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A SIMPL model of phage-bacteria interactions accounting for mutation and competition

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Pseudomonas aeruginosa is an opportunistically pathogenic bacteria that causes fatal infections and outbreaks in hospital environments. Due to the increasing prevalence of antibiotic-resistant strains of *P. aeruginosa*, the need for alternative therapies is critical. Bacteriophage therapy is emerging as a promising approach; however, it remains unapproved for clinical use and is hindered by limited understanding of the complex interactions between bacterial cells and phage virions. Mathematical models provide insight into these interactions. Through a system of ordinary differential equations, we determined necessary biological assumptions to effectively capture the dynamics observed between susceptible, infected, and mutated bacterial cells and bacteriophage virions in a microwell setting. Data fitting based on this model produced a set of parameter estimates unique to our experimental observations of a specific phage and *P. aeruginosa* strain. In translating observed optical density readings into bacterial concentrations, we also found that bacterial debris has a significant impact on optical density, with a lysed bacterium contributing roughly 31% as much to optical density readings as a living cell.

Keywords: pseudomonas aeruginosa, optical density, bacterial dynamics, bacterial debris, non-isolated equilibria, parameter fitting, optimization

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