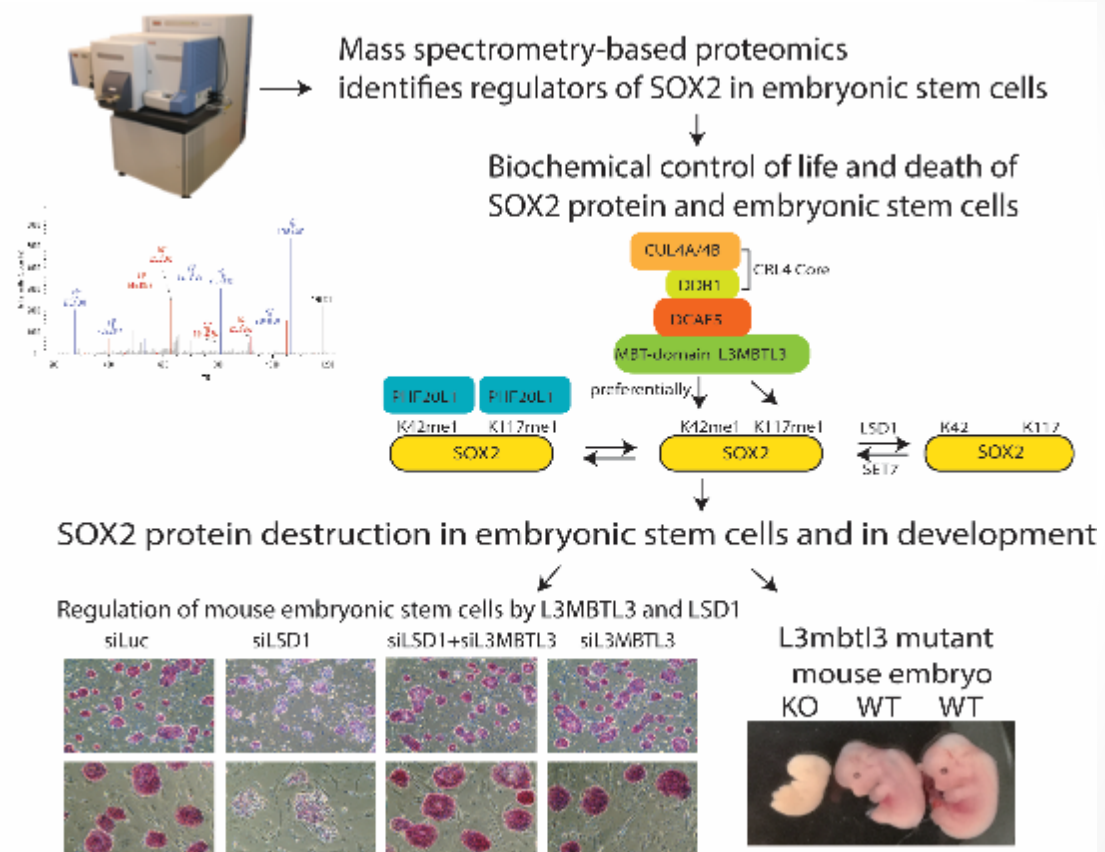
• Discover novel proteins essential for stem cell regulation, examples:

How SOX2 is regulated in embryonic stem cells and many other stem cells in development?

- Sox2 is a master stem cell protein that controls the self-renewal and pluripotency of embryonic stem cells that can develop into any tissue types of cells in development.

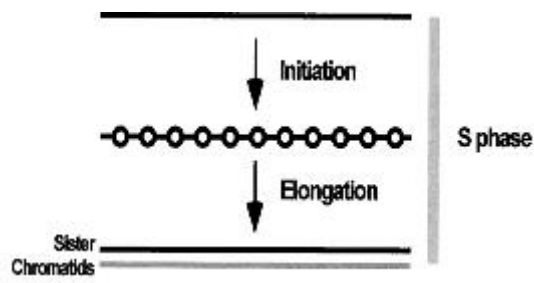
- SOX2 is also a master regulator of many adult stem cells including the stem/progenitor cells for brain, lung, colon, breast, liver, cochlea/ear, skin, retina, ovary, bladder, esophagus, and testes for tissue repair/regeneration.

- Artificial Sox2 expression (together with Oct4 and accessory Klf4, and Myc) can virtually convert any differentiated cells, such as skin or blood cells, into induced pluripotent stem cells (iPSCs), the embryonic stem cell-like cells.

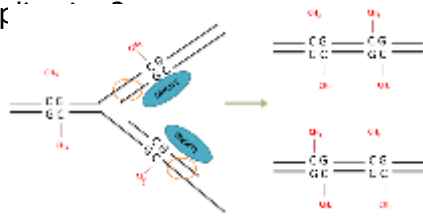


- Discover novel proteins important for epigenetic and cell cycle regulation, examples:
- Regulation of DNA replication and DNA methylation in normal and cancer cells**

How DNA replicates only once in one cell cycle in animal cells? How re-replication is prevented that causes genome instability and c

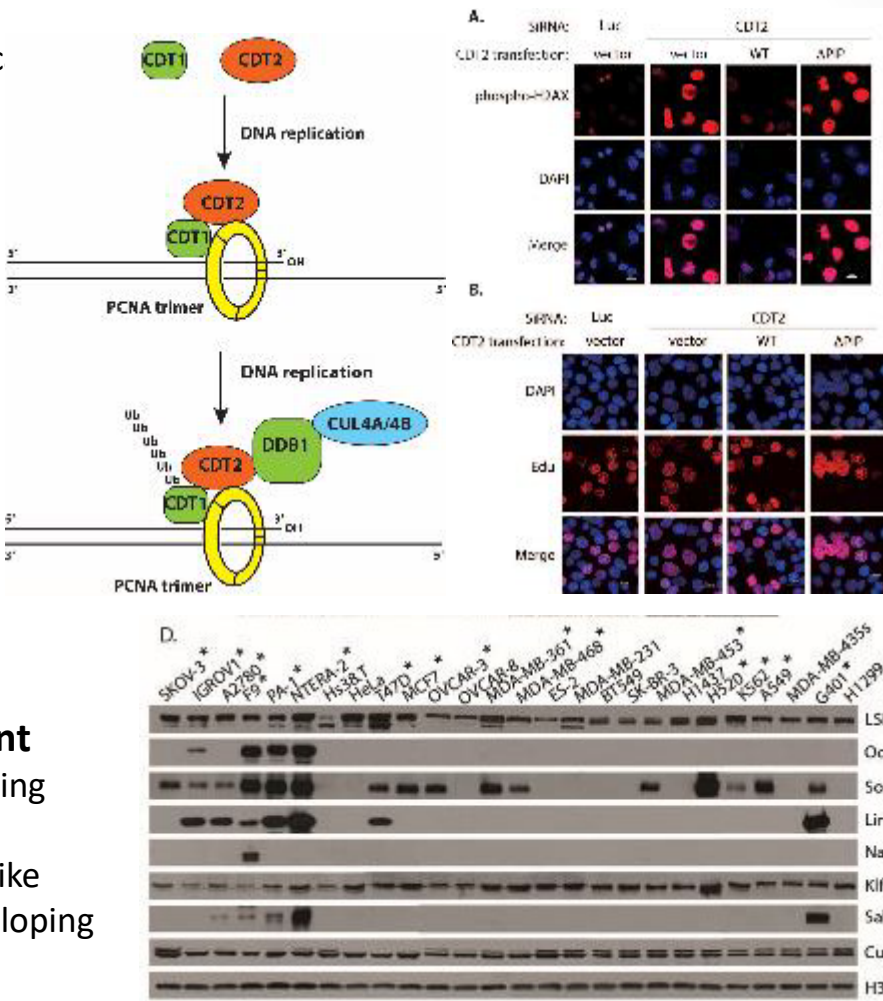


How the fidelity of epigenetic DNA methylation is maintained during DNA replication



Cancer Biology and therapy development

Elevated SOX2 levels cause many cancers including cancers of lung, brain, breast, and ovary. These cancers are hard to treat because they behave like stem cells due to SOX2 expression. We are developing novel LSD1 chemical inhibitors that target the epigenetic vulnerability of these cancer cells.



The presence of SOX2 in different types of cancer cells is responsible for sensitivity towards our LSD1 inhibitors. *: Sensitive to LSD1 Inhibitors