Microbes in the Environment Research

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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

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

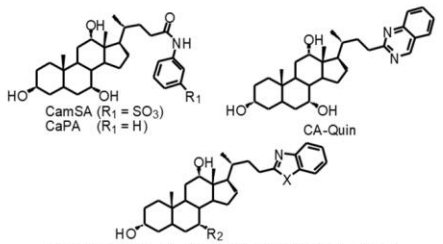
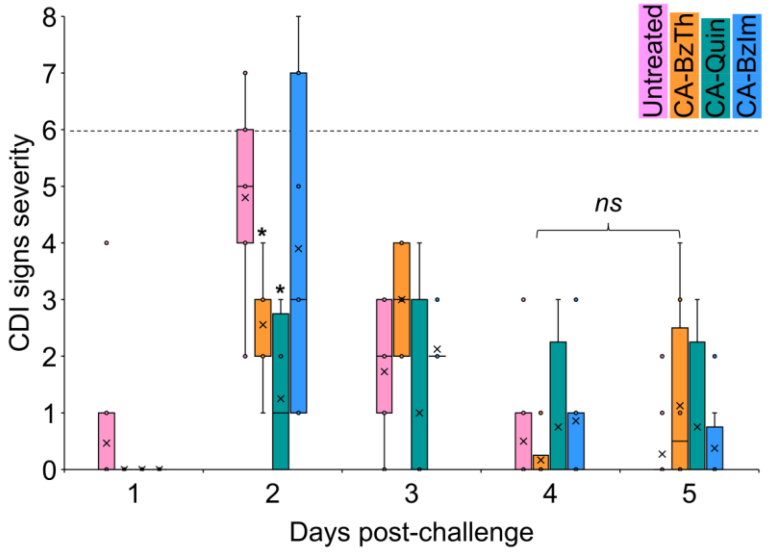
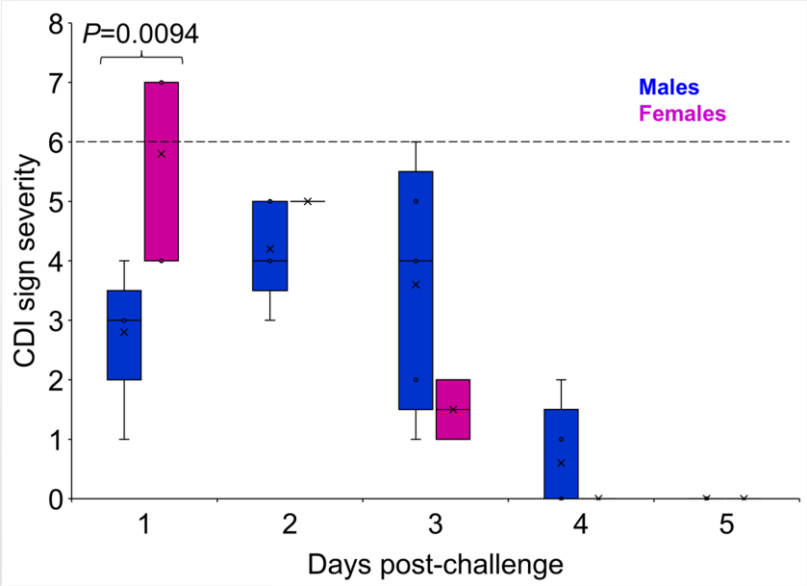


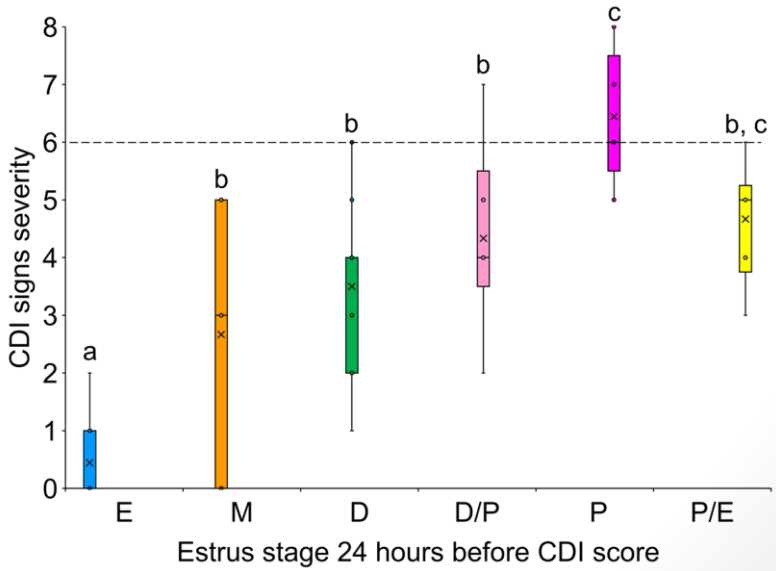
Table 1. NHBS-mediated germination inhibition of *C. difficile* strain R20291 spores

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





Aqueous Geochemistry and Astrobiology

- **Dr. Elisabeth (Libby) Hausrath**
- Professor
- Department of Geoscience
- Email: Elisabeth.Hausrath@unlv.edu
- Website: https://hausrath.faculty.unlv.edu/

Expertise

- Using laboratory experiments, field work, and modeling to interpret water-rock interactions and soil-forming processes on Earth and Mars
- Interpreting the signatures of past aqueous and biological impacts on minerals
- Participating Scientist on the Mars Science Laboratory Curiosity and the Mars2020 rover Perseverance and member of the Network for Life Detection (NFOLD) Steering Committee..

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Holes made by sampling soil on Mars

Image credit: NASA/JPL-Caltech

https://mars.nasa.gov/news/9311/nasas-perseverance-rover-gets-the-dirt-on-mars/#:~:text=The%20mission's%20first%20two%20samples,prepare%20for%20future%20missions%20there.

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Microbial Diversity & Ecology

Dr. Brian Hedlund
Professor
School of Life Sciences
Phone: 702-895-0809
Email: brian.hedlund@unlv.edu

Expertise

- Microbial diversity exploration
- Cultivation of recalcitrant microorganisms
- Systems biology

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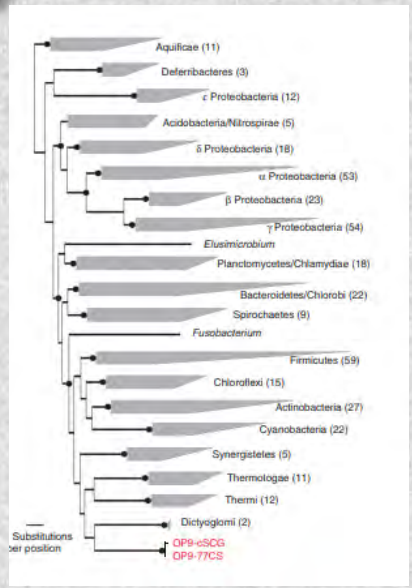
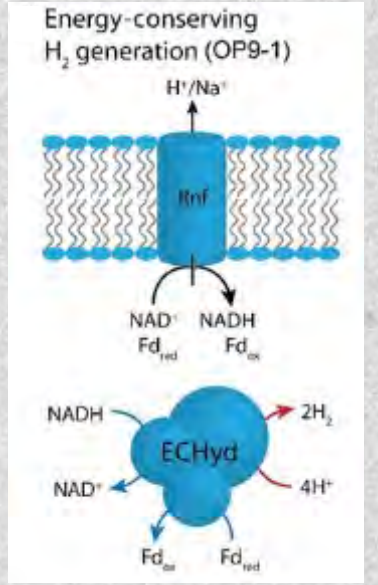
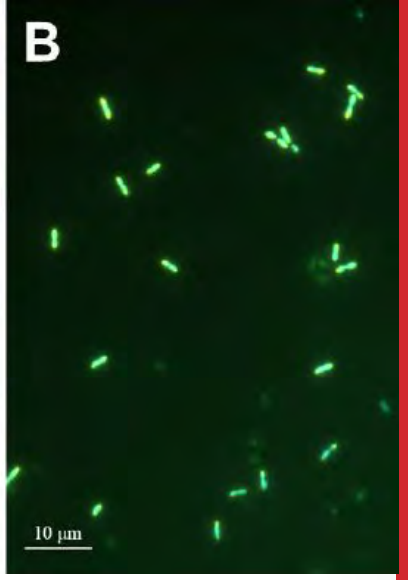
Exploring microbiology's "dark matter"

- Environmental genomics
- Genome-enabled cultivation
- Transcriptomics, proteomics, metabolomics
- Stable-isotope experiments







Big questions

- What is the function of billions-year-old microbial lineages that have never been cultivated in any lab? Why have they rebuked microbiologists for centuries?
- How can we organize and communicate microbial diversity effectively?
- How does thermal stress affect biology?
- How can we use microbial diversity to solve human problems?

https://hedlund.faculty.unlv.edu/

Geomicrobiology

Dr. Aude Picard

Assistant Research Professor

School of Life Sciences

audeamelie.picard@unlv.edu

Expertise

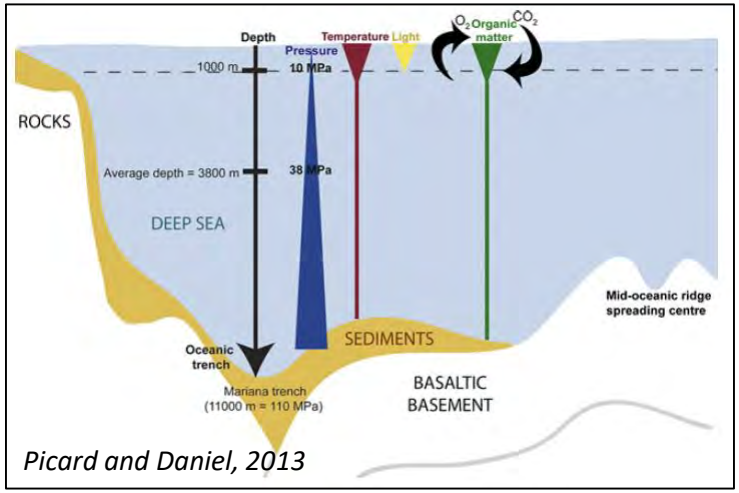
- Anaerobic microbiology
- Microbial physiology
- Biomineralization
- Astrobiology and biosignatures
- Microscopy & spectroscopy

Microbial life in extreme conditions

1 Microbial life under high pressure

◦ What are the pressure limits for microbial life?

High-pressure environments represent the largest habitat for microbial life on Earth



Picard and Daniel, 2013

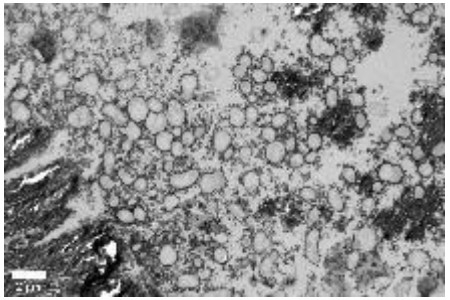
Oceans on icy moons (e.g. Europa) are potential habitats for microbial life in the outer Solar System

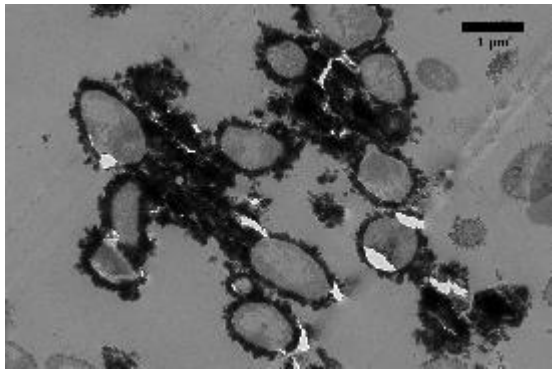
Europa (image credits: NASA)

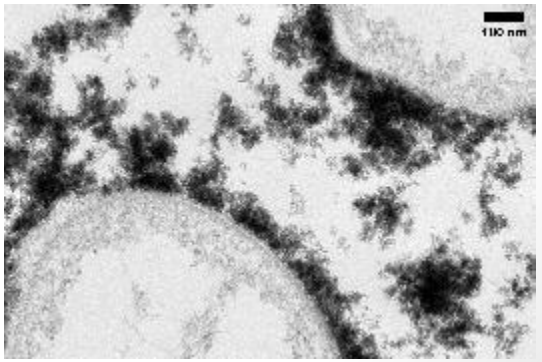
2 Microbe-mineral interactions

◦ How do bacteria cope with mineral encrustation?
◦ Do minerals play a role in long-term survival of bacteria?

Transmission electron microscopy images of bacteria encrusted in iron sulfide minerals







Dryland microbes and soil ecology

Dr. Nicole Pietrasiak

- Associate Professor of Sustainability in Arid Lands
- School of Life Sciences
- Email: nicole.pietrasiak@unlv.edu

Expertise

- Soil Microbiology and Ecology
- Biological Soil Crusts
- Phycology and Cyanobacteria/Algae Culture Collection
- Soil Science
- Dryland Ecology
- Biogeomorphology

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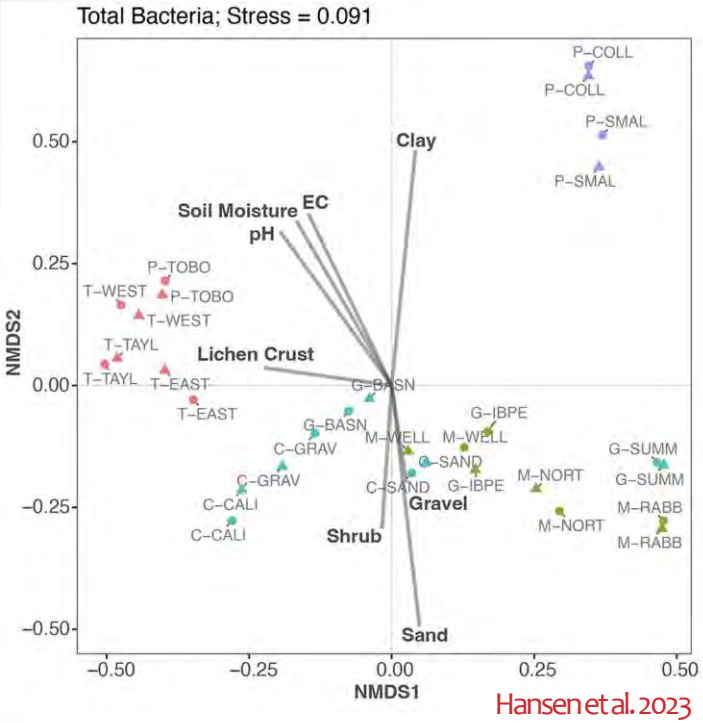
In our lab we investigate what shapes the diversity, abundance, and distribution of desert microbes



Hansen et al. 2023

Landscape and soil properties select for unique microbiomes

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DOI: 10.1111/jpy.12307

WHEN IS A LINEAGE A SPECIES? A CASE STUDY IN *MYXACORYS* GEN. NOV. (SYNECHOCOCCALES: CYANOBACTERIA) WITH THE DESCRIPTION OF TWO NEW SPECIES FROM THE AMERICAS[1]

Nicole Pietrasiak[2]

Plant and Environmental Sciences Department, New Mexico State University, 945 College Drive, Las Cruces, New Mexico 88003, USA

Karina Otero-Santos

Department of Comparative Biology, Faculty of Science, Universidad Nacional Autónoma de México, Coyoacan, Distrito Federal 04510, México

Sergei Shabgin

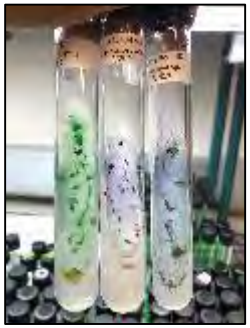
Plant and Environmental Sciences Department, New Mexico State University, 945 College Drive, Las Cruces, New Mexico 88003, USA

Michael P. Martin

Department of Biology, John Carroll University, University Heights, Ohio 44118, USA

and Jeffrey R. Johansen

Department of Biology, John Carroll University, University Heights, Ohio 44118, USA
Department of Botany, Faculty of Sciences, University of South Bohemia, Branišovská 31, České Budějovice 370 05, Czech Republic



We also describe species and genera new to science and society.

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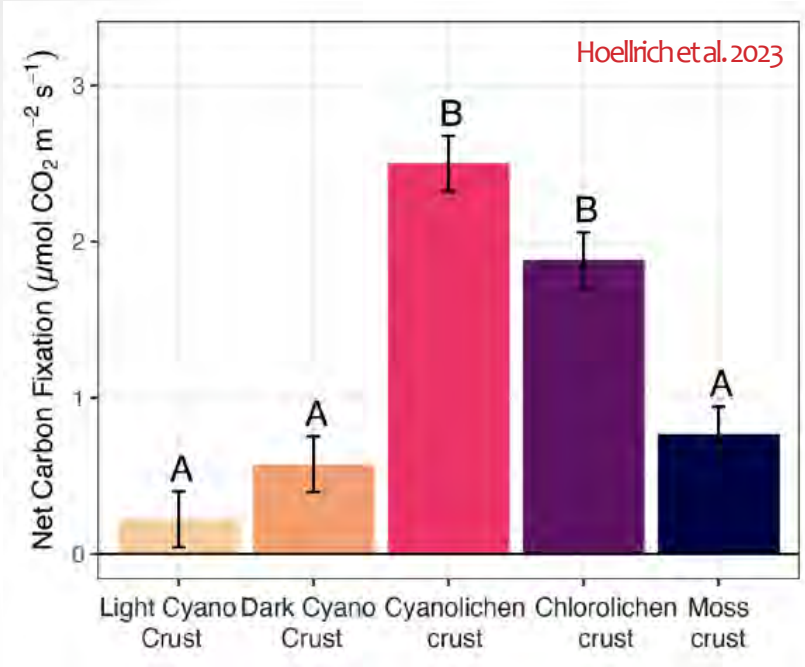
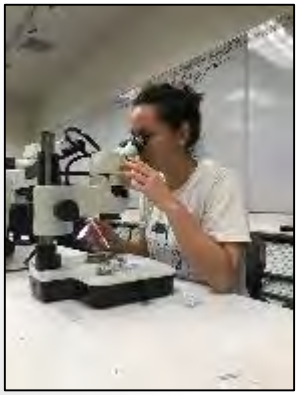
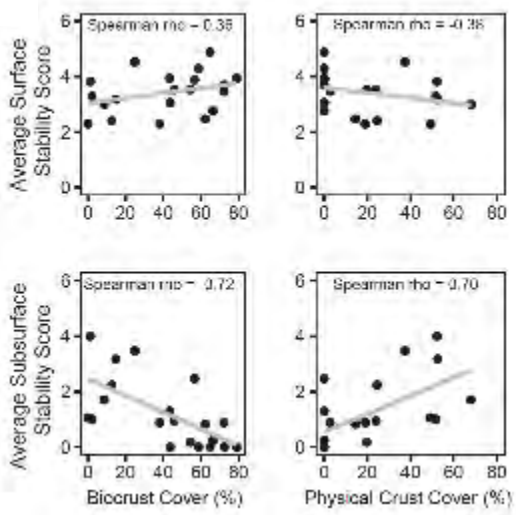
And we identify and quantify the roles microbes play in dryland ecosystem functioning and soil health







Microbes are part of our dryland biodiversity. They prevent soil loss, increase soil fertility, control nutrient cycling, and contribute to carbon sequestration.

Dryland microbes are crucial for maintaining sustainable arid lands.

Stovall et al. 2023

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Extremophiles

Dr. James Raymond
Adjunct Research Professor
School of Life Sciences
Phone: 702-895-3268
Email: raymond@unlv.nevada.edu

Expertise

Adaptations to cold environments
Snow algae
Ice-binding proteins
Horizontal gene transfer

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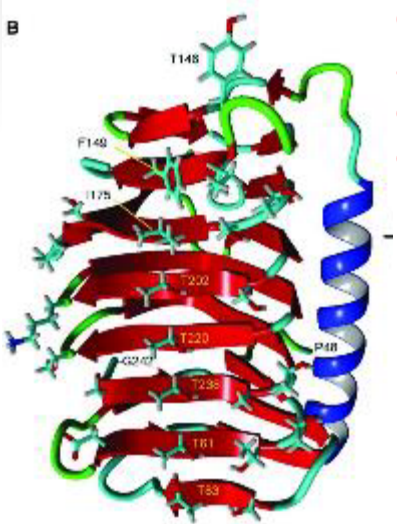
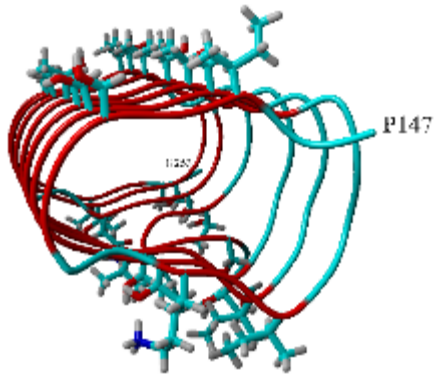
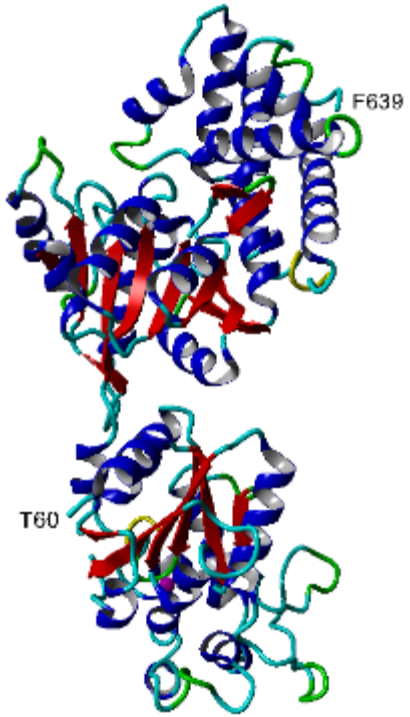
Much of the Earth's surface is exposed to extreme conditions such as freezing, high temperature and hypersalinity.

Organisms living in these regions have developed some remarkable adaptations that not only reveal the beauty of Nature, but also may have commercial applications (e.g., low-calorie ice cream) as well as provide clues to the presence of life in other worlds.

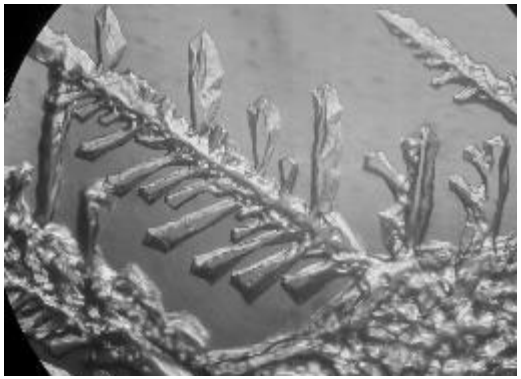


Ice-binding proteins. Above, from a snow alga from the Austrian Alps.[1] Below, from a grass growing on the coast of the Arctic Ocean.[2]





An unusual enzyme found only in a few species of algae. This one is from an alga that lives in a saline lake in Antarctica. The alga uses the enzyme to make glycerol so that it can remain in osmotic equilibrium with the lake water.[3]



Demonstration of how many proteins produced by microorganisms affect the growth of ice by binding to its surface. Here, proteins from a polar cyanobacterium distort the growth of a growing ice crystal.

References
1. Raymond and Remias (2019)
2. Sformo and Raymond (2020) (Submitted)
3. Raymond, Morgan-Kiss and Stahl (2020) (Submitted)

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High-dimensional Data Analysis

- **Dr. Farhad Shokoohi**
- Assistant Professor of Statistics
- Department of Mathematical Sciences
- Email: farhad.shokoohi@unlv.edu
- Website: https://farhad.faculty.unlv.edu

Expertise

- Bayesian and Frequentist Analysis
- Mixture Modelling
- Survival Analysis
- High-Dimensional Genomics and Epigenetic
- Sparse Estimation in Finite Mixture of Regressions
- Machine Learning in Medical and Financial Data
- Differential DNA Methylation Analysis in Cancer Epigenetics
- Hidden Markov Models
- Nonparametric and Semiparametric Regression
- Software Development

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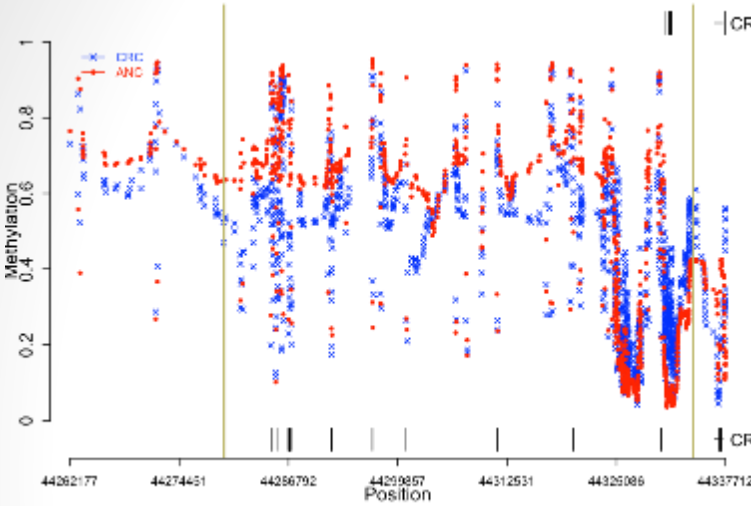
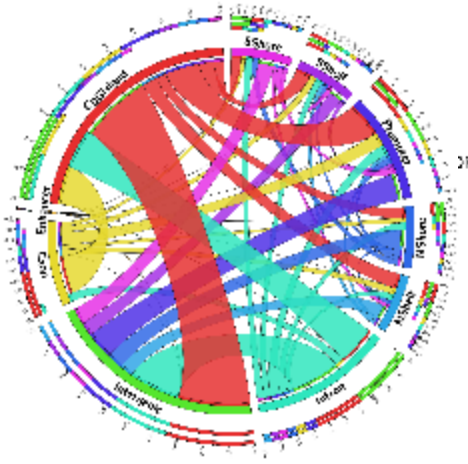
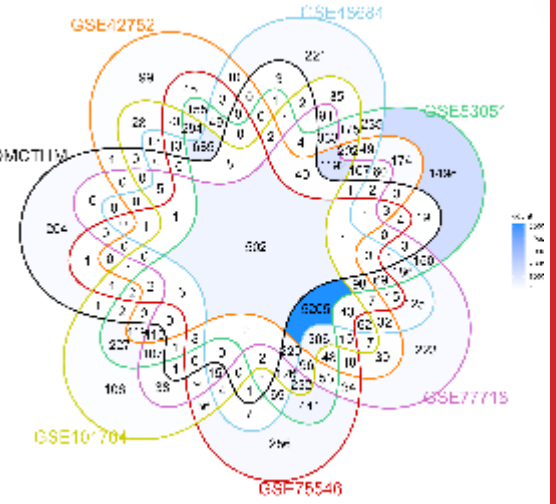
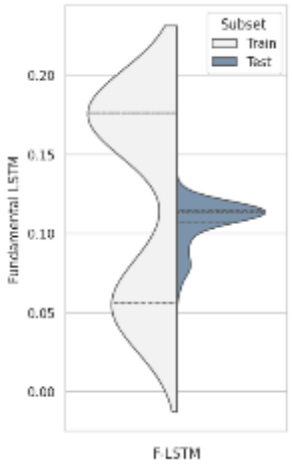
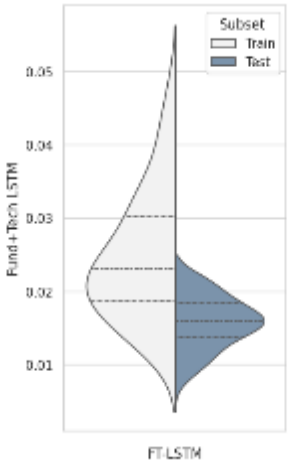
High-dimensional data analysis across a variety of sectors, including finance, healthcare, genomics, market, among others.

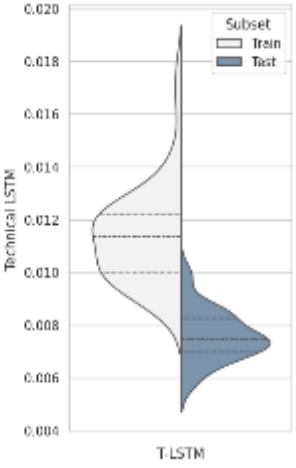


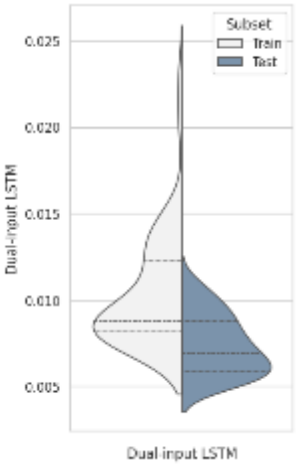


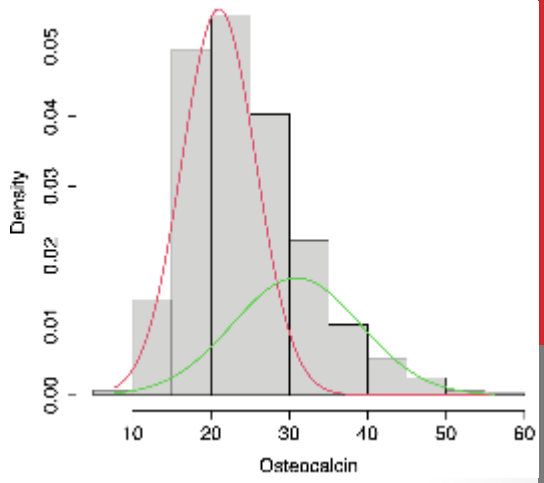












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Bacterial Physiology Research

Dr. Boo Shan Tseng
Assistant Professor
School of Life Sciences
Phone: (702) 895-2700
Email: boo.tseng@unlv.edu

Expertise:

- *Pseudomonas aeruginosa*
- Biofilms
- Bacterial stress response
- Antimicrobial susceptibility
- Cystic fibrosis lung infections

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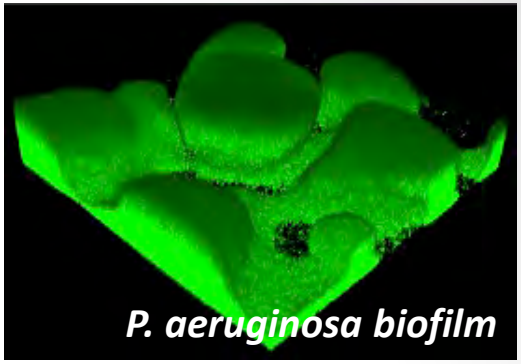
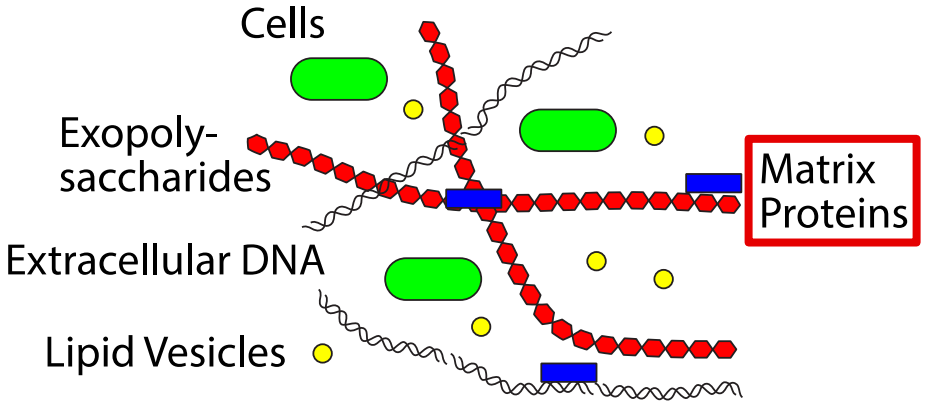
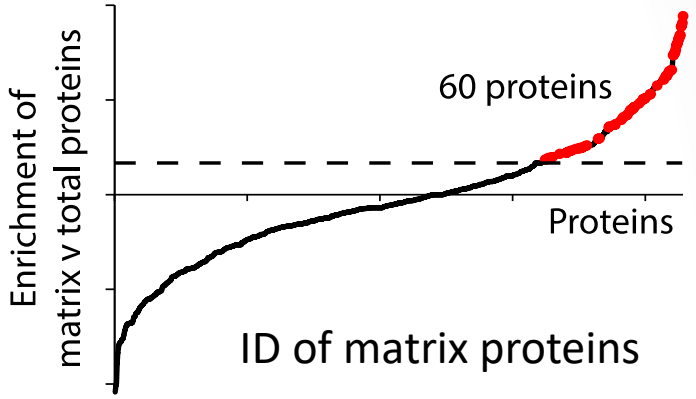
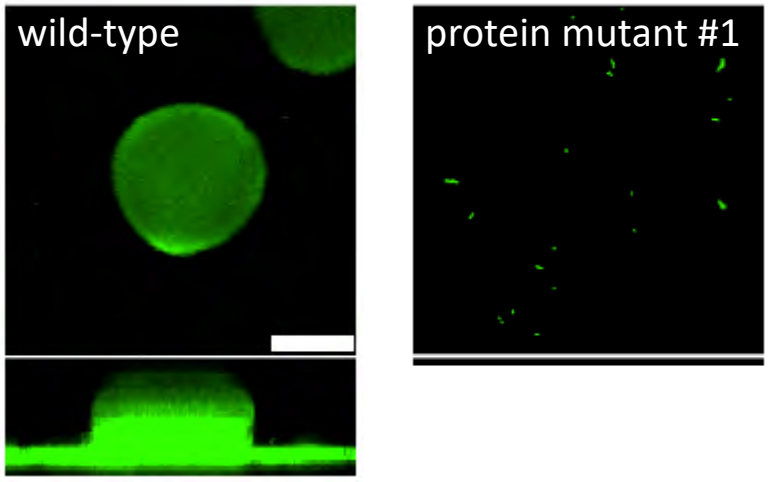
Identifying the roles of biofilm matrix components



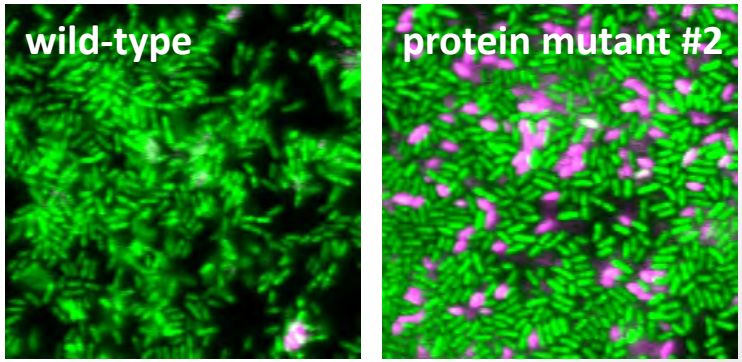




Functions in biofilm formation

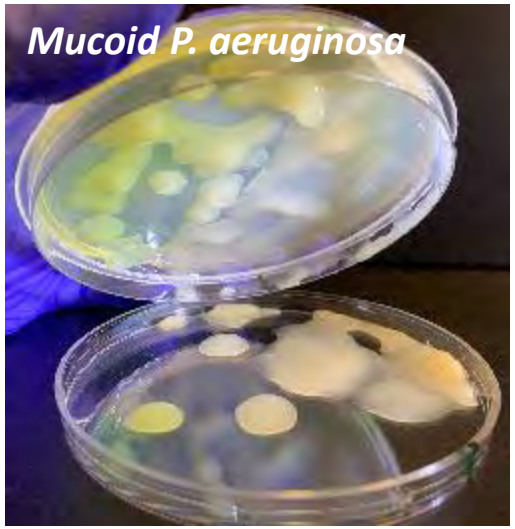


Functions in antimicrobial susceptibility

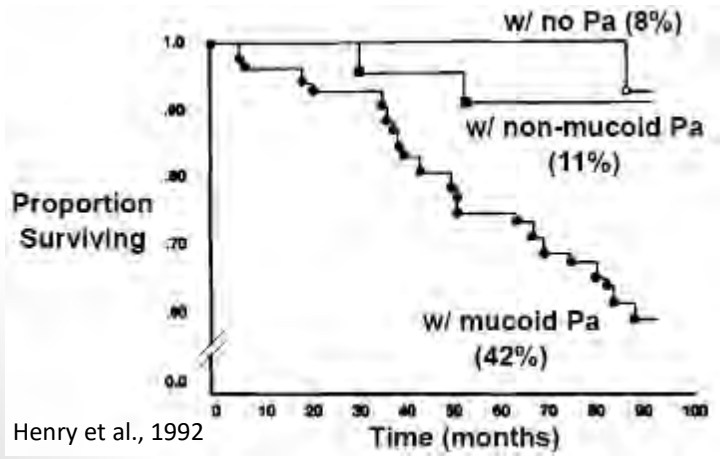


Treated with elastase (green: alive; purple: dead)

Mechanism behind the essentiality of bacterial envelope stress inhibitor

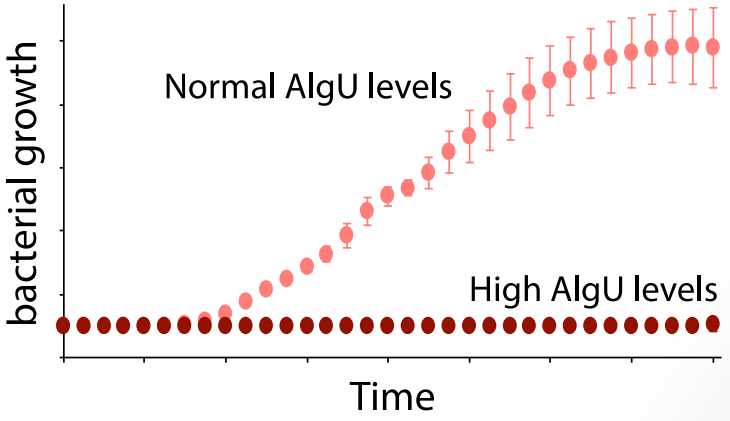


- Exopolysaccharide overproducing (e.g. mucoid) bacteria arise during chronic lung infection
- Associated with poor disease outcomes
- Due to mutation in *mucA* gene, which encodes for inhibitor of envelope stress response via AlgU
- BUT *mucA* required for bacterial viability and overproduction of AlgU inhibits growth



Henry et al., 1992

In children with cystic fibrosis



Question: why is a gene commonly mutated in clinical isolates required for bacterial viability?