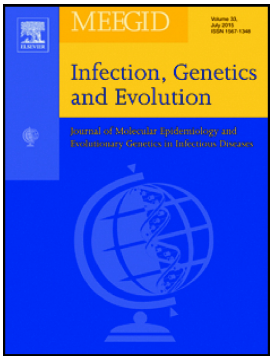

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Sex in microbial pathogens

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Abstract

We review the sexual processes common in pathogenic microorganisms and assess the primary adaptive benefit of such processes. The pathogenic microorganisms considered include bacteria, microbial eukaryotes, and viruses. The sexual processes include bacterial transformation, eukaryotic meiotic sex and virus multiplicity reactivation. Recent evidence shows that sexual processes are common in microbial pathogens. A major general challenge to pathogen survival and infectivity is the need to overcome the hostile defenses of their target host. These defenses characteristically involve production of stresses, including oxidative stress, that can damage the pathogen's genome. Pathogens appear generally to possess enzyme systems that are central to sex and are also associated with a particular type of genomic repair process, recombinational repair. For some pathogens, it has been directly demonstrated that infectivity and virulence depend on sex. The evidence reviewed here supports the conclusion that the primary benefit of sex in pathogens is the repair of genomic damages that would otherwise be deleterious or lethal. This conclusion is in agreement with similar conclusions derived from non-pathogenic model species of bacteria, microbial eukaryotes and viruses. In several pathogenic species it has been shown that the two partner genomes that engage in sex are most often clonally related or closely related genetically. Thus, in pathogenic species, sexual interactions likely generate little or no genetic variation among progeny. However, infrequent outcrossing can occur in these sexual species and this may have important long term consequences.