Course Syllabus
CH4721 – Research methods in Biomolecular Chemistry
College of Science and Arts
Spring 2014

Instructor Information
Instructor: Professor Thompson
Office Location: 510B Chem Sci
Telephone: Office – 906-487-3522
E-mail: thompson@mtu.edu *Put 'CH4721' in subject line*
Office Hours: 11am – 1pm MWF and by appointment

Course Identification
Course Number: CH4721
Course Name: Research methods in biomolecular chemistry
Course Location: 504 Chem Sci (Tuesday Labs)
215 Chem Sci (Thursday Presentations)
Class Times: Tues: 12-5 pm; Thur: 2 - 4 pm
Prerequisites: CH4710 (Biomolecular Chemistry I) and CH4222 (Bioanalytical Chemistry)
or CH4212 (Instrumental Analysis)

Course Description/Overview
The goal of the course is to introduce you to a variety of modern protein and nucleic acid techniques in a discovery-based manner. The course is divided into two parts: the first part will focus on the introduction of common biochemical techniques in a guided-inquiry format. In the second part, students will undertake a research project which will involve question formulation, project design, consultation of primary literature, execution of the project, and communication skills.

Course Resources
Course Website
- Course syllabus and detailed methods will be posted on the course website

Required Course Text
- Fundamentals of biochemistry by Voet, Voet, and Pratt, 3rd edition
Grading Scheme.

Grading System

<table>
<thead>
<tr>
<th>Letter Grade</th>
<th>Percentage</th>
<th>Grade points/credit</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>90% &amp; above</td>
<td>4.00</td>
<td>Excellent</td>
</tr>
<tr>
<td>AB</td>
<td>85% – 89%</td>
<td>3.50</td>
<td>Very good</td>
</tr>
<tr>
<td>B</td>
<td>80% – 84%</td>
<td>3.00</td>
<td>Good</td>
</tr>
<tr>
<td>BC</td>
<td>75% – 79%</td>
<td>2.50</td>
<td>Above average</td>
</tr>
<tr>
<td>C</td>
<td>70% – 74%</td>
<td>2.00</td>
<td>Average</td>
</tr>
<tr>
<td>CD</td>
<td>65% – 69%</td>
<td>1.50</td>
<td>Below average</td>
</tr>
<tr>
<td>D</td>
<td>60% - 64%</td>
<td>1.00</td>
<td>Inferior</td>
</tr>
<tr>
<td>F</td>
<td>59% and below</td>
<td>0.00</td>
<td>Failure</td>
</tr>
<tr>
<td>I</td>
<td>Incomplete; given only when a student is unable to complete a segment of the course because of circumstances beyond the student's control. A grade of incomplete may be given only when approved in writing by the department chair or school dean.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>Conditional, with no grade points per credit; given only when the student is at fault in failing to complete a minor segment of a course, but in the judgment of the instructor does not need to repeat the course. It must be made up within the next semester in residence or the grade becomes a failure (F). A (X) grade is computed into the grade point average as a (F) grade.</td>
<td></td>
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</tbody>
</table>

Grading Policy

Each lab experiment will be worth 100 points – 15% for pre-lab questions, 50% for lab performance and 35% for post-lab discussion and lab report.

Course Policies

You must conduct all the experiments. You are responsible for announcements made in class. Please be punctual; chronic lateness annoys fellow students and me.

University Policies

Academic regulations and procedures are governed by University policy. Academic dishonesty cases will be handled in accordance the University's policies.

If you have a disability that could affect your performance in this class or that requires an accommodation under the Americans with Disabilities Act, please see me as soon as possible so that we can make appropriate arrangements. The Affirmative Action Office has asked that you be made aware of the following:

*Michigan Tech complies with all federal and state laws and regulations regarding discrimination, including the Americans with Disabilities Act of 1990. If you have a disability and need a reasonable accommodation for equal access to education or services at Michigan Tech, please call the Dean of Students Office, at 487-2212. For other concerns about discrimination, you may contact your advisor, department head or the Affirmative Action Office, at 487-3310*
Academic Integrity:  
http://www.studentaffairs.mtu.edu/dean/judicial/policies/academic_integrity.html

Affirmative Action:  
http://www.admin.mtu.edu/aoa/

Disability Services:  
http://www.admin.mtu.edu/urel/studenthandbook/student_services.html#disability

## Course Outline

<table>
<thead>
<tr>
<th>Week</th>
<th>Experiment</th>
<th>Technique</th>
<th>Concepts</th>
<th>Lecture</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction; check-in; E-1: Pipette calibration</td>
<td>Mass of a defined volume of liquid</td>
<td>Calibration, precision, and accuracy</td>
<td>Introduction</td>
</tr>
<tr>
<td>2A</td>
<td>PCR reaction</td>
<td>PCR reactions at varying temperatures and Mg$^{2+}$ conc</td>
<td>Principles of PCR reactions</td>
<td>Introduction, Results and Discussion</td>
</tr>
<tr>
<td>2B</td>
<td>Separation of DNA from PCR</td>
<td>Agarose gel electrophoresis, Analysis of PCR products</td>
<td>Principles of DNA separation</td>
<td></td>
</tr>
<tr>
<td>3A</td>
<td>Sequence-specific cleavage of DNA with restriction endonucleases</td>
<td>Cleavage of plasmids with restriction endonucleases and analysis of products</td>
<td>Principles of sequence-specific cleavage of DNA</td>
<td>Introduction, Results and Discussion</td>
</tr>
<tr>
<td>3B</td>
<td>Separation of DNA from endonuclease cleavage</td>
<td>Agarose gel electrophoresis, Analysis of restriction enzyme cleavage products</td>
<td>Principles of DNA separation, effect of DNA size &amp; structure (linear, supercoiled, circular) on migration</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Biological database use</td>
<td>Introduce NCBI, Biology Workbench databases; employ search and analysis programs</td>
<td>Database searches and use of software such as BLAST, CLUSTLW</td>
<td>Introduction of research projects</td>
</tr>
<tr>
<td>5</td>
<td>Protein separation</td>
<td>SDS PAGE</td>
<td>Principles of protein separation; estimation of molar mass; subunit structure; role of disulfide bonds in quaternary structure</td>
<td>No class</td>
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<tr>
<td>6,7</td>
<td>Enzyme extraction and purification</td>
<td>Centrifugation, ammonium sulfate precipitation, dialysis</td>
<td>Principles of ammonium sulfate precipitation; dialysis; chromatography; specific activity; purification table</td>
<td>Introduction, Results and Discussion</td>
</tr>
<tr>
<td>8</td>
<td>Enzyme kinetics and inhibition</td>
<td>Enzyme activity assays with and without inhibitors</td>
<td>Michaelis-Menten kinetics; different graphical representations; calculation of Km and Vmax, analysis of inhibitors</td>
<td>Introduction, Results and Discussion</td>
</tr>
<tr>
<td>9</td>
<td>Spring Break</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Activation energies of enzyme-catalyzed and acid-catalyzed reactions</td>
<td>Monitor enzyme-catalyzed and uncatalyzed reactions at different temperatures</td>
<td>Role of activation energy in enzyme catalysis</td>
<td>Introduction, Results and Discussion</td>
</tr>
<tr>
<td>11-15</td>
<td>Original research projects - define a problem and design experiments</td>
<td>Combination of above techniques</td>
<td>Experience in defining problem, designing an experimental plan, execution of plan, analysis and interpretation of data</td>
<td>x</td>
</tr>
<tr>
<td>16</td>
<td>(Finals Week)</td>
<td>x</td>
<td>x</td>
<td>Present final research project results</td>
</tr>
</tbody>
</table>
Laboratory Reports:

The lab report should consist of the following sections: title, abstract, introduction, materials and methods, results, discussion, conclusion and references. The short lab reports should be about 4-5 pages long and the research report about 7-8 pages.

Abstract (Brief summary of the paper):

- Should be viewed as a mini-version of the paper.
- Should provide a brief summary of each of the main sections of the paper: Introduction, Material and Methods, Results and discussion.
- The Abstract should (1) state the principle objectives and scope of the investigation, (2) describe the methods employed, (3) summarize the results, and (4) state the principle conclusion.
- Brevity is very important
- The Abstracts should be written in the past tense

II. Introduction (What do you intend to do? What is the "Question" that you are setting out to answer?):

- Present the nature and scope of the problem investigated
- Review the pertinent literature to orient the reader
- Highlight unique features
- Explain principles underlying the experiment - present structures and equations
- Do not break up paragraphs to insert figures.
- Do not leave blank white space in your report. If you need to insert multiple figures in the same page, group figures at the top or at the bottom.
- The introduction should be written in the present tense.

III. Material and Methods (How did you do the experiment to answer the "Question"?):

- Describe the experimental details in a short paragraph since the procedure has been provided to you. Outline the key steps of the experiment.
- Describe any deviations you made from the procedure suggested
- Describe any mistakes made during the experiment
- Provide sufficient detail so that others can repeat the experiment from the same written source (procedure from the instructor) and your comments
- This section should be written in the past tense
IV. Results (What information did you generate in the lab? What is the best way to present the data to answer your “Question”?)

- This is the core of the report. Present all your data here – even if you think it is not correct
- There are two parts to presenting the results: first provide the overall description of the experiment – the “question” you propose to answer by doing a particular experiment (don’t repeat the experimental details previously provided), then, present the data
- Give thought to how best to present the data – graphs? tables? figures? Present raw data in an Appendix.
- Include data generated by other members of your group
- Although the results section is the most important part of the paper, it does not have to be the longest
- Graphs, tables and figures should have a title, should be properly labeled, and graphs and figures should have a legend
- Results should be clearly and simply stated
- Insert graphs, tables and figures at appropriate places in the text, close to when you first refer to them, preferably at the end of the paragraph
- This section should be written in the past tense

V. Discussion* (What do you think the data in Results mean?)

- Present what you think the data in the Results section are telling you. In other words, interpret and discuss your results
- Present principles, relationships and generalizations shown by Results
- Point out experimental mistakes that prevent you from drawing conclusions
- Point out any exceptions and lack of correlations
- The discussion should be written in the present tense

VI. Conclusions (Summarize in a few words the following: What is the answer to the “Question” you set out to answer?)

- Clearly articulate the answer to your “Question” as briefly as possible.
- Recap only the salient points

VII. References

Follow the format used in the Physical Chemistry Laboratory.
http://www.chemistry.mtu.edu/~kmsmith/PChem/MiscInfo/BCFormat.pdf

*The Results and Discussion sections can sometimes be combined if the later results can be better explained by a more complete discussion of the earlier data.
1. “Calibration of Pipettes”
   ➢ 01/14/2014
   Group 1 - Cody & Luke
   Group 2 - Yuqing & Tyler
   Group 3 - Katherine & Rayah
   Group 4 - Mike, Audra, & Courtney

2. “Polymerase Chain Reaction & Separation of DNA”
   ➢ 01/21/2014
   Group 1 - Audra & Yuqing*
   Group 2 - Mike & Cody
   Group 3 - Katherine & Courtney
   Group 4 - Luke, Tyler, & Rayah

3. “Enzymatic Digestion of DNA”
   ➢ 01/28/2014
   Group 1 - Rayah & Mike*
   Group 2 - Courtney & Luke
   Group 3 - Audra & Tyler
   Group 4 - Katherine, Cody, & Yuqing

4. “Introduction to Databases”
   ➢ 02/04/2014
   No Partners

5. “SDS-PAGE”
   ➢ 02/11/2014
   Group 1 - Tyler & Katherine*
   Group 2 - Audra & Rayah
   Group 3 - Yuqing & Courtney
   Group 4 - Mike, Luke, & Cody

6. “Purification of Polyphenol Oxidase from Fruits and Vegetables”
   ➢ 02/18/2014 - 02/25/2014
   Group 1 - Luke & Rayah*
   Group 2 - Cody & Tyler
   Group 3 - Mike & Yuqing
   Group 4 - Audra, Katherine, Courtney
7. “Enzyme Kinetics & Inhibition”
   ▶ 03/04/2014
   Group 1- Cody & Courtney*
   Group 2- Katherine & Mike
   Group 3- Audra & Luke
   Group 4- Tyler, Rayah, Yuqing

   ▶ 03/18/2014
   Group 1- Audra & Mike*
   Group 2- Yuqing & Katherine
   Group 3- Rayah & Cody
   Group 4- Luke, Courtney, Tyler

*Group one is responsible for introductions during presentations