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Bacterial strategies for chemotaxis response

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Bacteria respond to chemical cues by performing a biased random walk that enables them to migrate towards attractants and away from repellents. Bias is achieved by regulating the duration of the bacterial runs as a function of the environment, inferred from the history of chemoattractant detections experienced by the bacterium. This time-signal is processed using a time convolution function that can be assayed measuring the response of the bacterium to short pulses of chemoattractant. The convolution constitutes an elementary form of memory, which is encoded at the molecular level by the processes of (de-)methylation and (de-)phosphorylation of the underlying biochemical network. While the latter is being characterized in detail, the functional reasons shaping the bacterial chemotactic response are largely unknown. We show that the chemotactic response observed experimentally is the strategy that ensures the highest minimum (MaxiMin) uptake of chemoattractant, in any field thereof. The consequence is that adaptation of the chemotactic bacterial system appears to be evolutionary driven by the need to cope with space-time environmental fluctuations rather than the extension of the dynamic range of response.