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Signal integration, gain, and integral feedback in the *Escherichia coli* chemotaxis network

NED WINGREEN, Princeton University

Bacteria are able to sense chemicals in their environment, allowing cells to swim towards nutrients (attractant chemicals) and away from repellents (toxic chemicals). The chemotaxis network of the model bacterium *Escherichia coli* possesses remarkable signaling properties including high sensitivity to small changes in chemical concentration over a wide range of ambient concentrations. These signaling properties rely on the architecture of the circuit, including elements that implement signal integration, gain, and integral feedback. All of these elements rely on receptor clustering, which occurs at multiple length scales. At a small scale, the chemotaxis receptors form stable homodimers which then assemble into larger complexes in which receptors of different chemical specificities are intermixed, with trimers of dimers believed to be the smallest signaling unit. At a larger scale, $\sim$10,000 receptors form large polar and lateral receptor clusters. I will discuss recent experimental and theoretical progress in understanding how the biophysics of chemotaxis receptors leads to the remarkable signaling properties of the chemotaxis network.