2020 Summer Undergraduate Research Experience Information Sheet
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Faculty Mentor:
Name: Maureen Morrow
Department: Biology

Student:
Name: Hanaa Ahmed
Major (minor): Biology (Chemistry and Disaster Studies)
Expected graduation date: May 2022

Expected start date:
Note: this information is needed for budgeting purposes (to enable funding of as many proposals as possible). Provide the most accurate date possible. This information will not affect proposal ranking!

1. Does this work involve human subject? No

      If yes, has the IRB been notified?
2. Does this work involve recombinant DNA? No
      If yes, has the IBC been notified?
3. Does this work involve non-human vertebrates? No

4. List the faculty mentor's other funding sources (approved and pending): none

5. Preliminary supply budget summary: (cannot exceed $1,000 including delivery fees)
Please provide a general, preliminary list of items and associated costs:
none

Total amount requested: $0

Does the requested budget cover all expenses related to the proposed work?
If not, explain the sources of funding that will be used.

x   I accept responsibility for the conduct of this project and assure that the information in this
Question 1: Please provide a short title for the proposed project (<u>less than 70 characters with spaces</u>). If you would like to include a long and short title, you may, but we need a short title for our records.
Characterization of a Soil Bacterium Subject to Warming Conditions

Question 2: Provide a BRIEF review of the literature (citations <u>not</u> required- don't skip a clear explanation for citations) or previous work, appropriate for the diverse members of the RSCA advisory board, to provide the background information that led you to the proposed project. This proposal describes the computer-based genome analysis of bacteria subject to an experimental climate change mimic. I began work on this project last year, during my sabbatical, as part of an NSF funded project in collaboration with Dr. Kristen DeAngelis of UMass Amherst. The analysis will be performed using KBase, an open-source software and data platform, with a web-based user interface, maintained by the US DOE (https://kbase.us/).

The long-range goal of this project is to understand how bacteria respond to climate change, specifically increasing soil temperature. The Harvard Forest Long Term Ecological Research site is the location of a soil warming experiment that was initiated in 1991. This experimental site includes plots that have been maintained at 5°C (9°F) over the ambient temperature. Analysis has revealed that with 20 years of increased temperature, the abundance of specific groups of bacteria has changed. The bacteria that increased in population are oligotrophs; those with metabolic activity that enables the consumption of diverse, recalcitrant forms of carbon found in environments depleted of organic carbon food sources. The bacterial population shift may be due to the selection of a subset that was present in the soil prior to warming, or may represent species that underwent genetic changes that resulted in a new functional ability to survive. Because bacterial metabolism plays a significant role in the overall production of CO_2, a greenhouse gas, it is important to understand the effect of climate change on these organisms. Comparative studies of these bacteria will help us to understand the role of bacterial metabolism in response to warming and thus can help to predict the role bacteria will play in future climate change processes.

Question 3: State the purpose of the overall research or creative project. Include the major hypotheses, research question(s) and/or the aims of your project. Our aim for this summer is to characterize the metabolism of a bacterium based on its DNA sequence. The overall goal is to identify changes that may explain the adaptation to growth in the warmed soil, such as the production of more or different proteins that digest and metabolize recalcitrant carbon sources. This knowledge is used to learn about the functionality of the individual bacterium, and eventually will allow us to understand interactions with other bacteria and make predictions about the response to future climate change.

The DeAngelis lab has grown bacteria from heated and control plots, and then performed whole genome sequencing (WGS). The WGS methodology produces entire DNA sequences of the bacteria; a large amount of information that requires computer-based analysis. This bioinformatics analysis enables us to predict cell function, including metabolic activities. The KBase platform includes computational analysis methods ('apps') for the analysis of WGSs, including annotation, which reveals the presence of known and unknown genes and proteins. This analysis of a previously unstudied bacterium will enable us to both learn about the specific bacterium and compare it to other bacteria derived from the heated and control condition.

Question 4: State the methodology to be employed for the project (include number of trials/samples/subjects/etc., as appropriate). Explain the role of the student in the overall project as it will apply to the summer's work and the student's qualifications. Please indicate if the project is likely to continue past the award period. Hanaa will begin her project by reading several

papers that are the basis of the soil warming project. I will also provide worksheets with which she can work through some basic bioinformatics analysis. She will download a chosen WGS data set (to be chosen in consultation with Dr. DeAngelis) into KBase, and perform annotation of the genome. She will watch KBase tutorials for the metabolic analysis and comparative genome analysis apps, after which we will discuss the types of research questions that can be asked. Subsequent analysis will depend on the questions, but is likely to focus the metabolic modeling apps available at KBase, so she can determine which metabolic pathways are present. In some cases, missing metabolic steps will need to be identified using comparative protein sequence analysis. All of the work in KBase is maintained in the shared narrative, thus, I will be able to remotely monitor all of her work. To guide her work, she will review the KBase Narrative Library. I expect the introductory work to take about 3 weeks. The remainder of the time will be for her novel research. Hanaa has worked with me for 2 years on a laboratory based research project, during which time she has demonstrated insight and attention to detail. She also has performed self-directed research into topics that she has identified and then shared with me as it relates to her current research topic. I am confident that she will stay committed to this work throughout the summer. She will develop research questions that may be experimentally addressed in the fall or spring as a new project.

Question 5: Provide a brief description of the role of the requested budget items in the project. The RSCA Advisory Board may choose to partially fund a project if requested items do not clearly support the project goal. None

Question 6: State the expected outcomes of the project with regard to the advancement of knowledge in the field or the progress toward new creative works. The outcomes should be described in the context of the current state of the field of study. Overall, this work will provide insight into a previously unstudied bacterium. As Hanaa explores the WGS data, she will be able to develop testable hypotheses regarding metabolism. This can lead to opportunities for experimental analysis that can be carried out in the future. The research may identify one or more unique or interesting traits of the bacterium and thus enable us to publish a Genome Resource Announcement paper.

Question 7: Explain how this project provides a learning experience not available in the classroom/ regular programmatic activities/ major requirements. I have used a similar research and discovery process in my Capstone Microbiology class this semester, but this project will allow Hanaa to research WGS data in greater depth than is possible in a class. She will generate research hypotheses that she and other students can test in a post COVID-19 era. Because she will work on this project full-time and because I can provide one-on-one mentoring, Hanaa will be able to explore the data to a greater degree than would be possible in a class. She will be integrating her knowledge of an array of biology and chemistry courses. Hanaa has regularly demonstrated an interest in all aspects of biology, not just that which is related to medicine.

Question 8: Describe how the faculty mentor will guide the student. Inclusion of the arrangements for regular, meetings is necessary but not sufficient. Mentoring plans to address safety issues (laboratory, studio, field, travel, etc.) or ethical issues must be included, as appropriate. Hanaa and I will meet regularly (several times per week) using the WebEx platform, as we have done to communicate about her current research project in this second half of the semester. It has worked well for sharing and refining ideas. We will discuss published papers and her thought process as she develops research questions. As she gathers information and develops hypotheses, I will provide feedback on the feasibility of her ideas. Safety issues include cybersecurity and ethical issues will be similar to those we have discussed for laboratory work (such as data fabrication).

Question 9: (if applicable, include additional pages if needed) Provide a summary of the work accomplished with previous (past 3 years) SURE or AYURE funding, including funded work that does not directly relate to the proposed project. Information on the post-graduation placement of former AYURE and SURE students will be appreciated.

AYURE (Fall, 2019, Ahmed) Hanaa performed well controlled studies to quantify ATR activation of T cells and determined that there is not a statistically signification amount of activation.

AYURE (Fall, 2018, Fisher) This work sought to quantify the amount of T cells activation in response to ATR and was the basis of the above project. Ashley Fisher is now working as a Microbiology Associate I at Certified Laboratories, Inc. Melville, NY

AYURE (Fall, 2017, Fisher) Ashely determined that ATR does not inhibit T cells but instead activates them.

AYURE (Spring 2017, Scarimbolo) This project was the basis of the above project. Laura examined the effect of ATR on T cells. Her results were limited due to the technical issues described in this proposal. Laura has now completed a Master's in Public Health.

____X____ I accept responsibility for the conduct of this project and assure that the information in this application is correct. Indicate your agreement with this statement with an 'X'.

____X___ I will present my SURE project work in the Fall as required. Indicate your agreement with this statement with an 'X'.

Question 1: State your role in achieving the goal(s) of proposed project.
My role as a mentee would be to be read several papers to assist me with understanding the data and providing a scaffolding for the best-fit research questions for the WGS selected. I will also be responsible for watching videos to better inform myself on Kbase (the open software) to decide on the most cohesive research questions to use for this project. The analysis I conduct will be dependent on the questions we decide to research further. To perform analysis my responsibility will then shift into annotating the genome using Kbase.

Question 2: State the specific methodology you will employ in carrying out the proposed project
After formulation of the most relevant questions to investigate given the background information, I will then insert the desired WGS into Kbase. From there on I will annotate the genome and use this information to examine the general aspects of all the proteins made by the bacterium. This will be compared to similar bacteria to see find similarities and differences.

Question 3: Provide a description of your qualifications to participate in the proposed project.
As a biology major I have acquired fundamental knowledge to assist in understanding this project both evolutionarily and biochemically. I have more in depth knowledge on topics such as cell function, genetics, population shift/selection, and the functionality of pathways. I also have about 5 years worth of research experience, which will assist in formulating questions and ethics/data integrity.

Question 4: Describe your plans to meet with your mentor for guidance.
We will be meeting several times a week through WebEx to discuss information I have gathered from research papers and possible questions. Since Kbase uses a shared narrative, all my work will be available to be reviewed which will assist in providing me with guidance, keeping data on track, and addressing anything that I would have questions about either in the software or the biochemistry of the data.

Question 5: Describe the expected outcome/ product of your work.
To be able to identify novel enzymes/proteins that would present themselves in a bacterial population enough to demonstrate a shift in the population which would be attributed to selection onset by climate change. As well as creating a write up of the results to help discern what future bacteria selection might yield as a product of the heating of their ecosystem.

Question 6: Describe your plans after graduation and how your involvement in the proposed work relates to these goals.
I plan on pursuing an MD/Ph.D in which a significant component of both degrees is research experience to assist in any future research and academic endeavors. Most of the higher level knowledge I have acquired has certainly been attributed to participating in research. It has taken topics I have already learned and provided me with the opportunity to explore them at a finer level of detail than possible in a class.

Question 7: Describe your plans for presenting the results of your research, in addition to the Fall presentations that are required.

In addition to presenting at the fall SURE presentations, I expect to present at the Student Research Symposium, the SUNY Statewide Research Conference (SURC), as well as the C-STEP Spring Research Conference. My mentor also told me that we should consider presenting at the NorthEastern Microbiologists: Physiology, Ecology and Taxonomy meeting in June.