Course Syllabus

Course Description: Laboratory exercises dealing with the chemical properties of food components and changes they undergo in processing and storage. Relationships between the chemical composition of foods and functional, nutritional, and sensory properties are stressed. Laboratory techniques commonly used in food research are introduced. A laboratory research project is required. This involves writing a research proposal for the project, conducting laboratory research to test hypotheses described in the proposal, analyzing the data, and writing a paper following the format used by the Journal of Food Science. 2 credits. Thursday 12:20-4:25

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Teaching Assistants: Rachel Miller (ram524), Office: 352 Stocking
Larissa Vieira Di Marzo (lv98), Office: 281 Stocking

Teaching Support Specialist: Aaron Jacobsen (aj425), Office: 262 Stocking

Prerequisites: Food Chemistry (FDSC 4170) or Biochemistry (BIOBM 3300 or 3310 or CHEM 1570 or equivalent)

Academic Integrity: Each student in this course is expected to understand and abide by the Cornell University Code of Academic Integrity (http://cuinfo.cornell.edu/Academic/AIC.html). The following is a quote from the CU Code of Academic Integrity: “A Cornell student's submission of work for academic credit indicates that the work is the student's own. All outside assistance should be acknowledged, and the student's academic position truthfully reported at all times.” This course will involve individual and group work. Students will work together in pairs during the lab sessions. The lab report must be written individually (each student will write his or her own lab report) and must include an acknowledgement of the lab partner’s assistance in conducting the experiment. The pre-proposal, the proposal, the research project report, and the oral presentation are group efforts and students may share the work in preparing them. All papers, books, web sites, etc. used for writing reports and proposals and for oral presentations must be properly cited in the reference section.

Goal for the course

The overall goal of this course is to enhance students’ understanding of food chemistry principles through inquiry-based laboratory exercises and a student-designed research project.

A. Learning Outcomes

Students completing this course should be able to:

- Design and conduct laboratory experiments in food chemistry with little supervision.
- Demonstrate good laboratory skills in the following practices:
  - Preparing solutions
• Pipette liquids with good accuracy and precision
• Operating pH meters, spectrophotometers, analytical balances, and other common laboratory equipment
• Following good lab safety procedures
• Maintaining a proper lab notebook

• Search the food science literature using electronic databases.
• Write a research proposal that includes a literature review, a clear statement of objectives and/or hypotheses to be tested, a concise rationale and significance section, a methods section in sufficient detail to allow someone with a chemistry background to conduct the experiments described, a section describing data analysis, and a reference section.
• Analyze and interpret data and discuss results in the context of past knowledge on the topic.
• Write a lab report following the format and style used in the Journal of Food Science.
• Understand concepts and principles and apply current knowledge in the following areas:
  o Chemical leavening
  o Hydrolytic rancidity
  o Enzymatic and nonenzymatic browning
  o Food hydrocolloids
  o Food proteins
  o Enzyme kinetics
  o Food pigments (plant, animal, and synthetic)
  o Lipid peroxidation
  o Vitamin stability
• Solve practical problems in the food industry.

B. Tools used for assessment of learning outcomes
• Weekly quizzes (these are designed to test students’ understanding of and preparation for the lab exercise for the day as well as their understanding of the previous week’s lab).
• Lab discussions. Each week, one pair of students (lab partners) leads a discussion on the previous week’s lab exercise. This involves a power point presentation of their results and an interpretation of the data. They must be prepared to answer questions about the procedure, underlying principles involved, and their own results.
• Informal explanations of procedures and principles involved with lab exercises (during labs, the instructor asks students to explain what they are doing and why).
• Lab reports. Students are required to turn in 1 “full” lab report during the semester. This report will be written in the format of the Journal of Food Science.
• Research proposal. Students are required to write a research proposal for the independent research project they conduct during the final 4 weeks of the semester.
• Final presentation on the research project. In lieu of a final exam, students make oral presentations on their independent research project. The format of this is patterned after the oral presentations given in technical sessions at IFT annual meetings.
<table>
<thead>
<tr>
<th>Lab No./Date</th>
<th>Due Dates</th>
<th>Experiment Title</th>
<th>Instructor</th>
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<tbody>
<tr>
<td>1. Aug 29</td>
<td></td>
<td>Chemical Leavening Agents</td>
<td>Miller &amp; Miller</td>
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<tr>
<td>2. Sept 5</td>
<td></td>
<td>Properties of Sugars/Non-enzymatic Browning</td>
<td>Lee &amp; Marzo</td>
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<tr>
<td>3. Sept 12</td>
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<td>Meat Pigments*</td>
<td>Miller &amp; Miller</td>
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<tr>
<td>4. Sept 19</td>
<td>Pre-proposal</td>
<td>Functional Properties of Proteins</td>
<td>Lee &amp; Marzo</td>
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<tr>
<td>5. Sept 26</td>
<td>Lab report on meat pigments</td>
<td>Enzymatic Browning: Kinetics of Polyphenoloxidase</td>
<td>Miller &amp; Miller</td>
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<tr>
<td>6. Oct 3</td>
<td></td>
<td>Ascorbic Acid: Stability and Leachability</td>
<td>Lee &amp; Marzo</td>
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<tr>
<td>7. Oct 10</td>
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<td>Lipid Peroxidation</td>
<td>Miller &amp; Miller</td>
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<td>8. Oct 17</td>
<td></td>
<td>Food Hydrocolloids</td>
<td>Lee &amp; Marzo</td>
</tr>
<tr>
<td>9. Oct 24</td>
<td>Proposal</td>
<td>Hydrolytic Rancidity in Milk</td>
<td>Miller &amp; Miller</td>
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<td>Nov 7</td>
<td></td>
<td>Research Project</td>
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<td>Nov 14</td>
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<td>Research Project</td>
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<td>Nov 21</td>
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<td>Research Project</td>
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<td>Nov 28</td>
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<td>Thanksgiving, no class</td>
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<tr>
<td>Dec 5</td>
<td>Project report*</td>
<td>Research Project</td>
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<tr>
<td>Dec. 18</td>
<td>Final presentation</td>
<td>Oral presentation on research project</td>
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*Full lab report required for this lab exercise.
Requirements and Guidelines

A. Course Requirements

1. **Attendance.** Please make every effort to attend all laboratory sessions. Make-up sessions require a lot of extra work for the teaching staff.

2. **Laboratory participation.** All students are expected to contribute their fair share during the lab session. Students may work together with partners but everyone must understand what is going on.

3. **Lab notebook.** Each student must maintain a lab notebook (see below).

4. **Laboratory Technique.** Good laboratory technique is extremely important for success in this class. Poor technique often results in a failed experiment. Students must show their data to one of the teaching staff before leaving the lab for the day. If the data is suspect, students may be asked to repeat the experiment.

5. **Formal lab reports.** Written lab reports on 1 experiment (Hydrolytic Rancidity in Milk) and the research project are required. Please follow the Journal of Food Science guidelines for both papers. These guidelines are available at the following link under “Preparing Your Manuscript”: [http://www.ift.org/Knowledge-Center/Read-IFT-Publications/Journal-of-Food-Science/Authors-Corner/JFS-Author-Guidelines-2013.aspx#PreparingManuscript](http://www.ift.org/Knowledge-Center/Read-IFT-Publications/Journal-of-Food-Science/Authors-Corner/JFS-Author-Guidelines-2013.aspx#PreparingManuscript) You should use the JFS Template for the format of your paper and the author guidelines for the proper format for references. **The report on the experiment must be written individually. The research project report should be done jointly, i.e. one report from each group.**

6. **Data summary and analysis reports.** On those weeks when a formal lab report is not required, a one to two page summary of the lab experiment is required. This should include the title of the experiment, a summary of the data gathered including examples of calculations performed (tables and graphs are encouraged whenever appropriate), and a statement of the main conclusions drawn from the data. This is due on the Thursday following the experiment.

7. **Quizzes.** Each week there will be a short written quiz. Quiz questions will pertain to the current week's lab exercise as well as the exercise conducted the previous week.

8. **Class Discussion of Previous Week's Lab.** Each week, one group (chosen by lottery) will lead a class discussion of the previous week's lab exercise. This will involve a presentation and discussion of results of the experiment.

9. **Final exam.** The final exam will consist of an oral presentation on the research project. The members of each group will work together on the presentation. The presentation must include an introduction (including some background information), a statement of the hypothesis, an explanation of the rationale and experimental approach, a description of the experimental protocol, a summary of the results, and a recommendation for solving the problem. The presentation must be delivered using PowerPoint. It will be held during the scheduled final exam period. All members of the class must be present for all presentations.
B. Laboratory Sessions

1. Be prepared for each lab session:
   a. Read the lab exercise and work the problems in the problem set before coming to lab. Be sure you understand what you are to do. If in doubt, ask questions before beginning the experiment.
   b. Do any necessary calculations in advance (e.g. for preparing solutions).
   c. Set up tables in your lab notebook for recording results.
   d. Have a work plan in mind before you come to lab.

2. Record all observations in your lab notebook as you go along. For most experiments in this class there should be good agreement between sample replicates. When there is not good agreement, repeat the measurement.

3. Keep your bench area clean and neat.

4. Do not contaminate reagents. NEVER PUT A PIPET IN A REAGENT BOTTLE. Always pour some into a labeled beaker or flask and pipette from it.

C. Laboratory Rules and Safety Precautions

1. **Safety Glasses.** WEAR SAFETY GLASSES AT ALL TIMES. Failure to do so will result in a warning for the first offense and loss of points for subsequent offenses. **Do not wear contacts in the lab.**

2. **Safety Devices.** Be certain you know the location of the eye wash station, the fire extinguishers, the fire blanket, the safety shower, and the fire alarm box.

3. **Pipetting.** Choose the appropriate pipettor for each experiment. Never pipet anything by mouth.

4. **Food.** No eating or drinking in the lab.

5. **Smoking.** No smoking in the lab.

6. **Labeling.** Label all tubes, beakers, flasks, etc. as follows:

   Name of Substance
   Solvent (If a solution)
   Concentration
   Your Initials

7. **Waste disposal.** Discard all materials as soon as you have finished with them. Unless advised otherwise do not dispose of wastes in the drains. Waste containers will be placed in the hoods for your use and will be labeled appropriately. Be certain that your waste goes into the proper container.

8. **Hazardous chemicals.** Treat all chemicals with respect. Know the hazards associated
with the chemicals you use. Take appropriate safety precautions. When in doubt about the hazards of a chemical, consult the Material Safety Data Sheet (MSDS) for the chemical. These sheets may be found on websites of chemical suppliers such as Fisher Scientific or the Canadian Center for Occupational Health and Safety at http://ccinfoweb.ccohs.ca/msds/search.html

D. Cleanup

1. **Glassware.** Transfer all hazardous waste or waste not allowed in drains to the designated waste bottles in the hood. Rinse all used glassware thoroughly and place in the dishwasher racks before leaving the lab.

2. **Benchtop.** Use a sponge to wipe down your bench before leaving.

E. Laboratory Notebooks

1. **General Information.** Each student must maintain a laboratory notebook. Careful recording of experimental procedures and results is essential. Record all observations. Do not leave anything to memory. Failure to record an observation can lead to frustration and time-consuming repetition of experiments.
   
   a. You will need a notebook suitable for use as a lab notebook. Spiral bound notebooks are recommended.
   b. It is wise to leave a few pages blank at the beginning of the notebook for a table of contents.
   c. Label the notebook with your name and a general title.
   d. Number the pages and date them as you make data entries.

2. **Guidelines for Keeping Lab Notebook.**

   **Prior to Lab**
   a. Include title and number of the experiment.
   b. Briefly summarize the objectives of the experiment.
   c. Perform any calculations that can be done in advance.
   d. Sketch a brief flow diagram or step-by-step protocol that you can follow during lab.

   **During Lab**
   a. Carefully record all observations and data you collect.
   b. Complete all calculations in your notebook.
   c. Write the date on the top of each page.
   d. Clearly label all tables, graphs, calculations, etc.
   e. Before posting your data on the board and before cleaning up, ask a member of the teaching staff to check your notebook. If your data is not in reasonable agreement with results obtained during pre-testing by the staff, you may be asked to repeat an experiment.

F. Guidelines for Laboratory Discussion
Each week, one group will lead a discussion of the previous week’s laboratory exercise. The purpose of this is to give students experience with presenting scientific information to a group of peers and to enhance everyone's understanding of the laboratory exercises. Please adhere to the following guidelines for the discussion.

Prepare a short oral presentation (10 minutes maximum).

1. The presentation should include the following:
   - Objectives of the experiment (briefly stated)
   - Experimental approach (one or two sentences, refer audience to lab manual for details)
   - Results (prepare PowerPoint slides which concisely summarize the results)

2. Discussion. Discuss the results, include the following:
   - What do the results show? What do they mean?
   - Were the results expected? If not, what is a possible explanation?
   - Was there good agreement between groups? If not, what is a possible explanation?
   - Conclusions.

G. Format for Written Laboratory Reports.

Two (2) lab reports are required. Please do a careful and thorough job on them. Reports must be typed (double-spaced) on 8 1/2 x 11 paper. They should be written in the style of a scientific research paper. Please follow the template provided on the IFT website under Journal of Food Science Author Information, “manuscript template”: [http://www.ift.org/Knowledge-Center/Read-IFT-Publications/Journal-of-Food-Science/Authors-Corner/~/media/Knowledge%20Center/Publications/IFT_SciJournals_ManuscriptTemplate2013.doc](http://www.ift.org/Knowledge-Center/Read-IFT-Publications/Journal-of-Food-Science/Authors-Corner/~/media/Knowledge%20Center/Publications/IFT_SciJournals_ManuscriptTemplate2013.doc)

Briefly, the format should be as follows:

1. Title page: Include the title of your paper, your name and the name of your lab partner, and your complete address, including email address. Also include a short version of the title for your paper.

2. Abstract page: This should be a concise summary stating the objectives of your experiment, the methods you used, your major results, and your conclusions. The abstract should be 250 words or less. Include 5 key words on this page.

3. Introduction: The introduction should include a brief review of the literature pertinent to your project, a discussion of the importance of your project, and the objectives of the project. Cite key references. It should be no more than 2 pages, double spaced.

4. Materials and methods: This should be a description of all material and methods you used in your experiment. It should be sufficiently detailed so that any knowledgeable food scientist could repeat your work from the information in this section.

5. Results and discussion: Describe your results concisely in text form and include tables and graphs showing your results. Discuss your results: Do your results agree with results from similar experiments reported in the literature? What is new and unique about your results? Do your results support your hypothesis? If not, give a possible explanation. What further work is needed to extend your findings?
6. Conclusions: State your main conclusion or conclusions clearly and concisely. This is not a summary, rather it is a statement of one or two conclusions you can draw from your results.

7. References: List all references cited in your paper. See the IFT website or a recent paper from the Journal of Food Science for details on the format for citing references in the texts and for listing them in the Reference section. Examples:


H. Guidelines for Preparing Tables and Figures

1. **Tables.** Number all tables and include a concise caption at the top of the table. Clearly label each column and row. Include units. Use footnotes where appropriate. An example table (Table 1) is shown below. See the Journal of Food Science or similar journals for other examples.

   Table 1. Absorbances of cornstarch and Polydextrose solutions following incubation with either active or inactive alpha-amylase and reaction with the ferricyanide reagent. Values are means ± standard deviations; n=2.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Treatment (active or inactive amylase)</th>
<th>Absorbance (418 nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starch (^1)</td>
<td>Active</td>
<td>0.25 ± 0.02</td>
</tr>
<tr>
<td>Starch (^1)</td>
<td>Inactive</td>
<td>0.68 ± 0.06</td>
</tr>
<tr>
<td>Polydextrose (^2)</td>
<td>Active</td>
<td>0.63 ± 0.07</td>
</tr>
<tr>
<td>Polydextrose (^2)</td>
<td>Inactive</td>
<td>0.64 ± 0.05</td>
</tr>
</tbody>
</table>

\(^1\) Each starch tube contained a total of 0.3 mg starch.
\(^2\) Each Polydextrose tube contained a total of 0.336 mg Polydextrose

2. **Figures.** Number all figures and include a caption at the bottom of the figure. Use symbols to distinguish between treatments, etc. When space is available, put the key to the symbols on the graph, not in the caption. Label both axes clearly and include units. See figure 1 and journal articles for examples.
Figure 1. Effect of diet and iron loading on liver nonheme iron concentration in swine. Iron loading was achieved by injecting 30 mg iron for every kilogram gain in weight. Diets contained equivalent iron concentrations but varying iron bioavailability. Values are means ± SEM; n = 6. Bars with no subscript letters in common are significantly different (P < 0.05). Abbreviations used for diets: NHI, Nonheme iron; NHI/M, Nonheme iron with meat; HI, Heme iron.

**Research Project**

Learning outcomes for this project are to develop problem solving and critical thinking skills.

Food scientists are often asked to troubleshoot and solve problems that may arise in food products as a result of processing conditions, ingredient problems, storage abuse, etc. This may require a literature search, hypothesis generation, research project design, laboratory experimentation, and data analysis. This project is designed to give students experience in solving real-world problems that may occur in the food industry. This will involve the following:

- Choose a problem to solve. This could be one of the problems described below, a problem you may have noticed in a food product you purchased, or a problem you encountered while working on an internship.
- Conduct a literature search. You will use various electronic data bases, text books, and other sources to find information related to your problem.
- Develop a hypothesis. This is basically the diagnosis of the problem.
- Write a research proposal. This will include a description of the problem, a literature review, a statement of your hypothesis, and a design of an experiment to test the hypothesis.
- Conduct the experiment you proposed in your proposal.
- Write a research report on the work you did to test your hypothesis.
- Prepare and deliver a PowerPoint presentation on your project.
Guidelines for the Project

Project Proposal

Planning is crucial to successful research projects. Therefore, a written proposal describing your project is required. Please observe the following guidelines when writing your proposal.

1. Identification of a Researchable Problem

Problems to Solve:

1. The potato chips coming off a line in a small potato chip plant in mid December had an excessive number of very dark, almost black, chips. The plant manager checked the processing conditions, ingredients (oil used in the deep fryer and the potatoes) and everything else she could think of. The oil was from the same lot they had been using all along. The plant had its own potato warehouse on the premises and had been sourcing potatoes from this warehouse ever since the harvest in late September. All the potatoes in the warehouse were the same variety and had been harvested at approximately the same time in September. They had been producing potato chips almost continuously since the harvest. What caused the rather sudden appearance of the excessively dark chips in this plant?

2. Soy-based drinks are becoming very popular. A food company, which has a successful milk protein (mainly casein)-based drink, is interested in creating a new soy protein-based beverage. The company is planning to simply substitute soy protein for casein while maintaining the same protein content per serving. However, since casein is a good source of dietary calcium and soy protein is not, the company decided to fortify their new soy beverage with calcium. When they did this, however, the viscosity of the beverage increased to unacceptable levels. What is the likely cause of this increase in viscosity? What could be done to prevent this viscosity increase when fortifying with calcium?

3. The marketing department of a small green tea manufacturing company is aware of the inhibitory effects of tea on iron bioavailability. They decided to try to overcome this potential negative for their product by fortifying their tea with iron. The product development department went to work and added ferric citrate to the tea leaves that were later packaged in tea bags. The problem was that the “green tea” turned out to be blue-black in color when they put the tea bags in boiling water. What is the explanation for this color change? What might the company do to prevent this dark color while still fortifying the tea with iron?

4. You work for a company that manufacturers a range of soy products. A customer has requested that you provide assurance that your processing operations inactivate at least 99% of the soybean trypsin inhibitor present in your products. You are asked to develop an assay for soybean trypsin inhibitor and use it to test your products.

5. An age-old problem faced by bakers of fine breads is staling – day-old bread is rarely as good as it was the day it was baked. You are working for a small up-scale bakery that specializes in French bread. Your task is to choose an anti-staling agent that will extend the shelf-life of the bread out to at least 3 days and to provide evidence that the agent you choose is indeed effective.
6. You work for a company that manufactures jelly beans. They use “thin boiling” starch in their products to enhance the strength of the gel. Recently, they have been unhappy with the quality of the thin boiling starch they get from a supplier. Therefore, they have given you the task of preparing, in house, a thin boiling starch from ordinary corn starch which is readily available. Your task is to devise a protocol for making this thin boiling starch, adapting a method for measuring the dextrose equivalency of the starch, and characterizing the thin boiling starch you make.

7. An article in the July 18, 2009 issue of NewScientist (http://www.newscientist.com/article/mg20327171.200-the-calorie-delusion-why-food-labels-are-wrong.html?full=true) (accessed July, 2009) argues that the calorie values on food labels are inaccurate due to a failure to account for the effects of processing and cooking on digestibility and the energy required to chew and digest the food. You company wants to be sure the calorie values on its Nutrition Facts panels are accurate. Therefore, the management asks you to determine the effects of processing and cooking on the digestibility of starch or protein in the following products: wheat porridge, ground beef, potato flakes (compared to raw potatoes), and bread. Your task is to select appropriate methods for assessing digestibility and then to apply these methods to study the effects of processing and/or cooking on one of the products listed above.

8. Thermal processing (canning) exposes low acid foods to high temperatures for a long time that results in a decrease of the vitamin contents. However, some of previous reports** on vitamin A value of canned products showed that the vitamin A value (content of provitamin A carotenoids) of some vegetables such as carrots and green peas increased after canning. What are the possible reasons for this unusual result? Show the reason(s) by a simple experiment. **Food Technol. 1962, 16(8): 91; J. Inst. Can. Technol. 1970, 3(4):145; & USDA Handbook 8)

9. A juice company has been producing apple juice for many years. In order to expand the business, the company decided to produce concentrated juice with added ascorbic acid. The amount of ascorbic acid added to concentrated juice before processing was about five times the ascorbic acid in single strength juice needed to meet the RDA (90 mg/d) after dilution. However, a few months later, the company was forced to recall the concentrated juice product because they found that the concentrated juice turned brown. What are the possible causes of this discoloration? Can you prove the cause with a simple experiment?

Once you have selected your problem, write a brief preproposal for your project. This should include the following: 1. Project Title, 2. A statement of the question you plan to answer or the problem you plan to solve. 3. A brief description of experimental protocols you might use in the project (attach at least one research paper from the primary literature describing an experiment similar to the one you plan to do), 4. A short justification of your choice, i.e. why is your project significant? Turn this in to Dr. Miller on or before Sept 19,2013.

II. Proposal Guidelines

Once your preproposal has been approved, the next step is to write a full proposal for your project. Please adhere to the following guidelines when writing your proposal.

A. Project Title

Choose a title that gives a clear indication of the nature of your project.
B. Literature Review

1. The purpose of the literature review is to find out what has already been done on the topic. This will involve doing some library research. Make use of the data bases such as Food Science and Technology Abstracts on the Mann Library Gateway when conducting your search. Sometimes it is helpful to read a review article on your topic before going to more detailed and specific research papers. You must, however, include references to papers from research journals in your literature review. Cite at least 5 papers in your review.

2. Write a summary of the literature you reviewed. This should be about 2 to 5 double-spaced pages and must be carefully referenced. It should be a synthesis of the previous work, not simply a series of summaries of individual papers.

C. Specific Objective(s).

This should be a concise statement of the objectives of your project.

D. Rationale and Significance

1. Explain the rationale or hypothesis underlying your proposed experiment. For example, you may hypothesize that ascorbic acid retention is greater in baked compared to boiled potatoes. The rationale may be that cooking in water results in significant leaching of the ascorbic acid or dissolved oxygen in the water accelerates oxidation of the ascorbic acid.

2. Explain why your proposed experiment is significant. Will the answer to your question provide support for solving the problem you identified? Will it add to our current understanding of the chemical behavior of a particular food ingredient?

E. Experimental Protocol

1. Write a detailed, step-by-step protocol for the experiment you will conduct to answer your question. Include a list of all chemicals, solutions, glassware, instruments, etc. that you will need to conduct the experiment.

2. Carefully explain the principles underlying the experimental methods and techniques you plan to use.

3. Describe how you will analyze your data. Include example calculations and statistical techniques you will use.

F. References

Please follow the format used by the Journal of Food Science for citing references.

\textbf{The proposal is due Oct. 17, 2013.}

III. Experimental Work

After receiving approval of your proposal by the teaching staff, carry out the experimental work you planned. Please plan to do you lab work during regularly scheduled laboratory sessions. If you will need additional time, please see a member of the teaching staff.
IV. Project Report

After you have completed your experimental work, analyze your data as a group and write a report describing your results. Please follow the format for writing lab reports described in the “Requirements and Guidelines” section.

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<thead>
<tr>
<th>Research Project Deadlines</th>
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<tbody>
<tr>
<td>Assignment</td>
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<tr>
<td>Research Project Pre-proposal</td>
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<tr>
<td>Oral Presentation</td>
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Grading System

Final grades will be based on the overall percentage score for all graded assignments, quizzes, and exams. The following table outlines the relative weights of each category.

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<thead>
<tr>
<th>Basis for Final Grade</th>
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<tr>
<td>Relative weight (%)</td>
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<tr>
<td>Category</td>
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<tr>
<td>Quizzes</td>
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<td>Problem Sets</td>
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<td>Discussion presentations</td>
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<tr>
<td>Data Summary and Analysis Reports</td>
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<tr>
<td>Lab report (Enzymatic Browning)</td>
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<tr>
<td>Research project proposal</td>
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<td>Oral Presentation</td>
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Final grades for the course will be determined as follows (based on overall percentage score):

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<th></th>
<th>A+</th>
<th>98 and up</th>
<th>B+</th>
<th>88-89</th>
<th>C+</th>
<th>80-81</th>
<th>D+</th>
<th>70-71</th>
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<tr>
<td>A</td>
<td>94-97</td>
<td>B</td>
<td>85-87</td>
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<td>D</td>
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<td>A-</td>
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<td>82-84</td>
<td>C-</td>
<td>72-74</td>
<td>D-</td>
<td>60-64</td>
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</table>

Borderlines separating letter grades may be adjusted downward at the discretion of the instructors but will not be adjusted upward.
Software for Drawing Chemical Structures and Writing Chemical Equations

The Department of Chemistry and Chemical Biology has purchased a site license for drawing chemical structures and made it available to anyone with a Cornell net i.d. If you are interested in using this software for preparing your lab reports, you may download the software onto your computer. Here are the instructions and codes for downloading the software:

Thank you for using your organization's Site License program to obtain free software.

To access your product information online, go to http://sitelicense.cambridgesoft.com/software/ff.cfm?email=ddm2@cornell.edu&ServiceID=43&userid=459138

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INSTALLING YOUR SOFTWARE
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Below you will find the Serial Number needed to install your Windows software.

SERIAL NUMBER: 303-422718-5275
This Serial Number Code will be valid until 31-Jul-2014.

Please contact your institution's technical administrator, Chemistry IT, at chemit@cornell.edu, with any problems. You may re-download as needed from http://sitelicense.cambridgesoft.com/sitelicense.cfm?sid=683

Below you will find the Serial Number and Registration Code needed to install your Macintosh software.

SERIAL NUMBER: 7649635
REGISTRATION CODE: 26RW-5NNH-D7SY-3QOX-SH
This Serial Number and Registration Code will be valid until 31-Jul-2014.

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