Developing Antibacterial Surfaces Using Bio-Inspired Methods: Investigating the Bactericidal Efficiencies of Different Nanopillar Arrangements Found on Insect Wings

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Previous research showed that wings of dragonflies, damselflies, and cicadas possessed nanopillars with antibacterial properties. The purpose of this research was to investigate the relationship between insects' nanopillars and their unique bactericidal efficiencies. Nanopillars have the potential for applications in the creation of antibacterial surfaces; therefore, determining bactericidal efficiencies of various nanopillar arrangements is important. This research was done by collecting damselflies, dragonflies, and cicadas, incubating bacteria on the wings of the insects, and determining the amount of bacteria killed using fluorescent dyes. It was hypothesized that Odonata insect wings kill bacteria more effectively than cicada wings because their nanopillars have more varied heights and spacings; these could be more conducive to stretching and rupturing bacterial cell membranes. Qualitative data shows that nanopillars on dragonfly, damselfly, and cicada wings do rupture bacteria as seen by clusters of fluorescing red dye, which only stains dead bacteria. Analysis of qualitative and quantitative data suggests that damselfly nanopillars possess the most bactericidal nanopillar arrangement against Gram-negative bacteria due to smaller nanopillar diameters and varied nanopillar heights and spacings. When comparing the bactericidal efficiencies between Gram-negative and Gram-positive bacteria, it is clear that damselfly and dragonfly insects are significantly better at killing Gram-negative than Gram-positive bacteria. There was no statistically significant difference between the bactericidal efficiencies of cicada nanopillars on both Gram-negative and Gram-positive bacteria. In the future, the damselfly nanopillar arrangement could be fabricated onto hospital equipment.