Structural characterization and mimicking of biological nanostructures in native heterogeneous environment

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Abstract
In the quest for obtaining inspiration from Nature's advanced nano machineries, it is of great interest to establish high-resolution structure information of biological macromolecules in their heterogeneous, native, and functional environment. This is not trivial using traditional high-resolution methods such as X-ray diffraction and liquid-state NMR spectroscopy requiring the molecular entities either being in well-ordered 3D crystals or in a state with fast molecular tumbling in solution.

With examples addressing antimicrobial peptides [1], amyloid fibrils [2,3], and the photo antenna system of the chlorosomes in green sulfur bacteria [4], we demonstrate that combinations of solid- and liquid-state NMR spectroscopy, AFM/SPM, SAXS, TEM, cryo-EM, and MRI offers great potential to explore structure and dynamics of proteins residing in functional, heterogeneous environment. In addition to providing fundamental biological insight, these studies motivates the design of artificial nanoscale ion channels (Fig. 1) [5], biomarkers for early-stage detection of dementia [6], and artificial photo receptors.

References

[1] J. Dittmer, L. Thøgersen, J. Underhaug, K. Bertelsen, T. Vosegaard, J. M. Pedersen, B. Schiøtt, E. Tajkhorshid, T. Skrydstrup, and N. C. Nielsen, *J. Phys. Chem. B* **113** (2009) 6928.
[2] J. T. Nielsen, M. Bjerring, M. D. Jeppesen, R. O. Pedersen, J. M. Pedersen, K. L. Hein, T. Vosegaard, T. Skrydstrup, D. E. Otzen, and N. C. Nielsen, *Angew. Chemie Intl. Ed.*, **48** (2009) 2118.
[3] S. Zhang, M. Andreasen, J. T. Nielsen, L. Lei, E. H. Nielsen, T. Skrydstrup, F. Besenbacher, N. C. Nielsen, D. E. Otzen, and M. Dong, *Proc. Natl. Acad. Sci. USA*, in press (2013).
[4] N. V. Kulminskaya, M. Ø. Pedersen, M. Bjerring, J. Underhaug, M. Miller, N.-U. Frigaard, J. T. Nielsen, and N. C. Nielsen, *Angew. Chem. Intl. Ed.* **51** (2012) 6891.
[5] C. U. Hjørringgaard, B. S. Vad, V. V. Matchkov, S. B. Nielsen, T. Vosegaard, N. C. Nielsen, D. E. Otzen, and T. Skrydstrup, *J. Phys. Chem. B* **116** (2012) 7652.
[6] M. N. Burkhardt, R. Taaning, N. C. Nielsen, and T. Skrydstrup, *J. Org. Chem.* **77** (2012) 5357.

Figures

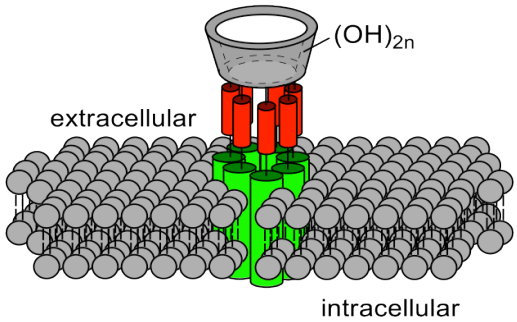

Fig. 1. Artificial antimicrobial ion channel.