Single-cell bacterial electrophysiology

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Electrochemical gradient of protons, or proton motive force (PMF), is at the basis of bacterial energetics. It powers vital cellular processes and defines the physiological state of the cell. Here we use an electric circuit analogy of an *Escherichia coli* cell to mathematically describe the relationship between bacterial PMF, electric properties of the cell membrane and catabolism. We combine the analogy with the use of bacterial flagellar motor as a single-cell "voltmeter" to measure cellular PMF in varied and dynamic external environments. For example, we apply several different stresses and find that butanol acts as an ionophore, and we functionally characterise membrane damage caused by the light of different wavelengths. We next investigate, from the point of view of energetics, differences between dormancies of *E. coli*, all thought to be low-energy states, and suggest energy maintenance strategies that are emerging from our results. Our approach coalesces non-invasive and fast single-cell voltmeter with a well-defined mathematical framework to enable quantitative bacterial electrophysiology.

REFERENCES

[1] Krasnopeeva E, Lo CJ, Pilizota T 'Single-cell bacterial electrophysiology reveals mechanisms of stress induced damage', Biophysical Journal, 201

[2] Arlt J, Martinez V A, Dawson A, Pilizota T and Poon W C K. Painting with light-powered bacteria. Nature Communications 2018;9: 76

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