Life in Extreme Conditions
Research
Population projections derived from an Integrated Population Model (IPM) and Bayesian Population Viability Analysis (BPVA), based on six general circulation models.

Expertise
- Science Education
  — Evidence-Based Practices
- Population Ecology
- Animal Behavior
- Alternative Reproductive Tactics
- Ecological Modeling
- Science Communication
- Science Policy
Environmental Biology Research

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Expertise

• Environmental physiology
• Insect physiology
• Experimental evolution
Environmental Physiology of Desert Invertebrates

Adaption to water stress:

Adaptation to high temperatures:
Experimental Evolution Research Using Fruit Flies

Starvation resistance:
- a fly model for obesity

Desiccation resistance:
- understanding responses to desertification

Pigmentation:
- phenotypic correlations of melanization
Aqueous Geochemistry and Astrobiology

- **Dr. Elisabeth (Libby) Hausrath**
  - Professor
  - Department of Geoscience
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**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.
Holes made by sampling soil on Mars

Image credit: NASA/JPL-Caltech
Dr. Allyson Hindle
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Expertise
• molecular mechanisms of hypoxia tolerance in hibernating and diving mammals
• cardiovascular and blood pressure regulation
• comparative genomics, biomarker discovery and bioinformatics
• cell line resource development for non-model systems
Cardiovascular protection of deep divers
Metabolic control of small hibernators

**Graphs:***
- **Body Temperature (°C)**: The graph shows a fluctuation in body temperature over time, with a significant drop during winter and a rise in summer.
- **Plasma Lipids**: A line graph illustrating the changes in plasma lipids over time.

**Images:**
- **SUMMER**: A picture of a small mammal, possibly a hibernator, during summer.
- **WINTER**: A picture of the same species during winter, showing a decrease in body temperature.

**Images (right):***
- **REFERENCE**, **SQUIRREL 1**, **SQUIRREL 2**: Three images depicting different conditions or samples, possibly related to the study of plasma lipids.
Meiselman Lab: Vectors and Dormancy

- **Dr. Matthew R. Meiselman**
  - Assistant Professor of Neurophysiology
  - School of Life Sciences
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  - Website: meiselmanlab.com

**Expertise**
- Dr. Meiselman completed his PhD in Cell, Molecular, and Developmental Biology at University of California-Riverside before studying neurobiology during his Postdoctoral work at Cornell University.
- Dr. Meiselman focuses on the molecular and neural components which comprise dormancy (an extended depression of metabolism and behavior).
- Mosquitoes, ticks, and other medically-relevant arthropods depend on this state change for survival during winter or dry seasons.
- We use the genetically tractable fruit fly as an “engine for discovery” to learn about this state, with the goal of applying this knowledge to other species to curtail the contraction of vector-borne disease.
Our lab currently has two main projects:

1. We are searching for neurons that control dormancy in *Drosophila melanogaster*. By using transgenic activators and inhibitors of neural activity, we are attempting to induce dormancy (normally a response to cold) in warm conditions, and to prevent induction of dormancy in cold conditions. We are also searching for **ethological signatures of dormancy**, such as changes in circadian rhythmicity, sleep or photopreference, which can complement our metabolism-oriented definition.

2. We are attempting to understand the drivers of tick questing (hunting) behavior. We are using custom-built apparatus and high-resolution video analysis to determine how tick circadian rhythm or activity levels respond to ambient temperature, humidity and lighting conditions. This may lead to better information linking climatic conditions to tick bite risk.
Dr. Aude Picard
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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

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- School of Life Sciences
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Expertise
- Soil Microbiology and Ecology
- Biological Soil Crusts
- Phycology and Cyanobacteria/Algae Culture Collection
- Soil Science
- Dryland Ecology
- Biogeomorphology
In our lab we investigate what shapes the diversity, abundance, and distribution of desert microbes. Landscape and soil properties select for unique microbiomes. We also describe species and genera new to science and society.
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.
Extremophiles

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Expertise
Adaptations to cold environments
Snow algae
Ice-binding proteins
Horizontal gene transfer
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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Expertise
• Big Data Analysis to Study Biology, Agriculture and Medicine
• Molecular Mechanisms Controlling Plant Responses to Drought, Heat, and Salinity
• Seed Germination, Tissue Culture and Plant Transformation
• Molecular Basis of Leukemia (in collaboration with Dr. J. Cheng at the University of Chicago Medical School)
• Nutrition of Cereal Crops (in collaboration with Dr. Christine Bergman, Ph.D. and R.D. at UNLV)
Molecular Basis of Drought Stress Responses and Seed Germination

Gene Gun | Yeast Two Hybrid | Confocal

BMC Genomics, 2016, 17:102
Plant Science, 2015, 236:214-222
Front. Plant Science, 2015; 6: 1145

Short Read Assembly Algorithm
for Genome and Transcriptome Analysis
http://shenlab.sols.unlv.edu/shenlab/software/Tiling_Assembly/tiling_assembly.html
DNA Research, 2015, 22: 319-329
Genomics, 2014, 103:122-134

Promoter and Coding Region Structures
http://shenlab.sols.unlv.edu/shenlab/software/TSD/transcript_display.html
Bioinformatics, 2016, 32:2024-2025

Molecular Basis of Leukemia
(in collaboration with Medical School, University of Chicago)

Cytogenetically normal refractory cytopenia with multilineage dysplasia (CN-RCMD)

Nature Communications, 2018, 9:1163
Leukemia, 2013, 27: 1291-1300
STEM Education Research

Dr. Jenifer C. Utz
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Expertise
- Undergraduate STEM education
- Digital learning resources
- Mammalian hibernation
Facilitating academic achievement for a diverse undergraduate population

- Effects of self-testing:

**Voluntary Web-Based Self-Assessment Quiz Use is Associated With Improved Exam Performance, Especially for Learners with Low Prior Knowledge**

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Abstract

This study examined students’ voluntary use of digital self-assessment quizzes as a resource for learning in a large anatomy and physiology lecture course. Students (n = 238) could use 16 chapter quizzes and four analog quizzes to rehearse and self-assess knowledge. Most students (75%) engaged in occasional use of self-assessment quiz items, repeated use was uncommon (12%), as was lack of use (13%). Exam performance differed between quiz use groups. Quiz use improved exam performance more among students who entered the course with low prior knowledge of concepts from the prerequisite course. Cumulatively for all students and all exams, repeated self-assessment quiz users significantly outperformed occasional users (+7.5%) and non-users (+11.9%) on course exams. Incorporation of optional learning resources can enhance the learning success of students.

- Effects of skill training:

**Can a Brief, Digital Skill Training Intervention Help Undergraduates “Learn to Learn” and Improve Their STEM Achievement?**

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Students who drop out of their science, technology, engineering, and math (STEM) majors commonly report that they lack skills critical to STEM training and career pursuits. Many training programs exist to develop students’ learning skills and they typically achieve small to modest effects on behaviors and performance. However, these programs require large investments of students’ and instructors’ time and effort, which limits their applicability to large lecture course formats commonly employed in early undergraduate STEM coursework. This study examined whether brief, digital training modules designed to help students apply learning strategies and self-regulated learning principles effectively in their STEM courses can impact students’ beliefs and performance in a large biology lecture course. Results indicate that a brief Science of Learning in Exam training had significant effects on students’ use of...
Developing the Skill and Will to Succeed in STEM Scholarship Program

A primary goal of this scholarship program is to diversify and increase the number of students entering STEM professions.

- The School of Life Sciences welcomed the first cohort of 17 Succeed in STEM Scholarship recipients in 2019.
- Over $420,000 of scholarship support will be distributed across the lifetime of this 5-year program.
Hibernation physiology

- Rewarming from torpor:

- Resistance to bone disuse atrophy:
School of Life Sciences

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Expertise
• Metabolic depressions like mammalian hibernation
• Life in extreme environments
Areas of research
- Hibernation in tenrecs and ground squirrels
- Paradoxical anaerobism in pupfish
- We use a variety of approaches from whole animal physiology to biochemistry to understand how animals live in extreme environments