

# Chemistry 422(G) Advanced Biochemistry

## Fall 2017

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### Instructor contact

Mette Soendergaard, Ph.D.

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Office phone: 298-1714

Office: Currens Hall 540A

Office hours: MWF 9-10:20 AM. Other times by appointment.

### Class meeting time

Lecture: MWF 8:00-8:50 AM Currens Hall 206

Lab: TH 2:00-4:50 PM Currens Hall 202 (pre-lab lecture 2-3 PM), Currens Hall 535 (lab 3-5 PM)

### Course description

A continuation of Chem. 421 emphasizing the structure of key biochemical macromolecules, regulation of biosynthetic pathways and gene expression.

### Course prerequisite

Chem. 421 or equivalent.

### Recommended Text

"Biochemistry," 7/e or 8/e by Berg, Tymoczko, and Stryer; W. H. Freeman and Company Textbook Home Page URL: <http://www.macmillanlearning.com/Catalog/product/biochemistry-eighthedition-berg>

### Other supplemental materials

Web links listed in My Western online.

Any other recent biochemistry textbooks.

### Instructor communication and feedback

Students are encouraged to contact the instructor with questions about the content, grading, etc., of the course. This can be done by face to face meetings or by email ([m-soendergaard@wiu.edu](mailto:m-soendergaard@wiu.edu)). I will answer emails within 24 hours during the regular business days, but less frequently during the weekend or scheduled WIU breaks. For quizzes and lab reports, I will provide feedback and assign grades within 1-2 weeks from their due date. Other assignments (eg. term paper, exams) will be graded within 1-2 weeks of their due date.

### Instructor's expectations of students

Regular and punctual class attendance is vitally important to a student's academic achievement. Students are expected to attend every class possible. Attendance will be taken during both lecture and lab classes. Attendance is mandatory for all lab sections. To accommodate special circumstances (eg. medical illness or participation in University sponsored trips), you are allowed one excused absence from lab without penalty. Students are expected to use Online Absence Reporting System (OARS) every time they miss class by log on to <http://wiu.edu/oars> and submit an absence form for that day's classes. The system is served to help students and faculty document absences; it doesn't excuse students from class. It is the instructor's discretion on how to use this absence information based on the attendance policy.

Students are expected to come to class on time. Any student who misses more than 10 minutes of class by either arriving late or leaving early, then the student will be counted as absent. Missing fewer than 10 minutes of class is a tardy. Three tardies count as one absence. If you miss more than 3 lab classes, you will automatically fail the class.

Students are not to go in and out of the class during lecture or an exam unless there is an emergency. Students leaving the classroom will be counted tardy for missing any time or absent for missing more than 10 minutes of class time. Students should make arrangements to go to the restroom between classes, not during class.

Students are responsible for all information and materials given in class whether you are present or not.

Students are expected to self-motivate themselves and are expected to read ahead, prepare for class and participate in class discussion.

Please turn off cell phones, tablets and laptops (and other electronic devices) while in class. These are very distracting and cannot be out during lectures, lab classes and exams unless instruction are given to do so! Also, class time is not a social hour. Please refrain from casual conversation during class time.

## Writing Component

“This course has been designated to meet the Writing Instruction in the Disciplines (WID) graduation requirement. WID courses provide instruction in the processes and formats for the writing content and style needed to be an effective professional in a student’s chosen field.”

This course requires a significant writing component, involving extensive lab reports and a research term paper. All reports and papers are to be submitted electronically as Word Files. An oral presentation of the research paper is required at the end of the semester. Lab reports will be in scientific paper format.

## Homework assignments

Homework is due at the beginning of class on the day of the assignment. Homework that is not submitted on time will not be counted. There are 10 homework assignments due over the semester (10 points each). Students are encouraged to work on these problems together to enhance understanding. However, the assignments must be written individually and may not be copies of other’s work (see statement on ethics).

## Research term paper

Term paper must be on a topic of biochemical relevance and must be chosen in consultation with the instructor. You must choose a fresh topic that you have not used in other courses and each student must have a different topic. **It is strongly encouraged that you start working on your term paper early in the semester.**

The topic and research articles should be approved by the instructor by **Oct 11** (5 points). The penalty for late submission of research topic and articles will be 1 point per day.

The majority of your research articles must be selected from biochemistry journals (eg. [Journal of Biological Chemistry](#), [Biochemistry](#) etc). The draft of the paper is due by **Nov. 6 at the start of class** in order to receive feed-back from the instructor. **Late drafts will not be reviewed.**

The paper is to be approximately 3000 words (10 typed, double-spaced pages) and must include no less than eight journal references with publication dates of 2007 or later. Use an Arial, Times New Roman, or Georgia typeface, a black font color, and a font size of 12 points. Use an inch margins (top, bottom, left, and right) for all pages.

The term paper must be your own work (see statement on ethics). Sources of ideas or information must be referenced. The paper will be graded on the basis of content, construction, and conciseness (75 points) and the presentation (20 points). The final version of the term paper is **due on or before Nov 27 at the end of the day (5 pm)**. One electronic copy in Word format must be submitted to the instructor. The student presentation dates will be on **Nov. 29, Dec. 1, 4 and 6**. The penalty for late term paper is 5% per day. Term paper will not be accepted after **Dec. 8**.

## Graduate students

Graduate students (including undergrads taking bridge credit) have additional course requirements compared to undergraduates. Graduate students will be required to complete an extended 16-20 page research report involving an in-depth discussion of the approved topic. In addition, graduate students will be expected to demonstrate a higher level of understanding of concept presented; a greater amount of detail and understanding of complex processes when answering exam questions; a greater independence in performing laboratory exercises and assisting others as needed.

## Grading

This course consists of three credits of lecture work and one credit of laboratory. The semester grade will consist of 70% (700 points) from the lecture and 30% (300 points) from the lab. In order to receive credit for the course as a whole, one must complete the lab with at least 60%. Failure to complete the lab will result in failure of the course. There are 1,000 points possible during the Semester. Your letter grade will be based on your total accumulated points.

Two 50 min exams	300 points
Comprehensive final	200 points
10 homework assignments	100 points
Research term paper	100 points
Laboratory	300 points

## Grading Scale (including plus/minus grading) for undergraduate or bridge credits

90.00% and above	A
86.70 - 89.99%	A <sup>-</sup>
83.40 - 86.69%	B <sup>+</sup>
80.00 - 83.39%	B
76.70 - 79.99%	B <sup>-</sup>
73.40 - 76.69%	C <sup>+</sup>
70.00 - 73.39%	C
66.70 - 69.99%	C <sup>-</sup>
63.40 - 66.69%	D <sup>+</sup>
60.00 - 63.39%	D
56.70 - 59.99%	D <sup>-</sup>
56.66% and below	F

## Grading Scale for graduate credits

90.00 % and above	A
80.00 - 89.99%	B
70.00 - 79.99%	C
60.00 - 69.99%	D
59.99% and below	F

**Make up exams:** The only acceptable excuses for missing an exam will be for personal illness, family emergency, or University sponsored functions (i.e. WIU band trips, field trips in other WIU classes, WIU athletics, etc.). In all cases, documentation is required, and must be submitted to the instructor in advance or as soon as possible in case of emergency. Make-up exams are always designed to be at least as difficult as the regular exam. **No make-**

**up quizzes will be given.** In order to accommodate absences due to illness and other excused absences, the lowest two quiz grades will be dropped. Any student who arrives late for a quiz/exam loses that amount of time to work on the quiz/exam.

Seating will be assigned by the instructor during the exams and/or any other time deemed necessary. Only **simple scientific calculators** may be used on quizzes and exams. Graphing calculators may **NOT** be used on quizzes or exams.

An incomplete grade will **NOT** be given to a student with a failing grade. No incomplete will be given to a student without documented evidence of an emergency that requires that the student be away from the university or requires that the student miss the final examination. The student shall notify the instructor of the emergency as soon as possible and prior to the final examination.

## **Statement on Ethics**

Western Illinois University, like all communities, functions best when its members treat one another with honesty, fairness, respect, and trust. Students have rights and responsibilities (<http://www.wiu.edu/provost/students.php>). Plagiarism, falsification of data, cheating, and other forms of academic dishonesty constitute a serious violation of WIU conduct regulations. Students who engage in dishonesty in any form shall be charged with academic dishonesty. Make sure that you as the student are aware of the WIU Academic Integrity Policy (<http://wiu.edu/policies/acintegrity.php>). **Please remember that you are expected to do your own work at all times.**

Even though some of the lab work will be done in groups and you collect data in groups, the analysis of your common data and preparation of your report must be completed independently. Using any part written or done by others is plagiarism and a form of cheating. It is also cheating if you use a diagram created by someone else to analyze your data. Using someone else's data (other than what you have collected in your group) is considered falsification of data, and is also a form of cheating. (Re)using your own data or material generated outside of this course, for example from other courses, is also considered plagiarism and falsification of data, and is a form of cheating. Plagiarism, falsification of data, cheating or any other form of academic dishonesty, will **NOT** be tolerated. A zero tolerance policy will apply. **Incidents will result in a grade of zero for the assignment and a failing grade for the whole course. This will happen the first time a student commits an offense of academic dishonesty. There are no second chances, when it comes to academic dishonesty!**

## **Emergency evacuation procedures for the building**

If a fire alarm should happen to ring, or if students are ordered to evacuate a lab or classroom by the instructor, the students should walk to the nearest stairwell (Do not use the elevators) and proceed to the ground floor and out the building. Any student on an upper floor who cannot physically proceed down the stairs should go to the southernmost stairwell and await assistance. If the building should be evacuated all students and personnel should gather at the southwest corner of the Higgins Parking lot near the fence (parking lot just outside the building) to wait further instructions.

## **Emergency Preparedness**

WIU Office of Risk Management and Emergency Preparedness provides resources on how to respond to emergency situations. Please view the video resources at [www.wiu.edu/rmep/](http://www.wiu.edu/rmep/) (Click "Resources" on the left side of the page).

## **Students with Disabilities**

In accordance with University values and disability law, students with disabilities may request academic accommodations where there are aspects of a course that result in barriers to inclusion or accurate assessment of achievement. To file an official request for disability-related accommodations, please

contact the Disability Resource Center at [309-298-2512](tel:309-298-2512), [disability@wiu.edu](mailto:disability@wiu.edu) or in 143 Memorial Hall. Please notify the instructor as soon as possible to ensure that this course is accessible to you in a timely manner.

### **Holidays and other important dates**

<b>Date</b>	<b>Event</b>
August 21, Mon. 2017	First Day of Classes
September 4, Mon. 2017	Labor Day Holiday
October 20, Fri. 2017	Fall break
November 20-24, Mon.-Fri. 2017	Thanksgiving break
December 11-15, Mon. –Fri. 2017	Final exam week
December 16, Sat. 2017	Commencement

**Detailed lecture schedule (tentative).**

<b>Date</b>	<b>Topic</b>	<b>Readings and deadlines</b> "Biochemistry," by Berg et al.
8/21	<b>Class introduction:</b> Go over class requirements and syllabus.	
8/23	<b>Protein structure:</b> Amino acids and primary structure. Secondary structure.	2, 2.1, 2.2
8/25	<b>Protein structure:</b> Tertiary and quaternary structure.	2.4, 2.5,
8/28	<b>Protein structure:</b> Stability and protein folding.	<b>Homework 1</b>
8/30	<b>Protein structure:</b> Protein folding.	2.6
9/1	<b>Library visit:</b> How to search for literature.	<b>We meet at the library</b>
9/4	<b>Labor Day</b>	
9/6	<b>Exploring Proteins and Proteomes:</b> Protein Purification.	3.1.1-3.1.5
9/8	<b>Exploring Proteins and Proteomes:</b> Immunology Methods.	3.3, 34.1, 34.2.-34.2.1
9/11	<b>DNA, RNA, and the flow of genetic information:</b> Nucleic acids and structure of DNA.	(1.2, 1.3) 4.1, 4.2 <b>Homework 2</b>
9/13	<b>DNA, RNA, and the flow of genetic information:</b> From DNA to protein.	4.3, 4.4,
9/15	<b>DNA, RNA, and the flow of genetic information:</b> From DNA to protein cont.	4.5, 4.6, 4.7
9/18	<b>Exploring genes and genomes:</b> Exploring genes and genomes.	5.1, 5.3.1-5.3.3 <b>Homework 3</b>
9/20	<b>Exploring genes and genomes:</b> Recombinant DNA technology and genomes.	5.2.1-5.2.2, 5.4.2-5.4.3, 5.4.6
9/22	<b>Exploring genes and genomes:</b> Recombinant DNA technology and genomes cont.	5.2.4-5.2.7, 5.4.1, 5.4.4-5.4.5, 5.4.7
9/25	<b>Review.</b>	<b>Homework 4</b>
9/27	<b>Exam I</b>	
9/29	<b>DNA replication:</b> Polymerases and other enzymes of DNA replication.	28.1
10/2	<b>DNA replication:</b> DNA unwinding and supercoiling.	28.2 <b>Homework 5</b>
10/4	<b>DNA replication:</b> Coordination of DNA replication.	28.3
10/6	<b>DNA repair and recombination:</b> DNA damage and recombination.	28.4, 28.5
10/9	<b>Transcription:</b> RNA polymerase.	29.1 <b>Homework 6</b>
10/11	<b>Transcription:</b> Eukaryotic transcription.	29.2 <b>Deadline for instructor approval of research paper topic and articles.</b>
10/13	<b>Fall Break</b>	

10/16	<b>Library visit:</b> How to cite.	<b>Homework 7</b>
10/18	<b>Transcription:</b> RNA processing.	29.3, 29.4
10/20	<b>Translation:</b> The genetic code and tRNAs.	30.1, 30.2
10/23	<b>Translation:</b> The ribosome.	30.3 <b>Homework 8</b>
10/25	<b>Translation:</b> Protein synthesis in prokaryotes and eukaryotes, and protein targeting.	30.4, 30.5, 30.6
10/27	<b>Review</b>	
10/30	<b>Exam II</b>	
11/1	<b>Control of gene expression:</b> Prokaryotes; operons.	31.1, 31.2,
11/3	<b>How to cite</b>	<b>Homework 9</b>
11/6	<b>Control of gene expression:</b> Prokaryotes; operons cont.	31.3, 31.4 <b>Draft of research paper due</b>
11/8	<b>Control of gene expression:</b> Eukaryotes; DNA organization.	32.1, 32.3
11/10	<b>Control of gene expression:</b> Eukaryotes; transcription factors.	32.2
11/13	<b>Control of gene expression:</b> Eukaryotes; transcription factors cont.	32.2
11/15	<b>Control of gene expression:</b> Eukaryotes; posttranscriptional control.	32.4.2, 5.4.5 <b>Homework 10</b>
11/17	<b>Research paper draft feedback</b>	
11/20-11/24	<b>Thanksgiving Break</b>	
11/27	<b>Control of gene expression:</b> Eukaryotes; RNA interference.	<b>Student research paper due</b>
11/29	<b>Student presentations.</b>	
12/1	<b>Student presentations.</b>	
12/4	<b>Student presentations.</b>	
12/6	<b>Student presentations.</b>	
12/8	<b>Review</b>	
12/12-12/16	<b>Final exam: 8:00 AM.</b>	

***SYLLABUS IS SUBJECTED TO CHANGE WITH NOTICE***

***Last Updated on Aug. 20, 2017 by Dr. Mette Soendergaard, Department of Chemistry, Western Illinois University.***

## Chem. 422 Laboratory

### Lab Instructor:

Dr. Mette Soendergaard, Currens Hall 540A, email: [m-soendergaard@wiu.edu](mailto:m-soendergaard@wiu.edu)

**Laboratory meeting time and place:** TH 2:00-5:00 PM. Currens Hall 202 (pre-lab lecture 2-3 PM), Currens Hall 535 (lab 3-5 PM)

**Office hours:** MWF 9:00-10:20 AM., other times by appointment.

**Safety:** Safety is the first concern in a chemistry lab. Personal protective eye wear is required. The student must purchase safety goggles. Safety goggles are to be worn at all times in the lab. Proper handling of chemicals, especially correct pipetting technique is expected. Material Safety Data Sheets (MSDS) information about all chemicals utilized in the laboratory can be found at the following web site. <http://hazard.com/msds/>

**Students without goggles, closed-toe shoes or proper attire (Pants must cover the entire shin. Shirts must cover your entire shoulder) will not be admitted to the lab and this will count as a missed lab session.**

**Students enrolled in this course are levied a non-refundable laboratory usage fee of \$35 to cover the cost of consumable supplies utilized during the semester.**

### Suggested reading:

*Lab manuals (available on Western Online).*

**Grading (300 points total):** The laboratory portion of the course will be graded based on two lab exams (midterm 40 points; comprehensive final 60 points), quizzes (50 points), and lab reports (150 points). Only simple scientific calculators may be used during exams. Graphing calculators or equivalent may NOT be used during exams.

### Lab reports

Lab reports are to be typed. The reports are due electronically as directed by the instructor. Late lab reports will be docked by 5% per day. Lab reports turned in two weeks after the due date or after the last day of classes (December 8<sup>th</sup>, 2017), whichever comes first, will not be graded. 10% of the grade for each report will be for writing style and presentation. Make sure that you use spell checking and that you proofread all reports before submission.

**Formatting:** Use an Arial or Times New Roman typeface, a black font color, and a font size of 12 points. Use one inch margins (top, bottom, left, and right) for all pages. The lab reports must be your own work (see statement on ethics). Sources of ideas or information must be referenced.

**Title Page:** (5%) The title page should include the title of your report, your name (in bold), your lab partner's name(s), course number and date.

**Abstract:** (5%) This should be a short version, or a summary, of the entire paper. Therefore, it should include a brief introduction, methods, results, and discussion, expressed in 200-300 words. Basically, from the abstract people should be able to understand scientific findings without having to read the entire paper. Writing an abstract



can be challenging, as you are trying to summarize your entire paper in a few words. Greatly abbreviating the methods is usually a good way to start. If you are struggling, look up some recent scientific papers for inspiration.

**Introduction:** (15%) This section should describe background information about the scientific problem you are addressing. Also, you must convey the overall goal of the experiments and the hypothesis tested. Think about what relevant information is necessary to include, so that someone that did not participate in the experiments are able to understand the hypothesis and why is it important. What are you hoping to learn from the experiments, what need to be accomplished? You must use research papers (or cite the lab manual) to back up your claims and cite these. *An introduction without citations will result in a low grade.*

**Materials and Methods:** (10%) This section should be a brief and concise summary of what you did. It needs to include enough detail so that any scientist in your field could repeat your work. However, it does not need to be reported down to the smallest detail. Ask yourself: “Would I be able to repeat my experiment using this information?” “Have I included too much information to a point where it becomes confusing?” Also, you must include the source (company) of the reagent and any equipment used, so make sure to take notes during the lab.

**Results:** (40%) This section should be a description of what you did **in words**, supplemented with figures and tables. It is **not** enough to have several figures and tables. Do not merely list results in the text. Instead, explain the findings, and in short fit them into the overall context of the report. For each experiment consider what you were doing in the lab and what you were trying to accomplish? Why were you using the methods that you did? And of course, what were your results? And what do they mean in regard to what you set out to accomplish? You must briefly summarize how the experiment was performed, what the results were, and how you interpret these results. Fx. *“In order to confirm that the protein purification of enzyme X was successful, an SDS-PAGE was performed using an aliquot from the last purification step. The SDS-PAGE showed (Figure X) that only one band was present, and that this band corresponded to the expected size of enzyme x (Figure XX). This indicated that the protein purification was successful since only one protein band was detected. However, this needed to be further confirmed by Western blotting.”*

For reporting numbers in the text, convert the numbers to be easily readable and to have reasonable values. For example, 1.4567102 mg/μl is **not** reasonable. Converting the value to 1.46 mg/ml is much easier to read, and the number of significant figures becomes less excessive. Always include units when appropriate. Failure to include units will result in a low grade for the results section.

***Figures and Tables*** if done correctly, are extremely useful. You must refer to the figures and tables in the text. For example: *“The protein concentration was determined to be 1.02 mg/mL using the Bradford method (Table 2A)”*. Again, each figure and table must have a figure/table legend that describes what the figure or table means in enough detail, so that the reader does not need to be searching in the main text for an explanation (although it does not have to be in as much detail as in the main text). Figure legends should be below the figure, while table legends should be above the table. Each figure and table must have a number and a legend that describes what the figure/table means in enough detail, so that the reader does not need to be searching in the main text for an explanation. Each figure/table should be referenced in the text as shown in the example above.

***Calculations*** should be included in the results. You may show one example of each type of calculation. Remaining calculations may be included in the appendix if needed.

**Discussion and conclusion:** (20%) Begin with a brief summary of what you set out to accomplish with the experiment. What did you set out to accomplish, and did you accomplish it? What was the hypothesis? Briefly summarize and explain your results. What did you discover? Were the results expected? Which of your results are interesting? What can you say about your hypotheses now that you have performed the experiments? Was

anything surprising? Overall, you should answer the question (the hypothesis) that you asked in the introduction. Sometimes the original hypothesis turned out to be flawed, and then you must propose a new hypothesis to account for your observations. At other times your original hypothesis is supported by your data, which you must then convince the reader of. If you have unexpected results, you must explain these with sound biochemical knowledge. Use research papers to back up your claims. *A discussion without citations will result in a low grade.*

The conclusion should include a brief description of your hypothesis, and whether or not you proved your hypothesis to be correct and why. Is anything next?

**References:** (5%) In the reference section you give proper credit to the originators of the information you are presenting. Which scientific papers or books did you read to get the information for your introduction and discussion? In general, every time you present background information, it must be references. Also, where did your methods come from? (Note that, unless you invented the method, you should always reference the paper that first described the work. In some cases this will be the lab manual, in others you must find the original research paper and cite this).

**Appendix:** Include your raw data and any calculations that you used to analyze your results in the Appendix section. In most scientific peer-reviewed papers, the appendix sections are only included for the description of novel calculations or lengthy methods. However, in this course, the Appendix is included so that your lab instructor can understand how you calculated and obtained your results.

*Even though some of the lab work will be done in groups and you collect data in groups, the analysis of your common data and preparation of your report must be completed independently. Using any part written or done by others is plagiarism and a form of cheating. It is also cheating if you use a diagram created by someone else to analyze your data. Using someone else's data (other than what you have collected in your group) is considered falsification of data, and is also a form of cheating. Plagiarism and falsification of data, or any other form of academic dishonesty, will NOT be tolerated. Incidents will result in a grade of zero for the assignment and failing grade for the whole course. This will happen the first time a student commits an offense of academic dishonesty. There are no second chances, when it comes to academic dishonesty!*

**Attendance:** You are expected to attend ALL of the lab meetings punctually. If it should be necessary to miss a lab, please notify me in writing (by e-mail), before the fact if possible. The only acceptable excuses for missing a lab are personal illness or family emergencies or University sponsored functions (i.e. WIU band trips, field trips in other WIU classes, WIU athletics, etc.). In all cases, documentation is required, and must be submitted to the instructor in advanced or ASAP in case of emergency. Makeup labs are subject to availability of reagents and time and must be completed ASAP. In addition, you are allowed only a single make-up lab per semester (exceptions can be made in some circumstances, such as for athletes, but this needs to be discussed with the lab instructor well in advance). All other absences, excused or unexcused, will be considered a "missed" lab period and the student will receive zero points for the missed lab.

**Students who show up late to the lab will loss 1 points per min up to 5 points. Students who show up more than 15 minutes late will be given an unexcused absence and will NOT be allowed to perform the experiment. The student will receive zero points for the missed lab.**

**Objective:** This laboratory is designed to introduce the principles of native protein purification, as well as molecular cloning.

**Lab schedule (tentative)**

<b>Date</b>	<b>Activity</b>	<b>Lab manual</b>	<b>Points Quiz/Lab report</b>
8/24	No lab		
8/31	Lab check in: Safety rules. Pipettes, dilutions and spectroscopy.	1	No quiz/10
9/7	Protein purification: Tissue homogenization, and salting out.	2A	5
9/14	Protein purification: Dialysis.	2B	5
9/21	Protein purification: Ion-exchange chromatography.	2C	5
9/28	Protein purification: Bradford assay and enzyme activity assay.	2D	5
10/5	Protein purification: SDS-PAGE.	2E	5/70
10/12	<i>Midterm.</i>		
10/19	Molecular cloning: PCR. Plasmid isolation.	3A	5
10/26	Molecular cloning: Agarose gel electrophoresis.	3B	5
11/2	Molecular cloning: Restriction enzyme and alkaline phosphatase digests.	3C	5
11/9	Molecular cloning: Ligation and transformation.	3D	5
11/16	Molecular cloning: Selection and screening.	3E	5/70
11/23	No lab: Thanksgiving break.		
11/30	No lab		
12/7	<i>Comprehensive lab final</i>		60

**Supplies to be provided by students**

- Safety goggles. Eye protection is required and must be purchased by the student.
- Scientific Calculator
- Notebook

**Syllabus is subjected to change with notice.**

*Last updated on August 19, 2017 by Dr. Mette Soendergaard, Department of Chemistry, Western Illinois University.*