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Effect of Mutation Rate and Population Size on Microbial Rate-Yield Trade-Offs

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Biological trade-offs are an inherent aspect of life because limiting resources force all organisms to compromise between multiple opposing goals. Bacteria have demonstrated that processes like virulence and metabolism are managed under a trade-off, because the environment influences whether one function is favored over another. These trade-offs are important for dictating evolution, as they allow for adaptability to the environment, which means that many factors can influence the trade-off. My project focuses on the rate-yield trade-off in microbial metabolism, which is the conflict of devoting resources to faster growth and resource acquisition or greater yield and reproduction. Previous work has shown that cooperation and competition are important factors in microbial metabolism. More competition favors faster resource acquisition, because bacteria are competing to acquire food before their neighbors deplete the environment. Oftentimes competition is a result of less relatedness, because there is a greater range of growth rates. Conversely, spatial structure creates microenvironments that favor cooperating bacteria. The result is the evolution of bacteria that can use their resources efficiently. My project looks at two more factors, mutation rate and population size. I hypothesized that greater mutation rate would evolve high-rate mutants as more mutations would result in more competition. I also hypothesized that larger population would result in more competition because there would be more bacteria competing for resources, and therefore it would be favorable to acquire resources quickly. Results supported the mutation rate hypothesis, but opposed the population size hypothesis. This result may be due to the effect of density and toxin build-up impeding the growth ability of the bacteria. My project demonstrates two more factors that influence the rate-yield trade-off. It is important that we continue researching the rate-yield trade-off as it has implications in understanding how metabolic pathways function and how they may evolve.