The Stress Response of *Bacillus subtilis*

In order to survive, living organisms must have a way to respond to stressful situations. Humans have what is called a fight or flight response so that when threatened, they can quickly defend themselves against the threat or escape it. This response can also kick in when you’re about to speak in public or ride a roller coaster. Your heart will begin to beat faster and your breathing will quicken. Your body is preparing for a burst of energy that may be needed to defend itself.

Even organisms that are too small for us to see respond to stress and prepare to defend themselves. One microorganism that has an interesting response to stress is the bacterium *Bacillus subtilis.* This bacterium is found in soil and the gastrointestinal tract of humans. Bacteria respond to stress differently than humans because they are so small. Even a tiny change in their environment can cause a huge impact for the microorganism. In *B. subtilis,* the main player in response to stress is called σB, or sigma factor B.  According to Dr. Matthew Cabeen, σB response is like a 2nd grader running away from a bully, but he doesn’t know exactly what the bully wants. So he starts throwing his lunch and everything he has at the bully. In the same way, σB generates a general stress response to help *B. subtilis* survive the next few minutes after an environmental or energy stress is detected.

To study this stress response, Dr. Cabeen and his team grow the bacterium in a microfluidic device. This device is unique in that the bacterium can grow confined to a plate, while a medium full of nutrients flows through and is continuously replenished. In the lab, this medium is not only used to nourish the cells, but also as a vehicle for the stressor that is being studied. For example, if the team is studying environmental stressors, they could add ethanol, salt or acid to the medium. A small amount of stressor needs to be added in order to initiate a stress response, but not so much that the bacterium can’t continue to grow or survive.

Because bacteria respond so quickly to a detected stressor, it is vital that researchers are able to observe the bacterial response immediately after the stressor is added to the medium. What researchers have discovered in these crucial moments, is that there is a long line of proteins that are activated by σB in response to stress. One protein senses the environmental stress and activates a chain of other proteins that eventually free σB. This entire process starts with a complex of RsbR and RsbS proteins called the stressosome. There are between 10-20 stressosomes in each cell, each leading to the activation of a sigma factor when stress is detected. This intricate pathway not only causes immediate changes in the cell, but also changes that can be detected for generations of cells to come.

This is just one example that the need to defend oneself against attack is not unique to larger organisms. It is just as critical for microorganisms to sense and respond to changes in their environment and we’re learning more about this complex process every day.  This research can also be used to help humans further understand bacterial stress response and to help develop better antibiotics to treat infections.