



## Evolution of Aging, Mortality and Immortality in Bacteria



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### ABSTRACT:

Deleterious mutations appearing in a population increase in frequency until stopped by natural selection. The ensuing equilibrium creates a stable frequency of deleterious mutations or the mutational load. Here I develop the comparable concept of a damage load, which is caused by harmful non-heritable changes to the phenotype. A damage load also ensues when the increase of damage is opposed by selection. The presence of a damage load favors the evolution of asymmetrical transmission of damage by a mother to her daughters. The asymmetry is beneficial because it increases fitness variance, but it also leads to aging or senescence. A mathematical model based on microbes reveals that a cell lineage dividing symmetrically is immortal if lifetime damage rates do not exceed a threshold. The evolution of asymmetry allows the lineage to persist above the threshold, but the lineage becomes mortal. In microbes with low genomic mutation rates, it is likely that the damage load is much greater than the mutational load. In metazoans with higher genomic mutation rates, the damage and the mutational load could be of the same magnitude. A fit of the model to experimental data shows that *Escherichia coli* cells experience a damage rate that is below the threshold and are immortal under the conditions examined. The model estimates the asymmetry level of *E. coli* to be low but sufficient for persisting at higher damage rates. The model also predicts that increasing asymmetry results in diminishing fitness returns, which may explain why the bacterium has not evolved higher asymmetry.

Host: Van Savage, Ph.D.

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