

Faculty Fellows Department Project Report

Pamela Harvey - Molecular, Cellular, and Developmental Biology

Statement of Purpose

Engaging in scientific research promotes improved understanding of and continued interest in science. Our department and others are redesigning curricula to include course-based research experiences (CUREs). However, students require broader engagement in the scientific community to authenticate their experiences in these courses and other mentored research projects. To this end, a scientific journal that features the peer-reviewed research of undergraduates will be created (Journal of Scientific Inquiry). The journal will be piloted in MCDB, then made available to other departments in the following semesters. It will serve as a platform to publically showcase the work of undergraduates from multiple departments. Additionally, to address issues with students feeling disconnected from the faculty and staff, members of our department will be recruited to participate in several roles related to administration of the journal.

All research articles, review papers, and editorials will be solicited from undergraduates. Five undergraduates will join faculty members as editorial board members for the journal. Responsibilities will include attending bi-annual meetings to discuss the scope of the journal, which will likely evolve from year-to-year, and to plan expansion of the journal within our department and to other departments. At least 20 undergraduates will serve as editors and proofreaders for accepted papers. They will be joined by faculty, postdoctoral fellows, and graduate students, who will serve as manuscript reviewers. Finally, three undergraduates will serve as webmasters.

The Journal of Scientific Inquiry (domain secured: www.jsscientificinquiry.com, archived through CLOCKSS) will be a peer-reviewed, multidisciplinary journal that publishes electronically and in print three times per year. Print issues will be available to departments and authors. The audience will be undergraduates and faculty with diverse interests in life sciences.

Project Details

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Journal name: Journal of Scientific Inquiry

Journal mission statement: To provide a platform for undergraduate students to report novel scientific research and to experience the peer-review process.

Journal description: Open access, peer-reviewed multi-disciplinary journal that publishes on a rolling basis articles describing scientific research. Articles written for the Journal of Scientific Inquiry should be geared toward a diverse college-educated audience.

Open access policy: Creative Commons licensing will allow public use and distribution. Authors will maintain copyright privileges.

Publication: Publication online will be three times per year (October, February, May). Authors will be provided with a print copy. Print copies will also be made available to authors' respective department(s) and Norlin Library.

Archiving articles: Archiving will be achieved initially through CLOCKSS, a non-profit service with the aim of archiving with PMC once scientific credibility is established. PMC requires two years and publication of 25 peer-reviewed articles for archiving consideration. Each article will receive a DOI number for indexing purposes.

Required participation from department members:

1. Recruit at least **5 faculty members** and **5 undergraduates** to serve as **editorial board members** for the journal. Responsibilities include annual meetings to discuss the scope of the journal, which will likely evolve from year-to-year, plan expansion of the journal to more courses in our department and ultimately, to other departments,
2. Recruit at least **5 undergraduate or graduate students** to serve as **primary editors** for accepted papers. Responsibilities include copy editing accepted papers, interacting with authors, and producing final full-text and PDF versions of accepted papers.
3. Recruit at least **5 undergraduate or graduate students** to serve as **proofreaders** for accepted papers.
4. Recruit **15-20 faculty, postdoctoral fellows, and graduate students** to serve as **manuscript reviewers**. Papers will be reviewed four times per year with a turnaround time of not more than two weeks. Reviewers will provide full reviews in accordance with provided guidelines regardless of acceptance status. In other words, all papers get reviewed, and all students receive feedback. The anticipated acceptance rate would be approximately 50%, but may vary depending on the quality of submitted work. Student authors will receive mentoring related to responding effectively to reviewers. Students may also choose to pursue the research during a second summer session and resubmit to the journal.
5. Solicit one **editorial article** bi- or tri-annually from **undergraduates** who are interested in issues related to undergraduate education and specifically, in research opportunities for undergraduates. Editorial articles will be open for comment on the journal website. All comments will be approved by an editor before becoming publically viewable. Authors will be encouraged to respond to comments.
6. Solicit from **undergraduates** one **review article** per issue that is accessible to a diverse audience on an area of scientific research.

[5 faculty (editorial board), 15-20 faculty/postdocs/graduate students (peer reviewers), 5-10 undergraduates (editors), 5 undergraduates (proofreaders) – all volunteer]

Submission requirements:

1. Work must be performed while an undergraduate student, however, the manuscript may be published after graduation.
2. All authors must be or have previously been a student at University of Colorado for the first three years after the launch of the journal. After the journal has been made available to at least five departments, submissions may be considered from authors at other institutions.
3. Work cannot be submitted simultaneously to another journal or include previously published work.
4. Submissions must be accompanied by a statement of manuscript approval and permission to publish from the mentor. In the case of CUREs, permission must be obtained from the sponsor laboratory.
5. Authors may submit more than one article, but articles cannot be under review simultaneously.
6. Manuscript must adhere to formatting guidelines for specific article type (original research, review, editorial).
7. Submissions are accepted for review three times per year: October 1, February 1, and May 1.

Manuscript formatting:

1. The Journal of Scientific Inquiry is a multidisciplinary journal featuring quality research performed by undergraduate students. As such, the primary audience of the journal is broad. Articles should be written at a **college-level but be readable by a diverse audience**.
2. Manuscripts should be submitted with a **cover page** describing the important findings of the manuscript and the name of the mentoring scientist.
3. Manuscripts should be divided into: **Title, Abstract (200 word limit), Introduction, Methods, Results, Discussion, Acknowledgments, References, Figure Legends**.
4. Figures should be referenced in the text and shown **one per page at the end of the manuscript**.

Review process:

1. Editor reviews article for completeness and to determine whether the article meets the general requirements for submission in terms of authorship, formatting, and subject area. Articles that do not meet these expectations will be returned to the author, but may be resubmitted after corrections are made.
2. Editors select two reviewers for each article. Reviewers will be encouraged to support the development of an improved manuscript whether or not it is suitable for publication through production of a complete and informative review. Reviews will focus on several areas: consideration of previous work leading to the research presented, detailed methods such that a scientist in the field could repeat the experiments and obtain the same results, objective presentation of results, consideration of how the research contributes to the field, and explanation of future studies that should be performed to increase the scope or impact of the project.
3. If reviewers recommend rejections, students will be encouraged to write a response to the reviewers itemizing how issues are resolved or describing why the author does not agree with the assessment. The response to reviewers must be approved by the mentoring scientist prior to resubmission.

Assessment of Journal Success:

Assessment will be initially performed in conjunction with an independent study pilot for which funding has also been awarded by HHMI UROP.

Fall 2017: Student group 1 (8 students)

Spring 2018: Student group 2 (8 students)

December 2018, prior to manuscript submission: Collect survey data [opinion data used to evaluate The Python Project <https://www.ncbi.nlm.nih.gov/pubmed/25452492>, the Survey of Undergraduate Research Experiences (SURE) <https://www.grinnell.edu/academics/areas/psychology/assessments/sure-iii-survey>, and the Undergraduate Research Student Self-Assessment (URSSA) <http://www.colorado.edu/eer/research/undergradtools.html>]

December 2018 – January 2019: Evaluate submitted manuscripts, January issue of Journal of Scientific Inquiry is published

April 2019, prior to manuscript submission 2: Collect survey data (opinion data, SURE survey, and URRSA)

April – May 2019: Evaluate submitted manuscripts, May issue of Journal of Scientific Inquiry is published

Resources and Support

Annual cost:

1. Web hosting: approximately \$60 – Bluehost is hosting www.jscientificinquiry.com, paid from personal funds 1/31/2017, reimbursement will come from \$1,500 Faculty Fellows funding awarded December 2016.
2. Website and interface \$0 – will be developed through the Public Knowledge Project (Open Journal Systems), no development fee (PH is developing the online platform)
3. DOI numbers and CrossRef membership: \$100 – OASPA does not allow membership until the journal is accepting submissions and meet basic quality guidelines. OASPA is the most economical way to get DOIs. Membership is about \$100 per year and provides 50 DOIs. The organization also covers the cost of CrossRef membership.
4. Archiving: CLOCKSS: \$227
5. Printing three issues per year (approximately 30 copies per issue initially): \$1,000
6. ISSN: \$0, requested from Library of Congress 2/21/2017, due to be processed within ten business days. Received approval and assignment 2/23/2017 ISSN (print): 2476-1877, ISSN (online):2476-1885 (**Appendix I**).

HHMI UROP team and publication grant funding was awarded for the project in April 2017 (**Appendix II & III**). All costs will be covered for the first year, from May 2018 - May2019. Continued support will be sought during this time period from both the department and university.

Timeline

- November 2016:
1. Outlined basic strategy for efficiently offering experience with manuscript development to undergrads,
 2. ASSETT Faculty Fellows application for funding to support journal pilot (*funded 12/16 - \$3,000*).
- December 2016:
1. Researched mechanisms for setting up an open access journal: website hosting, website development, costs, “personnel” requirements, publication time lines, funding resources at CU, copyrighting, indexing, ISSN access, CrossRef membership.
- January 2017:
1. Named the journal after discussion with students and two faculty members (Journal of Scientific Inquiry),
 2. Secured website and hosting (BlueHost),
 3. Began learning Open Journal Systems (OJS) software for website development
- February 2017:
1. UROP Team application filed (February 17) for funding to support independent study research Fall 2017 and Spring 2018 (*funded 4/1/2018, \$3,000*),
 2. UROP Publication application filed (February 17) for funding to support website hosting, indexing, etc (*funded 4/1/201, \$3,000*),
 3. Meetings with Tin Tin Su, Corrie Detweiler, and Leslie Leinwand (PIs of sponsor labs) to discuss scope of research students are allowed to pursue independently – questions that arose: who’s intellectual property is the research? The independent study or the sponsor or lab? Is giving the students the opportunity to “publish” appropriate when the scope of the project is so limited?
 4. Meeting with Mike Klymkowsky. He suggested increasing the scope of the journal to include not only bench work but also commentary, review articles, and topics related to MCDB like patent law, drug development, public health, etc.
- March 2017:
1. Researched continued funding opportunities: NSF CCE STEM? Chancellor’s Award for Excellence in STEM Education? – possible 4/15 deadline – applied & *not funded*
 2. Announce fall independent study availability to students who took 1171, 2171, and 4202 in AY 2015/6 and 2016/7
 3. Recruited faculty/postdocs/grad students in journal roles including reviewers. Identified post-doctoral fellow in EBIO (Ashley Rowland) for collaboration.
 4. Continued Open Journal Systems training
- September 2017:
1. First semester of pilot independent study. Four students from 4202, four students from 2171, one student from 1171. All continued their projects from the courses in which they were enrolled.
 2. Funding for students came from UROP team grant.
- January 2018:
1. Second semester of pilot independent study. Four students from 4202, three students from 2171, one student from 1171. All but two were from Fall 2017 and continued their research.
 2. Funding for students came from UROP team grant.

Challenges Associated with Development

Two main challenges have arisen during the development of the journal: **intellectual property** or who owns the data and recruitment of **volunteers** to assist with running the journal. After meeting with the sponsor laboratories, PIs questioned whether the students “own” the data. Undergraduate research-based courses were originally set up to provide students with the opportunity to contribute data to a larger project being performed in MCDB. Over time, the utility of these data have been questioned and issues of whether students are making a true intellectual contribution to the work were discussed. To answer this challenge, I mentored students in independent study experiences to allow them to increase their contributions and to provide them with opportunities for creative thinking about the directions of the projects. Three of the projects resulted in data that were not directly related to the sponsor laboratory’s interested and were deemed “publishable.” Two of the students have registered for independent study in Fall 2018 to pursue development of manuscripts, while one of the students secured a position in the sponsor laboratory to continue his work. It became clear that there existed a need for research opportunities unrelated to the courses to give students more agency in their projects.

As a solution to the issue of **intellectual property**, I assembled a group of four students from the Python Project in Spring 2018 to work on a project related to my own research interests. An overview of the research plan is described below. This plan was developed in collaboration with these four students. During Spring 2018, the student optimized conditions for injecting dsRNA in *Drosophila* larvae and adult flies (Aim 2).

Overview of Research Plan

To address the gap in understanding the relationship between lipid homeostasis and brain health, we plan to use models of neurodegenerative diseases in *Drosophila melanogaster*. Specifically, the initial focus of the research will be on Huntington’s Disease. Expansion to other neurodegenerative diseases can be achieved using the same strategies. The plan below outlines the main aims for approximately 3-5 years’ work with estimates of time period required for completion of each project. Projects are designed with the aim of providing a broad range of basic molecular biology techniques at a relatively low cost and in the interest of involving students, who are likely to be in the laboratory 8-10 hours per week. The project could broadly engage undergraduates in research with goals ranging from simply gaining laboratory experience to developing thesis projects.

Aim 1. *Observation and Characterization.* Determine the relationship between lipid homeostasis and Huntington’s Disease.

1. Cross Huntington’s Disease model *Drosophila* with four characterized models of lipid dysregulation,
2. Examine the behavioral phenotypes resulting from altered serum lipid levels (12),

Techniques used:

Drosophila husbandry and associated preparation of reagents required for maintain fly colonies, microdissection, immunofluorescence microscopy, behavioral observations

Timeline for experiments:

- Genetic cross to observable adult phenotypes – three weeks
- Microdissections and immunohistochemistry – 3-6 hours over two days
- Behavior observations – 2 hours per day for approximately one week per genotype

People involved:

Part-time undergraduate works study and independent study students.

Aim 2. *Small- to Large-scale RNAi Screen.* Using a forward genetics approach, identify genes involved in regulating lipid metabolism relevant to neurodegenerative diseases.

1. Perform directed or library-based screen of RNAi libraries available,
2. Examination of transcript expression after RNAi knockdown of selected RNAs,
3. Immunohistochemistry validation of protein knockdown,
4. Lipid staining and stain recovery of sectioned *Drosophila* using Oil Red O to determine whole body lipid concentrations,
5. Characterization and observation described in Aim 1.

Techniques used:

In vivo RNAi micro-injection, semi-quantitative PCR, cryosectioning, immunohistochemistry, behavioral observations

Timeline for experiments:

- RNAi screening – dependent upon the type of screen performed, individual RNAi sequences can be injected and evaluated within three weeks.

- Semi-quantitative polymerase chain reaction (PCR) – primer design from annotated transcriptome, RNA isolation, reverse transcription polymerase chain reaction (2 hours), semi-quantitative PCR
- Cryosectioning and immunohistochemistry
- Cryosections and lipid staining
- Oil Red O recovery and spectrophotometry

To further increase opportunities for students to experience the publication process, the journal was expanded from its original scope to include papers that are not research reports. After discussions with Mike Klymkowsky, the journal is now formatted with a structure more similar to the journal Nature with many sections. The aim was to give students the opportunity to explore subjects related to MCDB and to encourage them to recognize that the major is useful not only for a career in research or medicine, but also in journalism, public health, patent law, science education, science policy, and many other fields. I am currently considering consulting with other departments to identify possible collaborators who would mentor our students in developing these manuscripts.

The issue of recruiting **volunteers** continued to be a problem, however, I have commitments from half of the “staff” needed to get the journal functioning. I think that as the launch nears, it will be easier to discuss the plan with members of the department. I have tentatively schedule a departmental talk for Fall 2018 to announce the journal’s launch and to ask for volunteers.

Reflection

This project was only possible through my involvement with the ASSETT Faculty Fellows program. Meeting with faculty in a multi-disciplinary setting allowed for the sharing of ideas and resources. It allowed me to identify funding sources such as the UROP Team and Publication grants, for which I secured funding. This funding supported the independent study student for Fall 2017 and Spring 2018. Through my participation, I also recognized the value of these interactions, which later resulted in my facilitating a Faculty Learning Community on development of course-based undergraduate research experiences with Lisa Corwin (EBIO) and with the support of Transforming Education, Supporting Teaching and Learning Excellence (TRESTLE). It also inspired my acceptance in the Faculty Teaching Excellence Program (FTEP) Assessment Institute in Summer 2018. The value of the Faculty Fellows reached beyond the development of the journal; it opened my eyes to other opportunities for faculty on campus and gave me the confidence to pursue them.

APPENDIX I. LIBRARY OF CONGRESS ISSN APPROVAL

From: U.S. ISSN Center issn@loc.gov
Subject: ISSN (prepub) for *Journal of scientific inquiry*.
Date: February 23, 2017 at 12:24 PM
To: pamela.harvey@colorado.edu, U.S. ISSN Center issn@loc.gov



LIBRARY OF CONGRESS *U.S. ISSN CENTER
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2/23/2017

Dear Publisher:

This is your official notification that the following prepublication ISSN assignment(s) were made under the auspices of the U.S. ISSN Center at the Library of Congress. Please print or save this notification for your records.

Journal of scientific inquiry (Print)
ISSN 2476-1877

Journal of scientific inquiry (Online)
ISSN 2476-1885

Expected date of publication: September 2017

Please note that a separate ISSN is needed for each version you publish in a different medium (e.g., print, online, CD-ROM) or for each major change of title. For your convenience, we have reported the ISSN of all medium versions of this title we have in our database even if not all were assigned at this time.

For print serials, please display the ISSN on the upper right-hand corner of the cover, or the masthead, or another prominent place. For online serials, display the ISSN on the title screen, home page, or other prominent place. Always include the letters "ISSN" before the number. If you publish this title in both print and online versions, please display both ISSN together on each version, filling in the blanks in the example below with the digits of your ISSN:

ISSN _ _ _ _ - _ _ _ _ (print)
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Please note that prepublication ISSN are provisional and subject to cancellation until you send a sample published issue to this office or inform us of a URL where the published serial may be freely accessed. The sample issue is used to create an official record of your publication for national and international databases, and to consider your publication for addition to the Library's collections. Only actual issues (as opposed to photocopies of certain pages from print serials as described below) receive this consideration. If it is impossible for you to send a sample issue or provide access (temporary access is acceptable) to an online issue, we will accept photocopies, printouts, or screen shots of the cover, title page, masthead (or their online equivalents) or other pages showing title or publishing information.

Attached to the email version of this message are documents about uses and benefits of the ISSN, how to present and title your serial, and your Copyright obligations. Our web site at www.loc.gov/issn includes these documents as well as additional ISSN information and an ISSN application form that you can download for future ISSN requests. If you have any questions or if we may be of additional assistance, please feel free to contact us.

Sincerely,

ISSN Publisher Liaison Section staff
esb

APPENDIX II. UROP PUBLICATION GRANT APPLICATION

Submitted 2/17/2017

Funded 4/1/2017

Situate your project within other work in the field by providing a summary of the work done and discuss the theoretical traditions influencing your project. State the specific objectives/purpose of your project. Explain the project's relevance and who stands to benefit. Note what is original about your project and what contribution it makes to the field.

Undergraduate students who engage in research demonstrate improved conceptual understanding and retention in science (<http://www.wiley.com/WileyCDA/WileyTitle/productCd-0470227575.html>). However, support for research opportunities is limited by the availability of funding and personnel, especially in traditional one-on-one mentoring models (<https://www.ncbi.nlm.nih.gov/pubmed/25452492>). Course-based Undergraduate Research Experiences (CUREs) offer a solution to this problem by providing the structure necessary for a single instructor to mentor up to 20 students at a time while offering a curriculum based on discovery. Our department (MCDB) is committed to offering research experiences and is requiring all students to participate in a CURE as part of the major. However, these courses have created two new issues: (1) students are increasingly interested in securing research opportunities, and (2) students require more advanced training and independence after participating in a CURE. I am proposing to assemble two groups of 8 independent study students who have successfully participated in CUREs I teach. The opportunity aligns with the objectives of our department and will help raise expectations for undergraduate students in departmental laboratories. I aim to create a model by which independent study students can be efficiently mentored through production of a small laboratory setting focusing on increased student independence.

Explain the method(s)/strategy used in this project, including a justification for your approach. Also justify off-site work and/or international travel if your project requires it. Note any experience, training and/or coursework required for students.

Each semester for the past two years, I have mentored three independent study students who have taken The Python Project, an upper division CURE that I teach (www.pythonproject.org), to allow them to continue their research. I aim to expand this opportunity to students who have successfully completed the lower division CUREs that I teach (www.discoverylabs.org). I am proposing to mentor 16 independent study students in Fall and Spring (8 students each semester) as a pilot for a two-session summer research experience that I am developing. Summer sessions provide students with the opportunity for immersion, similar to summer research internships, but with the benefit of having been previously trained in the techniques and of beginning the research with preliminary data. To complement this, I am also creating an onsite peer-reviewed journal to allow students to experience the peer-review process.

Outline the major phases of your project timeline. (e.g., "October; Data Collection" or "Sep.-Oct., Data Collection")

Fall 2017: Student group 1 (8 students)

December 2017, prior to manuscript submission: Collect survey data [opinion data used to evaluate The Python Project <https://www.ncbi.nlm.nih.gov/pubmed/25452492>, the Survey of Undergraduate Research Experiences (SURE) <https://www.grinnell.edu/academics/areas/psychology/assessments/sure-iii-survey>, and the Undergraduate Research Student Self-Assessment (URSSA) <http://www.colorado.edu/eer/research/undergradtools.html>]

December 2017 – January 2018: Evaluate submitted manuscripts, January issue of Journal of Scientific Inquiry is published

Spring 2018: Student group 2 (8 students)

April 2017, prior to manuscript submission: Collect survey data (opinion data, SURE survey, and URRSA)

April – May 2018: Evaluate submitted manuscripts, May issue of Journal of Scientific Inquiry is published

Explain how you will recruit and select undergraduate researchers.

An announcement will be made by email to all students who participated in a CURE (MCDB 1171, 2171, or 4202) during the 2016-2017 academic year. A minimum grade of A- must be earned, and proposed research must be related to that of the CURE in which students participated.

Anticipated Number of Students

Faculty awarded UROP Team Grants are NOT required to identify the students selected for their teams until they submit the Final Report near the end of the award period. Students already receiving UROP funding in the same award period are NOT eligible to receive funding from a Team Grant, but faculty are currently not limited in the number of students they can mentor.

In the current academic year, I am teaching 6 sections of The Discovery Lab and 2 sections of The Python Project. Based on previous experience, I expect to receive approximately 25-30 requests for continued involvement in these courses. Of these, in the pilot year, I will accept 8 students per semester (two from each section of The Discovery Lab, plus two from The Python Project). In academic year 2017-2018, I will be supervising 12 sections of The Discovery Lab and 2 section of The Python Project, which will increase the need. To meet this need, I will transition to summer independent study credit and will be able to accept 16 students in the first session and 16 students in the second session.
2017-2018 – 16 students total
Summer 2018 – 32 students total

Explain your role and, if applicable, that of the additional supervisor in the mentoring of students in this project. What learning outcomes should they expect? Will they have the opportunity to co-author or present this work? Note previous experience mentoring undergraduate researchers and summarize your mentoring approach/philosophy.

Eight years ago, as a postdoctoral fellow in Dr. Leslie Leinwand's lab, I enthusiastically accepted the opportunity to teach a CURE, The Python Project (www.pythonproject.org, <https://www.ncbi.nlm.nih.gov/pubmed/25452492>). I continue to teach this course and recently starting teaching two lower division CUREs (MCDB 1171 and 2171, The Discovery Labs, www.discoverylabs.org), which are two of the three CUREs now required of the nearly 400 incoming MCDB majors each year. My approach to teaching CUREs is to prepare students for experiences common to a PhD program in the life sciences including optimizing experiments, experiencing the failure associated with discovery, presenting research to peers, attending lab meetings, and publically defending data. To further expand students' experiences in CUREs, I also organize a research symposium, which includes nearly 150 student research posters, five student speakers, and more than 500 total attendees (www.CUREsymposium.org). However, despite these efforts, the problem of limited support for independent research remains, and demand is increasing as more students express interest in continuing their research after taking a CURE. I am therefore proposing to mentor 8 students per semester in an independent study group. My experience in mentoring multiple students per semester from The Python Project has prepared me on the greater task of mentoring 8 students. A second aim of the next two semesters is to develop efficient methods for organizing a more intensive research experience including manuscript development during Summer 2018.

Learning outcomes for expanded CURE independent study:

1. Experience developing a research project in a less structured environment,
2. Obtain technical and analytical skills that build on those gained during participation in a CURE,
3. Improve communication skills through attendance and presentation in weekly lab meetings,
4. Develop an expanded scientific community at CU Boulder through attendance at departmental graduate student and faculty talks,
5. Present work in a poster session at the CURE Symposium in December or May,
6. Prepare a manuscript for submission to Journal of Scientific Inquiry, a journal for undergraduates launching in Fall 2017.

APPENDIX III. UROP PUBLICATION GRANT APPLICATION

Situate your project within other work in the field by providing a summary of the work done and discuss the theoretical traditions influencing your project. State the specific objectives/purpose of your project. Explain the project's relevance and who stands to benefit. Note what is original about your project and what contribution it makes to the field.

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What learning outcomes should they expect? Will they have the opportunity to co-author or present this work?

Note previous experience mentoring undergraduate researchers and summarize your mentoring approach/philosophy.

Eight years ago, as a postdoctoral fellow in Dr. Leslie Leinwand's lab, I enthusiastically accepted the opportunity to teach one such CURE, The Python Project (www.pythonproject.org, <https://www.ncbi.nlm.nih.gov/pubmed/25452492>). I continue to teach this course and recently starting teaching two lower division CUREs (MCDB 1171 and 2171, The Discovery Labs), which are two of the three CUREs now required of the nearly 400 incoming MCDB majors each year. My approach to teaching CUREs is to prepare students for experiences common to a PhD program in the life sciences including optimizing experiments, experiencing the failure associated with discovery, research presentations, attending lab meetings, and publically defending data. To further expand students' experiences in CUREs, I also organize a research symposium, which includes nearly 150 student research posters, five student speakers, and more than 500 total attendees (www.CUREsymposium.org). However, despite these efforts, the problem of limited support for independent research remains, and demand is increasing as more students express interest in continuing their research after taking a CURE. I am therefore proposing to mentor 8 students per semester in an independent study group. My experience in mentoring multiple students per semester from The Python Project has prepared me for the greater task of mentoring 8 students. A second aim of the next two semesters is to develop efficient methods for organizing a more intensive research experience including manuscript development during Summer 2018.

Learning outcomes for expanded CURE independent study:

1. Experience developing a research project in a less structured environment,
2. Obtain technical and analytical skills that build on those gained during participation in a CURE,
3. Improve communication skills through attendance and presentation in weekly lab meetings,
4. Develop an expanded scientific community at CU Boulder through attendance at departmental graduate student and faculty talks,
5. Present work in a poster session at the CURE Symposium in December or May,
6. Prepare a manuscript for submission to Journal of Scientific Inquiry, a journal for undergraduates launching in Fall 2017.