CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

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Project Number

J0519

Project Title

Were Micelles or Vesicles the First Protobionts? Measuring DNA Phase Extraction into Lipids

Abstract

Objectives/Goals

The objective of the study was to investigate a specific stage in the process of abiogenesis. In the packaging stage, where DNA and other genetic material need to be packaged into some sort of compartment to form protobionts. Micelles and vesicles are two different forms of compartments that are able to contain genetic material. Micelles are more lipid-based, having a hydrophobic core while vesicles are more complex and have an inner water based core. Therefore, I aimed to determine whether or not DNA is soluble in, and thus more compatible with, lipids (a micelle environment) or water (a vesicle environment).

Methods/Materials

I used falcon test tubes to set up a phase extraction between the lipids and DNA. I also used both saturated and unsaturated oil to perform the phase extraction. I increased ratios of oil to DNA with every phase extraction, simulating ratios of lipid to water that may exist in prehistoric oceans. I isolated DNA from strawberries using a detergents and rubbing for my experiment. By layering the DNA and oil on top of one another, shaking and centrifuging them both, I can test whether DNA may be extracted into the lipid layer or not. I measured the DNA concentration of the water layer after extraction using a spectrophotometer to calculate the percentage of starting DNA that was soluble in oil. Methods such as these have not been used in labs and research facilities, and this is a new way to analyze this topic.

Results

Results indicated that DNA was less likely to be extracted into the lipid layer due to the incompatibiity of DNA with lipids. It was concluded that micelle-based protobionts were less likely to form in comparison with vesicle-based protobionts. DNA is known to be hydrophilic, and may not be comfortable in an hydrophobic environment. Based on this study, micelles are less likely to package genetic material due to its hydrophobic environment. Therefore it is concluded that vesicles were likely to arise as the first protobionts, and therefore were the first compartments to package genetic material. DNA could easily package into a vesicle-based structure. NASA, and other astrobiologists count infer that if all the necessary ingredients to life are present, and genetic material is packaging into vesicles, life will form sooner. For, genetic material is already fitting into protobionts. If no vesicles or other hydrophilic structures are containing genetic material, NASA could conclude that it would take a long time for life to evolve.

Conclusions/Discussion

Results indicated that DNA was less likely to be extracted into the lipid layer due to the incompatibility of

Summary Statement

Through DNA and lipid phase extractions, it was shown that DNA is insoluble in oil and that protobionts probably emerged from vesicles, leading to the first basic prokaryotic cell.

Help Received

Mr. Tom Caldwell, Pre-Doctoral Student, Chessler Lab, UC Irvine Health-School of Medicine assisted me by supplying the needs for equipment. Mr. Caldwell clarified any questions related to the research. He assisted with centrifuging the samples and measured the DNA with a spectrophotometer.