Introduction

How is research funded? Research is funded by government agencies, such as the National Institutes of Health (NIH) and National Science Foundation (NSF), as well as private foundations like the Camille and Henry Dreyfus Foundation and the Bill and Melinda Gates Foundation. For a scientist to secure support and begin an independent research program, s/he will create a project or respond to an initiative known as a Request for Proposals (RFP) from a funding source.

In this exercise, you will be asked to create a research proposal in response to this RFP, similar to how a real scientist would prepare a proposal.

General Information

The development of a method for DNA sequencing by Frederick Sanger and colleagues in the 1970s revolutionized the study of biology. This technology was still in use in 1990, when the Human Genome Project was proposed. This monumental project took over a decade to complete, at a cost of almost $3 billion. In the last five years, next-generation sequencing approaches have been developed that enable significantly faster and cheaper DNA sequencing — it is now possible to sequence a human genome in about three days at a cost of approximately $1000. Next-generation sequencing technology relies on a combination of special preparation of the DNA or RNA sample (also known as library preparation), the sequencing process itself, and the computational assembly of the sequence. A major advantage offered by this type of technology over Sanger sequencing is that it allows a large number of relatively short sequences to be produced simultaneously in a single instrument run. The piecing together, or assembly, of these relatively short reads to form one sequence as long as an organism’s genome requires knowledge of a field known as bioinformatics.

Bioinformatics uses computational tools to study biology. These computational tools can assist in the acquisition and storage of DNA and protein sequences, and they can help tackle the challenges of sequence alignment and comparison. The combination of next-generation sequencing technology with specialized computational analysis makes possible a wide range of research projects that would be difficult or even impossible to complete with Sanger sequencing. For instance, it is now possible to figure out what microbes are present in a sample collected from the environment without the need to go through the tedious process of culturing each strain of each species separately. Researchers can now sequence DNA collected from the microbes all at once and analyze the data to identify what species were present. If you want to find out what’s growing on your kitchen sink, you can do it in a week or two if you have the right tools!
Bioinformatics Inquiry through Sequencing (BioSeq) is requesting proposals for projects that will use next-generation sequencing to investigate interesting scientific questions. BioSeq maintains a sequencing center equipped with an Illumina MiSeq next-generation sequencer along with all the supporting instrumentation required to prepare samples for sequencing. The output of the MiSeq is only appropriate for certain types of experiments, and all I successful proposals must be able to be completed at the BioSeq sequencing center. We can support three major types of investigations:

a. Sequencing of several samples to find mutations by comparing the results to a reference genome. The BioSeq project called "The Mutations Investigation Experiment" is an example of this approach. You can find out more about this project on the BioSeq website.

b. Sequencing of a portion of the 16S rRNA gene to determine what organisms are present in a microbial sample. The BioSeq project called "The Microbiome Portrait Experiment" is an example of this approach. You can find out more about this project on the BioSeq website.

c. Sequencing of plasmids and small genomes such as those of bacteria, archaea, and viruses. If the organism you are interested in has a genome larger than a few million base pairs, it will not be possible to collect enough data to assemble the sequence.

Eligibility Requirements

1. The BioSeq open application process is part of a research project funded by the National Institutes of Health Science Education Partnership Award (SEPA). Accepted students will be required to participate in this research project by completing an online survey to assist in evaluating the program.

2. Proposals submitted by high school teachers for class projects, or by high school students themselves for individual projects.

3. All entries must have a "project sponsor" – a high school teacher who will oversee the sample collection and DNA purification experiments. This teacher also needs to agree to properly supervise the project activities and take responsibility for enforcing safety regulations. The only exception to this requirement is for individual projects where all students participating are over 18.

4. Individual projects may be proposed by single students or by a team of 2-4 students. Within a team, all students should participate in the preparation of the proposal.

Experiment Requirements

Students and Teachers are required to submit a proposal that meets the following requirements:
1. Experiments must make use of next-generation DNA sequencing.
2. Experiments may not make use of any samples derived from humans.
3. Experiments may not involve the collection of samples that are a known risk to human health.
4. All experiments must specify in detail what samples will be collected: what type of samples, an estimate of the number of samples, how the samples will be obtained, and where the samples will come from.
5. The experiments may not involve the destruction of any items that are on public or private property.
6. Any samples collected from commercial vendors (stores, markets, etc.) must be anonymized. This information may only be recorded in research notes. It may not be released without authorization.

**Format of the Proposal**

*Before you get started writing, you need to know your audience:* A panel of Tufts undergraduate students, Tufts staff and faculty, and several high school teachers will review this research proposal. This review process is called peer review. The goal of your investigation should be to answer a specific question. Furthermore, your proposal should follow the "scientific method" and indicate your understanding of the literature.

1. The proposal should be attached as a PDF to an email addressed to BioSeq@tufts.edu. Be sure to also attach a PDF of a completed cover page.
2. The proposal should be approximately 2 pages in length (excluding references and biography) and should contain the following sections:

   - **Introduction** – description of the background and purpose of the experiment, with references. Be sure to make note of any similar types of published research.
   - **Specific Aims** – goals and achievable objectives of the experiment including a hypothesis for the experiment, an estimate of expected results, and some discussion of the impact of the experiment. *Note to teachers: Classroom projects may want to consider the Massachusetts State Curriculum Frameworks to define how this project will tie into the class’s curriculum.*
   - **Methods section** – a general plan that includes a description and justification for the proposed experiments. This section should be written in the third person, and it should outline the entire experiment, from sample collection through to DNA isolation and purification. This section should not be a procedure or detailed protocol. *Note to all: There are established protocols that students can draw from in designing their experiments. Please consult the BioSeq website at http://ase.tufts.edu/chemistry/walt/sepa/index.html.*
• **References section** – all forms of resources used to generate this idea, such as journals, textbooks, website addresses, and mentors, should be included. (NOTE: references do not count against the page limit)

• **Biography** of all team members, including the project sponsor. Team members should describe the science courses they have completed, as well as the current science course that they are enrolled in. The project sponsor should describe the course(s) they are teaching.

3. The proposal must be typed, with single line spacing and 1-inch margins in all directions.

4. Work submitted by students is expected to be unique. In other words, it must be written in their words and not quote or paraphrase any other person without proper disclosure.

5. To simulate the selection process that will occur within the review panel of a funding agency, such as the NIH, students are encouraged to work together to decide on a project that “wins” out of a larger number of ideas from the class, thereby exposing students to cooperation, collaboration and team building.
Bioinformatics Inquiry through Sequencing
Open Application Cover Page

Student Team Information (skip this section for whole class applications)

Name of Primary Investigator: ____________________________
School: ______________________________________________
Email: ________________________________________________

Name of Co-investigator #1: ____________________________
School: ______________________________________________
Email: ________________________________________________

Name of Co-investigator #2: ____________________________
School: ______________________________________________
Email: ________________________________________________

Name of Co-investigator #3: ____________________________
School: ______________________________________________
Email: ________________________________________________

Project Sponsor Information (this section must be completed for all applications)

Name: __________________________________________________
School: ________________________________________________
Email: ________________________________________________

Proposal Information
Project Title: ____________________________________________
Research Site Location(s): ________________________________

If this is a student proposal, please complete the following:

I, ____________________________________________ (teacher’s name), certify that this proposal was written by the above investigator(s) and developed from their own ideas.

Project Sponsor’s signature: ____________________________ Date: __________

APPROVED
DEC 22, 2014
Tufts SBER IRB

EXPIRES
DEC 21, 2015
Tufts SBER IRB