Dr. Matthew Cabeen and His Research on the Stress Response of Bacteria

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Dr. Cabeen achieved his PhD in Molecular, Cellular & Developmental Biology

in 2010 from Yale University. Afterward, he did his post-doctorate at Harvard University where he studied biofilm production and stress response of bacterial colonies. After 6 years, he relocated to Oklahoma State University in the Fall of 2017 where he continues to work with the opportunistic pathogen *Pseudomonas aeruginosa* meaning that it does not normally affect people with healthy immunity. However, individuals that have severe burns, diabetics with open wounds, and those with cystic fibrosis are at a much greater risk of contracting this harmful pathogen. Dr. Cabeen also works with the model species *Bacillus subtilis*. *B. subtilis* is easily grown in lab, and has natural competent abilities meaning it can naturally uptake artificial plasmids, foreign DNA, and incorporate them into its genome. His work published in 2017 describes how bacteria respond to either environmental stress or energetic stress. Environmental stress was achieved by inducing ethanol concentrations at 1% to 4%. Increasing ethanol concentrations creates harmful oxygen species within the cell. Energetic stress is stress created by the depletion of ATP. Adenosine triphosphate (ATP) is the power currency of the cell and allows the cell to accomplish its many task. CCCP is a drug that reduces the amount of ATP in cells and was used to induce energetic stress on the bacteria. His work followed the work of Michael Elowitz where he also used the model species *B. subtilis*. Elowitz found that the bacteria, when induced to energetic stress, that there was a frequency modulated response meaning that the response from the population was a low amplitude response but was much more frequent over a period of time. However, in Dr. Cabeen’s work, it was observed that there was an amplitude modulated stress response meaning that the higher the input of stress, the higher the output response. Possible reasons for this is that Dr. Elowitz used agarose gel to test the bacteria where their waste products built up as the colonies continued to grow. Dr. Cabeen conducted his experiment in microfluidics devices. Microfluidics is the growth of bacteria in an open flow container. Fresh media, nutrients, and other substances such as ethanol or CCCP could be added uniformly across the population while washing away waste products and excess cells out of the media. This created a much more uniform environment where all cells were subjected to the same amount of stressor at any given time. This eliminated environmental variability as an uncontrolled variable. Dr. Cabeen’s experiment found that there was an amplitude modulated response, and also that there were four distinct response factors conserved in this strain of bacteria. Each cell sensed stress using large stressosomes. Stressosomes contain stress sensor proteins that activate cellular signaling. Furthermore, there are 4 varieties, each with its own specific response. For instance, one stress sensor had a very rapid response that was short lived. Another response was very slow in turning on but maintained on for a much longer period of time. Coupling these stress responses allowed the cell to successfully survive increasingly harsh environments. These findings helped to shed light on how pathogens sense stress which is a key factor in battling pathogens for the general population. Understanding how these cells sense stress within their environment can help us to better treat bacterial infections when we combat them with medications or other means of treatment.

Work Cited

Cabeen MT, Russell JR, Paulsson J, Losick R (2017) Use of a microfluidic platform to uncover basic features of energy and environmental stress responses in individual cells of *Bacillus subtilis*. PLoS Genet 13(7): e1006901.