The evolution of microbial defense systems

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Video Abstract

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Abstract

Just as we have evolved an immune system to defend against disease-causing bacteria and other pathogens, bacteria themselves are under constant pressure from parasites and have, thus, evolved their own defense systems. A recent study takes a closer look at the genes involved in these systems, particularly the rate of gene gains and losses. A widely discussed concept among evolutionary biologists is that of an ‘evolutionary arms race’ – organisms (and their genes) in a constant struggle to out-compete each other. A parasite evolves a new tactic to infect its host. The host, in turn, evolves a new defensive strategy to protect itself. The parasite responds with another novel tactic. Presumably, this never-ending loop results in rapid genetic change in both participants. But this may not be the case for all bacteria. The evolution of bacterial and archaeal genomes is a highly dynamic process involving gene gains, losses, and duplications. A team of researchers investigated the rates of these processes by building an evolutionary tree and comparing the genomes of 35 closely related bacteria and one archaea species. Close inspection of the genes involved in defense revealed a higher-than-average rate of change, as expected under the arms-race model. But at 1.4 times higher than the rest of the genome, this is a fairly modest increase. Furthermore, with the exception of a few parasitic odd-ball bacteria, no discernable connection was observed between evolutionary dynamics of the defense system and the life style of the microbes in question. These results are surprising given the common assumption of rapid change driven by the evolutionary arms race between hosts and their parasites. So, what explains this counter-intuitive result? As the authors point out, the evolution of defense systems is shaped by many different factors. So while the arms race may be increasing the rate of change in defense system genes, other forces are likely exerting an opposite pressure, constraining the mobility of these genes.