Online Proceedings

SESSION 1P

MCNAIR SESSION - SCIENCE AND TECHNOLOGY FROM CELLS TO OUTER SPACE

Session Moderator: Laura Pina, Human Centered Design and Engineering
MGH 295
12:30 PM to 2:15 PM

* Note: Titles in order of presentation.

Identifying Gene Inactivations that Produce Gallium Resistance in *Pseudomonas aeruginosa*
Lisa Khuu, Senior, Microbiology
McNair Scholar, UW Honors Program
Mentor: Pradeep Singh, Microbiology
Mentor: Richard Siehnel, Microbiology

Antibiotic resistance is a major public health problem. For example, in people with the genetic disease cystic fibrosis, *Pseudomonas aeruginosa* causes chronic lung infections that resist treatment to all existing antibiotics. Gallium is a promising new antimicrobial agent that works through a novel mechanism of action. Bacterial uptake systems are unable to distinguish gallium from iron due to their nearly identical ionic radii. Once inside, bacterial gallium is thought to disrupt iron-dependent processes because Ga^3+ cannot be reduced in physiological conditions, and iron's biological functions depend on its capacity for redox cycling. Here I sought to better understand gallium's mechanism of action by identifying gene mutations that decrease *P. aeruginosa* gallium sensitivity. To accomplish this, I used transposon (Tn) mutagenesis, which transfers a genetic element to random locations on the bacterial chromosome thereby inactivating genes. Of the 295,000 mutants generated, I selected for mutants capable of growing in the presence of increased gallium compared to the parental strain. Using a procedure known as rescue cloning, a restriction digest was performed on the chromosomal DNA of these mutants to produce individual fragments. One of these DNA fragments will contain the Tn insert and chromosomal DNA flanking that insert. The Tn insert encodes resistance to gentamycin and holds the capacity to replicate as a plasmid in *E. coli*. I ligated the isolated fragments and transformed *E. coli*, selecting for gentamycin resistance. I isolated this plasmid DNA from two mutants and their Tn insertion sites (and the genes inactivated by the Tn) were identified by sequencing the DNA surrounding the Tn inserts. These genes were found to be involved in iron transport. By completing these experiments, I hope to suggest hypotheses for the roles these genes play in gallium sensitivity and to provide data useful toward guiding its development as an antibacterial agent.

POSTER SESSION 2

MGH 206, Easel 170
1:00 PM to 2:30 PM

Improving Durability and Efficiency of Tread Scales to Study Foraging Patterns of Magellanic Penguins
Anika Naima (Anika) Hidayat, Sophomore, Center for Study of Capable Youth
NASA Space Grant Scholar
Mentor: Dee Boersma, Biology

Active nests at the world's largest Magellanic penguin (Spheniscus magellanicus) colony at Punta Tombo, Argentina have declined 40% since 1987. Climate change has increased rainfall and intense storms resulting in high chick mortality. Although these large-scale weather changes are known to factor into the decline, the effect of weather patterns on the scale of individual days is uncertain. To gain insight into penguins' daily foraging patterns throughout the annual breeding season, automatic tread scales were placed on a penguin "highway" so when a penguin crossed we could document their time and direction of crossing, weight, and RFID tag. We sought to redesign the scales to improve energy efficiency by switching to solar power and increase accuracy and durability by changing the protective covers on the devices. Most importantly, the modified scales were required to be waterproof to protect internal components from heavy rain and flooding. The batteries used to power the scales had to last 7 days before needing to be replaced. Lastly, the materials used had to withstand temperature fluctuations and be animal-proof. The new design implements solar panels to charge batteries for the scales and cable glands to prevent water ingress through sides of the scales. The updated scales are made of wood and fiberglass then encased in heat-sealable fabric and sealant for waterproofing. Prototypes were firstly tested in the lab to see if they resisted flood-like conditions. Next, we tested whether the scales performed well after being exposed to large temperature changes using temperature con-

trolled rooms. Additional tests were performed in the field to determine whether the design modifications decreased the amount of water ingress and increased battery life. Long-term tests in the field will be important to see how the materials weather over time when faced with temperature fluctuations, flooding, and animal usage.

POSTER SESSION 2

MGH 206, Easel 171

1:00 PM to 2:30 PM

Competitive Nest Positioning in Magellanic Penguin Chicks *Spheniscus magellanicus*

Desirae Ellen (Des) Thomaier, Senior, Biology (Ecology, Evolution & Conservation)
Mentor: Dee Boersma, Biology

Magellanic penguins (*Spheniscus magellanicus*) have highly variable reproductive success, and while most eggs successfully hatch, about 50% of the chicks survive to fledging. What determines which of the two chicks in a brood fledges? Typically the first chick hatches two days before its sibling, and has an early size advantage in terms of weight. We predict that larger chicks will occupy the preferred nest position, switching from the warmer position early in development to the optimal feeding position. We also expect that chicks more often found in the "better" position at these different stages will be more likely to fledge. To assess optimal nest positioning we collected weight, nest position, and fledging data on over 1,200 chicks during the 2017-18 Magellanic penguin breeding season at Punta Tombo, Argentina. We extracted data from our SQL Database using a number of SQL queries, and we will use R Studio to analyze our results. We expect to find larger chicks preferentially in the back (warmer) position of the nest early in growth for better thermoregulation, and in the front of the nest later in development since they would be closer to the adult's head during feeding. Developmental priorities should change as the chicks begin to independently thermoregulate at around 15 days old, so we expect a transition in chick positions at this time. Chicks consistently in the preferred position should have a higher likelihood of weight gain and fledging. These findings will further our understanding of the key factors and challenges in fledging and reproductive success at our study colony at Punta Tombo, Argentina.