

Faculty: Lenore Cowen, Professor, Department of Computer Science, School of Engineering

Project Locations: Island of Mo'orea, French Polynesia and Medford, MA. Remote work from home or at Tufts University/Medford, MA if international travel is not possible in summer 2022.

Dates: May/early June – early August

Project Title: Bioinformatics Methods for Uncovering Mechanisms of Coral Reef Resilience

Project Details: Corals are important natural resources that are key to the oceans' vast biodiversity and provide economic, cultural, and scientific benefits. While coral reefs cover only 0.1% of the ocean floor, they are home to the largest density of animals on earth, rivaling rain forest habitats in species diversity. Coral colonies are comprised of clonal coral animals, living in symbiosis together with algae that harvest light and synthesize carbon in exchange for shelter and nitrogen sources. This nutritional symbiosis, which is now known to extend to a much more complex community than anticipated with thousands of bacteria, bacteriophages, viruses and fungi. The entirety of this community is referred to as a holobiont, and thus these reef building, coral holobionts are more like cities than individual animals, as they provide factories, housing, restaurants, nurseries, and more for an entire ecosystem, both at the micro and macro levels.

The extreme vulnerability of reef-building corals to warming oceans and ocean acidification has led to an acute coral reef crisis. For example, a 2017 study estimated that coral reefs are likely to decline by 70-90% relative to their current abundances by mid-century, even if ocean temperatures increase only by the 2 degrees Celsius target of the Paris climate agreement. This estimate preceded the marine heatwave that led to the most recent mass bleaching events of the Great Barrier Reef. Because of a constellation of factors from human-generated climate change in the Anthropocene, the frequency and duration of heatwaves leading to coral mass bleaching events and coral habitat loss is only projected to accelerate.

In light of the complexity and sensitivity of corals and the urgency of the coral reef crisis under climate change, bioinformatics approaches are emerging as critical tools to help illuminate the biological pathways involved in coral stress response and disease. The proposed research experience involves a field component, collecting coral data in Mo'orea, French Polynesia with the Putnam lab, our collaborators at the University of Rhode Island. The Putnam Lab is actively conducting research to understand how environmental variation drives coral ecophysiology and the connections between physiological, epigenetic, and metabolic states to predict how coral population and community dynamics are influenced by epigenetically-modulated phenotypes. Field research includes monitoring corals and collecting samples on the reef, which is done by boating to research sites and snorkeling on shallow reefs. After spending a month in the field, students will come back to the Tufts campus and do bioinformatics analysis of the data with Prof. Cowen.

Tasks and Responsibilities of Research Assistant:

Students will participate in this field research in coral biology and ecophysiology on the island of Mo'orea, French Polynesia at the Richard B. Gump South Pacific Research Station. Mo'orea, an island in French Polynesia, is the site of Putnam Lab field research projects - coral reefs on Mo'orea are monitored and studied by a large group of researchers from multiple institutions as part of the NSF Long Term Ecological Network. Field research in Mo'orea includes the following activities:

Overview of activities:

- coral husbandry, physiological assays

- temperature, light and seawater chemistry monitoring
- snorkeling for coral surveys and collection
- in water and wet-lab monitoring of coral spawning
- coral fertilization
- wetlab equipment maintenance
- use of PC and Mac computers, wetlab notebook generation and quality control
- coding and statistical analysis, for example, open online lab notebooks; reproducible statistical analyses; coding in R and bash, written and oral summary of results; report and publication writing; outreach and education; website and online media contributions

Responsibilities at Tufts: learning RNAseq bioinformatics transcriptomics analysis pipelines, perform gene enrichment analysis, and other bioinformatics analyses as needed.

Qualifications:

Requirements:

- Able to swim & snorkel
- Able to lift & carry equipment, etc. (<50lbs)
- Comfortable in a remote island location as well as working in a foreign country
- Able to travel to foreign country

Additional considerations (not required):

- Previous field work experience
- Previous laboratory experience

For the computer science/data science component:

- Previous completion of CS15 or the equivalent course at Tufts
- Additional experience with Python or R is not required but a plus
- Additional biological background or computational biology background (i.e. CS167 course, etc.) is also not required but a plus.

Description of Field Site: The Richard B. Gump South Pacific Research Station is located on the island of Mo'orea, French Polynesia and is a hub for world-class science and research of coral reefs and tropical marine ecosystems. The Gump Station provides direct access for researchers to conduct research in the Mo'orea Coral Reef Long-Term Ecological Research (LTER) site within the network of the National Science Foundation LTER Network. To have access to field sites and the research community in Mo'orea, students will be housed at the Richard B. Gump South Pacific Research Station during the field research component. Access to Moorea is through air travel to Tahiti and ferry transit from Tahiti to Mo'orea. Once arrived at the airport in Pape'ete, Tahiti, students will take a taxi to the ferry terminal, which is the easiest, safest, and most cost effective mode of transportation to the ferry. Ferry service from Tahiti to Mo'orea is available daily and once arrived on Mo'orea, Gump Station staff or researchers will pick up students and provide transportation to Gump Station.

Housing in Mo'orea, French Polynesia: To have access to field sites and the research community in Mo'orea, students will be housed at the [Richard B. Gump South Pacific Research Station](#) during the field research component. Accommodations are on the research station property and is best for students and researchers conducting field work to stay in Gump Station housing in order to have easy access to all amenities and access to field research (ex: boats, laundry, wifi, laboratory and office spaces). Students will be placed in the bungalows or the student dormitory, depending on availability. Bungalows have single or

shared bedrooms, shared bathroom, outside kitchen. Student Dormitory has 16 individual rooms, dormitory style, shared kitchen and bathrooms.