Elaborate mechanism for the synthesis of lipopolysaccharide points to its functional importance in Gram-negative bacteria

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Abstract

Gram-negative bacteria such as *Escherichia coli* and *Salmonella enterica* possess two phospholipid bilayer membranes in the cell envelope. Known as the inner and outer membrane, proteins encased in the outer membrane as well as surface moieties displayed by the membrane play important roles in host-cell recognition, cell-cell interactions and triggering of immune response in host. One such molecule that partakes in triggering immune responses in human is lipopolysaccharides that constitute the outer leaflet of the outer membrane of Gram-negative bacteria. Specifically, recent research has added new details and mechanisms for the elaborate choreographed enzymatic reactions that synthesize lipopolysaccharides. In particular, lipopolysaccharides are synthesized in the inner membrane and transported to the outer membrane through a dedicated protein channel formed by proteins of the same lipopolysaccharide synthesis pathway. In short, significant amount of proteins and cellular resources are expended in the synthesis and transport of lipopolysaccharides which suggests important evolutionary significance and functionality of the molecule. Specifically, evolutionary significance of lipopolysaccharide can be gleaned from the organisation of the pathway that mediate its synthesis, where dedicated channels are constructed from proteins to help the unidirectional transfer of the molecule from the inner to outer membrane. Such dedicated channels are not of high occurrence in cells, which suggests critical functional importance of lipopolysaccharides to Gram-negative bacteria. Perhaps, signalling mechanisms responsible for cell-cell interactions are mediated by lipopolysaccharides, or the molecule might play important roles in cellular recognition between different bacterial species in community assemblage such as biofilm. Collectively, mechanistic studies aimed at understanding the formation of the outer membrane of Gram-negative bacteria has opened our eyes to the elaborate mechanism by which lipopolysaccharides on the outer leaflet of the outer membrane are synthesized. Comprising a synthetic machinery and a dedicated protein channel for transporting the synthesized lipopolysaccharides from the inner to outer membrane, a dedicated pathway of proteins mediates the synthesis of this molecule; thereby, pointing to its functional importance to the bacterial cell. While lipopolysaccharides are known to trigger immune responses in humans, its potential broader role in cell-cell communications such as those important for maintaining organisation and community structure in biofilm communities remain unappreciated. Overall, given the significant amount of energy and cellular resources dedicated to its synthesis, lipopolysaccharides should have broader functional roles and might partake in many as-yet unknown signalling and metabolic activities at the cellular and community level.

Keywords: Gram-negative bacteria, lipopolysaccharides, protein channel, outer membrane, inner membrane, periplasm, synthetic machinery, immune response, signalling cascade, biofilm,

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