Research Background: Boosting Yeast's Appetite for Sugars

Figure 1: (Left) Professor Audrey Gasch (right) and graduate student Maria Sardi. (Right) GLBRC microbiologist Dr. Trey Sato.

Yeast (*Saccharomyces cerevisiae*) is the powerful microbe that gives us bread, beer, wine, and biofuels. Through the process of **fermentation**, yeast 'eats' sugar and makes it into carbon dioxide and ethanol. Carbon dioxide is what makes bread rise and beer fizzy. Ethanol can be used as a renewable fuel for vehicles that contributes less new carbon dioxide to the atmosphere.

But just as kids can be picky eaters, so can yeast. Yeast only eats sugar if it has exactly six carbon molecules. This is a problem for making biofuels from biomass sources such as corn stalks, wood and grasses. That's because about 40% of that biomass is cellulose, composed of long chains of 6-carbon **glucose** molecules, which yeast ferment easily. But another 30% is hemicellulose, made of 5-carbon **xylose** molecules, which yeast won't touch.

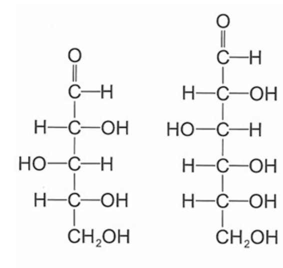

Figure 2: The simple molecular structure of the sugars xylose (5-carbon) and glucose (6-carbon)

Great Lakes Bioenergy Research Center scientists Dr. Trey Sato and Dr. Audrey Gasch are trying to overcome this problem by engineering a yeast strain that can ferment both glucose and xylose. Yeast that could eat both sugars would make much more ethanol from the same amount of biomass. They used a process called **directed evolution** to help develop yeast varieties with genetic mutations that allow them to ferment xylose.

In their experiment, they grew a standard **yeast strain** in a series of flasks that contained xylose as the only energy source. They let the yeast population slowly grow and reproduce for many generations. Through the process of evolution, they expected that some yeast cells in the population would develop genetic mutations that allowed them to ferment the xylose and that those mutants would become dominant over time. This is because mutants with the ability to ferment xylose should be able to grow and reproduce faster than yeast without the beneficial mutations.

After four months of maintaining the culture, the scientists extracted and isolated a single cell from the evolved yeast culture growing in the flask. They wanted to know if this evolved yeast was more efficient at converting xylose to ethanol than the original yeast strain. To answer this question, they set up a side-by side fermentation experiment with xylose as the primary sugar source. In one container they added the original parent yeast and in the other they added the evolved yeast. They measured xylose and ethanol concentrations over 32 hours and organized the data in a table.