SPS Interim Project Report

Fractal Dimension of Bacterial Chemotaxis and Eukaryotic Expansion in Nutrient-Starved Agar

Requested: $820

Spent: $0

Submitting Students: Noman Ali, Ricki Kumar, Syed Hassan Amir, Sai Medi, Tanaya Mandal, Linh Do, Sarin Patel, Johana Dickerson, Rebecca Cook, and Franklin Leal

Faculty Advisor: Dr. James Claycomb
Abstract:

*Bacillus subtilis* and *Proteus mirabilis* morphologies at varying conditions are currently being studied to identify their fractal dimensions. Changes in the fractal dimension as a result of pH in both bacteria were analyzed and the results were presented at the Houston Baptist University (HBU) Spring Scholarship Symposium. Further testing to determine the changes in the fractal dimension as a result of electromagnetic fields, temperatures, and enzymes will be conducted during the following school semester.

Progress made:

We prepared two sets of agar plates with 0.1% peptone. One set contained 0.9% bacto-agar, while the other set contained 1.5% bacto-agar. These two sets were further subdivided into pH values of 6, 7, and 9 agar plates. We conducted three trials of each pH value for both of the concentrations of bactoagar plate, yielding a total of 18 agar plates. We used Tris buffer to set the agar plates at pH of 7 and 9 with the aid of HCl and NaOH, respectively. For the agar plate with the pH of 6, we adjusted the pH using HCl and did not use buffer. Then, we inoculated the 0.9% bacto-agar plates with *Bacillus Subtilis* and the 1.5% bactoagar plates with *Proteus Mirabilis* by using inoculating needles which were first sterilized by the flame of a Bunsen burner using aseptic technique. We then placed the agar plates in a plastic bag (Ziploc) to prevent dehydration of the agar. We incubated the agar plates at 37°C for nine days while checking the plates periodically for growth. After nine days, significant growth was observed on some plates. Fractal dimension analysis was then conducted on the plates that displayed the most growth. In order to perform the analysis, we took high resolution photographs of the morphologies using a fourteen megapixel camera. The photographs were edited using gimp and made a black and white, binary image. We analyzed these images using the FRAC LAC program’s boxcounting algorithm to obtain the fractal dimensions of the growth morphology.

We presented our results at the Houston Baptist University (HBU) Spring Scholarship Symposium on April 4th, 2011. This research project was the overall winner of the HBU symposium (Figure 1). Our research was also recognized in the HBU news paper, the Collegian (Figure 2). During the 2011 spring semester, we were also able to set an SPS account with the HBU accounting department to accept the award and transmit invoices. We made progress in preliminarily testing static and alternating magnetic fields using Helmholtz coils and an alternating current power supply (Figure 3). For this, we had to purchase some Hall probe magnetometers to measure the fields of the alternating and static magnetic devices.

In addition to the experiments conducted above, we also managed to acquire ceramic thermoelectric cooling pads for the temperature testing part of the research through departmental partial matching funds.

Budget:

Currently, we have not spent any of the Sigma Pi Sigma grant money. However, during the 2011 summer, we plan to buy agar plates, bacto-agar, and pH 6 buffer that does not affect solidification of the agar for the for the pH test. Additionally, we will purchase varying magnets
with known magnetic fields in Teslas and use them for the electromagnetic component of the research. We will also purchase stomach enzymes to test how fractal dimension is influenced by the presence of different enzymes. We would also like to take higher resolution photographs of bacterial growth by investing in a camera with a microscope.

Figure 1: Award for winning the Houston Baptist scholarship symposium
Physics society earns research grant

by LAUREN SCHOPENEMANN
S&T editor

Students in Sigma Pi Sigma, the national physics honor society that is part of the Society of Physics Students, received the Society of Physics Students Undergraduate Research Award in the form of a $820 grant to help fund its latest research project.

The organization earned the grant for its proposed study on using fractal physics to characterize the growth of bacterial cultures.

The experiment, which began in the fall and will conclude by Dec. 31, makes Sigma Pi Sigma the first group in the College of Science and Mathematics to garner funds for independent research.

Dr. James Claycomb, associate professor of physics and the Society of Physics Students chapter adviser, received the award notification letter earlier this month from the national director of the Society of Physics Students and Sigma Pi Sigma.

The announcement congratulated the group for the potential of its proposal for “Fractal Dimension of the Morphology of Bacillus Subtilis and Proteus Mirabilis” to promote undergraduate research and to enhance the chapter’s presence on campus.

In the past, the group has pursued its research endeavors with limited resources and needed to organize fundraisers to purchase supplies for projects, said Dr. Gordo Blado, associate professor of physics.

“The Society of Physics Students, including Sigma Pi Sigma, is a very special group,” he said. “Very seldom do you see students who would spend a considerable amount of time doing outside work just to pursue their interest in science on their own initiative.”

Senior Linh Do, Sigma Pi Sigma president, said the group is excited that it earned recognition for its experiment’s potential and that it hopes the study will incite continued research by other students.

“Sigma Pi Sigma’s goals are to spread awareness about physics throughout the community and to create a rich research environment directed by student leaders,” she said. “We believe that this project will encourage future students to initiate their own projects.”

Do added that Sigma Pi Sigma aspires to achieve publication in a nationally-recognized scientific journal and that it looks forward to the establishment of a research area in the Culven Science Center.

Figure 2: Fractal Physics research was recognized in the HBU Collegian
Figure 3: Testing static and alternating magnetic fields using Helmholtz coils and an alternating current power supply