

The chemotactic response and motor function of a bacterial flagella motor in a single cell

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An *E. coli* cell transduces extracellular stimuli sensed by chemoreceptors to the state of an intracellular signal molecule, which regulates the switching of the rotational direction of the flagellar motors from counterclockwise (CCW) to clockwise (CW) and from CW back to CCW. We performed high-speed imaging of flagellar motor rotation and show that the switching of two different motors on a cell is controlled coordinately by an intracellular signal protein, phosphorylated CheY (CheY-P). The switching is highly coordinated with a sub-second delay between motors in clear correlation with the distance of each motor from the chemoreceptor patch localized at a cell pole, which would be explained by the diffusive motion of CheY-P molecules in the cell. Our results suggest that a transient increase and decrease in the concentration of CheY-P caused by a spontaneous burst of its production by the chemoreceptor patch at steady state (FIG.1). In chemotaxis system, the binding of signaling molecule, CheY-P, to a bacterial flagellar motor is believed to induce the rotational switching of a motor. By direct imaging of CheY-GFP, we directly demonstrated that the binding and dissociation of CheY-P induce CW and CCW rotation of a motor. It was found that ~ 13 CheY-P molecules bind to and dissociate from a motor within about 100 ms during switching, indicating the possibility of the cooperativity in the binding or dissociation process of CheY-P. The direct imaging of CheY-GFP also revealed that the CW motor has a higher affinity than the CCW motor for CheY-P. From these results, we would like to discuss the regulatory mechanism in the rotational switching of flagellar motor by binding of CheY-P. (FIG.2)

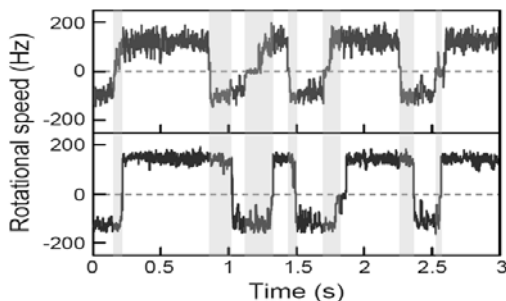


FIG. 1: Correlation analysis of the switching between two motors. The plus and minus values represent CCW and CW rotations, respectively.

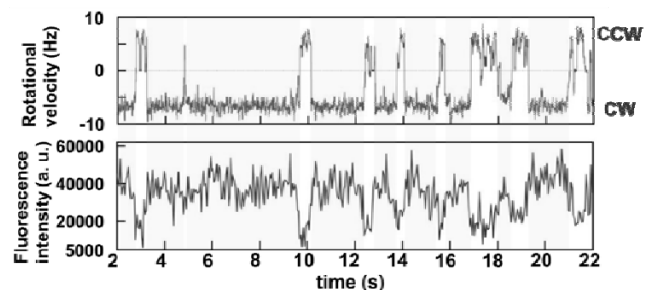


FIG. 2: Fluorescence intensity at the rotational center (top) and rotational velocity (bottom) of a tethered cell. Plus and minus values in rotational velocity indicate CCW and CW rotation, respectively. A.U., arbitrary units.