

Experimental report

16/09/2019

Proposal: 9-13-763

Council: 4/2018

Title: Direct evidence of acyl chain reversal in oxidized lipid bilayers

Research area: Soft condensed matter

This proposal is a new proposal

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Samples: C42H51NO8PD31
C33H64NO9P

Instrument	Requested days	Allocated days	From	To
D17	2	2	20/10/2018	22/10/2018

Abstract:

The oxidation of the lipids and proteins in biological membranes is implicated in a range of adverse health effects. Oxidation of unsaturated lipids can lead to the incorporation of more polar, oxygen containing groups, into the lipid tail. POPC is a common lipid in mammalian membranes. POnPC is an oxidation product of POPC containing a carbonyl group at the end of the truncated second acyl chain. It has been suggested, based on molecular dynamics simulations, that this oxidized acyl chain undergoes "acyl chain reversal"; with the terminal carbonyl group orientated towards, and associating with, the head group region, rather than the tail group region of the lipid bilayer. In this proposal we plan to use neutron reflection to study the structure of POPC bilayers with increasing amounts of POnPC present to determine directly if this structural re-organization is occurring. The results will be of significance in understanding changes to the biophysical properties of cell membranes following oxidative damage.

Final report for Experiment 9-13-763: Direct evidence of acyl chain reversal in oxidized lipid bilayers. 2 days on D17: 9 am Saturday 20th October – 9 am Monday 22nd October 2018.

Introduction

The oxidation of the lipids and proteins in biological membranes is implicated in numerous health problems including cancer. Oxidation of unsaturated lipids can lead to the formation of lipids with additional oxygen containing functional groups such as POnPC, a known oxidation product of the common mammalian lipid POPC. The structures of POPC and POnPC are shown in figure 1.

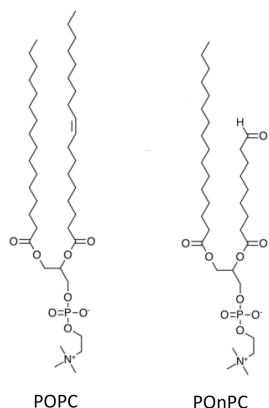
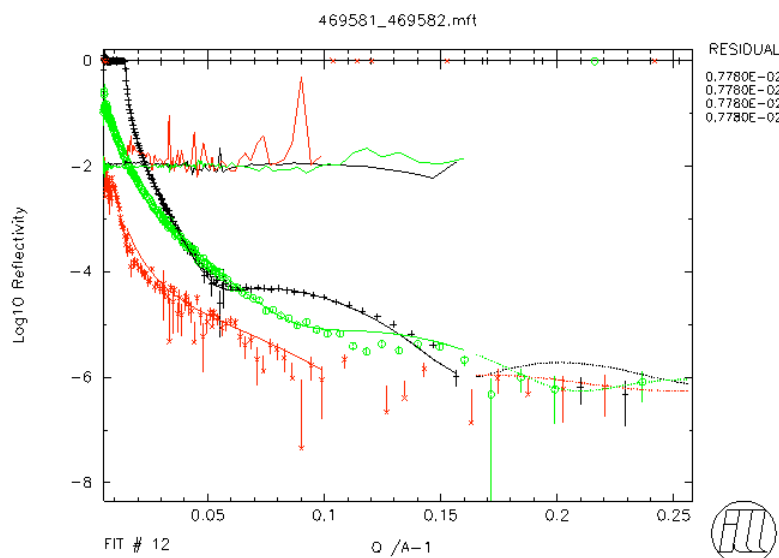


Figure 1. Chemical structures of POPC (left) and POnPC (right). POPC is a common lipid found in mammalian cell membranes. POnPC is an oxidation product of POPC. The effect of POnPC on the membrane structure was explored in this experiment, particularly the positioning of the new aldehyde group relative to the initial bilayer structure.

In this experiment we wished to look at the impact of the presence of an oxidized lipid on the bilayer structure. We prepared mixed lipid bilayers, POnPC:POPC on both quartz and silicon supports, with different amounts of POnPC to POPC. POnPC was only available as the 1H-isotopologue, whereas both 1H-POPC and d31-POPC were available and provided useful contrasts. In order to extract maximum information on the structural changes to the bilayer we recorded reflectivity profiles for the bilayers in aqueous solutions with a range of different scattering length densities, SLD, and, where necessary (depending on the SLD of the particular lipid mixture studied) recorded reflectivity profiles on both quartz and silicon solid supports. The experiments were very successful and we now have a good picture of the disruption to the tail and head regions caused when levels of POnPC are 20% or more and we are preparing this for publication. At levels of POnPC below this, where obviously differences are more subtle, we will require more contrast to conclusively determine the structure.

Example data for POnPC:POPC 20:80

+ 469592_469593.mft x 469588_469589.mft o 469581_469582.mft



Supported bilayer of POnPC:d31POPC 20:80 on silicon substrate with aqueous phases of differing SLD: D₂O (black), H₂O (green) and contrast matched to silicon (red). Fitted lines from co-fitting of all three contrasts.