Student – Faculty/Manager Mentor Contract: BIOEN 4990 (BIOEN Research/Internship)

### Duties

**Student**
- Minimum of 200 actively engaged project hours
- Hours don’t include training time and are often spread over multiple semesters
- 80 hours minimum for 1 credit of BIOEN 4990 (may be repeated under BIOEN 4995)
- Approximately 6 hours/week (minimum)
- Be integrated into a research/design group
- Make weekly contact with faculty advisor/manager (or representative)
- Participate in lab/company culture including attending group meetings
- Become trained to perform experiments, simulations, device testing, or related tasks
- Conduct literature review for project
- Read key papers related to research project under guidance of research advisor/manager
- Be actively engaged in the research or design activity for the thesis project
  - Actively participate in experimental/engineering design
  - Conduct experiments, simulations, tests and/or designs
  - Apply statistics to experimentation
- Generate results for papers, posters, and presentations to be used in BIOEN 4991/4992
- Papers, posters, and presentations will be single author documents in BIOEN 4991/4992
- Students must not plagiarize, including other lab documents
- Material submitted for a grade in BIOEN 4991/4992 must be the student’s work product and should accurately reflect the student’s ability (i.e. mentor/manager will not write or edit the thesis)
- Create a project abstract that is approved by PI/Manager
  - **Submit an abstract describing the project when submitting the contract (250 words max)**
- Submit a 3-5 page research report to the Thesis course Primary Instructor (Heather Palmer) prior to enrolling in BIOEN 4991 (Thesis I). See assignment sheet for report requirements.

**Faculty Advisor/Manager**
- Act as a mentor for the student
  - Direct in development of a clearly defined thesis project
  - Meet regularly with student
  - Provide direct, regular feedback to student on his/her performance
  - Facilitate lab participation (e.g., be considerate of student’s class schedule)
- Provide instruction on bibliography generation
- Provide three papers to start literature research
- Instruct student on literature search methodologies
- Provide instruction on lab methodologies
- Involve student in experimental or engineering design of project
- Instruct on lab safety and appropriate methodologies for project
- Introduce appropriate statistical treatment of data and post-hoc analysis
- Provide limited review of project-relevant papers, posters, and presentations
- Papers, posters, and presentations will be single author documents in BIOEN 4991/4992
  - Remind students not to plagiarize lab documents
  - Material submitted to BIOEN 4991/4992 must be the student’s work product and accurately reflect the student’s ability (i.e. mentor/manager will not write or edit the thesis)
- Identify intellectual property concerns and develop an appropriate disclosure strategy
  - Student will publically present work in April of the year taking BIOEN 4992
  - The senior symposium in April is considered a public disclosure by USPTO standards

**Expectations**
- Student will contribute at least 80 hours for BIOEN 4990
- Student will contribute at least 200 hours toward completing thesis project
- Student will enhance lab/company community
- Student has no expectation to be paid for research hours (except in an internship setting in industry) but advisor is not restricted from paying the student

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I, the undersigned, hereby acknowledge that I have read and understand the advisor/manager expectations as well as the student expectations and will comply with them to the best of my ability. I also understand and verify that the project represented in the abstract is the student’s thesis project that will be used and presented in BIOEN 4991/4992.

**Advisor/Manager’s Name (Please Print):**

**Advisor/Manager’s Signature:**

**Advisor/Manager’s Email:**

**Graduate Student’s Name (if applicable):**

**Graduate Student’s Email:**

**Student (print):**

**Student Email:**

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Student – Faculty/Manager Mentor Contract: BIOEN 4990 (BIOEN Research/Internship)
BIOEN 4990, Bioengineering Research or Internship Abstract Assignment

Purpose/Background:

An abstract is an excellent tool to convey in writing the key points of your research or project done at your internship. It can be a very difficult document to write as every word must be carefully selected to convey the maximum amount of exclusively relevant information in a limited amount of words.

Assignment:

1. Because the abstract is a synopsis of your entire thesis project, it includes elements of your introduction/background, methods, results, and discussion of those results. It is important to include your hypothesis/method aim/design aim.

2. The length of abstract cannot exceed 250 words.

3. The abstract content must represent your actual thesis project.

4. The abstract content must be approved by your research professor/manager prior to being submitted to the course instructor. Planning an appropriate amount of time to receive abstract approval is essential to timely enrollment in BIOEN 4990. Revisions may be necessary prior to approval.

5. The abstract must be submitted in conjunction with research/internship project contract to the course instructor. The abstract will be used to determine your eligibility to enroll in BIOEN 4990. Similar to receiving approval from your research professor/manager, planning an appropriate amount of time to receive abstract approval from Heather Palmer is essential to timely enrollment in BIOEN 4990. Abstracts and contracts will not be accepted separately. Furthermore, abstracts and contracts will not be accepted later than 1 week prior to the beginning of the semester.
BIOEN 4990 Research/Design Report Assignment

Purpose: Eligibility for BIOEN 4201 (Thesis Writing and Communication I) is based on the content of this report. As you are aware, you need to meet two minimum requirements: 1) at least 200 hours of research on one project (this can be done as part of an internship) and 2) a completed research/internship project. The research/internship project may be done in conjunction with a graduate student or coworker, but you will EXCLUSIVELY focus on your personal contribution to the research/project. This paper is SINGLE AUTHOR (i.e. you).

Your eligibility will be determined by the results you include in this report. Please provide relevant tables, charts, and figures to demonstrate your findings.

Your audience for this report is a general, academic biomedical engineering reader. Your audience dictates much about the writerly choices you make.

This report is due by the last day of classes in the semester (the specific date will be communicated to you). Please use Microsoft Word, not pdf.

Please cover these 7 aspects as thoroughly as possible in 3-5 pages (1.5 or double spaced). Include headers to designate specific sections (e.g. Introduction, Methods, Results, Timeline). Note that the page limit does not include figures, charts, and tables (these can take as many pages as necessary beyond the 3-5):

1. Title and author: Use a title that balances the general area of the research with your specific contribution. A reader will decide whether or not to continue with a scientific article based on the title, so choice of words and phrasing is part of the effectiveness of the paper—be careful to make the title accessible and not unwieldy. Finally, this is a single-author paper, so only your name will appear in this area.

2. Introduction: Appropriately cover the global context as well as the project’s context. Be sure to include your hypothesis, design aim, or method aim. Any work that is not your own that is included here should be cited.

3. Methods: Include the materials used, describe the experimental method and the rationale behind why this method was used, and describe any data processing used (including statistical analysis). You may organize the methods according to subheadings. Provide sufficient detail to demonstrate that you followed a robust methodological approach.

4. Results: Include the relevant results derived from your methods. You need sufficient detail to allow your reader to fully understand your findings, but DO NOT interpret. You may organize the results section according to the relevant subheadings found in methods, but it isn’t required. You need sufficient detail to allow your reader to fully understand your findings. Also, include appropriate tables with useful titles and figures with useful captions, and relevant statistics.

5. In-text References: Cite any information pulled from primary literature according to IEEE Transactions on Biomedical Engineering.

6. Reference Section: Include 5-7 references. Cite in the text where applicable (this is most likely to come up in the background). Format according to IEEE Transactions on Biomedical Engineering.

The report format is submission style (i.e. single-column, 1.5 or double spaced, 10 or 12 pt., any professional font). However, provide your charts, tables and figures as near as possible to the text where you describe them. Also include a title and page numbers.

7. Timeline: If you are finished with your project, please simply indicate that you are done. If the results are preliminary, provide a detailed timeline (dates) of when you will have your results. The results must be collected, analyzed, and ready to report by October. The timeline will greatly determine whether or not you will be allowed to take BIOEN 4201.

Please refer to the grading rubric for more details on content areas.
<table>
<thead>
<tr>
<th>BIOEN 4990 Report Rubric</th>
<th>Comments</th>
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<tbody>
<tr>
<td><strong>Background:</strong></td>
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<tr>
<td>Global Context, Project Context, Research/Design/Method Statement, Strategy and Accomplishments</td>
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<td><strong>Methods:</strong></td>
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<td>Description of Materials, Experimental methods with rationale, and data processing, including statistics</td>
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<td><strong>Results:</strong></td>
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<td>Detailed description of findings or prospective findings from methodological approaches (qualitatively and quantitatively)</td>
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<td>Include data analysis and statistics (if available)</td>
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<td><strong>Timeline:</strong></td>
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<td>If results are preliminary, provide a timeline of major milestones</td>
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<td><strong>Structure and Organization</strong></td>
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<td>Logically ordered ideas, Flow, Transitions, Appropriate sign-posting and over-viewing (between sections), Clearly identifiable topic sentences, Balance</td>
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<td><strong>Supporting Material/References:</strong></td>
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<td>5-7 relevant references</td>
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<td>Consistent citation format</td>
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<td><strong>Overall written presentation quality:</strong></td>
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<td>Effectively communication to the intended audience (discourse community)</td>
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<td>Balance between concision and detail</td>
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<td>Definition of terms/abbreviations/symbols</td>
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Report Example:

Development of a Biodegradable Lipid Implant for Treatment of Choroido-Retinal Neovascularization

Marissa Record

Age related macular degeneration (AMD) is the leading cause of irreversible vision loss, affecting between 30 and 50 million people worldwide [1]. This is due in part to the choroidal neovascularization (CNV) that is associated with 10-20% of AMD cases [2]. CNV is a condition in which new blood vessel growth occurs from the choroid layer into the sub-retinal pigment epithelium (sub-RPE) or sub retinal space, through a breach in the Bruch membrane. This vasculature causes vision loss because it disrupts the layers of the retina. Fortunately, anti-vascular endothelial growth factor (anti-VEGF) drugs, like ranibzumab, are an effective treatment option for reducing the effects of CNV. Due to the chronic nature of CNV, patients affected with AMD have to be treated on a monthly basis with intra-vitreal injections of these anti-VEGF drugs. These injections are not only painful but pose risks of infection and tissue damage to patients. A small biodegradable sustained-release implant that delivers anti-angiogenic drugs for at least 6 months would be a solution that could help many patients with AMD.

A suitable animal model for CNV that could be used for trial implants is needed for the development of a biodegradable implant. Currently, mice and rats have been proven to be reliable CNV models, however, they are not suitable for ocular drug delivery due to their small size. Although rabbits have typically been used for testing of intraocular lenses there is not a reliable model of persistent CNV in rabbits [3, 4]. To create a model vascular endothelial growth factor (VEGF) genes were delivered through sub-retinal injections of adeno-associated virus (AAV) into rabbit eyes. This induced CNV in the rabbit model, which is then monitored for over a month to demonstrate the progression of CNV. The results establish the rabbit eye as a suitable model of persistent CNV.

Next, we developed the material to use for the implant itself. We needed a material that would degrade naturally in the eye. The eye contains significant lipase activity, so a blend of lipids was chosen.
as the material for the implant [5-7]. Different blends of small chain triglycerides (SCTs) will have different degradation rates by the lipases in the eye. The design aim of this project is to develop an *ex vivo* model to determine the biodegradation rates of different SCT blends in the conditions of the eye. This will allow us to create an implant that we can manipulate to degrade at a precisely known rate. This implant will help thousands avoid painful monthly injections and prevent further complications of their disease.

**Methods and Materials:**

**Study Design**

To create an *ex vivo* model to determine biodegradation rates of different lipid blends, it was necessary to determine whether lipase activity is maintained long-term in lens tissue after it is removed from the body. Human lens tissue samples were placed in an incubator at 37°C or kept at room temperature over the course of a month. Two controls of Bovine Serum Solution were kept in the same conditions as the tissue. Samples of the tissues and controls kept at both temperatures were taken once a week for four weeks. Once all the samples had been collected, three assays of each of the samples were run and averaged to accurately determine lipase activity in each of the samples.

**Preparation of Lens Tissue**

Human lens tissue was collected in the form of cataracts removed during surgery and were kept at 4°C until time of use. Twelve cataracts were combined using a sonicator to create a homogenous lens tissue mixture. Samples of 15 mL of this tissue mixture was placed into 24 PCR tubes and half of the samples were placed in an incubator at 37°C, while the other half were kept at room temperature, approximately 23°C.
Methods of Measurement

75 μLs were collected from each sample at the same time each week and stored in at 4°C until the end of the trial when all of the samples had been collected. 50 μL of these samples were taken and mixed with 100 μL of the Lipase Assay Buffer from the BioVision Lipase Activity Colorimetric Assay Kit II. This assay, which detects differences by measuring absorbance at 412 nm, was then run measuring the lipase activity in each sample. A set of wells with known lipase concentrations was prepared from the kit and run at the same time.

Analysis of Data

The data was exported to excel for data processing. A standard curve was created using the data from the wells with known lipase concentrations. The sample data was then adjusted according to the standard curve and the lipase activity was calculated. Data are summarized as a mean lipase activity for each week of the trial with a standard deviation. We considered a decrease of less than 25% of lipase activity over the course of the month as sufficient for ex vivo model.

Results:

The analyzed data provided the following results.
The lipase activity was maintained over the course of a month at a reliable level. Neither the room or body temperature samples decreased more than 25% of their initial lipase activity.

**Timeline**

I have completed my research.

**References:**


Faculty/Manager Memorandum of Understanding

Thesis Writing and Communication I and II (BIOEN4991/4992) are the research writing and communication capstone experience for the undergraduates in the Biomedical Engineering BS degree in the Department of Bioengineering at the University of Utah. Prior to taking this course sequence, students have participated in health-related, data-driven research, and have completed a research project. The scope of the project can be broad or narrow, simple or robust, but the purpose of the project is to be mentored and learn research practice, data analysis, and making claims substantiated by results. Furthermore, the project can be performed as a component of a larger project, but the student may only make claims based on his or her own contribution to that work.

The deliverables of this course are as follows:

1. A single-author (the student), publishable-quality thesis paper,
2. A conference-quality research poster geared toward a generally educated biomedical engineering audience and shown at the annual Bioengineering Senior Research Symposium*,
3. A 15-minute, conference-quality scientific presentation given to an audience of peers, and
4. A 5-minute research presentation geared to a public, non-scientific audience that will be presented at the annual Bioengineering Senior Research Symposium in April.**

I understand that ______________________________ (student) will be using research done under my guidance for his/her Thesis Project. He/she has my permission to use this research in the ways outlined above.

Name:_______________________________________  Date:_________________________________

Signature: ____________________________________

*The student will meet with his/her advisor to receive an additional permission on the research poster prior to it being presented at the Symposium.

**If you have concerns about a public disclosure (for reasons of IP), it is possible for the student to meet the course requirements with a private, closed presentation to the course instructors.

Note: If you feel that presenting the research publically is acceptable but feel uncomfortable with the way your name or lab may be represented, there is no obligation to have yourself included on the poster as the research advisor or in the presentation. Please simply request that the student remove your name.