MUSEUM OF COMPARATIVE ZOOLOGY
GRANTS-IN-AID OF UNDERGRADUATE RESEARCH

APPLICATION FOR AY 2007-08

Description:

The Museum of Comparative Zoology (MCZ) at Harvard University is pleased to award small grants in support of faculty-supervised research by Harvard undergraduates. Projects in any subject area are eligible for support, although priority may be given to projects that utilize the MCZ's research collections, laboratories and other facilities, and to related field work. Projects that facilitate senior honors theses or associated preliminary studies are particularly encouraged. Applications must include a brief research proposal (maximum 500 words) and identify a Harvard faculty member who has agreed to supervise the project. The proposal should describe the project's goals, the specific plan to accomplish those goals, and the role of the faculty sponsor. Awards range from $500 to $2500 and may provide support for the academic year (fall and spring semesters) or summer. Applicants for spring and summer grants are strongly encouraged to simultaneously apply for research support from the Harvard College Research Program (HCRP). Application deadlines: 10 October, 6 February, 2 April. Decisions typically will be announced within one month of each deadline.

APPLICANT INFORMATION

Name (last, first, MI)	[redacted]
Harvard email address	[redacted]@fas.harvard.edu
House mailing address	[redacted] Quincy Mail Center Cambridge, MA 02138
Permanent (legal) address	[redacted]
Phone	[redacted]
Concentration	Molecular and Cellular Biology
Citizenship (If not USA, visa status/number)	Citizen of Moldova, permanent resident of the USA (Green Card #[redacted])
Summer address (if project conducted during summer)	n/a

PROPOSAL INFORMATION

Project Title	Chemosynthetic symbiont functional genomics
Faculty Sponsor	Colleen Cavanaugh
Total Funds Requested	2,500

FRONT + BACK

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Please submit five hardcopies of all application materials (including required supporting documents) to Mrs. Catherine Weisel in the OEB Administration, 26 Oxford St., Cambridge, MA 02138, or submit your application as a single document via e-mail to grants@oeb.harvard.edu The faculty reference letter may be mailed separately by your sponsor. Incomplete applications will not be considered. For additional information, please contact Catherine at grants@oeb.harvard.edu.

CHECKLIST:

- [x] Application (pp. 1-2)
- [x] Budget (p. 3)
- [x] Other support (p. 4)
- [x] Research proposal (max. 500 words)
- [x] Resume
- [x] Undergraduate transcript
- [x] Letter of recommendation from faculty sponsor
- [x] Supporting documents, as needed (e.g. airfare price quote)

[redacted] 02/6/08

Signature of student applicant Date

[redacted] 02/06/08

Signature of faculty sponsor Date

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BUDGET

Name (last, first, MI): [redacted] Harvard ID: [redacted]

Eligible expenses include the cost of travel to field site(s), laboratory and field equipment and supplies, and a research stipend (summer only, at $9/hour and for a maximum of 35 hours/week). Local housing or living expenses are ineligible. The standard mileage rate for reimbursement of local travel expenses to research site(s) is 48.5 cents per mile. Airfare amounts must be based on a specific price quoted in writing by a commercial travel agent or travel website (please attach a copy).

RESEARCH EXPENSES:

Item:	Cost:
Stratagene lambda fix III fosmid kit	$500.00
Stratagene DNA ligation kit	$250.00
Fosmid screening through the FAS systems center	$300.00
DNA purification kits and sequencing	$500.00
General laboratory supplies and reagents	$250.00

Subtotal research expenses: *1,800.00*

TRAVEL EXPENSES:

Item:	Cost:
Travel to ASM meeting and poster printing for student	$700.00

Subtotal travel expenses: 700.00

TOTAL (research and travel expenses): 2,500.00

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OTHER SUPPORT

Please list other potential funding sources for the above project to which you have applied or intend to apply (both Harvard and non-Harvard). Indicate the amount(s) requested and any budgetary overlap with this application. Students receiving funds from other sources may still receive a grant-in-aid from MCZ if the project is unusually costly. If none, indicate "none."

1) HCRP undergraduate research grant – suggested 1,000.00 as budget and included Stratagene kits mentioned above.

2)

3)

Chemosynthetic Symbiont Functional Genomics

Genome research has generated an explosion of data that is dramatically redefining our perceptions of organisms and species, in particular, uncultivated microorganisms. This powerful technique has given us a new appreciation of the metabolic diversity and genetic capabilities of microorganisms, including many of those involved in symbiotic interactions. In the case of bacterial symbionts, many of which are unculturable, genome sequencing is revealing the nature, interaction and evolution of these associations with eukaryotes.

Symbioses between prokaryotic and eukaryotic cells are a globally important phenomenon that has powerful effects on the physiology, ecology, and evolution of virtually every organism on this planet. The chemosynthetic symbioses represent a novel form of primary production and ecosystem function. Initially discovered at vents 20 years ago, chemolithoautotrophic symbioses are now known from many biospheres and can be one of the major primary production routes in reducing sediments. In these interactions, the symbiont uses the energy of sulfide oxidation to fix carbon that supports the growth and maintenance of their invertebrate hosts.

While known to exist for 20 years, these symbionts have not yet been cultured, hence little is known about them. Genomic analysis of the Vesicomyid symbionts (those from the giant clams that live at hydrothermal vents) revealed that these organisms have all the pathways necessary for chemoautotrophy including mechanisms for generating all of the nutrients their hosts require. Given the intimacy of this relationship, indeed the physiological dependency of the host, it is not surprising that the symbionts should be so metabolically capable. This genomic sequence, however, has opened up new avenues of research within the study of chemosynthetic communities.

Objectives: Functional genomic analysis of Bathymodiolus mussel symbionts

1) Generate fosmid libraries from several of the Bathymodiolus mussel symbionts. We will be able to use the resources at the Museum of Comparative Zoology for this project as the MCZ has several *Bathymodiolus* mussel samples available for use. These fosmid libraries will provide a wealth of knowledge for both the Cavanaugh lab and my own specific research project.
2) Screen these fosmid libraries for functional genes of interest. I will be able, through the use of the FAS systems biology center, to do a high-throughput screen of the fosmid libraries to ensure that I target only the symbiont containing fraction and also to target genes of interest.
3) Clone these fragments into Escherichia coli to test for protein function. Although genomics sheds light onto the potential capabilities of these organisms, a functional approach is necessary to determine what they are actually doing within the host. I will use the amazing genetics resources available through *Escherichia coli* to clone my genes of interest and determine protein function. For example, by cloning the nitrate reductase operon into an *E. coli* mutant, and seeing if complementation occurs, I can support the functionality of this protein in the symbiont.

Significance and implications of research:

I propose to generate fosmid libraries of the *Bathymodiolus* mussel symbiont genomic DNA from the MCZ collections. I will use these libraries both for 454 sequencing of symbiont specific fragements as well as screening for functional genes of interest. As we don't have a complete genome of this symbiont yet, these fosmids will provide the framework for functional genomic research on this group of important symbionts. The genome project will provide tremendous insight into the biology of these uncultured microbes.

Detailed goals, time frames and use of funds:

I plan on beginning the fosmid library generation in the Spring of 2008 (February). I will hopefully be successful and the screening process will happen over March and April. The fragments identified as symbiont (using a hybridization approach) will be sent for 454 sequencing by the Cavanaugh lab. I will also design probes for targeting genes of interest within the symbiont genomes. For example, it is known that some of these symbiont genomes encode a pathway for an alternative electron acceptor. It would be of interest to me to find if the *Bathymodiolus* mussels also retained this pathway. As this project nears its end, I would also like to travel to the American Society for Microbiology General Meeting in Summer of 2008. This will be an amazing opportunity to present my work to the general scientific community.

Faculty involvement:

I will be working directly with Irene Newton, a 5th year graduate student in the Cavanaugh lab. Irene will provide my day to day mentoring, teaching me the techniques necessary to complete my project and guiding me through the bioinformatics and data analysis. Through her time in the Cavanaugh lab, as a senior graduate student, Irene is fully capable of providing me with the instruction I need. In addition, I will be meeting with Prof. Cavanaugh on a weekly basis to present my results and discuss the progress in my research. I will also be giving

lab meeting on a bi-monthly basis and this will give me the opportunity not only to sharpen my speaking skills but also to receive feedback from the other members of the laboratory.

Personal goals and development:

This project will enrich my laboratory experience, which will prove invaluable when conducting my senior thesis research. The project also has the possibility of leading into a senior thesis as so many questions will come out of the sequencing effort. I am also considering medical school and my participation in this project will help me decide whether or not my interests lie in medicine or academic research. Finally, the cooperative environment of the Cavanaugh lab will also help me to learn collaborative research skills, necessary if I am to work in a scientific community.