



BIOLOGY COLLOQUIUM

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Hosted by A/P Liou Yih Cherng

How a long bacterial adhesion protein forms a multispecies biofilm



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Many bacteria produce long adhesion proteins (adhesins) to bind various surfaces and commence biofilm formation. Using a 'dissect and build' approach with X-ray crystallography, NMR, and SAXS we have solved the first complete structure of a bacterial adhesin. This giant 1.5-MDa protein is produced by the Antarctic marine bacterium *Marinomonas primoryensis* and is composed of ~130 domains. Several domains at its N-terminal end anchor the protein to the bacterial outer membrane. Following this section are ~120 identical Ca²⁺-bound extender domains that project the C-terminal ligand-binding region ~0.6 μm away from the host cell surface. The C-terminal region includes ice-, sugar-, and peptide-binding domains. Homologues of these and other ligand-binding domains are found in the same region of adhesins produced by pathogenic bacteria. Using a temperature-controlled microfluidic apparatus, we have shown that *M. primoryensis* forms bacterial clusters on ice that are only released when melting occurs. Binding to this surface can be blocked, however, by polyclonal antibodies raised against the ice-binding domain. This study gives insight into how bacterial biofilms, including those of pathogens, can be disrupted early on, by blocking their ligand-binding domains. We hypothesized that the ice-binding function of the adhesin keeps its aerobic host immediately under the surface ice in the phototrophic zone of the water column where photosynthetic organisms produce oxygen. However, recent results show that motile *M. primoryensis* actually home in on, and bind to, the Antarctic diatom *Chaetoceros neogracile* to form mixed cell clusters that the bacteria then attach to ice. These diatoms are bound to the bacteria through the peptide- and sugar-binding domains of the adhesin. By recruiting diatoms to the ice-bound microcolony, *M. primoryensis* helps these photosynthesizers form a symbiotic community where light is most abundant.