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From genetic conflicts to molecular innovation

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Genetic conflict arises when distinct genetic elements within an organism pursue divergent evolutionary interests. These conflicting forces drive continuous cycles of adaptation and counter-adaptation that reshape microbial genomes and generate new molecular functions. In prokaryotes, this conflict is visible in the dynamic interplay between mobile elements such as transposons and bacteriophages, and the host genome. Bacteria deploy diverse mechanisms to combat foreign genetic elements, ranging from nucleic acid targeting and restriction to abortive infection and dormancy. To overcome these host barriers, mobile elements continuously evolve strategies to evade, subvert, and even repurpose host defense machinery for their own propagation. Far from being simple genetic parasites, mobile elements can shuttle functional cargo genes, including anti-phage defense systems, thereby facilitating their horizontal dissemination among bacterial lineages. The co-evolutionary interplay between phages, transposons, and host defense systems thus acts as a major engine for biological innovation, yielding intricate multi-protein complexes and versatile enzymatic tools. Understanding the mechanisms that emerge from these conflicts offers new perspectives on genome evolution while informing new strategies for biotechnology and synthetic biology.

Reference #1

Reference #2

Reference #3

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