

Is Mutation a Creative or Destructive Force in Evolution?

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Most biologists would agree it is both, but how does one present the subtle distinctions to undergraduates in an engaging, exploratory, and data-generating laboratory exercise? AVIDA* offers a perfect platform, modeling virtual organisms as mutations occur at random locations in their genome. As in real haploid replicators, any mutation may or may not affect the fitness-correlated outcome of a successful phenotype but is more likely to be disruptive than constructive. However, without mutations, constructive new phenotypic functions are unable to evolve. With AVIDA, students set the rate of mutations and measure the latency in generations required for new functions to evolve. Each is like how a new biochemical pathway due to mutations in enzyme-coding genes allows a bacterial population to metabolize novel chemical substrates (either for energy or as defense against antibiotics.) A graphing of class data and simple statistical analysis tests the student-generated hypotheses regarding the relationship between mutation rate and innovations. This is illustrated with data obtained by freshman biology majors at Hastings College, as well as examples of novel AVIDA labs utilized in upper division courses and labs prepared by other educators and shared on the QUBEShub.

*AVIDA is a program designed by researchers at Michigan State University to evolve virtual organisms with genomes that mutate at random and can fortuitously develop Boolean functions that can help Avidians replicate, just as haploid organisms do. AVIDA-ED provides a free, and easy to learn, experimental platform for the study of evolution in which students can design experiments to test hypotheses that relate to actual organisms and real-world concerns such as antibiotic resistance.

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