What drove bacterial cells to adopt an intracellular lifestyle in eukaryotic cells during pathogenesis?

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Abstract

Many bacteria invade eukaryotic cells and grow within the larger host cells. This typically results in pathogenesis and an intracellular infection, often detrimental to the host cells. But, from another perspective, such intracellular infection process also bears some resemblance to endosymbiosis, where a cell was engulfed by a larger host cell, and a symbiotic relationship subsequently develops between the invading cell and larger host cell. Hence, possibilities exist that ancestral cellular appendages might have evolved during interactions between bacteria and proto-eukaryotic cell to enable the bacterial cells to invade the larger host cells. Such cellular surface appendages might have exploited the primitive endocytosis mechanism in proto-eukaryotic cell to enter the larger host cells, where subsequent exposure to the interior of the host cells nourishes the bacterial cells. One approach for probing this hypothesis might be the profiling of the genes that encode various cellular surface appendages in bacterial cells and tracking their phylogenetic evolution through searching for homologs in other species. This analysis might reveal the evolutionary trajectory traversed by the different surface appendages genes. A potential problem with the above view on the evolution of intracellular bacterial pathogens for eukaryotic species is the question concerning why the bacterial cells did not get co-opted into an endosymbiotic relationship with the eukaryotic cell. Specifically, what prevents the evolution of an endosymbiotic relationship between the intracellular bacterial pathogen and eukaryotic host? Did the toxins secreted by the intracellular bacterial pathogens prevent the evolution of an endosymbiotic relationship? Collectively, why particular bacterial species could enter an endosymbiotic relationship with an eukaryotic host that resulted in the formation of modern mitochrondrion and chloroplast remain poorly understood. More importantly, what drives a bacterial cell to enter a larger eukaryotic host? Probing the evolutionary trajectory of the bacterial surface appendages and machinery might be one approach to answer the questions, but ultimately, a deeper question concerns why the intracellular bacterial pathogen did not enter into an endosymbiotic relationship with the larger eukaryotic host cell. Specifically, what cellular mechanism hampers the formation of such a relationship?

Keywords: bacteria, eukaryotic cells, surface appendages, evolution, pathogenesis, intracellular, endosymbiosis, phylogeny, endocytosis, toxins,

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