Precision

Chemotaxis

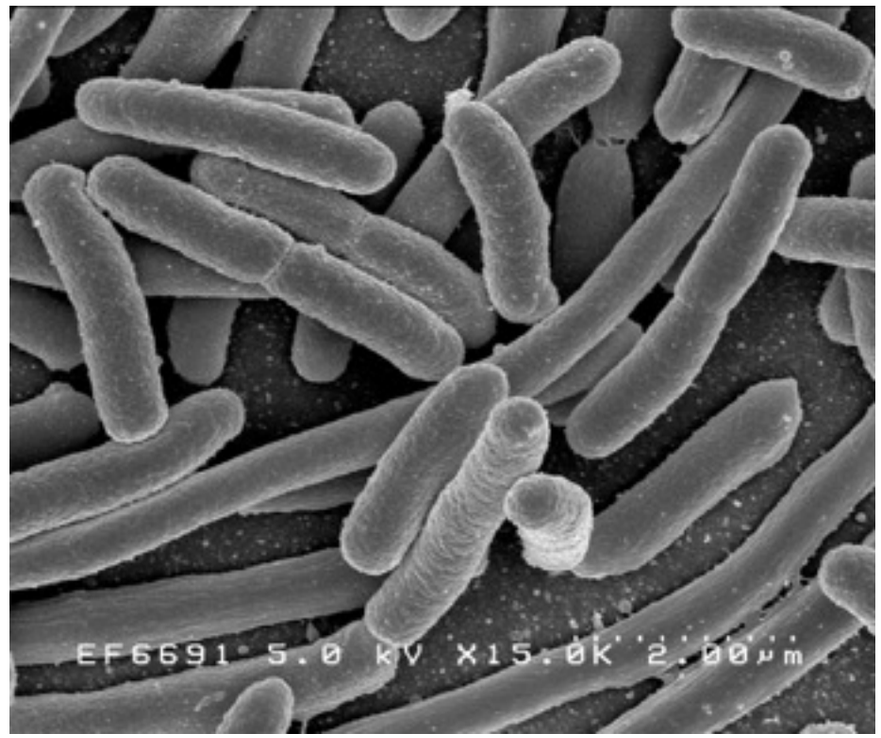
Neutrophil

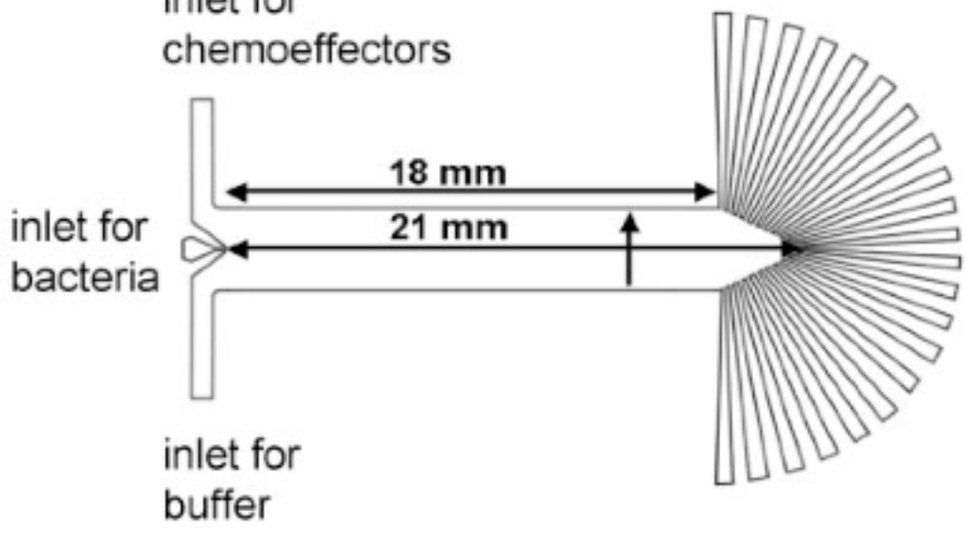
Chemotaxis

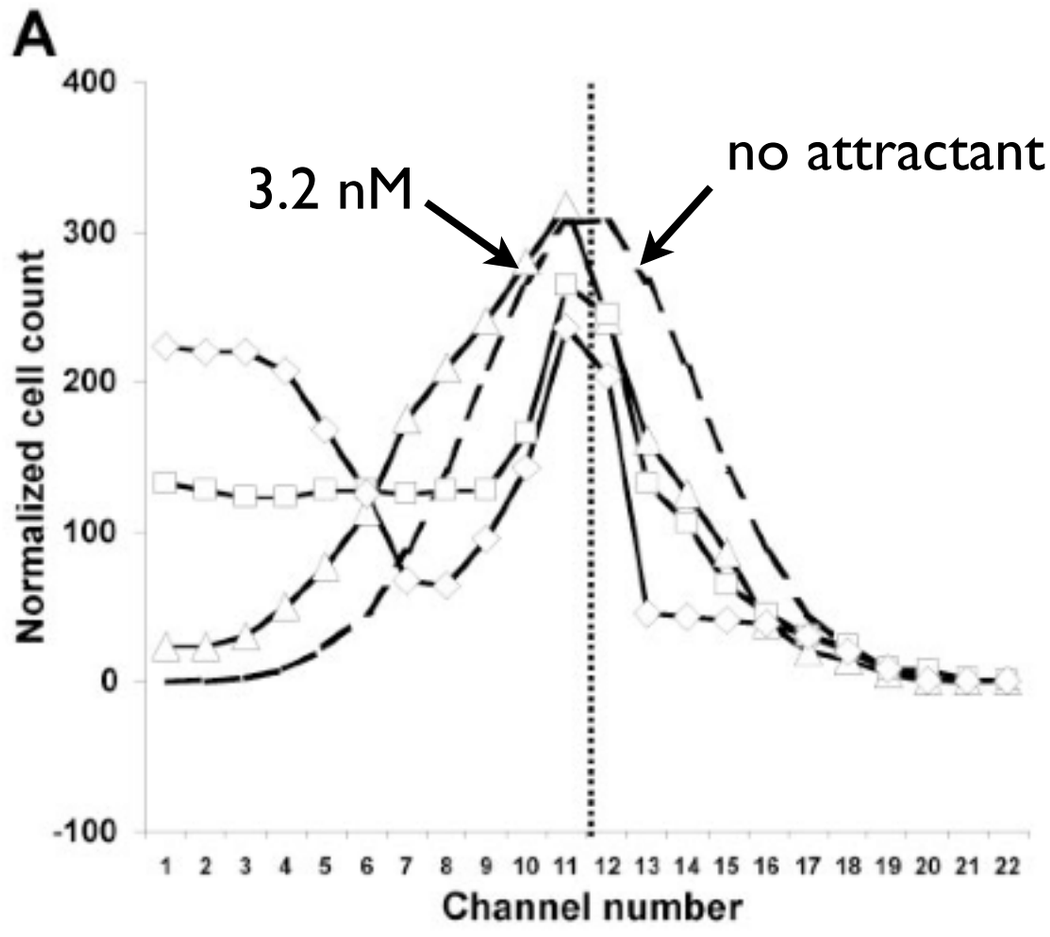
Neutrophil

Chemotaxis

E. Coli

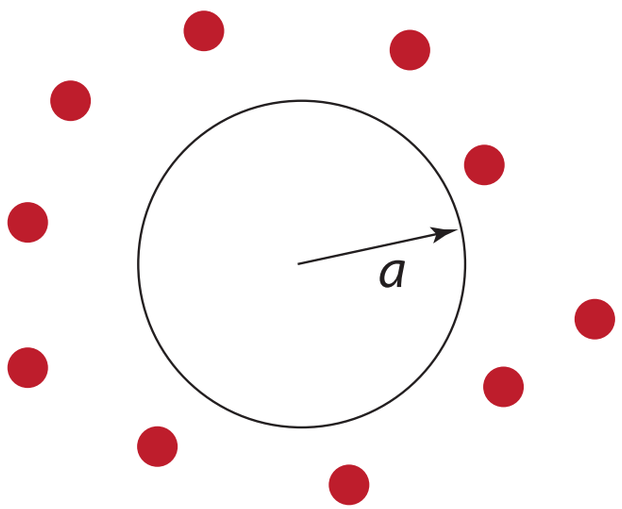






(Mao Cremer Manson PNAS 2003)

Sensing concentration changes: real numbers



perfectly absorbing sphere

$$\frac{\delta c_1}{c_0/T} = \sqrt{\frac{3}{\pi DacT}} < \frac{c_1}{c_0/T}$$

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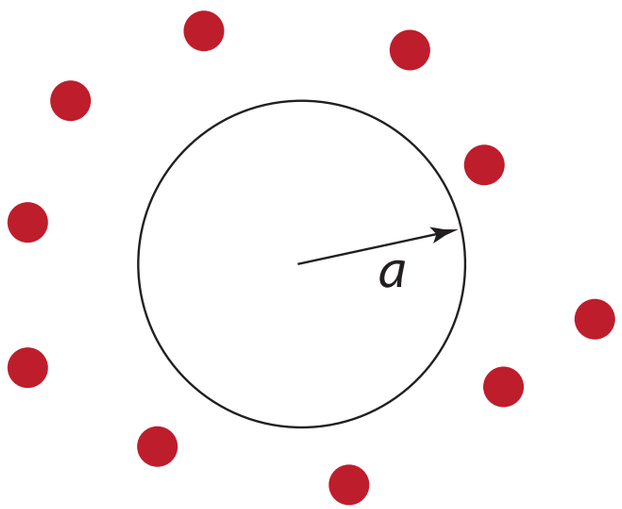

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$$c_0 = 1 \text{ mM}$$
$$c_1/c_0 = 10^{-3} \text{ s}^{-1}$$
$$D = 1,000 \ \mu\text{m}^2/\text{s}$$
$$a = 0.8 \ \mu m$$

causes twofold change in run length

(Dahlquist Elwell Lovely J Supramol Struc '75)

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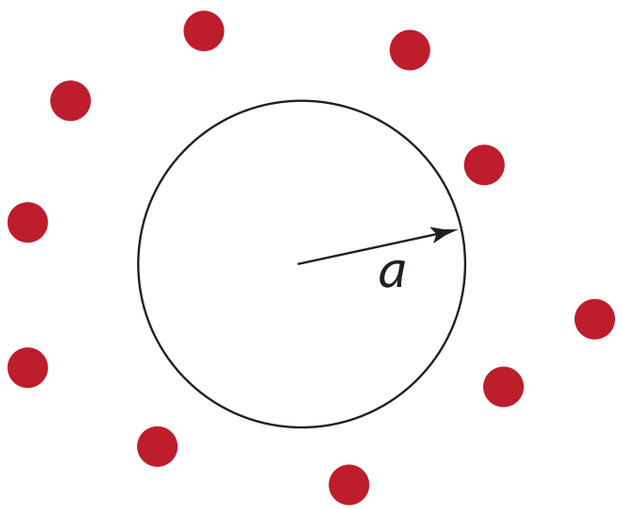

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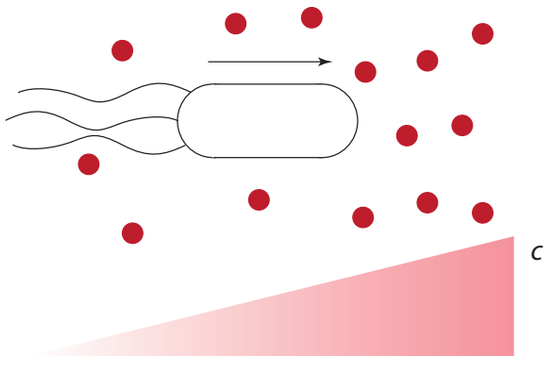
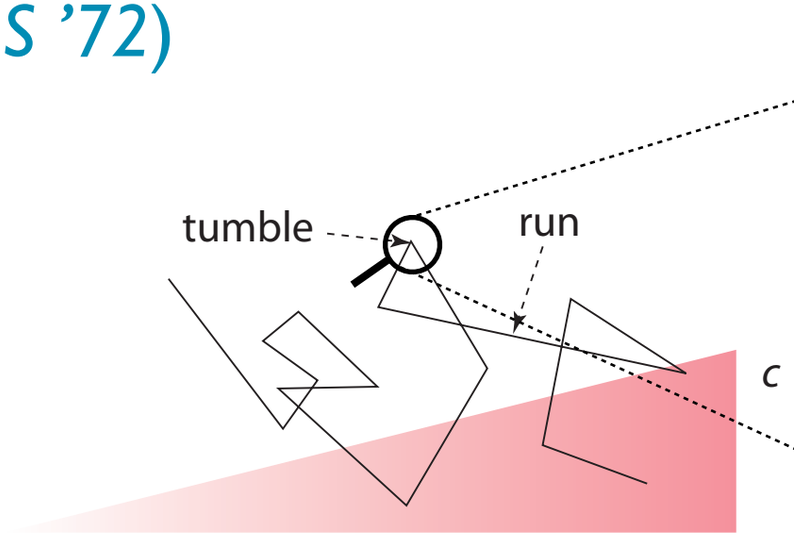
$$\Longrightarrow T \approx 0.13 \ s$$

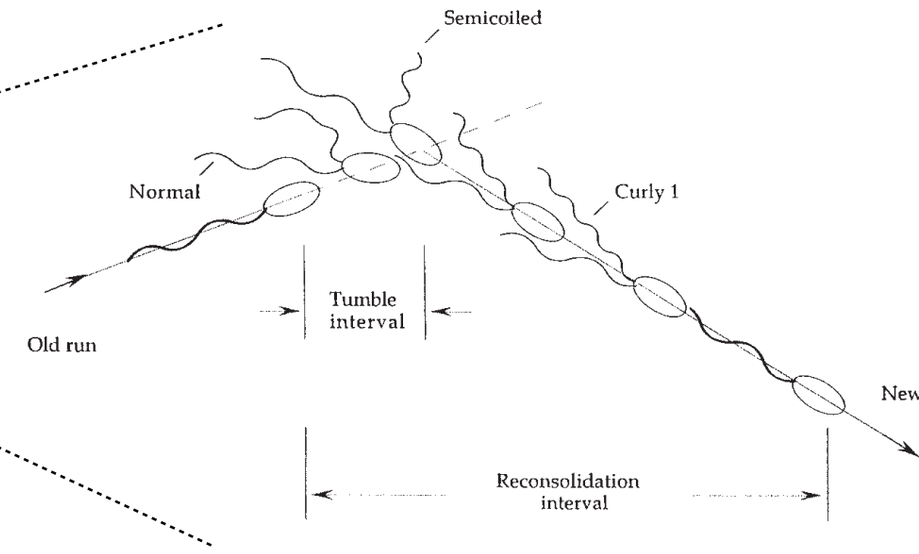
to compare to run length = 0.8 s

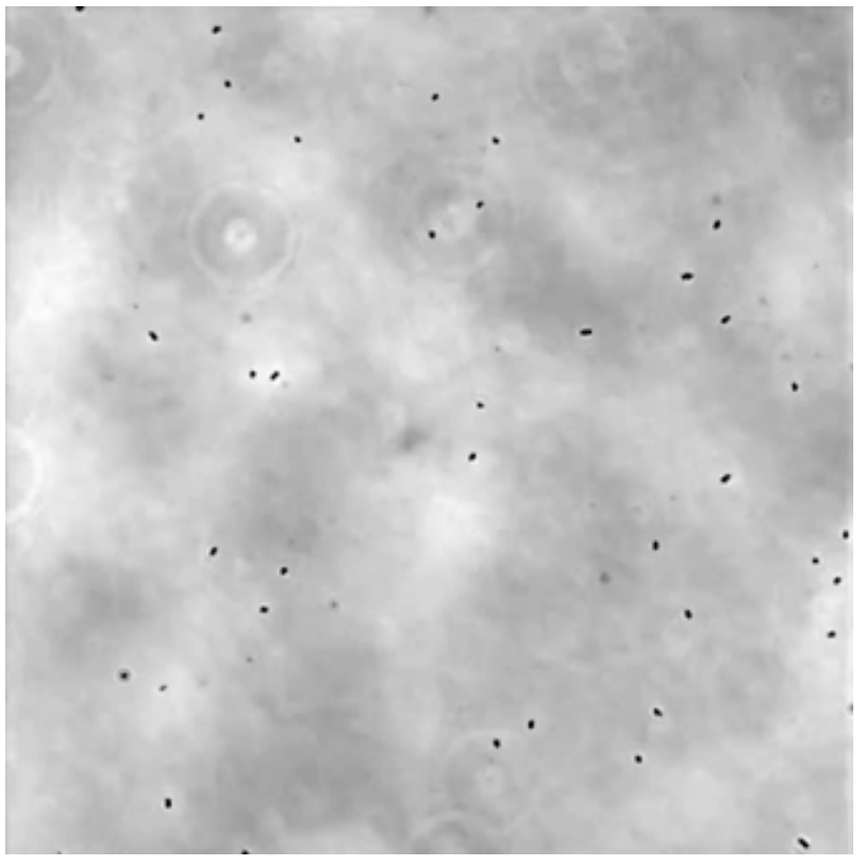
Run and tumble

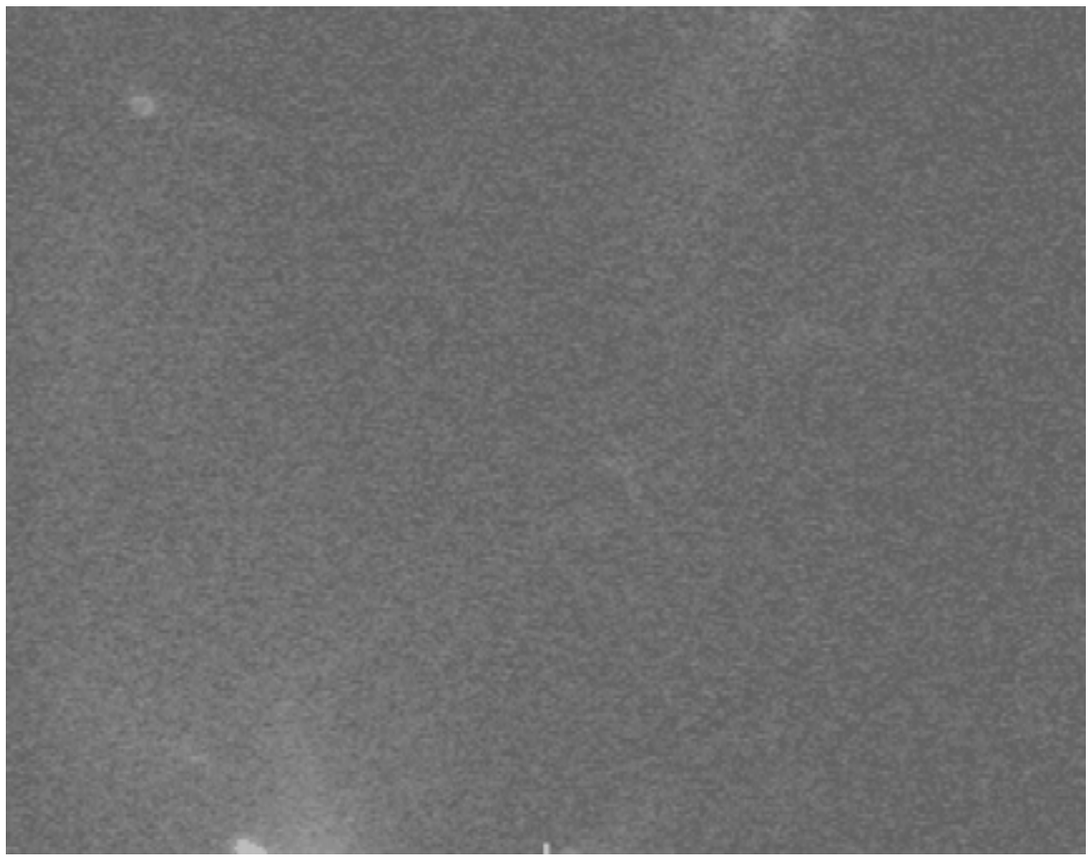
(Macnab & Koshland PNAS '72)







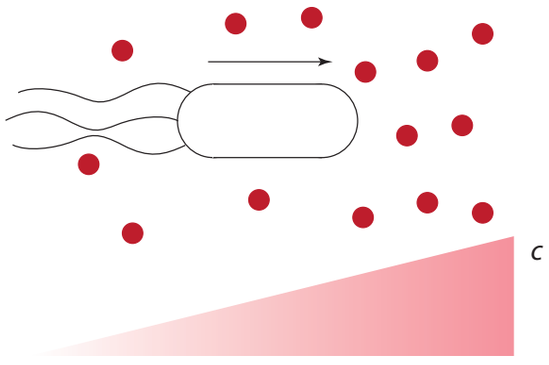


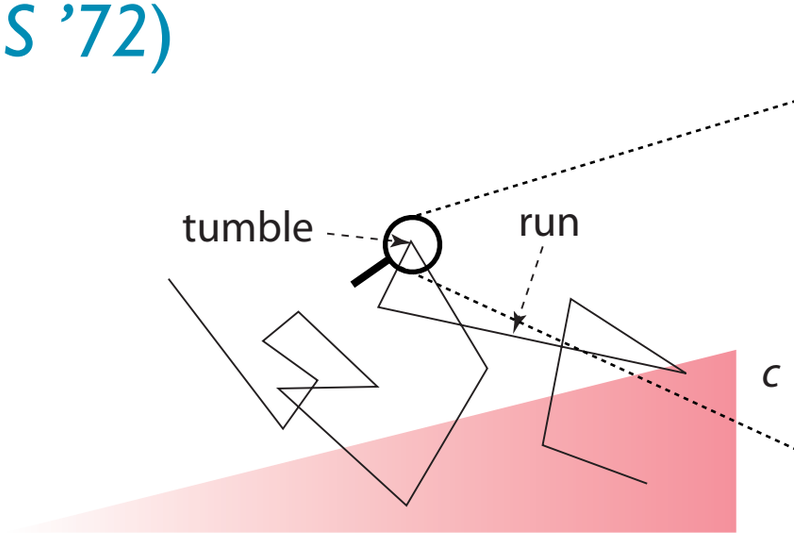


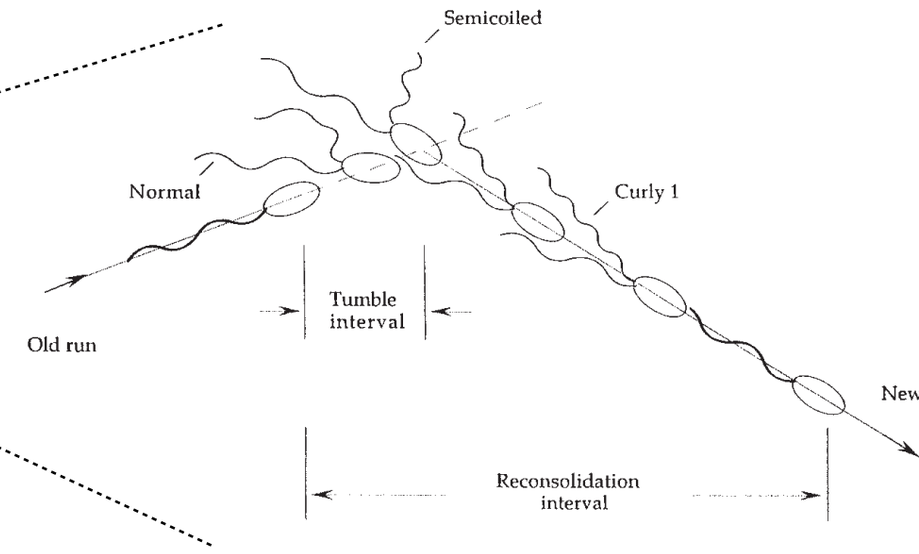
Howard Berg Lab

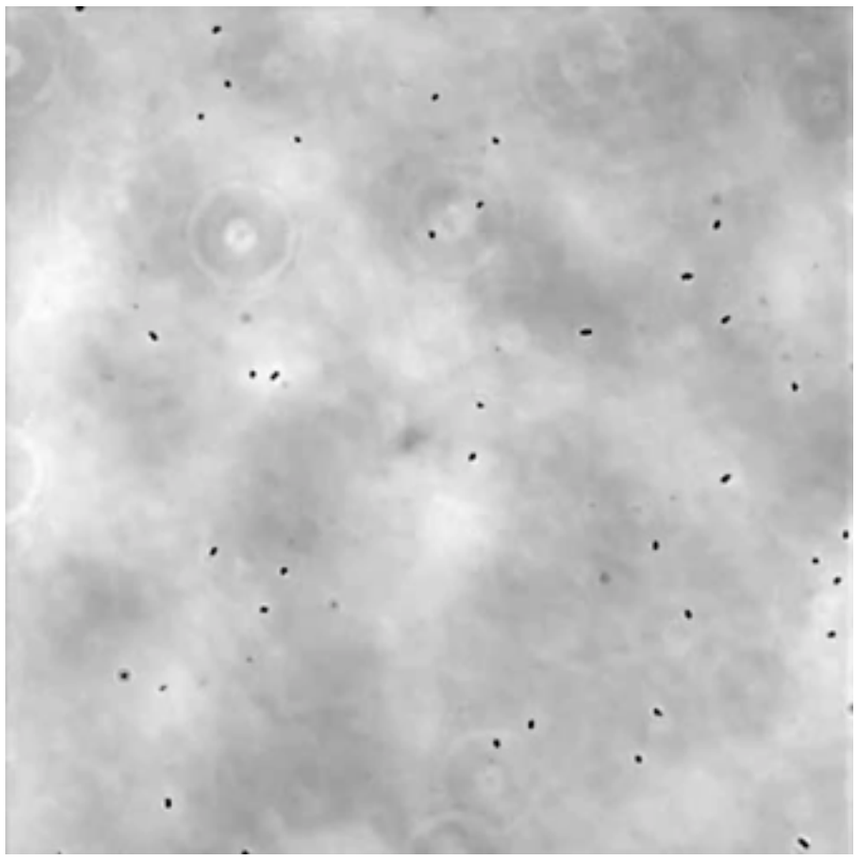
Run and tumble

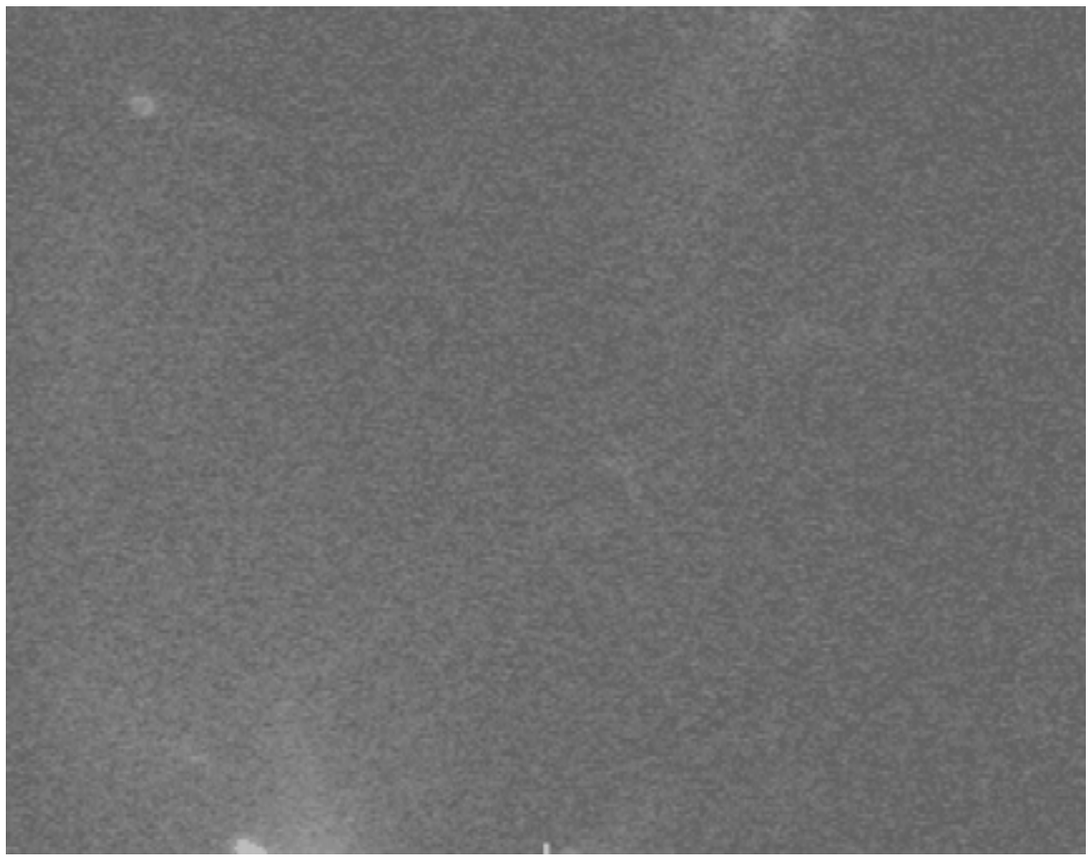
(Macnab & Koshland PNAS '72)







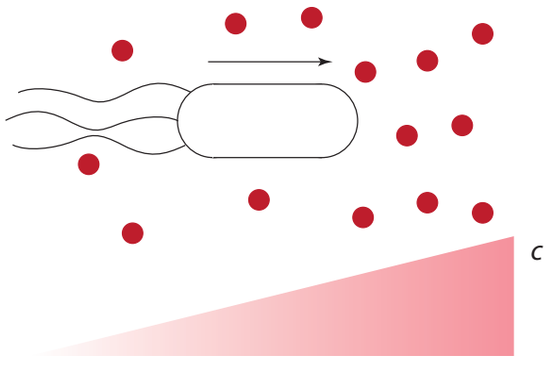


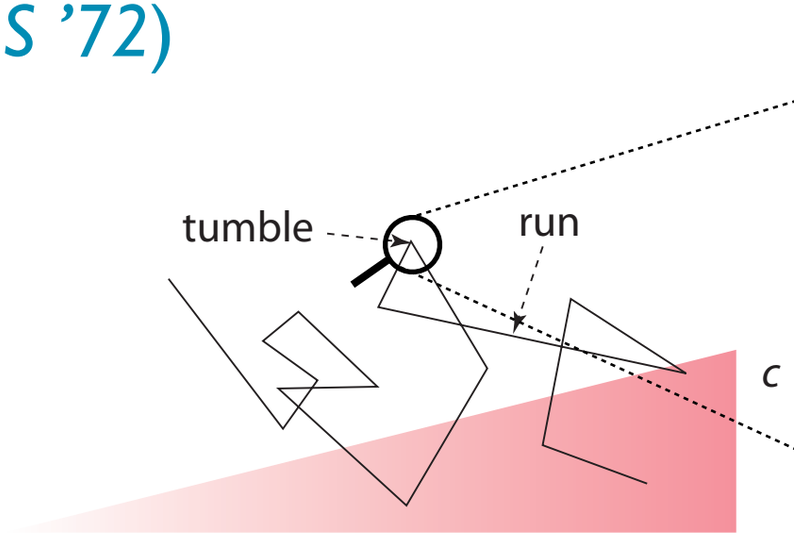


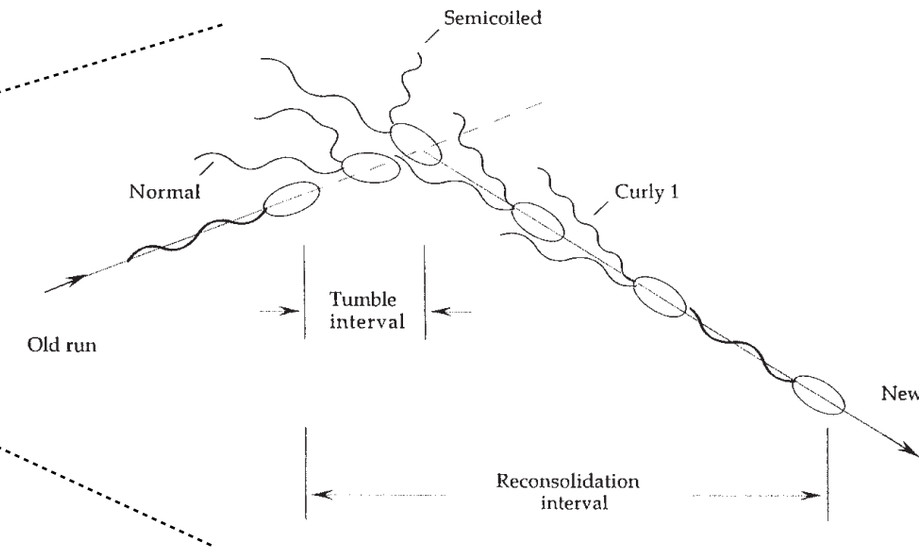
Howard Berg Lab

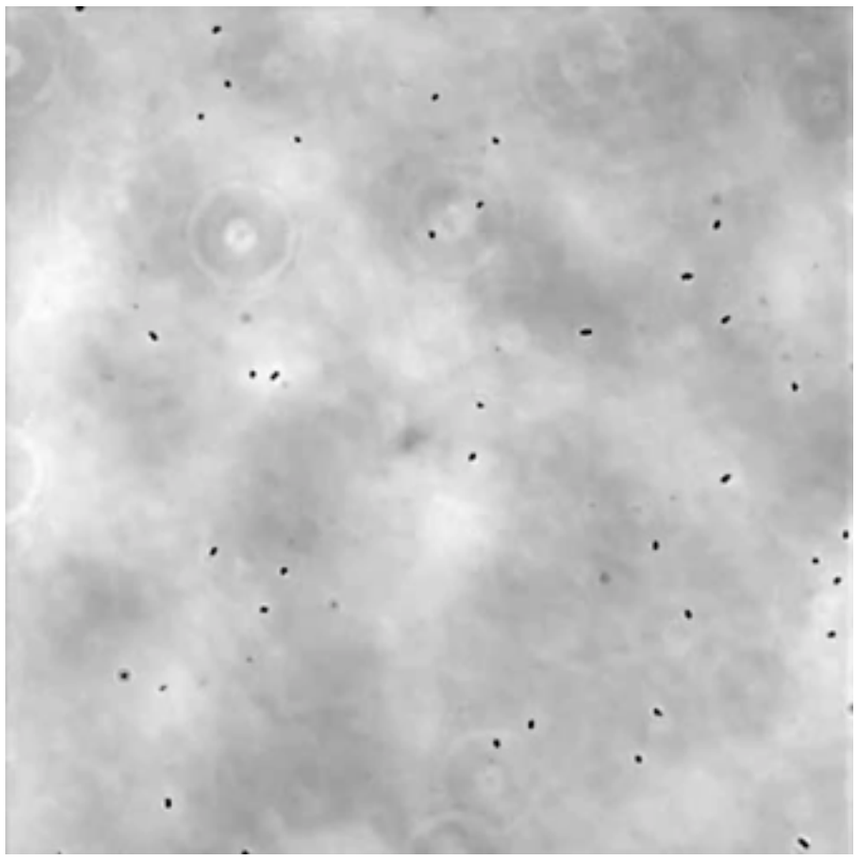
Run and tumble

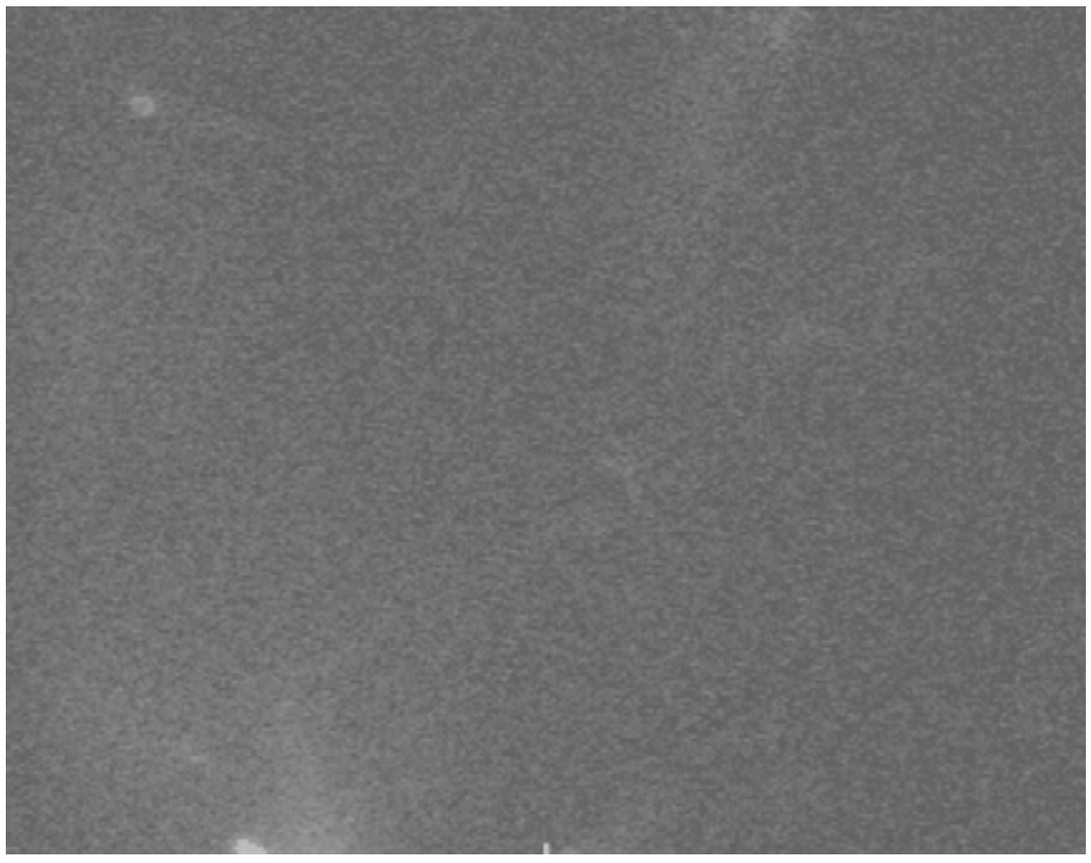
(Macnab & Koshland PNAS '72)







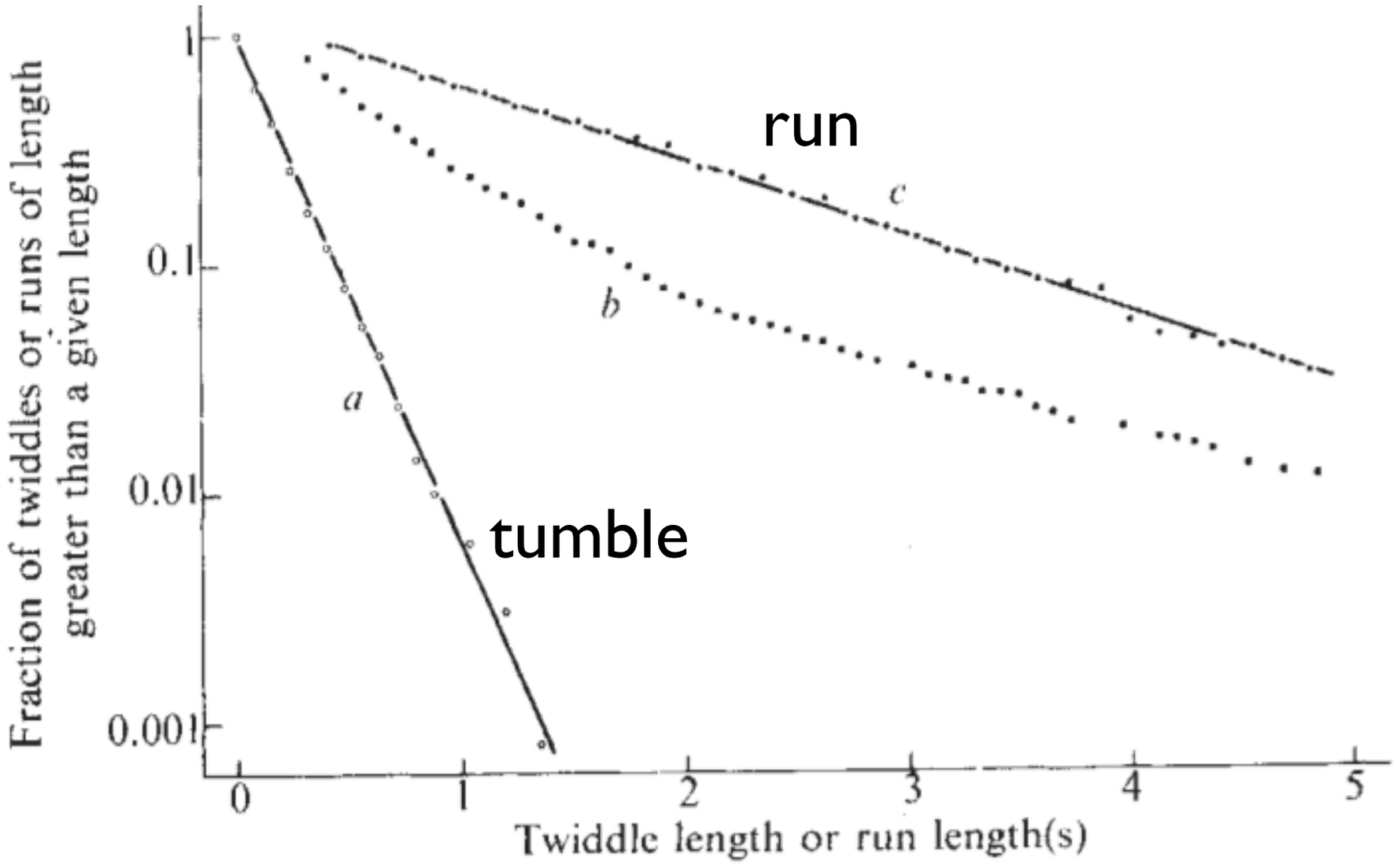




Howard Berg Lab

Statistics of runs and tumble lengths

(Berg & Brown '72)



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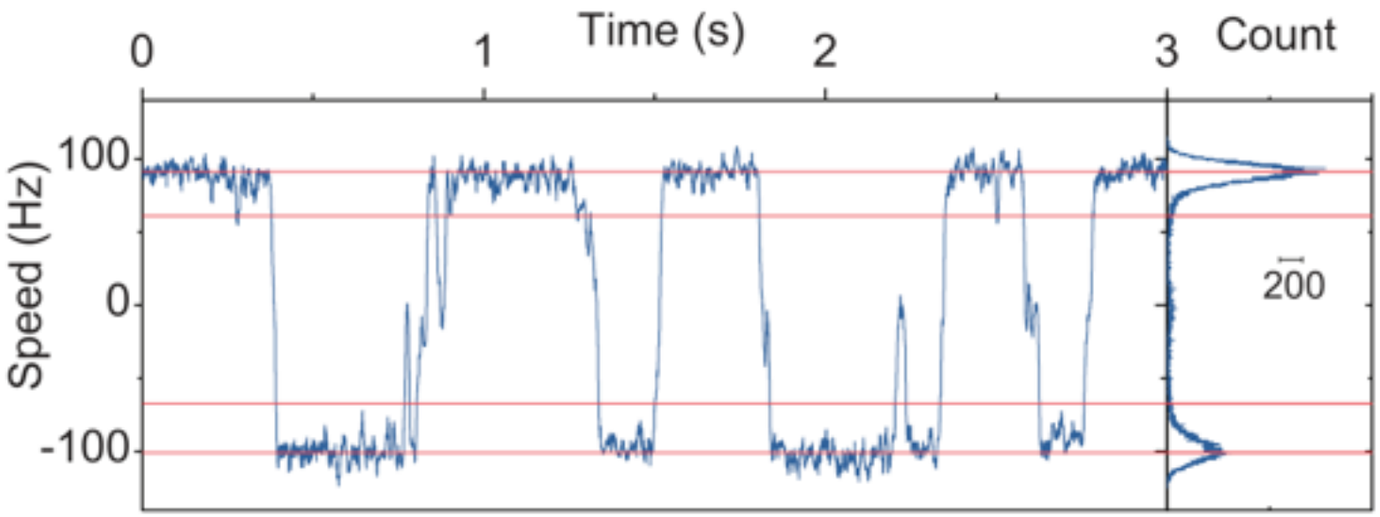
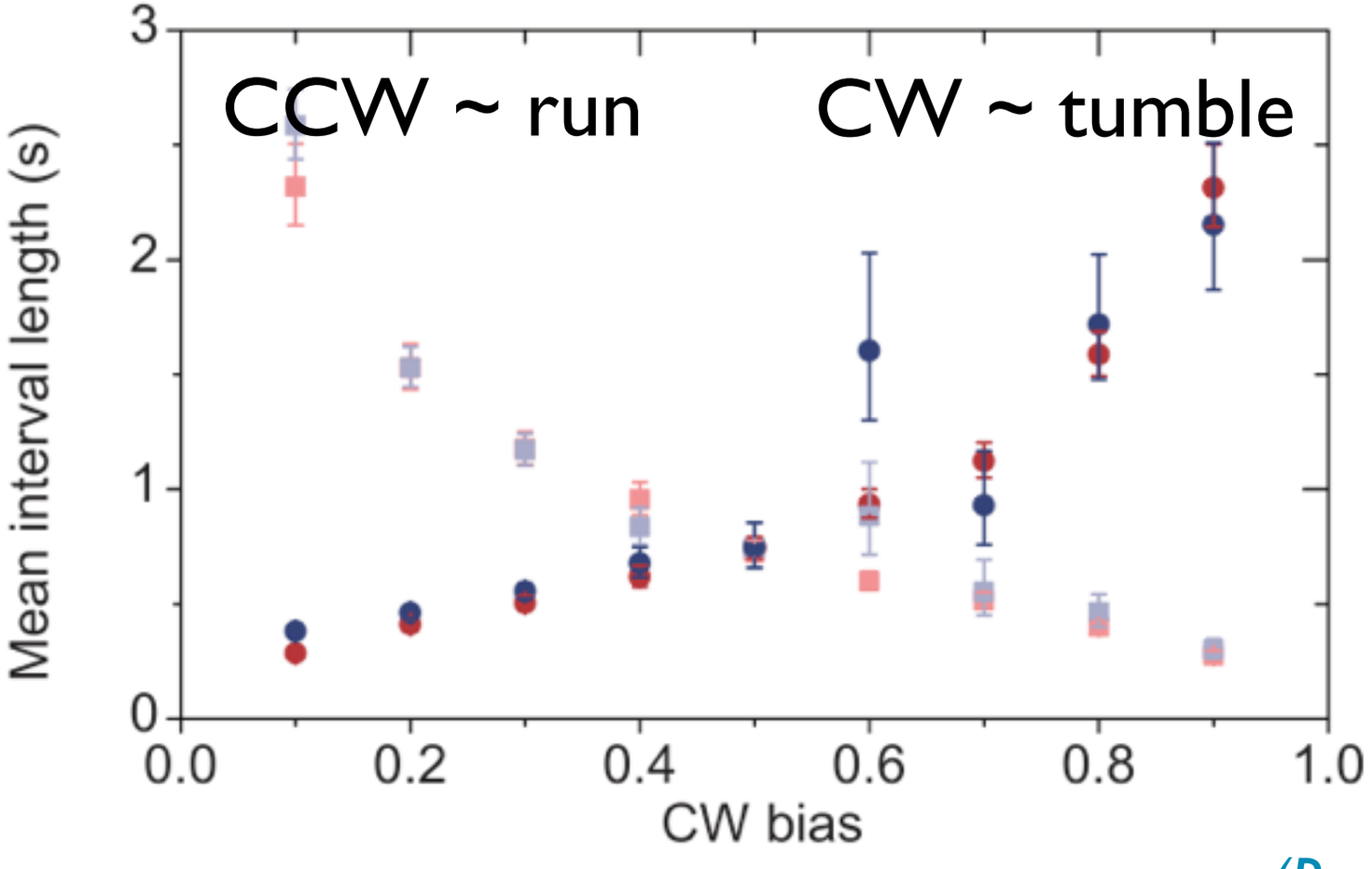
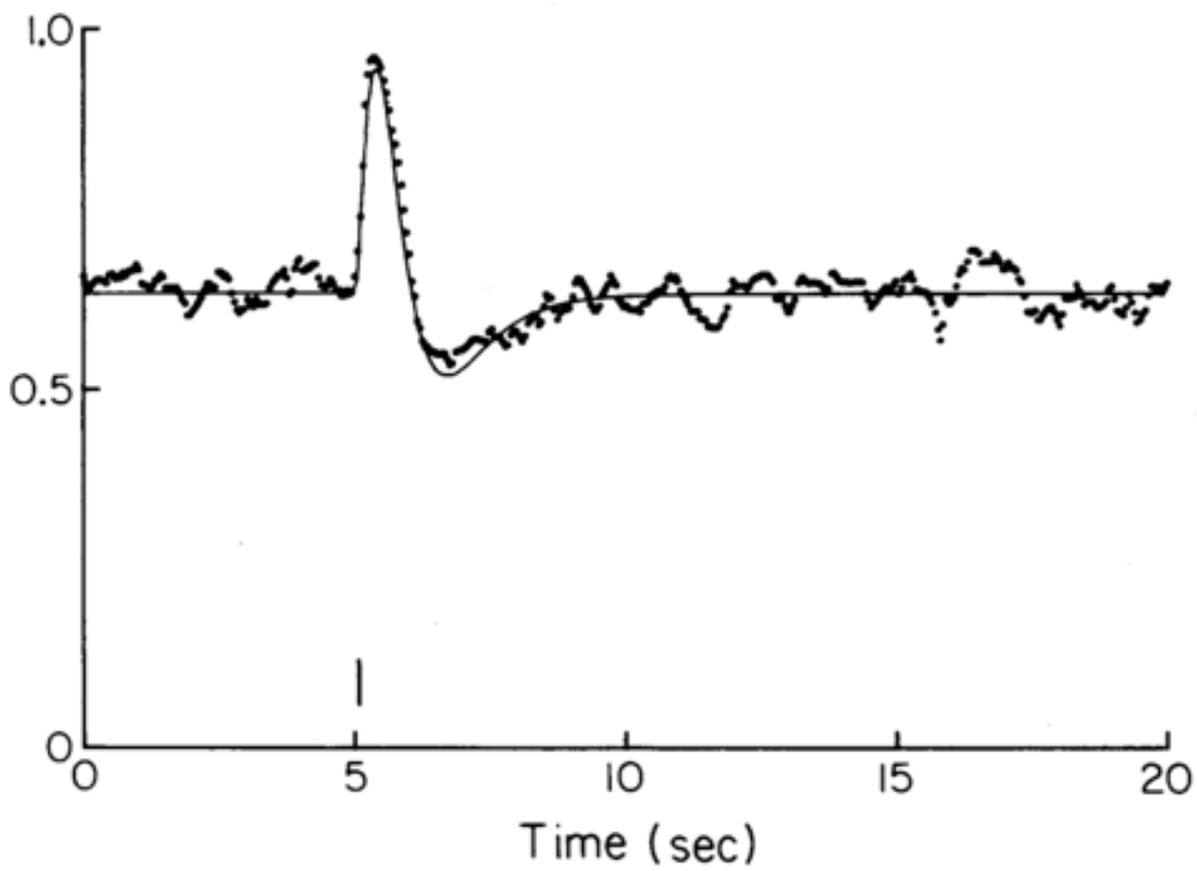


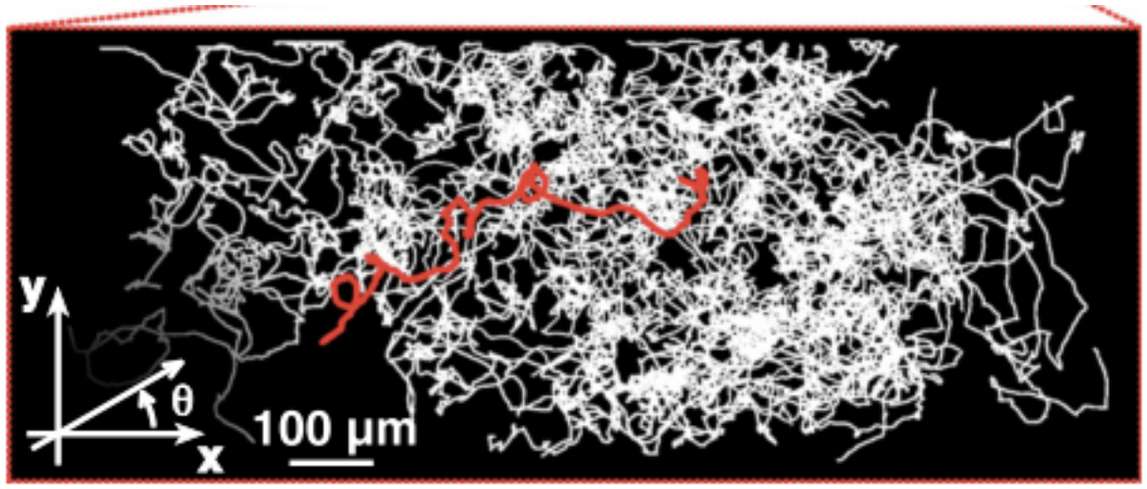


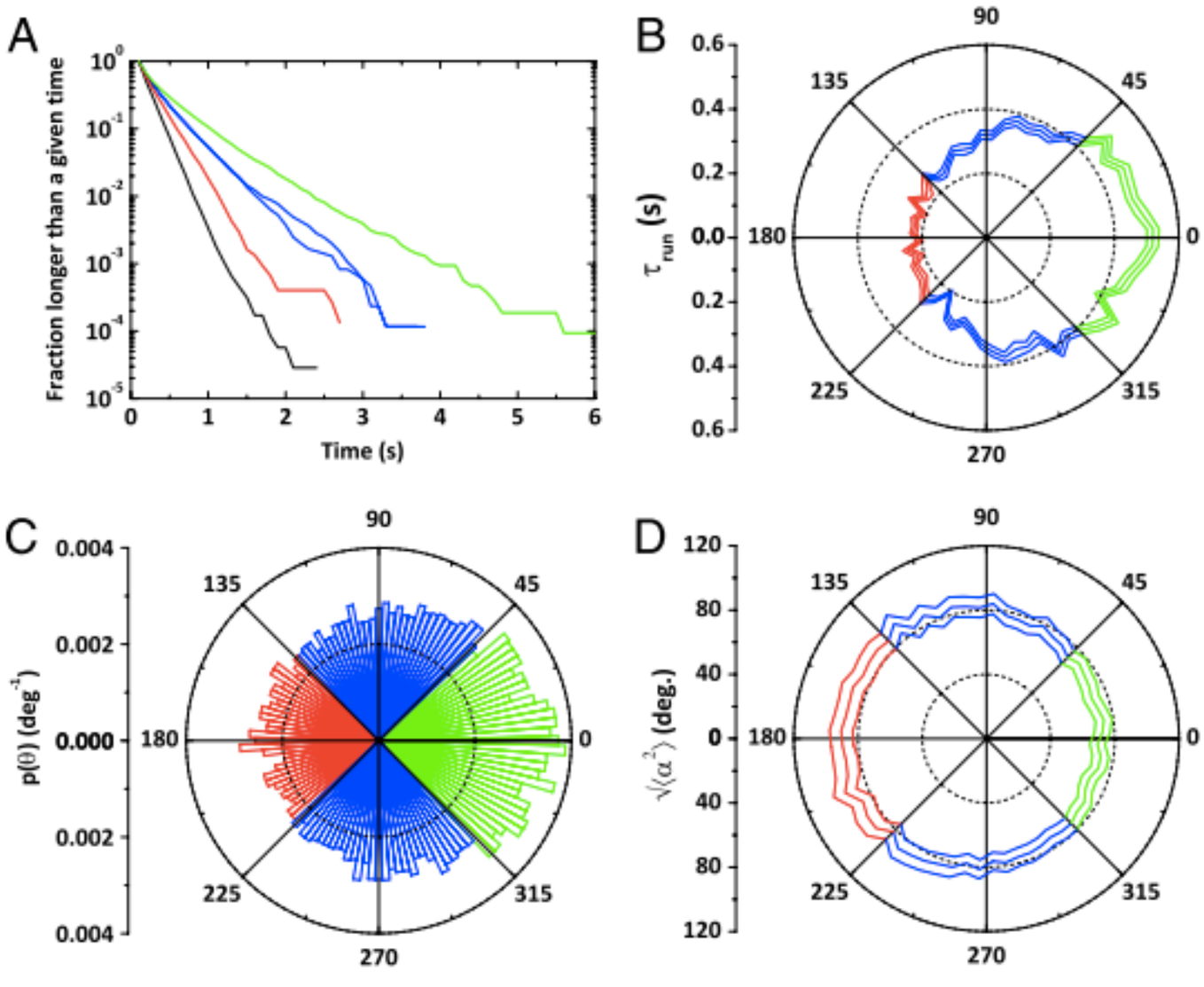
(Ban et al Science 2010)

Chemotactic response



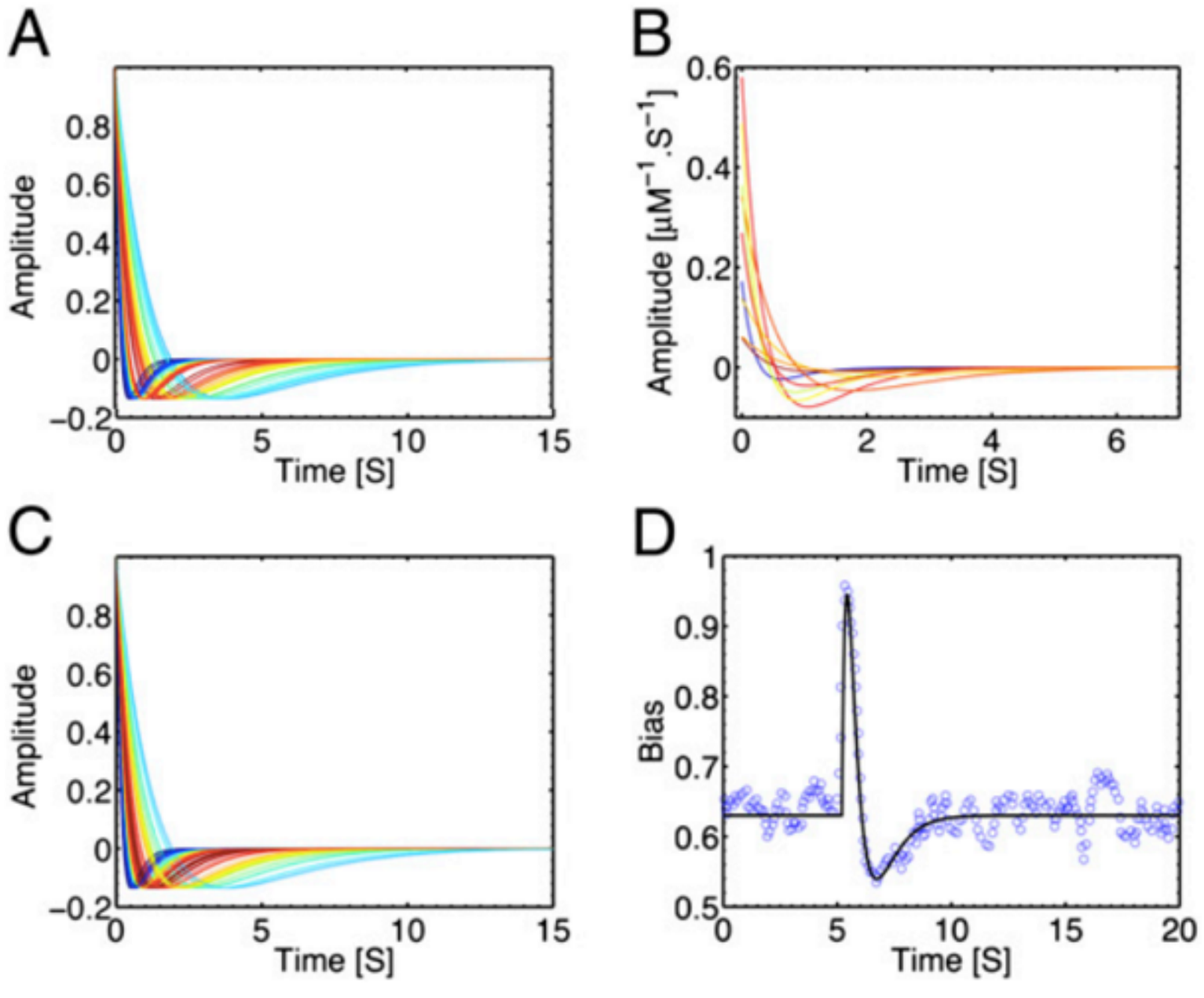
(Segal, Block & Berg 1986)





(Saragosti et al. PNAS 2011)

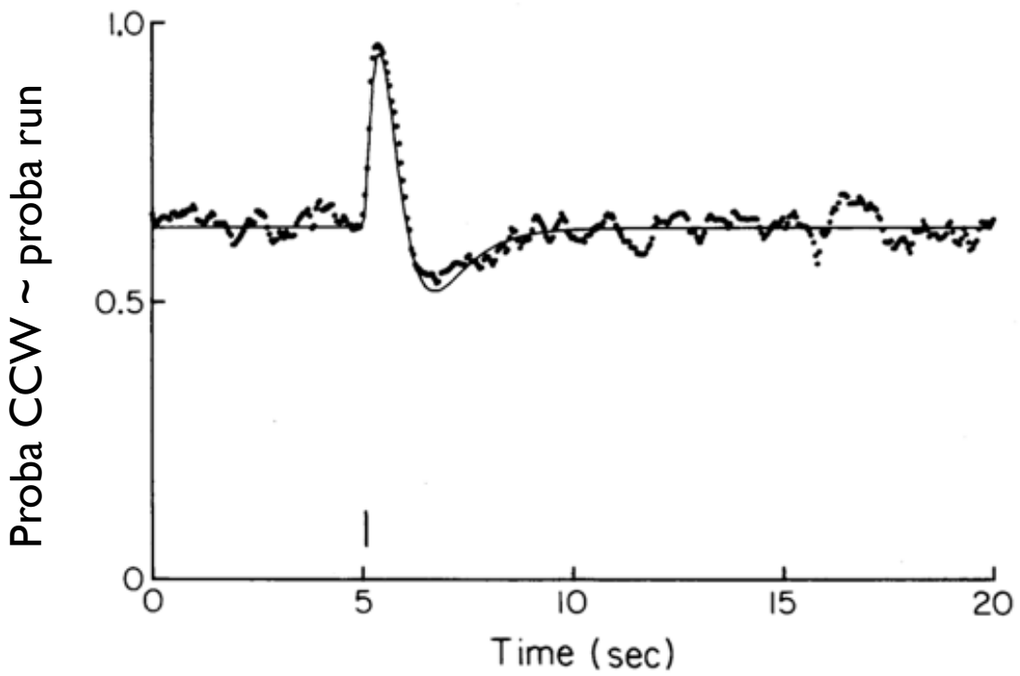
(Masson et al. PNAS 2012)



Chemotaxis response

(Segal, Block & Berg 1986)

to an impulse



to an concentration ramp

(Shimizu et al. 2010)