Structural and kinetic studies of the lamellar, cubic, and hexagonal phases

This summer I, Drew Folkerts, worked for Professor Harper in the Physics and Astronomy department studying lipid phase transitions. My research focused specifically on the lipid monononadecenoin (MNd) and its transition from a minimal surface based cubic phase to a hexagonal phase. Lipid research has many applications most notably in the fields of protein crystallography, administration of medicine, and in biology in general. The two main research methods that we used were a Differential Scanning Calorimeter (DSC) and a Polarized Light Microscopy (PML) device. The DSC measured the amount of heat flow that occurred when the lipid underwent the different phase transitions. Since going to a higher temperature phase requires energy input, we can see the additional heat flowing into the sample when it makes a transition. The location and rapidity of this phase transition is analyzed and that is then used to help understand the lipid phase transition kinetics. The data that we obtained from the DSC is used for most of the quantitative data of my research. The PLM uses a microscope to optically observe the lipid phase transition. The phases have different opacity and this can be used to reveal the identity of the phases. We can also use polarized light to yield additional phase information.

Another major part of this research is seeing how different sucrose concentrations alter the location and rapidity of the phase transition. We have found that more sucrose is correlated to lower transition temperatures. We also discovered that the kinetics of the transition is altered slightly. Hysteresis is the amount of super cooling or super heating of the sample. The amount of hysteresis is key in the understanding of the lipid kinetics and we saw that the hysteresis follows a very clear and clean dependence upon the ramp rate, sucrose concentration, and temperature. From the hysteresis we are able to calculate an exponent, describing this super cooling or super heating. The temperature dependence of the exponent matched that of monoolein, a sister compound, with substantially different phase behavior. We are currently working on understanding the implications of this finding.

Near the end of the summer, my group starting working on another new project. Traditionally the method of x-ray samples is using very delicate and relatively expensive glass x-ray capillaries. We are experimenting with a new method that uses thermal plastics to easily make robust and inexpensive samples. So far we have had promising results with our samples exhibiting water-tight seals.

This research has been an immense blessing on me and my future. It has gotten me much more familiar to the academic realm and the relevant work that goes on in it. Also, as a premed student, I fully recognize its benefits for preparing me for medical school. It has even trained me to be extremely organized and thorough in my work, as any lapses in this are not welcome in research. Therefore, research has been a blessing, not only to my future aspirations, but also for improving me as a person.