49. The Novel Cellulolytic Strategy of Cellulomonas gilvus

Caryn S. Wadler[1*], Meagan C. Burnet[2], Stephen J. Callister[2], and Garret Suen[1]

[1]University of Wisconsin-Madison, Madison; [2]DOE Pacific Northwest National Laboratory, Richland

Project Goals: The use of cellulolytic bacteria for generating cellulosic ethanol has recently been the focus of extensive research. This research has primarily focused on using engineered strains of cellulolytic bacteria, but there is growing interest in understanding the fundamental processes of cellulose degradation for identifying novel enzymes or for finding organisms capable of more efficient cellulose fermentation. One family of Actinobacteria, the Cellulomonadaceae, includes the only reported bacteria capable of both degrading cellulose aerobically and anaerobically and producing ethanol as a byproduct of this metabolism. This could thus represent a novel strategy for cellulolytic activity, as the known strategies for aerobic and anaerobic cellulose degradation are functionally distinct with any given bacterium utilizing only one approach. The goal of this project is to understand the strategy through which the cellulomonad Cellulomonas gilvus accomplishes cellulose degradation.

The ability to degrade cellulose is found in a handful of organisms including bacteria. Within bacteria, two mechanisms for cellulose deconstruction exist, including the cell-attached and cell-free models. Both strategies are known to be associated with either anaerobic or aerobic bacteria, respectively, and thus represent mutually exclusive approaches for this difficult physiological process. An exception to this observation is Actinobacteria within the genus Cellulomonas, which are known to degrade cellulose under both aerobic and anaerobic conditions. However, very little is known regarding the process through which this occurs. In this study, we investigated the strategy that cellulomonads use for cellulose degradation, using Cellulomonas gilvus as a model organism. We employed a combination of RNA-seq and proteomics to determine that C. gilvus expresses the same sets of genes and proteins to degrade cellulose under both aerobic and anaerobic conditions. This suggests that it uses a conserved mechanism regardless of condition. To better understand this mechanism, we performed a series of experiments examining the motility, chemotaxis, cellulase localization, and fiber adherence capabilities of C. gilvus. Our results suggest that C. gilvus degrades cellulose using a novel hybrid of the canonical aerobic and anaerobic strategies and provides further insights into the metabolism of this organism.

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