A tyrosine phosphoregulatory system controls exopolysaccharide biosynthesis and biofilm formation in Vibrio cholerae

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Production of an extracellular matrix is essential for biofilm formation, as this matrix both secures and protects the cells it encases. Mechanisms underlying production and assembly of matrices are poorly understood. Vibrio cholerae, relies heavily on biofilm formation for survival, infectivity, and transmission. Biofilm formation requires Vibrio polysaccharide (VPS), which is produced by vps gene-products, yet the function of these products remains unknown. Here, we demonstrate that the vps gene-products vpsO and vpsU encode respectively for a tyrosine kinase and a cognate tyrosine phosphatase. Collectively, VpsO and VpsU act as a tyrosine phosphoregulatory system to modulate VPS production. We present structures of VpsU and the kinase domain of VpsO, and we report observed autocatalytic tyrosine phosphorylation of the VpsO C-terminal tail. The position and amount of tyrosine phosphorylation in the VpsO C-terminal tail represses VPS production and biofilm formation through a mechanism involving the modulation of VpsO oligomerization. We found that tyrosine phosphorylation enhances stability of VpsO. Regulation of VpsO phosphorylation by the phosphatase VpsU is vital for maintaining native VPS levels. This study provides new insights into the mechanism and regulation of VPS production and establishes general principles of biofilm matrix production and its inhibition.
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