

# **Nano-scale length control of the flagellar drive-shaft requires hitting the protein-tethered outer membrane**

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The mechanisms for assembly of the flagellar rod that spans the periplasmic space remain unknown. The first rod component, FliE, is followed by FlgB,C,F to form the ~11 nm proximal rod, which is followed by the ~11 distal rod composed of a single protein FlgG. What determines the lengths of these rod structures? I will present evidence that distal rod length terminates by hitting the outer membrane as a physical barrier. Amino acid substitutions and small deletions in FlgG lose normal rod-length control and place distal rod-length under control of the FliK ruler. These *flgG\** mutants are defective in motility. Suppressors of *flgG\** alleles include mutants in the distal rod cap gene, *flgJ*, and the P-ring structural gene, *flgI* and in loss-of-function mutants in Braun's lipoprotein gene *lppA*. We show that Braun's lipoprotein determines the spacing between the cell wall and outer membrane acting as a tether to hold the outer membrane to the cell wall. We also show that the tethering of the outer membrane to the cell wall is responsible for distal rod-length control.