

Orientation of vitamin E in highly biological relevant phospholipids

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Polyunsaturated fatty acid (PUFA)-containing phospholipids are essential components of neural membranes and are implicated in the alleviation of numerous diseases [1]. They are highly susceptible to oxidation due to the presence of multiple double bonds. Vitamin E (α -tocopherol) is the major lipid soluble antioxidant in cell membranes. We hypothesize that α -tocopherol and polyunsaturated phospholipids segregate into domains to optimize the local concentration of the vitamin next to the lipid species most vulnerable to oxidative attack [2]. To test the hypothesized action of α -tocopherol in membranes, we explore how the phospholipid environment affects the orientation and dynamics of α -tocopherol within the bilayer using neutrons.

To investigate α -tocopherol behaviour in polyunsaturated phospholipid bilayers, we performed small angle neutron diffraction (SAND) on 1-stearoyl-2-docosahexaenoylphosphatidylcholine (SDPC, 18:0-22:6PC) and 1-stearoyl-2-oleoylphosphatidylcholine (SOPC, 18:0-18:1PC) bilayers containing 20 mol% α -tocopherol at 37 °C.

The location of α -tocopherol, by SAND, was determined to be high in the bilayer. The C5 deuterium label was found among the headgroups of the phospholipids. This observation is in agreement with the observations of other phospholipids, determined by Marquardt *et al.* [3]. This location provides an ideal position to intercept water borne radicals, as well as terminate lipid peroxides which may occur on PUFA tails [3].

MD simulations were also conducted with α -tocopherol in these lipid systems however simulation and experiment do not agree. α -tocopherol sits lower within the bilayer according to the simulation. Further experiments and simulations will have to be conducted to resolve these discrepancies.

References

- [1] W. Stillwell and S.R. Wassall (2003) Docosahexaenoic acid: membrane properties of a unique fatty acid. *Chem Phys. Lipids* 126:1-27.
- [2] J. Atkinson, T. Harroun, S.R. Wassall, W. Stillwell and J. Katsaras (2010) The location and behavior of alpha-tocopherol in membranes. *Mol. Nutr. Food Res.* 54:641-651.
- [3] D. Marquardt, J.A. Williams, N. Kučerka, J. Atkinson, J. Katsaras and S. R. Wassall and T. A. Harroun (submitted) Tocopherol activity correlates with its location in a membrane: A new perspective on the anti-oxidant Vitamin E. *J. Am. Chem. Soc.*

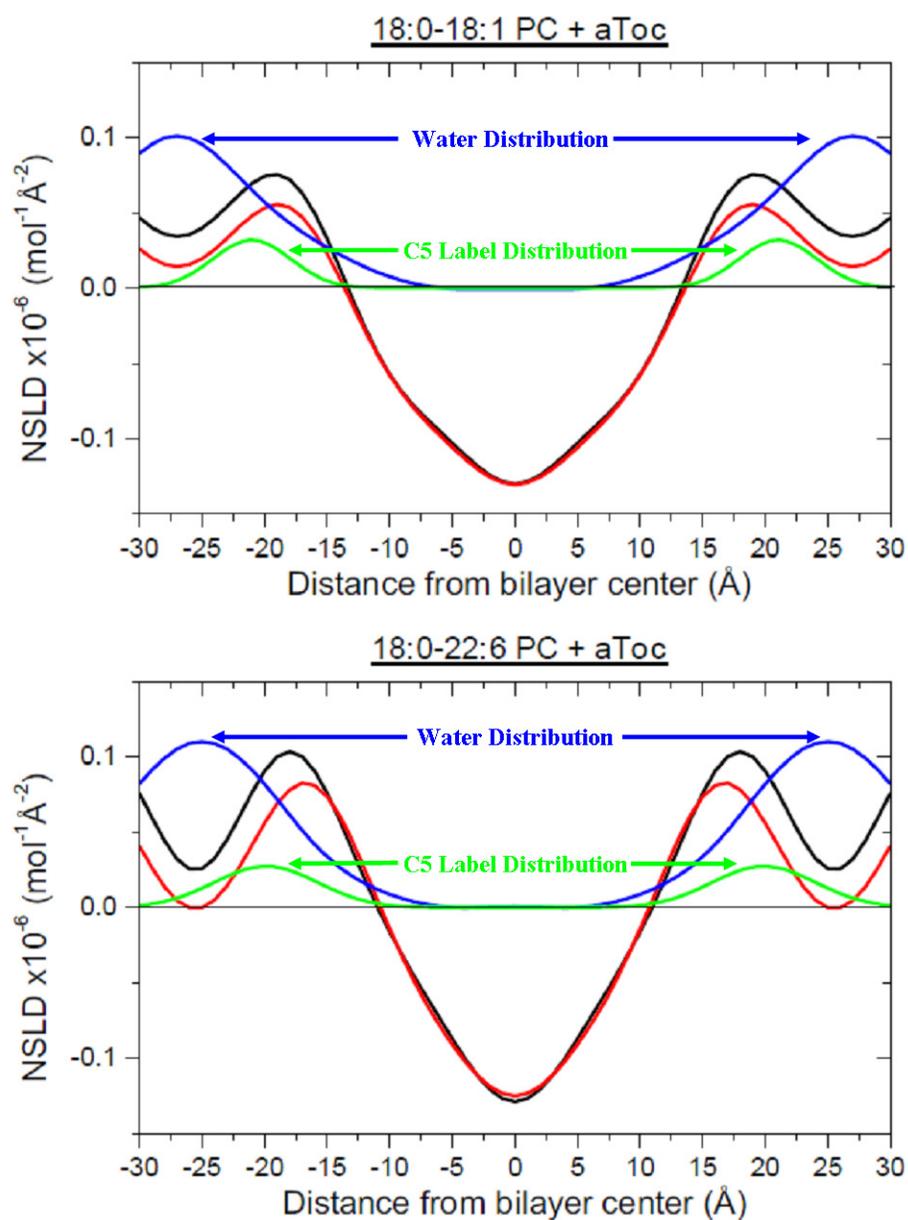


Figure 1: Above is the scaled NSLD profiles for 18:0-18:1 PC + α -tocopherol ("aToc") and 18:0-22:6 PC + α -tocopherol. The black and red lines represent the labeled and unlabeled respectively. The green line is the label distribution and the blue line represents the water distribution scaled by a factor of 0.2.