Mechanism of antibiotic translocation through porin: Guided by Electric field

Harsha Bajaj[1], Silvia Acosta Gutiérrez[2], Igor Bodrenko[2], Giuliano Malloci[2], Matteo Ceccarelli[2], Mathias Winterhalter[1]

[1]School of Engineering and Science, Jacobs University Bremen, Bremen, Germany,
[2]Department of Physics, University of Cagliari, Cagliari, Italy
E-mail: h.bajaj@jacobs-university.de

The outer membrane of bacteria forms an effective barrier; hydrophilic antibiotics are known to use porin pathway to reach the target inside the bacterium. Recent computational methods have shown an important role of electric field inside the pore which guides the antibiotic pathway[1]. In this study, we quantify experimentally the intrinsic electric field inside OmpF pore using zwitterionic antibiotic, norfloxacin with a strong dipole as a sensor. Application of increasing external transmembrane potential forces the norfloxacin molecule to translocate through single OmpF pore and the threshold voltage provides an estimate of the internal electric field for a single channel. Quantifying parameters like electric field inside a pore might be helpful in the rational design of drugs for efficient antibiotic permeation through a pore. This mechanism is verified experimentally for similar molecules and other porins. Using this simple model, we describe the filtering mechanism of dipolar molecules through protein pore.

References

1. Silvia Acosta-Gutierrez, Mariano Andrea Scorciapino, Igor Bodrenko, and Matteo Ceccarelli. Filtering with Electric Field: The Case of *E. coli* Porins. *J. Phys. Chem. Lett.*, 2015, *6* (10),1807–1812.
2. Bajaj H, Scorciapino MA, Moynié L, Page MG, Naismith JH, Ceccarelli M, Winterhalter M. Molecular Basis of Filtering Carbapenems by Porins from β-Lactam-resistant Clinical Strains of Escherichia coli. J Biol Chem. 2016 291(6):2837-47.