

Program: Yeast: Bread, Booze, and Biology

Speaker: Matthew Bochman, PhD, Department of Molecular and Cellular Biochemistry, Director of Graduate Studies - Biochemistry Graduate Program, IU

Introduced by: Roz Webb

Attendance: 94

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This week's Zoom recording can be viewed at: www.scientechclub.org/zoom/578.mp4

The lecture today was by Dr. Matt Bochman, Associate Professor and Director of Graduate Studies in biochemistry at IU Bloomington. The title was Bread, Booze, and Biology and includes the history of yeast, specifically, the yeast *Saccharomyces Cerevisiae* used to make beer.

There are over 150,000 species of yeast. Yeast is part of the fungi kingdom, a single cell organism and 10 times larger than bacteria in physical size. It is a biological workhorse. The fermentation by yeast *S. cerevisiae* is the anaerobic metabolic process of breaking down sugar into ethanol and carbon dioxide. This process is found in many of the foods we eat like bread, pickles, etc. Fermentation pre-dates humanity and is the earliest form of energy production. Alcohol and evolution are intertwined. Fruits are good sources of sugar and are readily fermented. Animals are attracted to the scent of fermentation as a source of food.

Aristotle, 2500 years ago, wrote the earliest book on fermentation wondering why sugar became alcohol. He named the sediments of alcohol production as "yeast". Anton van Leeuwenhoek used his microscope in 1680's and found "oval and round bodies" but did not know what they were. In 1789, Antoine Lavoisier thought that sugar turned into ethanol and carbon dioxide and confirmed the hypothesis with experimentation but again ignored the sediment. In 1794, Joseph Louis Gay-Lussac likewise worked on mixtures of alcohol and water to refine Lavoisier's process, and he also ignored the sediment. Unfortunately his promising experimentation was cut short when the French Revolutionary government gave him the guillotine in 1794.

Ironically, in 1803 the Institut de France offered 1 kg of gold to anyone who could figure out how fermentation works and nobody won. The French wine industry alone was worth \$2.5 billion by 1829 but no one was able to explain the fermentation process. In 1837, a German, Theodor Schwann, theorized that microbes were agents of fermentation. Schwann observed that yeasts were using asexual reproduction, that they ate sugar, required nitrogen to live, and excreted ethanol. However, three other German chemists disagreed. They thought it was a chemical process without microbial involvement.

Dr. Bochman then took us back to an earlier time in France when the fermentation process was still not understood. It was in 1850's when Louis Pasteur who, while studying fermented beet juice, found the microbes under a microscope and hypothesized that the round cells (yeast) were making ethanol. He experimentally proved that sugar added to the round microbes produced ethanol while sugar added to rods (bacteria) produced lactic acid. In 1897, Eduard and Hans Buchner fractionated yeast extracts finding one fraction that fermented sugar into ethanol and carbon dioxide and discovered the enzyme zymase. The Buchners won the 1907 Nobel Prize in Chemistry.

So why did some fermentations work better than others and which yeasts were the best at fermenting? In 1882, Carlsberg beer's microbiologist Emil Christian Hansen discovered 4 different

species of yeast in their beer when researching the problem of bitter flavors and off odors. The problems were due to one of the yeast strains. The "Carlsberg bottom yeast no.1" (*S. calnsbergensis*) gave the best tasting beer which you can still buy today. By the 2000's, they found that *S. cerevisiae* is best for ale, and *S. calnsbergensis* is best for lager. Sequencing the genome of *S. calnsbergensis*, they found it is composed of one-half *S. cerevisiae* and one-half *S. eubayanus*. The world-wide hunt for novel yeasts continues...

Matthew L. Bochman, PhD
(Photo courtesy of IU)

