INTERESTED IN
CHEMISTRY RESEARCH?

SUMMER RESEARCH INFO SESSION



OCTOBER 23, 2026 | 3:45 PM - 4:45 PM

DRUCK 016

Join members of the Chemistry Department for our Summer

Outline for today's session



Introduce Chemistry Faculty and Their Research



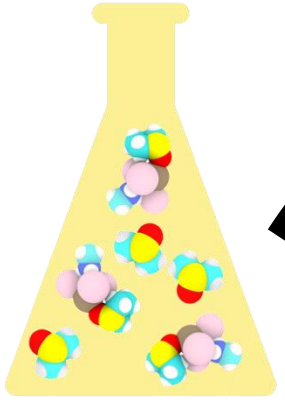
Summer Research Opportunities at Bowdoin



Summer Research Opportunities Beyond Bowdoin

From Solution to Crystals: How Can We Make Better Materials?

Ortoll-Bloch Lab
Materials chemistry

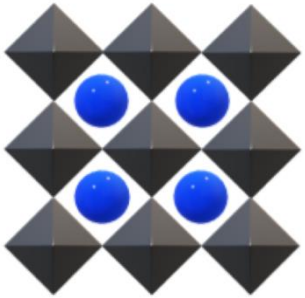


Growth solution

Crystallization **conditions**

Crystallization **pathways?**

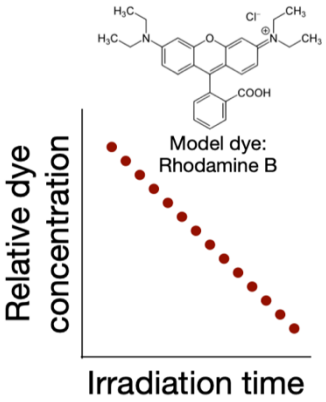
correlations?



Crystalline material

Crystallization outcome (crystal phase/form, shape, size, assembly)

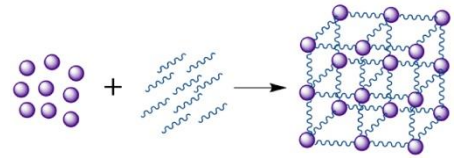
correlations?



Performance in application

Exploring crystallization pathways is important for many systems and applications

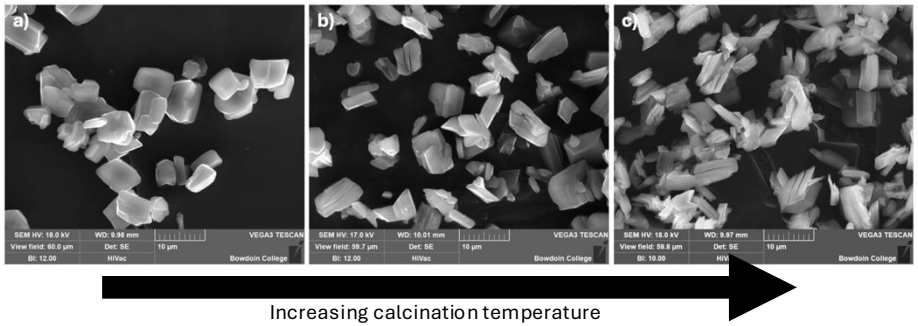
Metal–organic frameworks

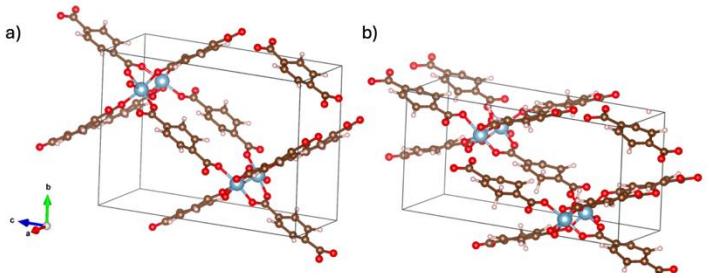


Metal ions or clusters

Organic linkers

Metal–organic framework





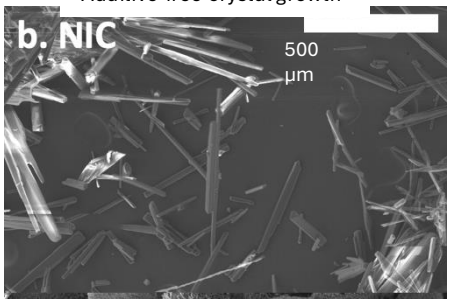
MIL-53(Al) large-pore phase

MIL-53(Al) novel phase

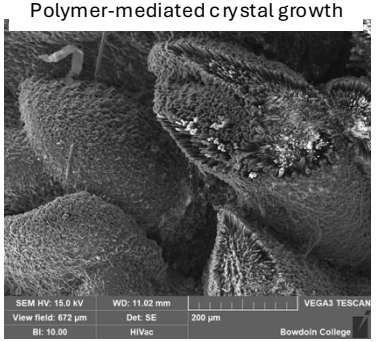
Pharmaceutical crystals and cocrystals

Additive-tuned crystallization of pharmaceuticals

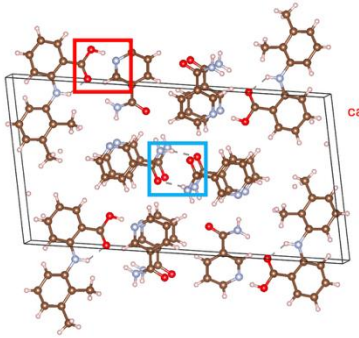
Additive-free crystal growth

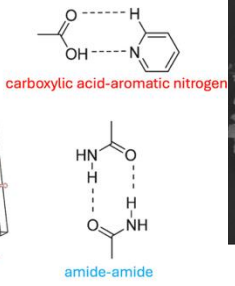


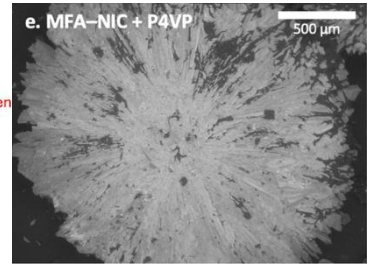
Polymer-mediated crystal growth



Mefenamic acid–nicotinamide cocrystal







Applications of analytical chemistry to address questions in chemistry and biology











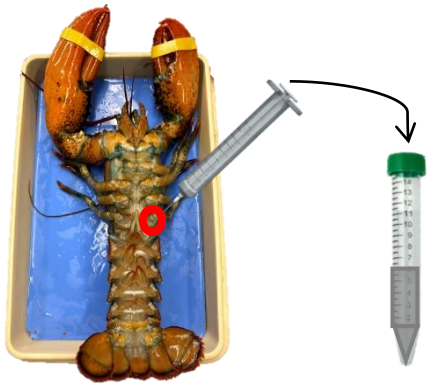
Stemmler Laboratory

Project 1: What are the identities of antimicrobial peptides (AMPs) present in lobster circulatory fluid? What provokes their production and what are their activities?

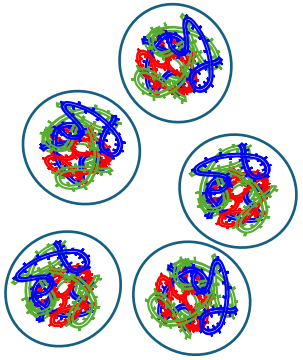


Goals: Identify novel AMPs and enhance knowledge regarding the crustacean innate immune system

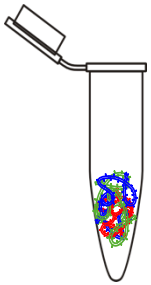
Approach: Use mass spectrometry, genomics, and transcriptomics to characterize AMPs from the lobster, *H. americanus*



Collect hemocytes (cells)



Extract AMPs

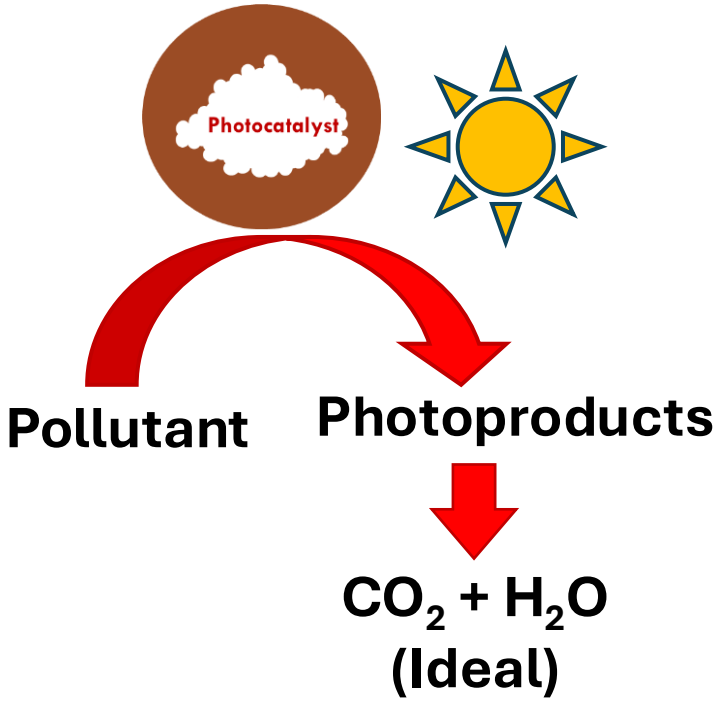


Tools:
Chromatography
Bioinformatics
Mass Spectrometry

Purify and identify

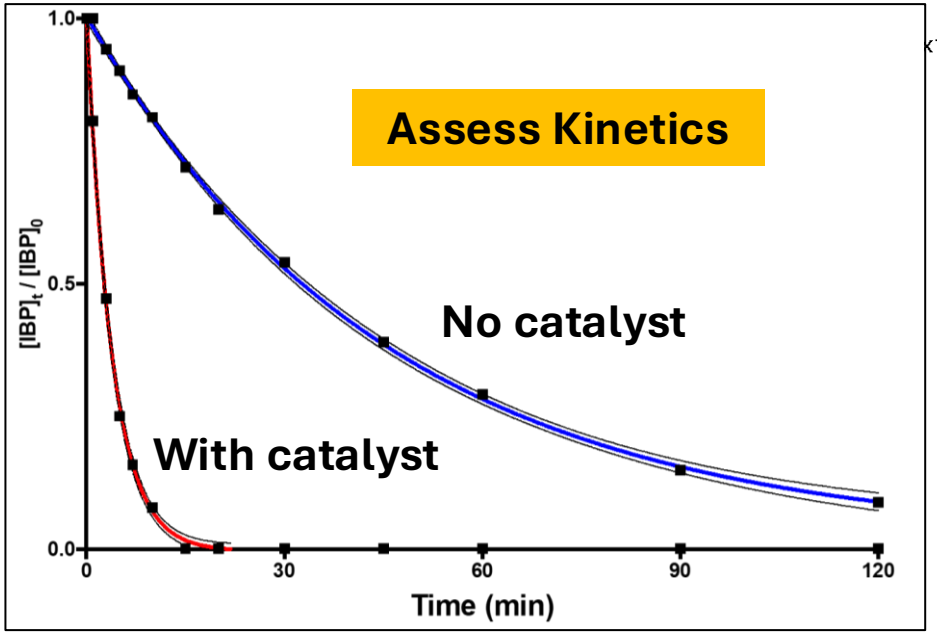
Activity testing

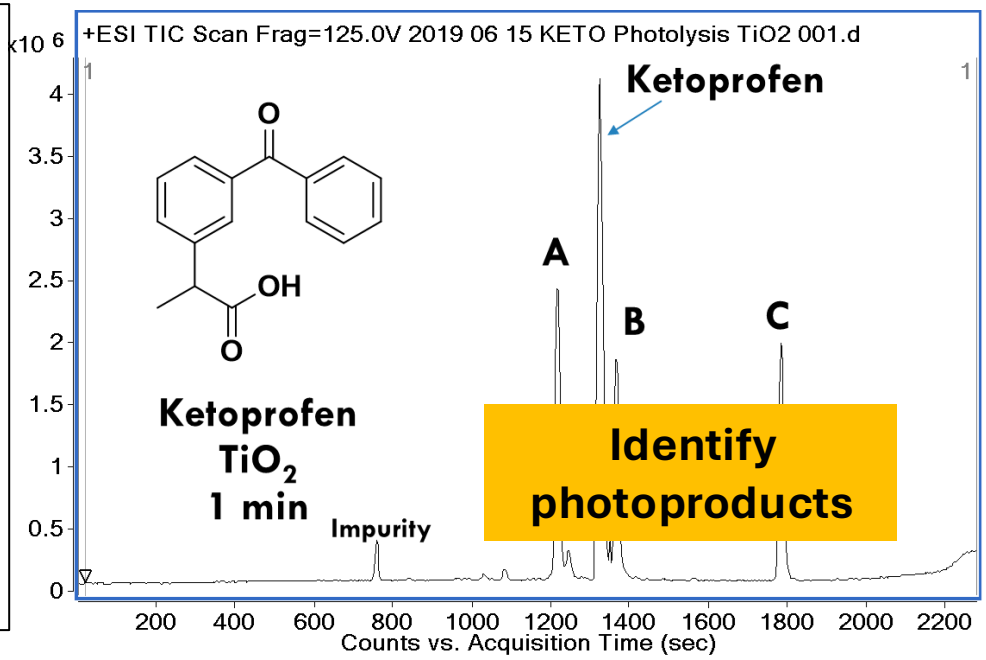
Project 2: What products are produced by photodegradation of pharmaceuticals with and without a photocatalyst?



Goals: To understand rates and degradation pathways relevant to remediating contaminated water

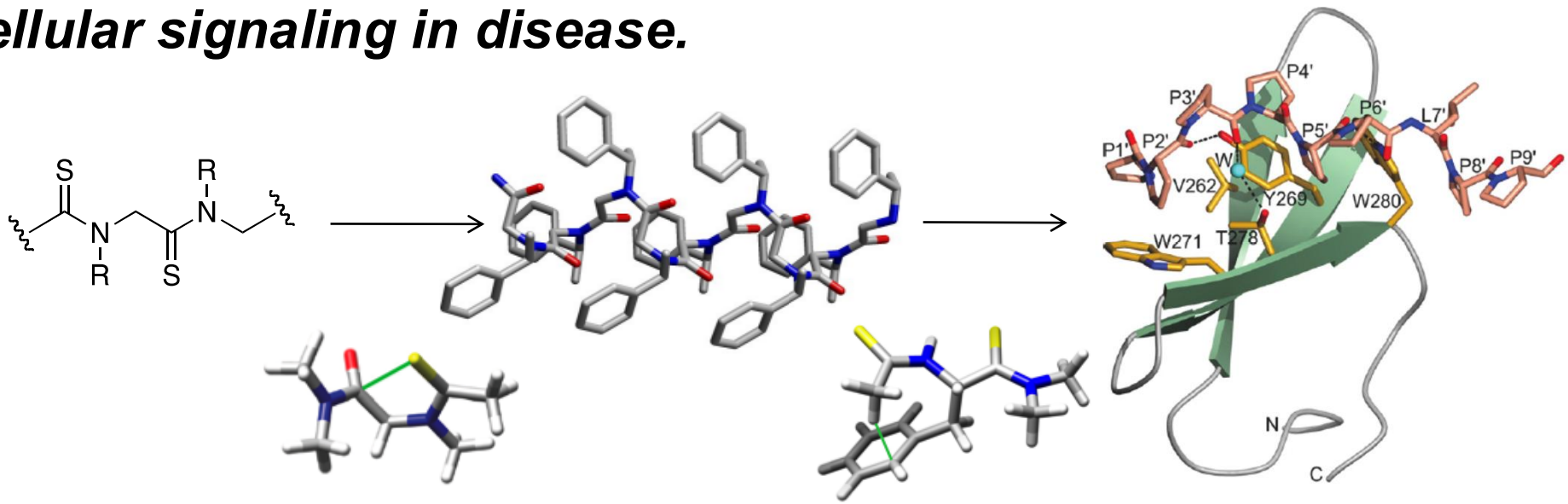
Approach: Use chromatography and mass spectrometry to monitor kinetics and identify photoproducts and assess photocatalyst efficacy





The Gorske Lab: Synthesis of biomimetic molecules for chemical biology and catalysis

Synthesis of protein mimics for investigating the roles of cellular signaling in disease.



$n \rightarrow \pi^*$ interactions

C–H$\cdots\pi$ interactions

<u>protein-protein interactions</u>

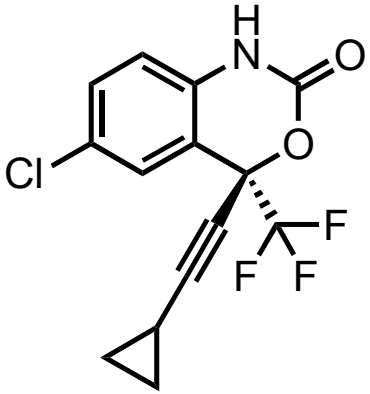
- **cellular signaling**
- **Alzheimer's disease**
- **cancer**

<u>common techniques</u>

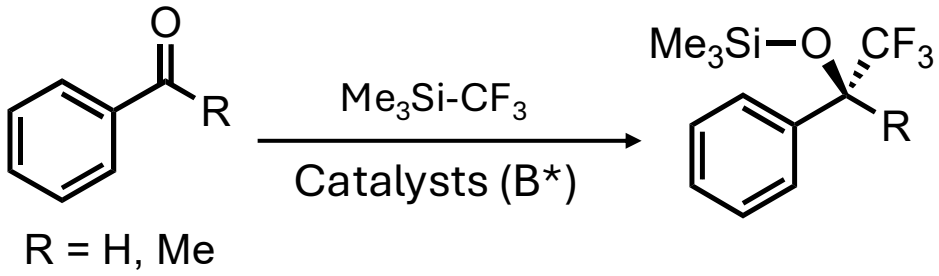
chemical synthesis – solution and solid phase
NMR spectroscopy and X-ray crystallographic analysis
HPLC purification and mass spectrometry
Protein binding assays

The Gorske Lab: Synthesis of biomimetic molecules for chemical biology and catalysis

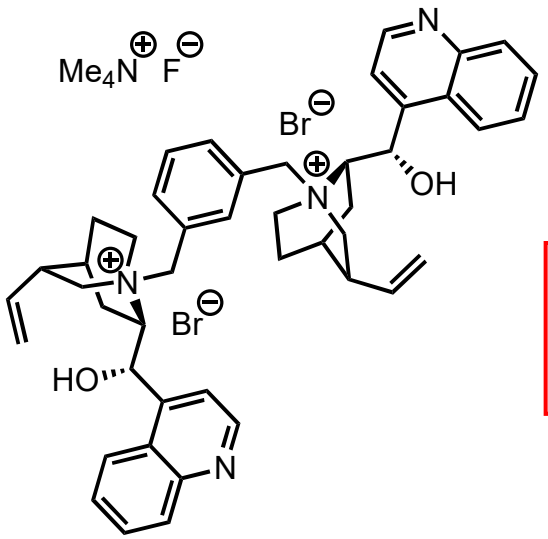
Developing enzyme mimics for trifluoromethylation



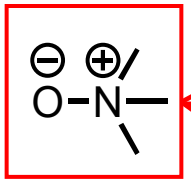
Efavirenz

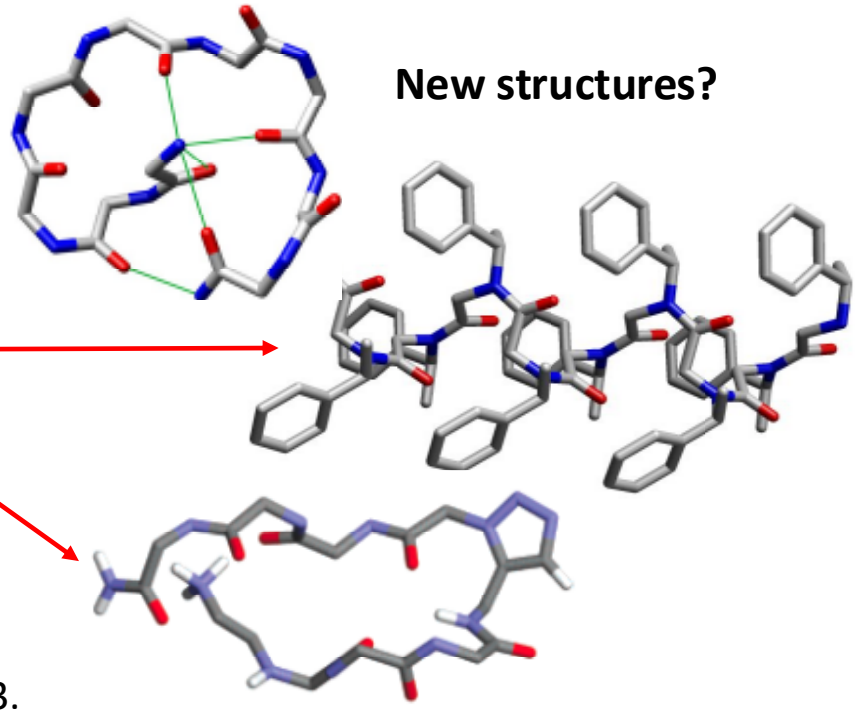


R = H, Me



R = Me: 70-94% ee





N. Shibata *et al*. *Tetrahedron: Asymmetry* **2008**, *19*, 2633.

Chemicals in the Environment: Risk, Resistance and Responsibility

Dharni Vasudevan
Chemistry Department and Environmental Studies Program
dvasudev@bowdoin.edu
Druck/Cleaveland 156

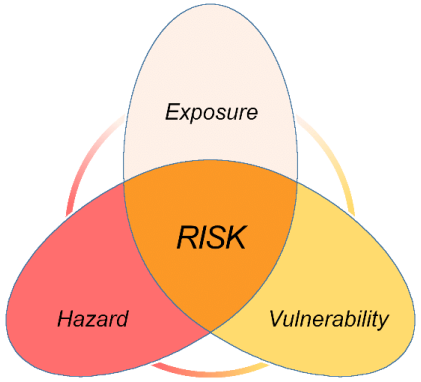
Chemicals in the environment pose RISK

We use chemicals

Chemicals get out and move

Chemicals may cause problems

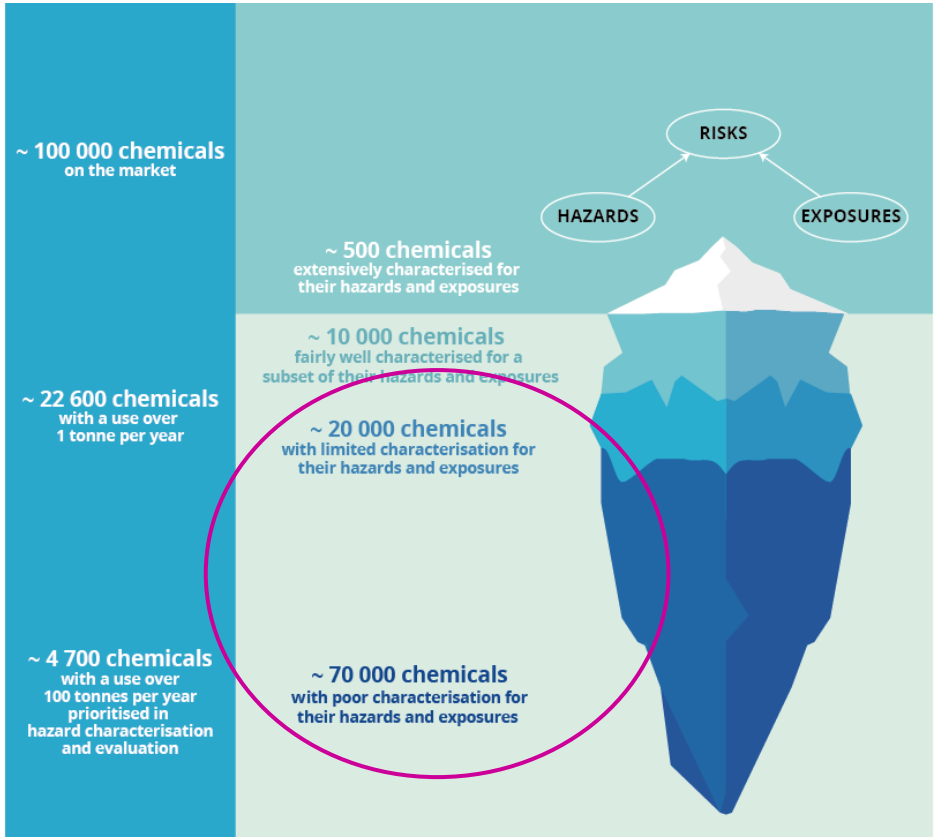
Life Sustaining and Life Endangering



OUR CURRENT FRAMEWORK

- Community must prove harm
- Chemicals are innocent until proven guilty
- Harm is usually not a surprise
- The right to manufacture or dispose is presumed but the right to not be exposed has to be earned
- Burden of Proof: what counts as knowledge, what level of proof, and at what cost

KNOWLEDGE GAP and REGULATORY GAP



https://www.eea.europa.eu/signals/signals-2020/articles/living-healthily-in-a-chemical-world

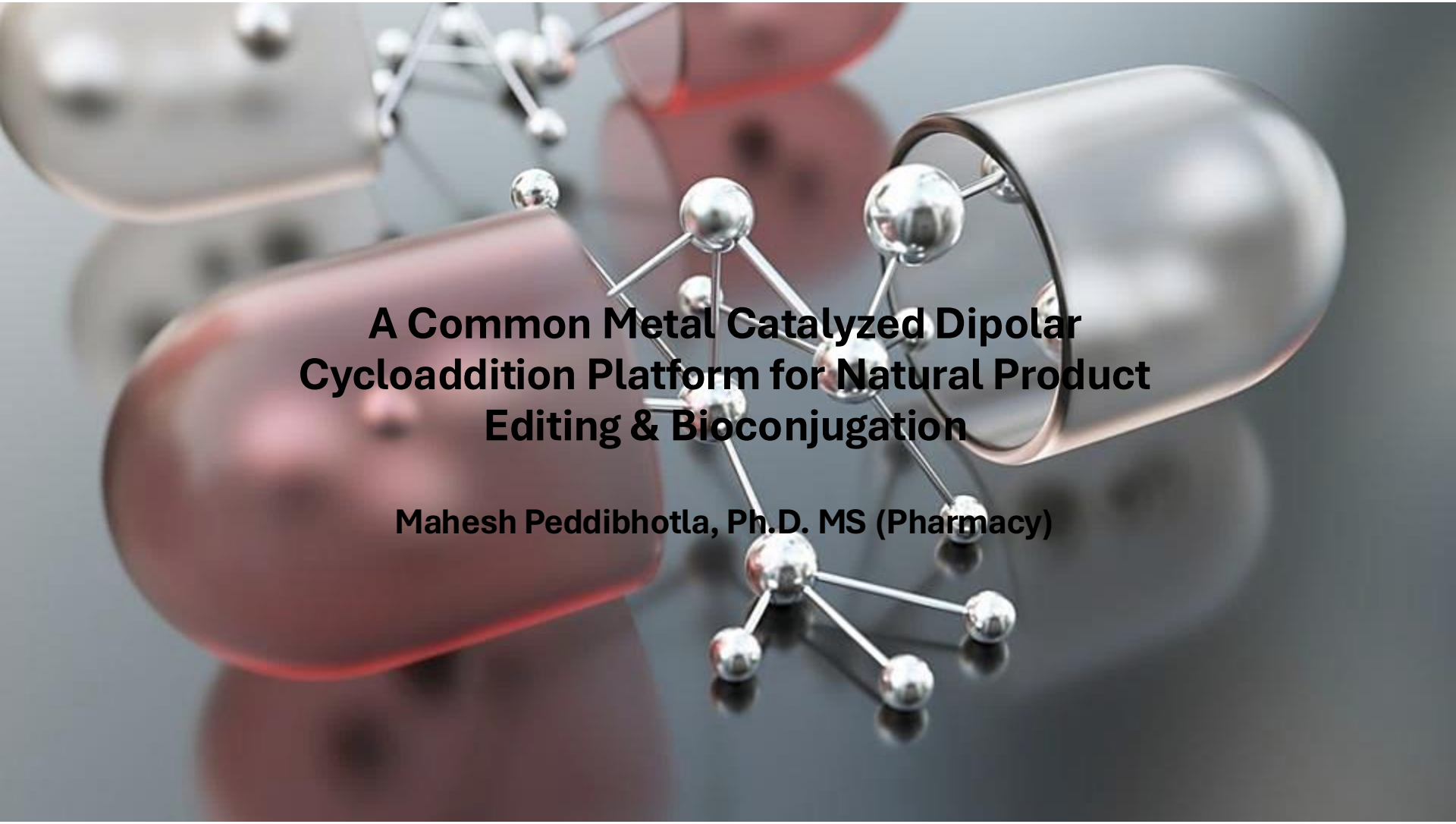


Fool Me Once

On May 25, 2016 approximately five million U.S. citizens woke up to learn that their drinking water contained perfluorooctanoic acid (PFOA) and perfluorooctyl sulfonate (PFOS) at concentrations exceeding the revised health advisory levels of the U.S. Environmental Protection Agency (EPA). The news that another set of contaminants had found its way into the water supply further undermined public confidence in drinking water supplies—a trust that had been already been shaken by the lead problems in Flint, Michigan. But to our readers, widespread contamination by poly- and perfluorinated substances (PFAS) was old news: since 2002, close to 300 papers published in *ES&T* have documented the presence of these compounds in water supplies, wildlife, and humans. We also published papers describing the myriad sources of these compounds, their mobility in the subsurface and the challenge that the compounds pose to conventional water treatment technologies. Readers who have been paying attention to this issue were not surprised by this latest drinking water crisis. Rather, they were puzzled by why it took for regulators to act.

ACS Publications © 2016 American Chemical Society

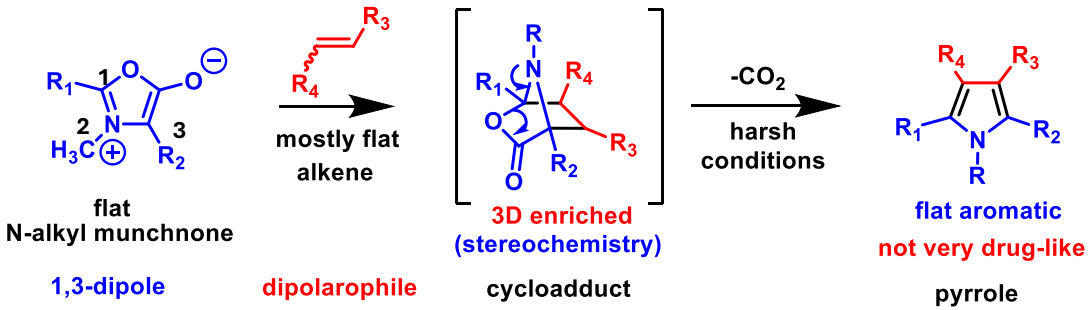
David Sedlak, July 2016



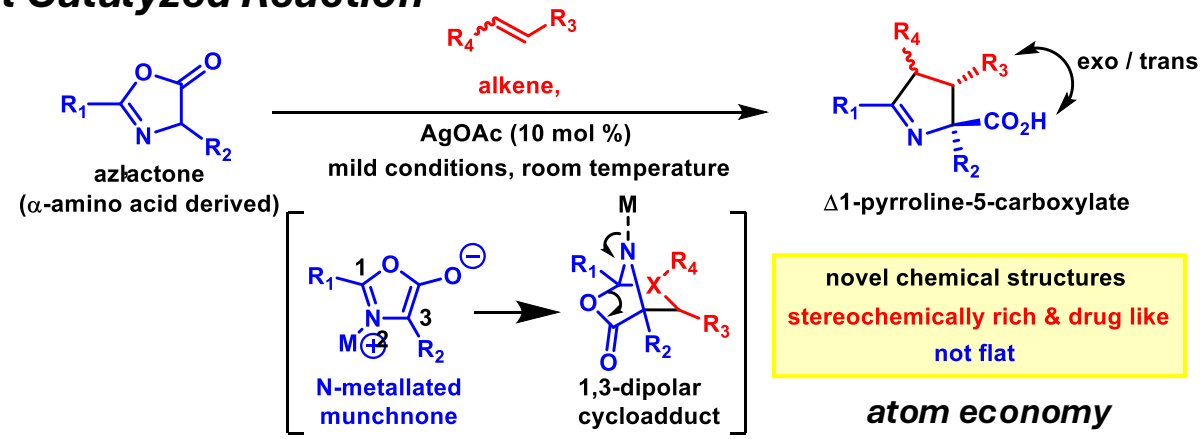
A Common Metal Catalyzed Dipolar Cycloaddition Platform for Natural Product Editing & Bioconjugation

Mahesh Peddibhotla, Ph.D. MS (Pharmacy)

Conventional Münchnone –Alkene Dipolar Cycloaddition Reaction

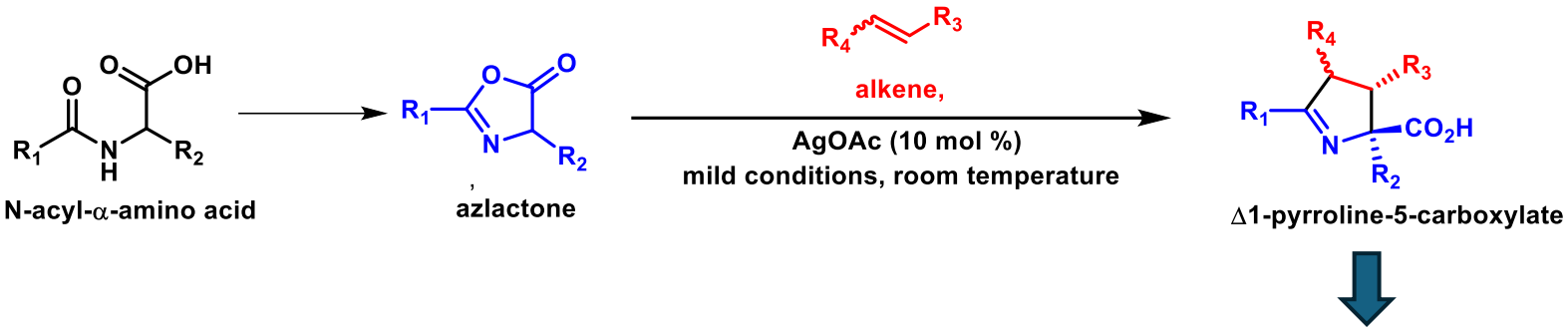


New Metal Catalyzed Reaction



Peddibhotla, S. e. al. J. Org. Lett. 2002, 4, 3533. & J. Am. Chem. Soc. 2004, 126(40), 12776-12777.

New Research & Innovation



Expanding scope & selectivity of reaction:

- ❑ amino acids – natural and unnatural
- ❑ N-acyl substituents – alkyl, aryl, heteroaryl, etc.

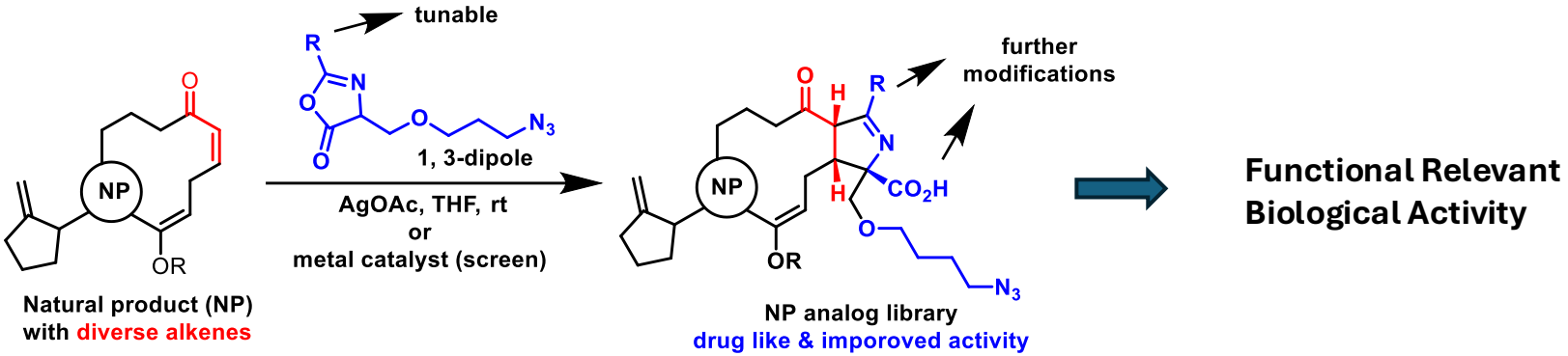
- ❑ Alkene electronic nature – electron poor, neutral, electron rich,
- ❑ Alkene substitution - acyclic, exocyclic, cyclic, strained, etc.

- ❑ Lewis acid screening & tuning – Hard, medium, soft acids
- ❑ Chiral Ligands & influence on stereochemistry

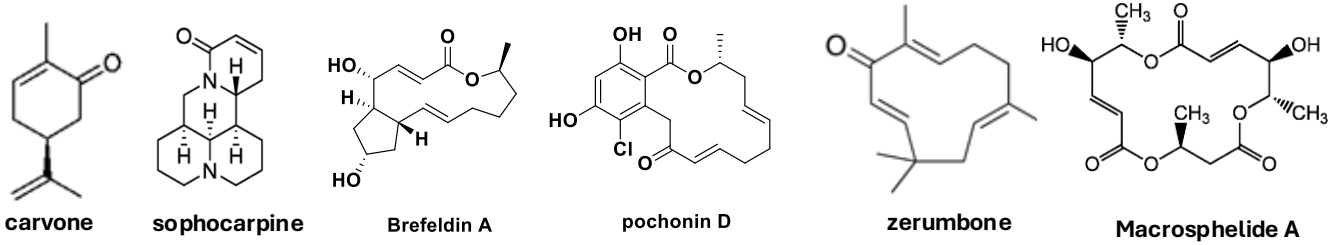
Evaluate biological activity (anti-infective, anti-cancer, CNS, metabolic)

Fisk JS, Tepe JJ. *J Am Chem Soc*. **2007**, 129(11):3058-9.

Selective Natural Product Editing & Activity Evaluation

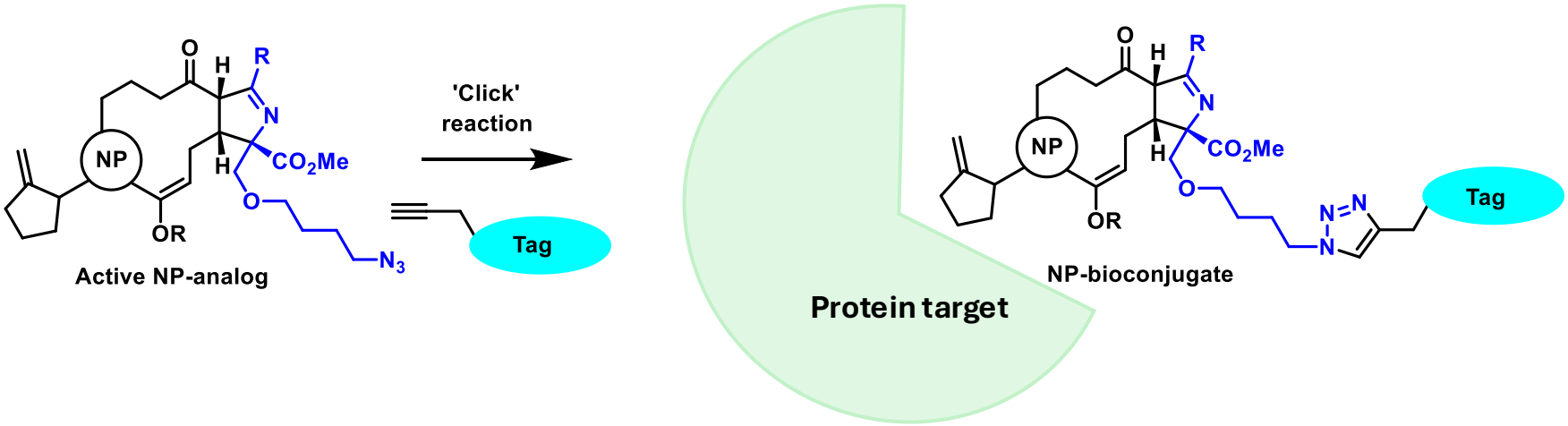


Bioactive Alkene Containing Natural Products



Peddibhotla, et. al. *J Am Chem Soc*. **2007,**129(40):12222-31
Robles O. et. al. *Org Lett*. **2012**,14(6):1394-7

Bioconjugation, Target Validation & MOA studies



Diverse Tags = Tunable application

E3 ligase binder = PROTAC/degrader
Biotin = Target ID
Fluorophore = Imaging
Photocrosslinker = target binding/engagement
Drug delivery

Peddibhotla, et. al. *J Am Chem Soc*. **2007,**129(40):12222-31

Biological Target Identification & Validation – *A key Bottleneck in New Drug Discovery*

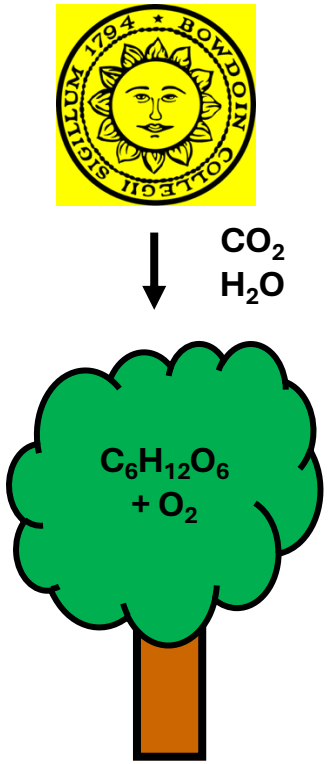
- Like target identification, target validation is a crucial step in drug discovery.
- Target validation ensures that a molecular target is directly involved in a disease mechanism - MOA
- Direct modulation of the target needs to be correlated to have a therapeutic benefit in models and patients - Efficacy
- Crucial evidence for further development



The Takematsu Lab

How do we convert light into the movement of charges?

Protons and harnessing solar energy



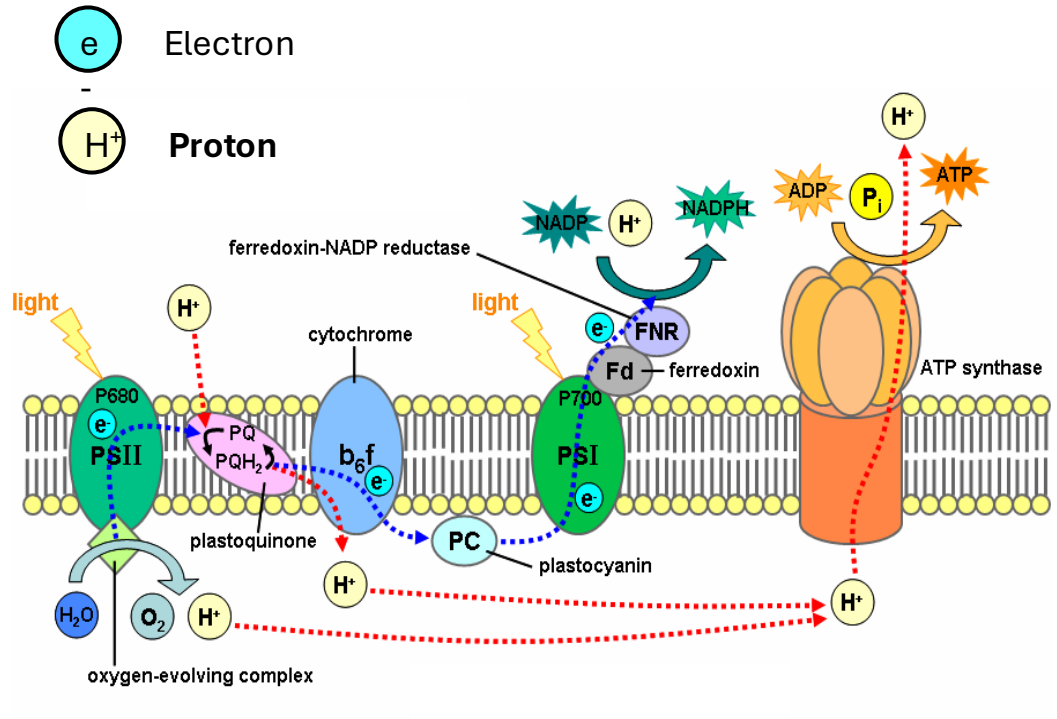
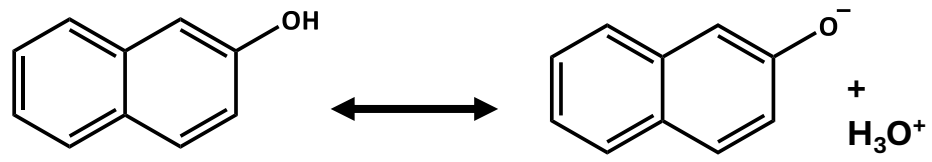


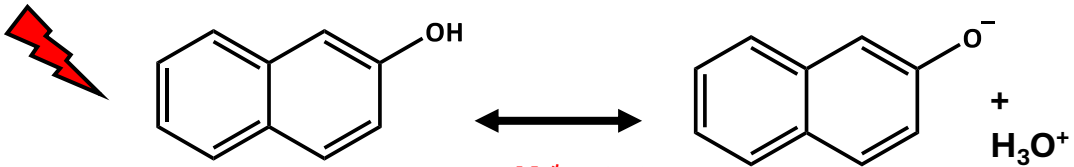
Image from Wikipedia

Photoacids: excited state proton transfer (ESPT)



2-naphthol (2OH)

pK_a = 9.5



2-naphthol (2OH)

pK_a^* = 2.8

In the excited state, we can access different reaction pathways!

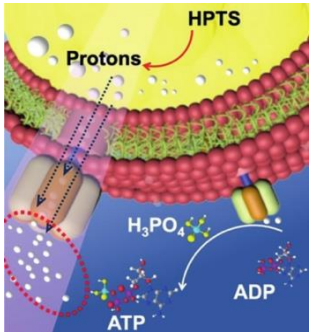
Review: Agmon. JPC A 2004

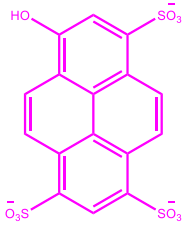
including Weller & Förster, Laws & Brand, Tolbert & Haubrich, Huppert, Pines, Fleming, Gutman, Fayer, etc.

A Broad Range of Photoacids

Imagination and creativity are parts of science

Biomimetic model of chloroplast

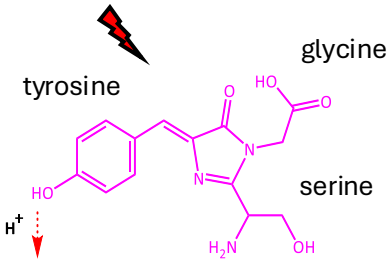




Li et al. Angewandte Chemie 2019

Green Fluorescent Proteins

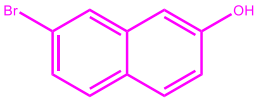


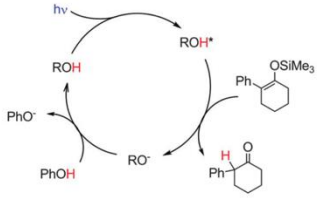


Aequorea Victoria jellyfish

Photocatalysis

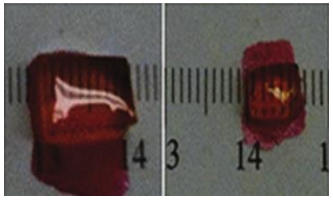




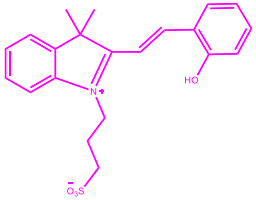


Das et al. Chem. Comm. 2016

Manipulation of polymers



Hydrogel: before/after radiation

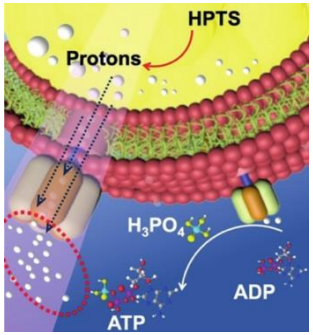


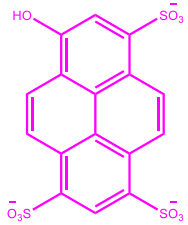
Shi et al. JACS 2011

A Broad Range of Photoacids + Photobases

Imagination and creativity are parts of science

Biomimetic model of chloroplast

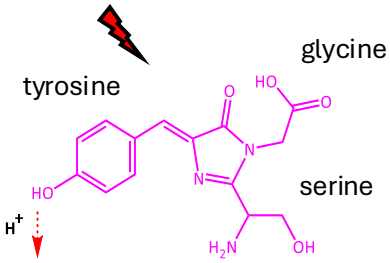




Li et al. Angewandte Chemie 2019

Green Fluorescent Proteins

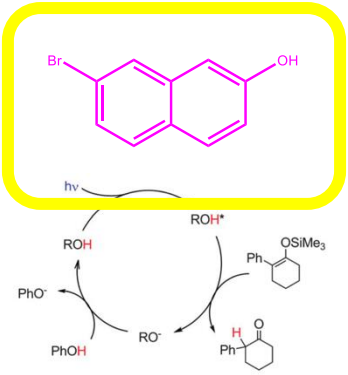




Aequorea Victoria jellyfish

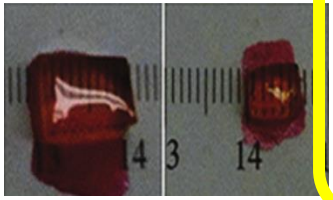
Photocatalysis

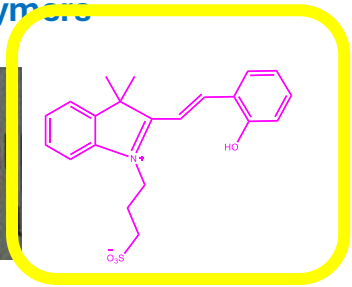


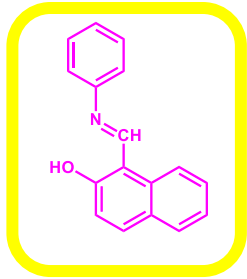


Das et al. Chem. Comm. 2016

Manipulation of polymers







Hydrogel: before/after radiation

Shi et al. JACS 2011

The wonderful thing about science is the community and how it just keeps growing….

Indy Pisitkasem







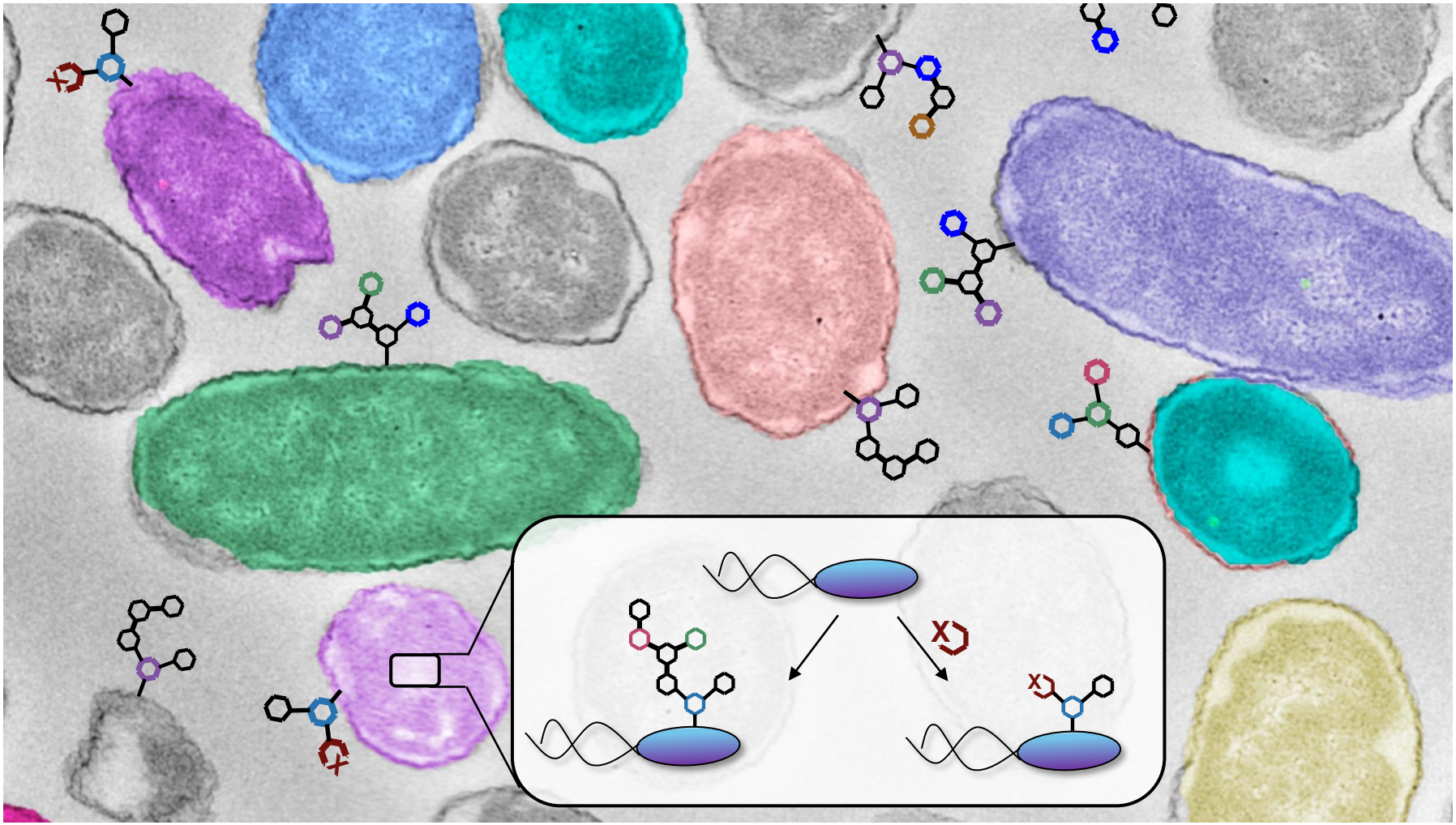
Hannah Crowley

Check out posters next Friday by:

Ben Perman
Calvin Burke

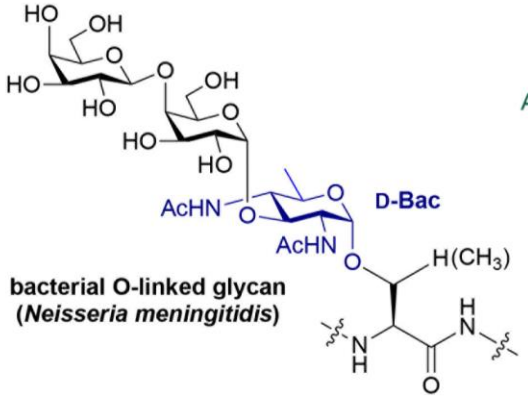
For the Takematsu lab:
ktakemat@bowdoin.edu

Chemical tools to detect, discover, and disrupt sugars in bacterial pathogens

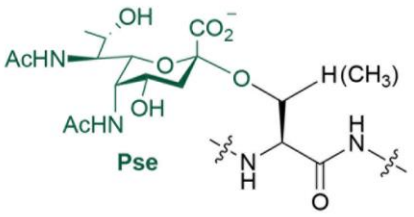


Dube Laboratory
Bowdoin College, Department of Chemistry & Biochemistry

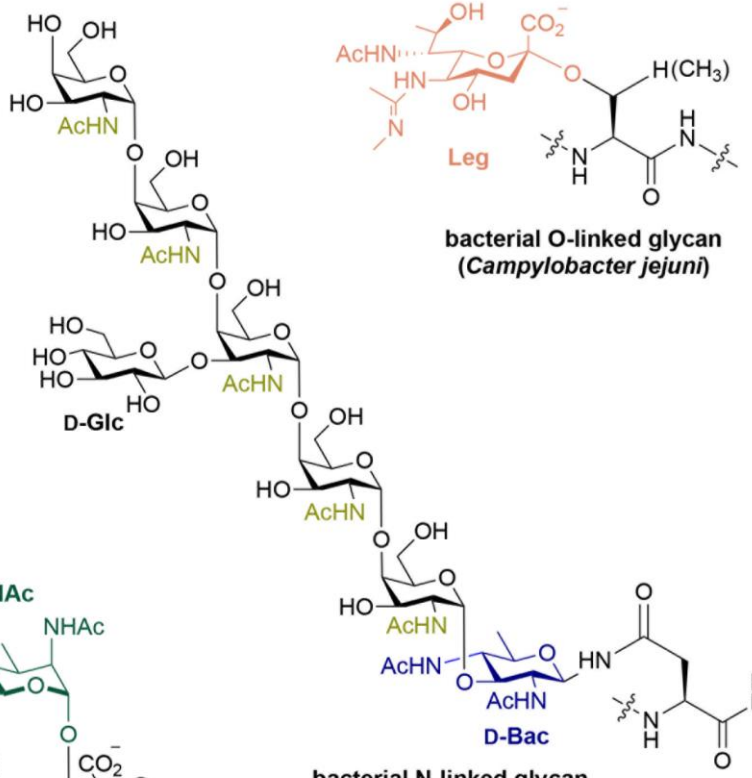
Bacterial sugars are critically important and difficult to study



bacterial O-linked glycan
(*Neisseria meningitidis*)

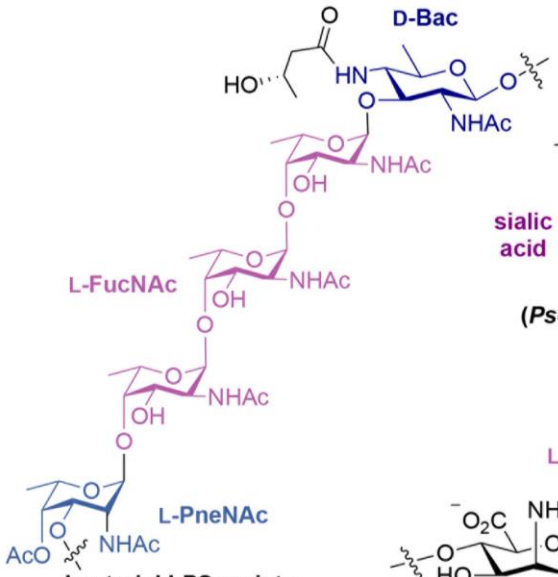


bacterial O-linked glycan
(*Helicobacter pylori*,
Campylobacter jejuni)

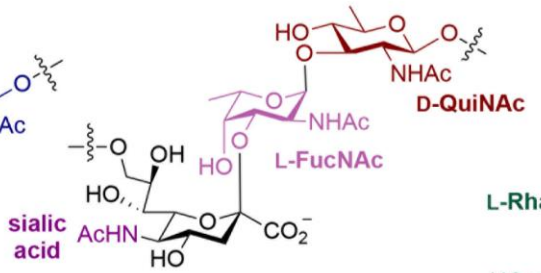


bacterial N-linked glycan
(*Campylobacter jejuni*)

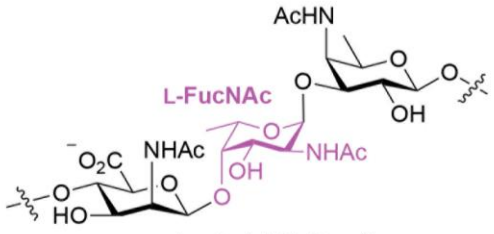
bacterial O-linked glycan
(*Campylobacter jejuni*)



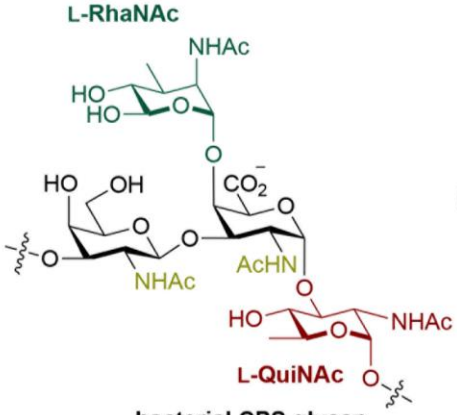
bacterial LPS moiety
(*Pleisiomonas shigelloides*
serotype O1)



bacterial LPS epitope
(*Pseudomonas aeruginosa* O12)



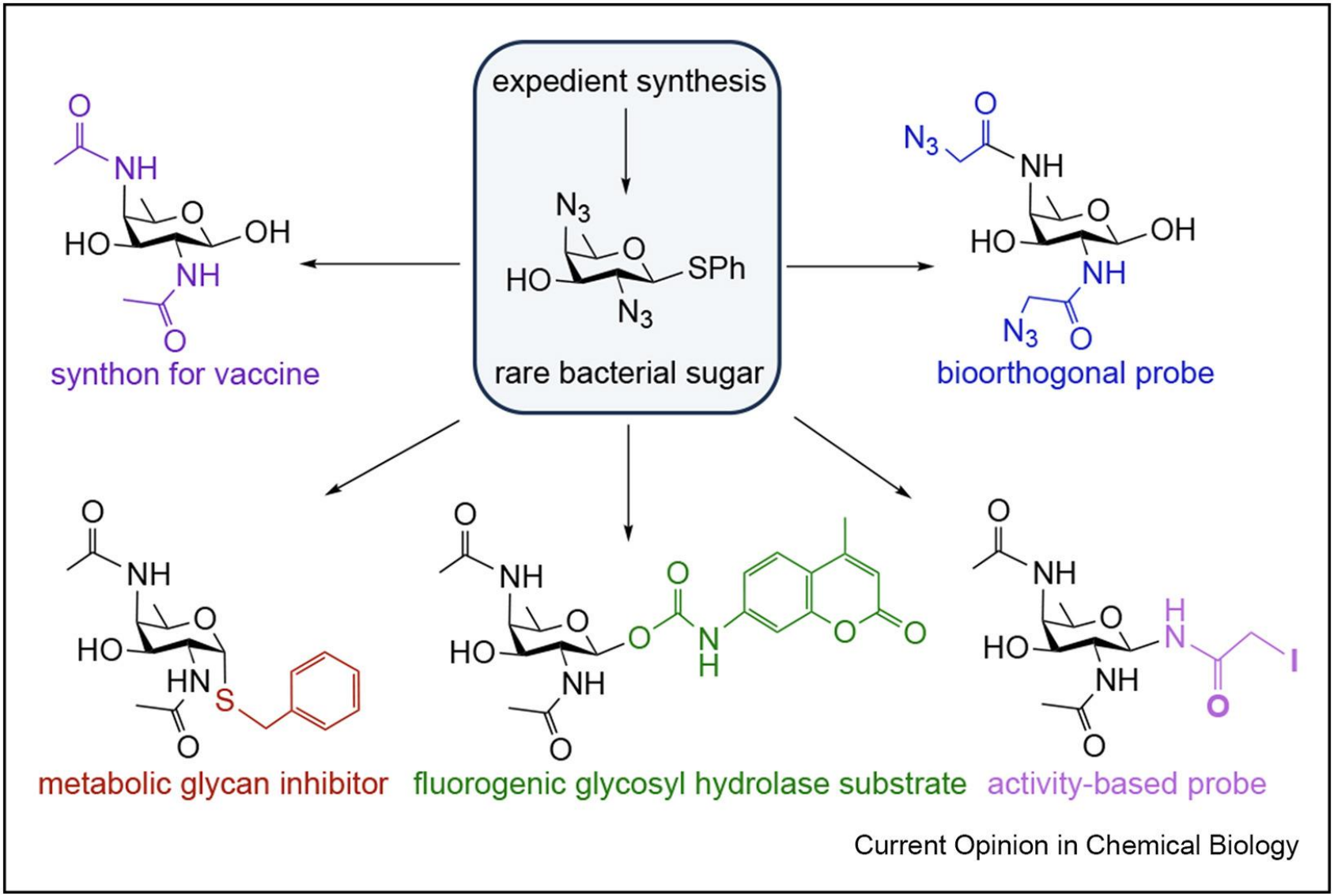
bacterial CPS unit
(*Staphylococcus aureus* type 5)



bacterial CPS glycan
(*Vibrio vulnificus* B06236)

Balonova, L., *et al*. *Curr. Opin. Struct. Biol.* **2008**, *18*, 544-550.
Dube, D.H.; Champasa, K.; Wang, B. *Chem. Commun.* **2011**, *47*, 87-101.

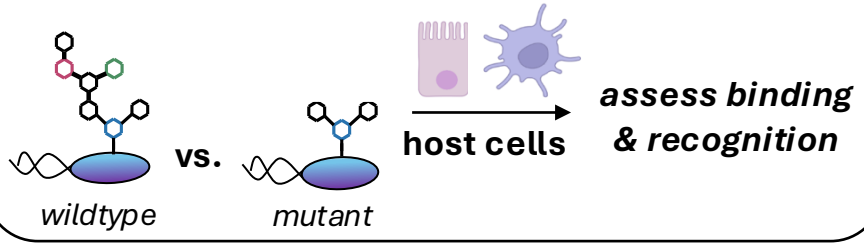
Chemical probes based on bacterial sugars provide a platform to study bacterial glycans



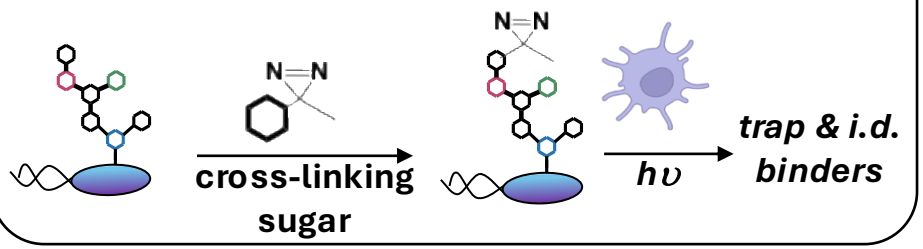
Calles-Garcia, D. and Dube, D. H. Curr. Opin. Chem. Biol. **2024**, https://doi.org/10.1016/j.cbpa.2024.102453

Chemical probes based on bacterial sugars provide a platform to study bacterial glycans

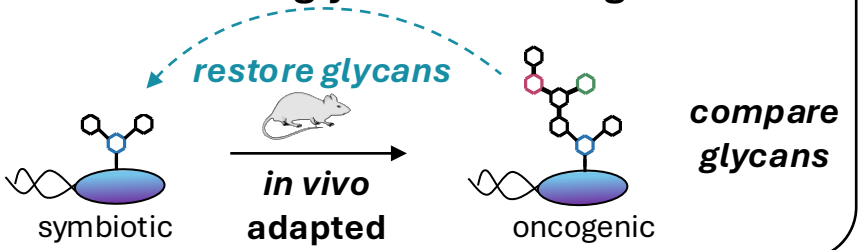
Discover glycans that bind host cells



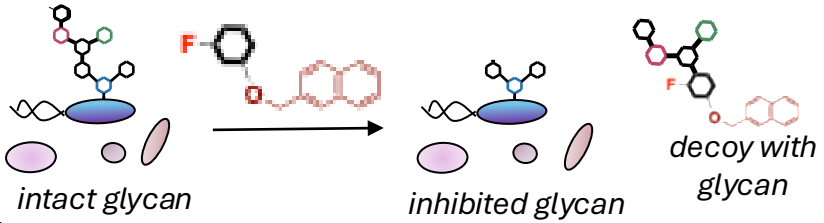
Identify host receptors that bind glycans



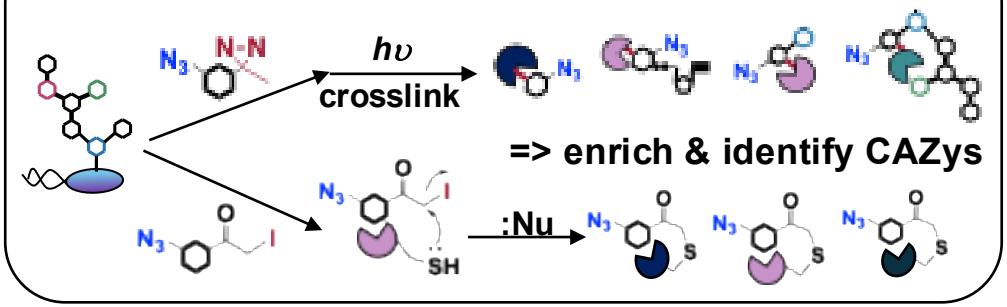
Evaluate role of glycans in driving cancer



Disrupt bacterial glycan biosynthesis



Create probes to identify carbohydrate enzymes



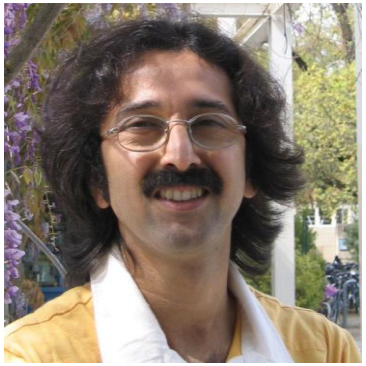
Research is an inherently collaborative endeavor

Lab bonding:



Recent & Current Members of the Dube Lab:





Collaborator:
Suvarn Kulkarni

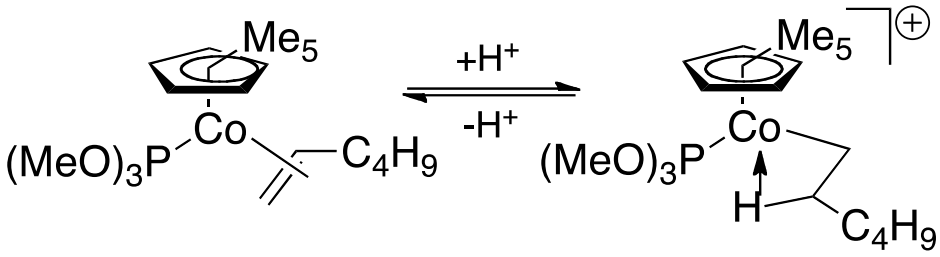
Funding: NSF, Maine-INBRE

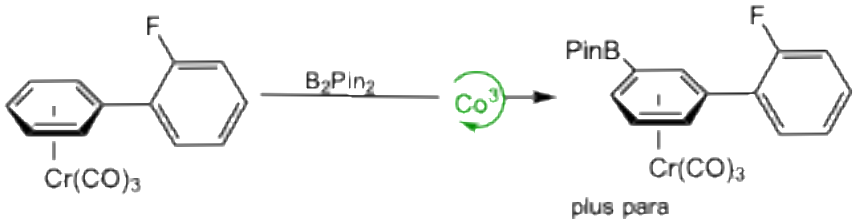


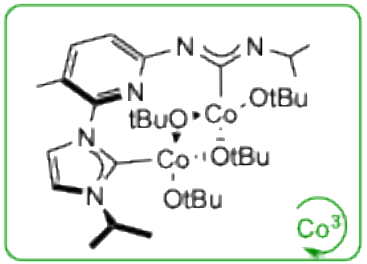




Transition Metals in Organic Chemistry







Why Transition Metals?

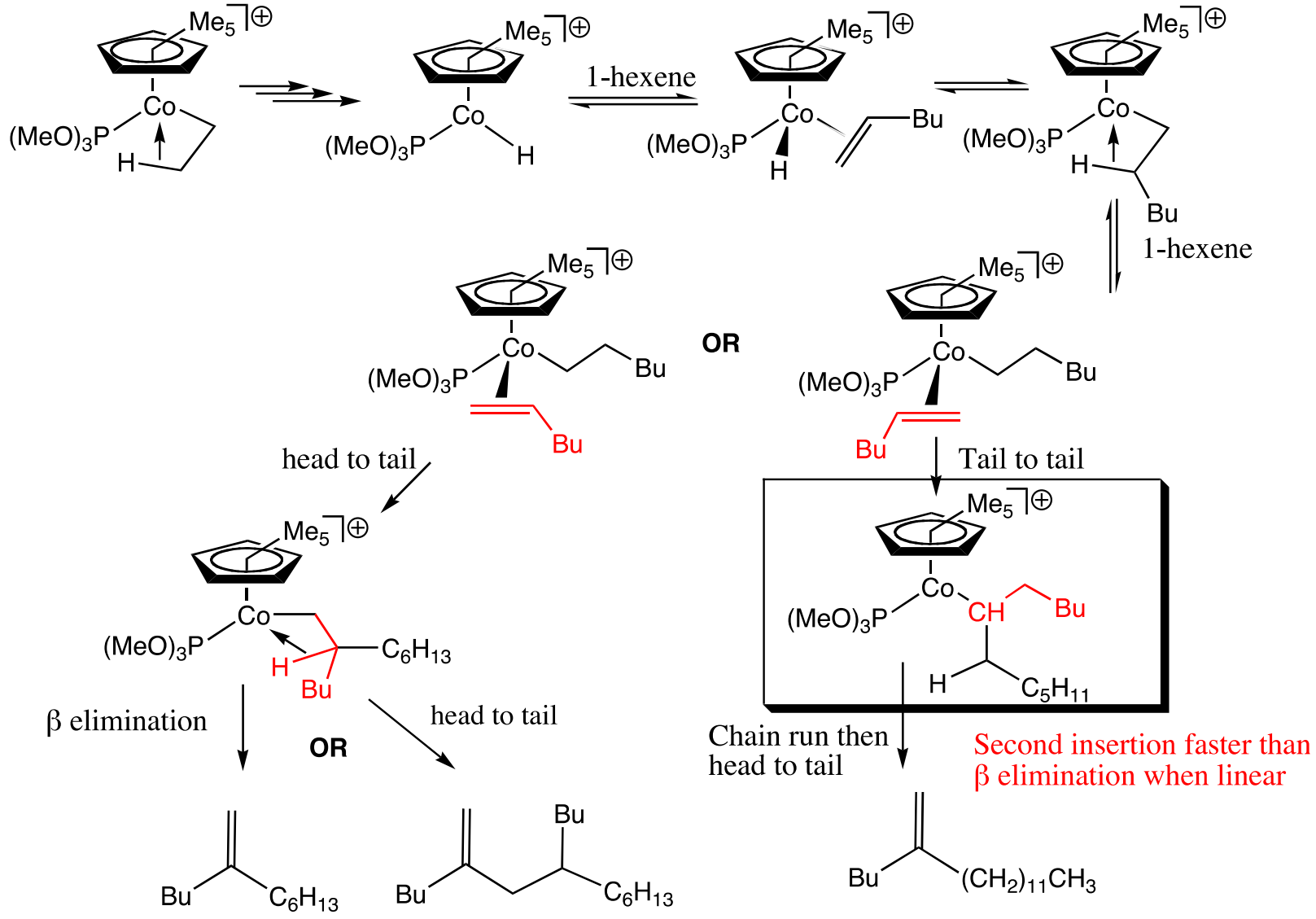
Variety

- Oxidation states available
- Number of ligands
- Geometry- d orbitals increase possibilities
- Ligand binding

Periodic Properties

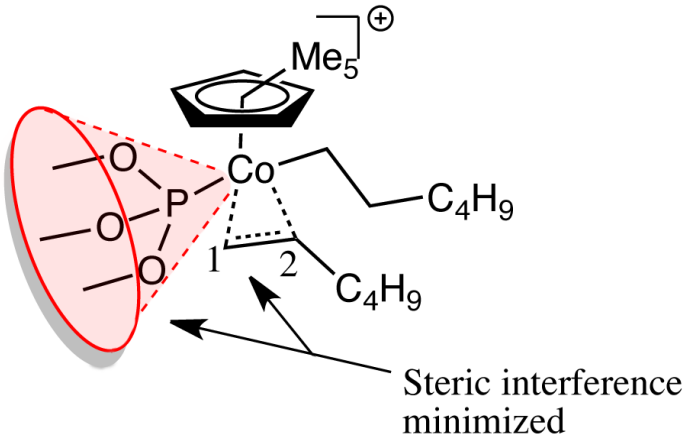
- If Co doesn’t work, maybe Rh or Ir will work

An Unselective Reaction

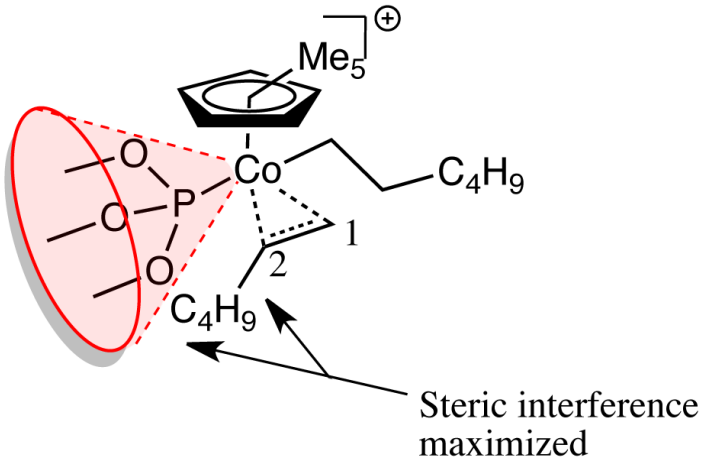


Cone Angle

Leads to 1,2-insertion
(yields branched products)

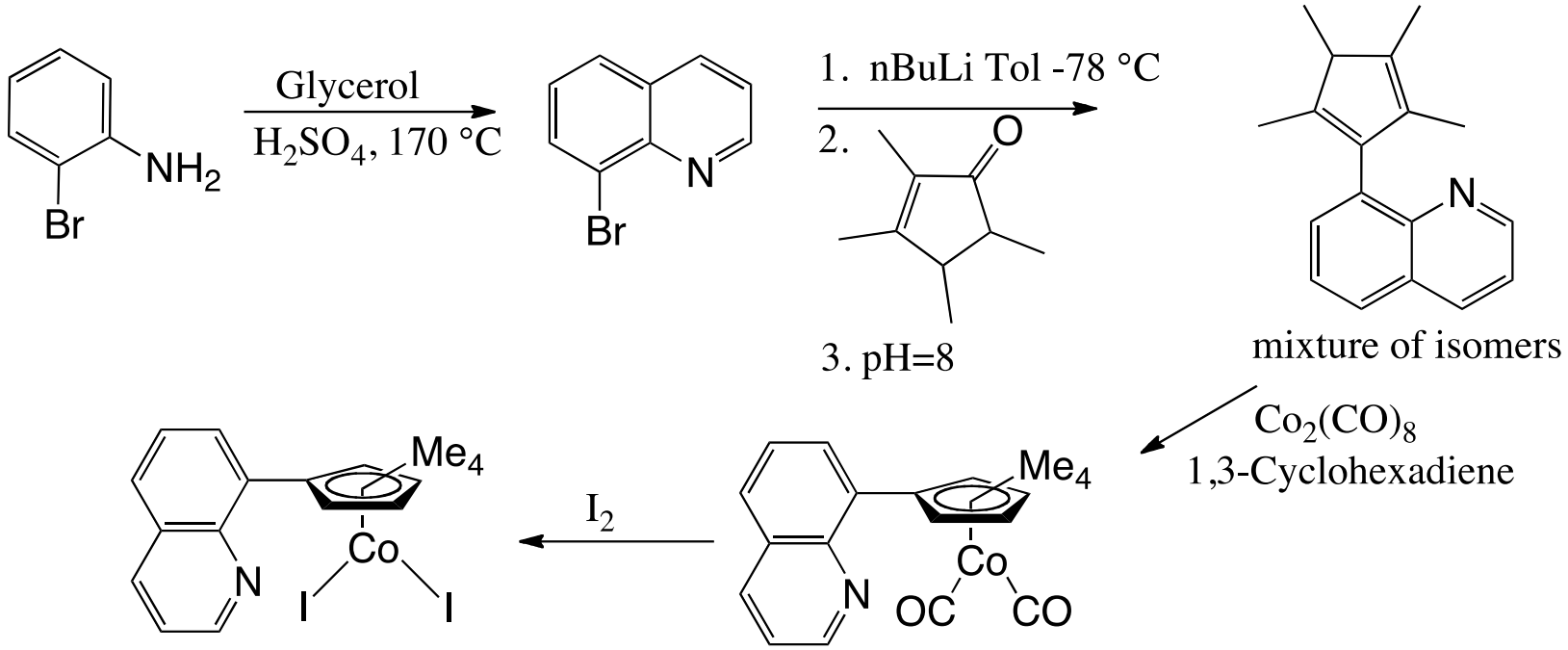


Leads to 2,1-insertion
(yields linear α-olefins)



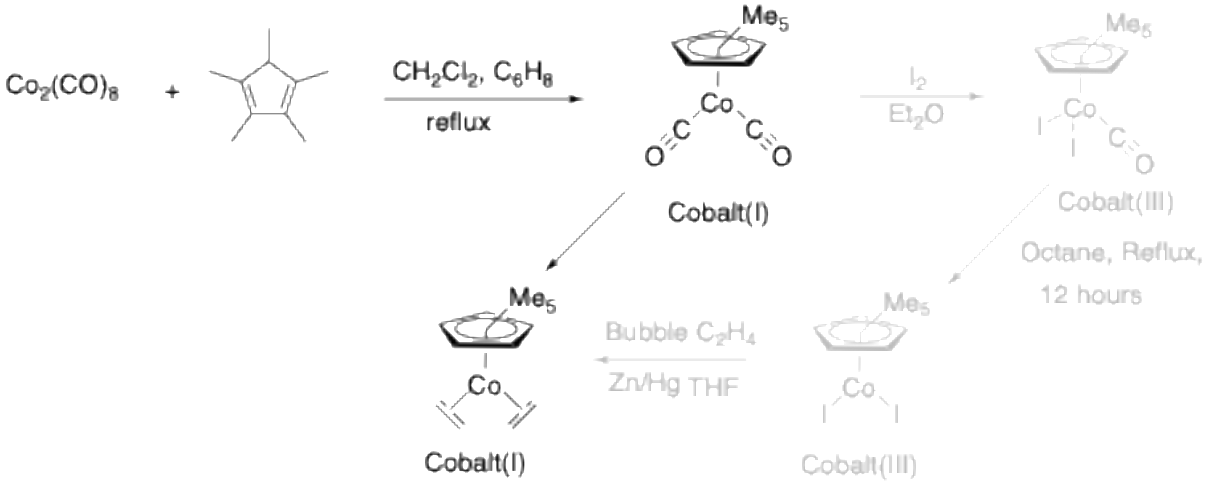
- Predict more favorable ratios with smaller cone angle

Organic Syntheses



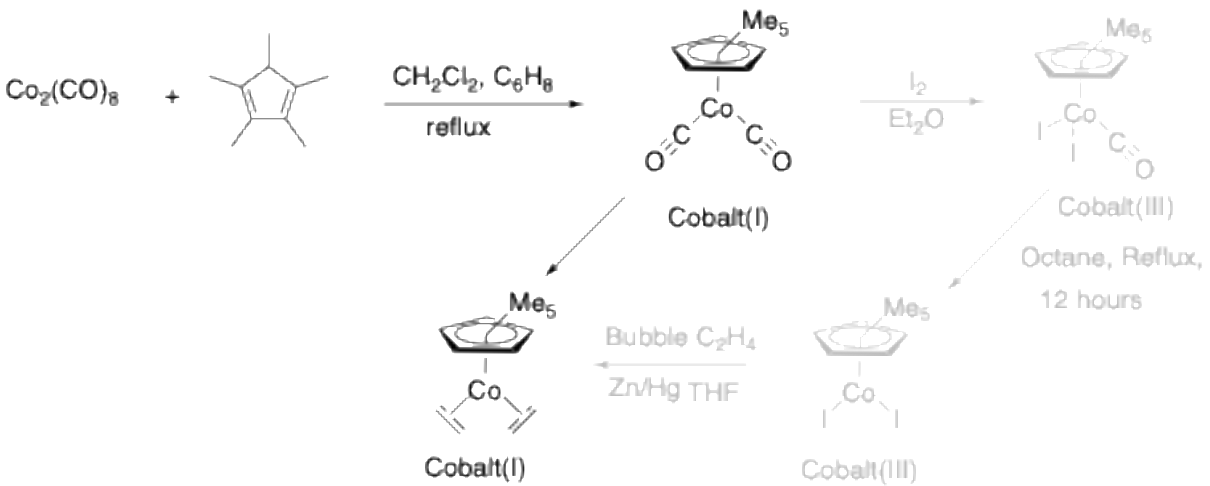
Inorganic Syntheses

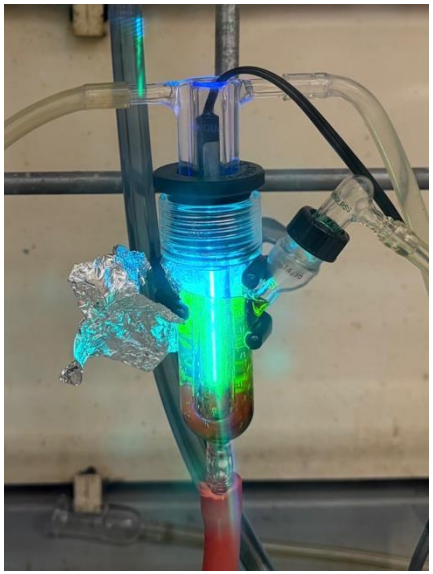




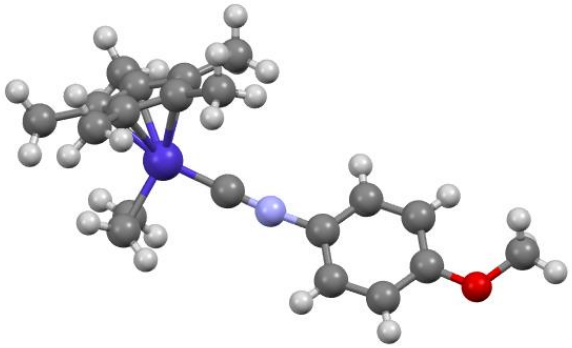
Inorganic Syntheses

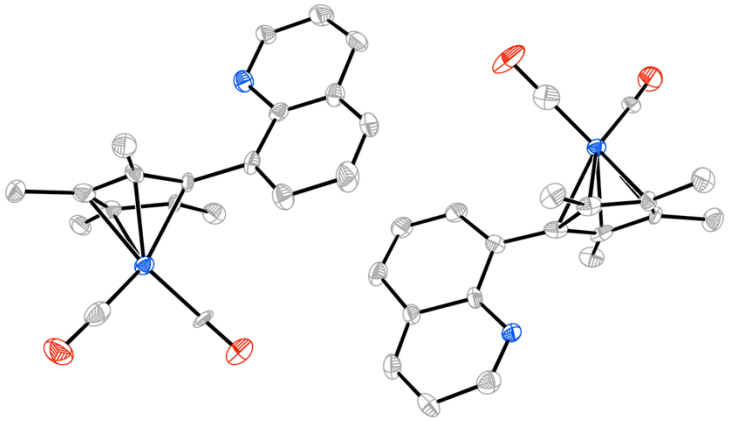


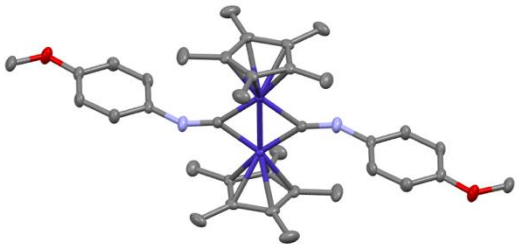




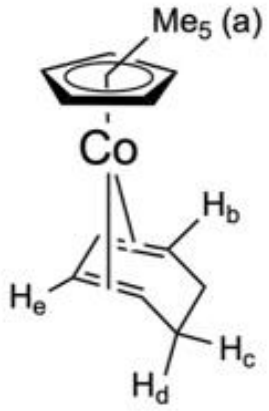
Identification techniques

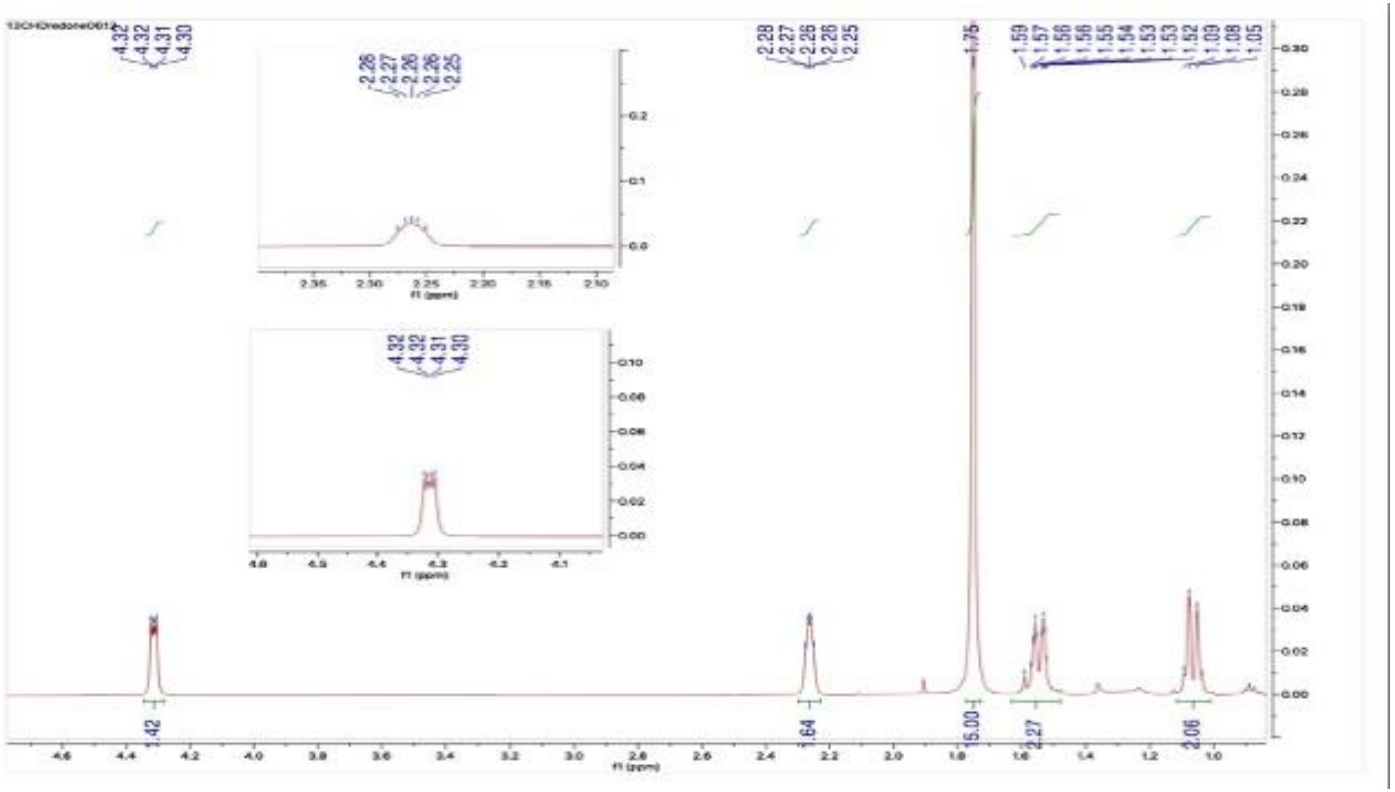






Identification techniques





Summer Research Opportunities at Bowdoin
And Key Dates for FUNDING

Chemistry Department Fellowships

Coles/Littlefield/Mayo summer research fellowships

https://www.bowdoin.edu/chemistry/student-research/fellowships/index.html

The program is open to all students* and provides the following support:

- **$615/week stipend** for 8-10 weeks of full-time research
- **Housing subsidy** for the College
- Funding for research supplies

Applications are due on
Friday, February 26, 2027 at noon

Summer Research Opportunities at Bowdoin And Key Dates for FUNDING

Institutional Fellowships (Requires faculty sponsor)

https://www.bowdoin.edu/student-fellowships/summer-opportunities/research-fellowships/

Student Fellowships and Research

(207) 208-2805

- National Fellowships
- Academic-Year Research
- Summer Opportunities
  - Research Fellowships
    - Overview
    - Key Dates
    - Application
    - Selection Criteria
    - Final Report Information
    - For Recommenders
    - For ADCs
    - FAQs
  - Language Study
- Faculty and Chamberlain Scholars
- Recent Recipients

Research Fellowships

With nearly **200 Bowdoin students** engaging in faculty-mentored research each year, Bowdoin is one of the most active research institutions among liberal arts colleges today.

Students find that immersing themselves in a particular research question gives them a chance to personalize their undergraduate experience and often serves as a springboard for independent study and honors projects. Fellowships often lead to students co-authoring papers with their faculty mentor or presenting their findings at professional meetings, experiences that are invaluable for those students considering graduate study.

However your interests evolve, you will find that you draw upon the knowledge, skills, and experiences gained through these enhanced learning opportunities for years to come.



Anuoluwapo Asaolu '19 presenting her poster at the 2018 President's Research Symposium

Key Dates

- **February 22, 2027 (noon)*** Phase One Deadline
- **March 1, 2027 (noon)*** Phase Two Deadline (faculty recommendations due)
- **April 7, 2027** First round of awards are released
- **April 12, 2027** Deadline for students from the first round of awards to accept/decline fellowship awards
- **April 19, 2027** All applicants not selected in the first round of awards will be notified of their final award status
- **April 21, 2027** Deadline for students who were notified of a fellowship award on April 19 to accept/decline offer
- **August 15, 2027** Deadline for students who were awarded a summer research fellowship to submit their final report

***Late applications will not be accepted; students should plan accordingly.*

Summer Research Opportunities
Beyond Bowdoin

- **Programs at other universities:**

NSF-REU programs:
https://www.nsf.gov/funding/opportunities/reu-research-experiences-undergraduates
https://www.nsf.gov/funding/opportunities/che-reu-sites-chemistry-research-experiences-undergraduates-sites

- **Programs at governmental institutions:**

National Institutes of Health (NIH), Bethesda, MD:
https://www.training.nih.gov/programs/ugsp
Internships at National labs: Los Alamos, Sandia, Pacific Northwest, Argonne, Lawrence Livermore, NASA, JPL, and many others!
(https://www.lanl.gov/engage/collaboration/student-programs/undergrad for example)

- **Programs and opportunities for International Students**

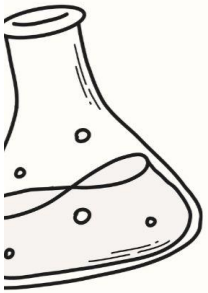
https://www.sas.rochester.edu/chm/undergraduate/i-scholar.html

- **Other programs at Bowdoin**

https://www.bowdoin.edu/summer-opportunities/
Maine Community Fellowship, Global Citizens Fellowship, **CXD Internship**

Chemistry and Biochemistry

Off-Campus Research Student Panel



October 26th, 7-8 pm
Druck 16

Come learn from students about opportunities to do chemistry or biochemistry research off campus!

