

Chemistry 425 Biochemistry of Human Disease Spring 2018

Instructor contact

Mette Soendergaard, Ph.D.

E-mail: m-soendergaard@wiu.edu

Office phone: 298-1714

Office: Currens Hall 540A

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

Class meeting times

Lecture: MWF 1:00-1:50 PM, 552 Currens

Lab: TH 11 AM – 12 PM 552 Currens (pre-lab lecture).

TH 12-1:50 PM, 535 Currens (lab).

Course description

This course focuses on the biochemical aspects of human diseases. The objectives of this course are to allow students to become familiar with the biochemical principles of disease development, as well as contemporary biochemistry and molecular biology methods and approaches for studying human diseases. By the end of this course, students should be knowledgeable of the biochemical causes of the diseases covered in the class, in addition to existing and future prospects for biochemically based treatments.

Course prerequisite

CHEM 421 (or equivalent), BIOL 330 (or equivalent).

Recommended Texts

“Molecular Biology of Cancer” by Lauren Pecorino. 4th edition Oxford University Press.
<https://global.oup.com/ushe/product/molecular-biology-of-cancer-9780198717348?cc=us&lang=en&>

“Thrive in Immunology” by Anne Cunningham. Oxford University Press.
<https://global.oup.com/ushe/product/thrive-in-immunology-9780199642977?q=Thrive%20in%20Immunology&lang=en&cc=us>

Other supplemental materials

"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>

Web links listed with the syllabus or on Western online.

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). Emails will be answered within 24 hours during the regular business days, but less frequently during the weekend or scheduled WIU breaks. For quizzes and lab reports, the instructor will provide feedback and assign grades within 1-2 weeks from their due date. Other assignments (eg. journal club and 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, family emergency, or participation in university sponsored trips), you are allowed one excused absence from lab without penalty. Documentation will be required for excused absences. Unexcused absences will not be accommodated. Students are expected to use Online Absence Reporting System (OARS) every time they miss class by logging 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. 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 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 is given to do so! Also, class time is not a social hour. Please refrain from casual conversation during class time.

Homework assignments

Homework is due at the beginning of class on the day of the assignment. Homework cannot be submitted after the due date and time, and will not be counted. There are 10 homework assignments due over the semester (20 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).

Journal Club

Students will present a research paper individually or in groups (depending on the number of students in class). Students should make a PowerPoint presentation containing the most important information, figures and findings from the paper. The presenting student(s) will be expected to lead a discussion about the research paper, and should know the findings in detail (including background information, hypothesis that was tested, materials, methods, results, discussion and conclusion, and all figures and tables). Students that are not presenting at a given journal club are likewise expected to know the research paper and its findings in detail, and should be able to participate in a discussion of these. Grading will consist of the paper presentation (80 points) and participation in

discussions (70 points). Grades will be based on a combination of the quality of the presentation, student participation and the quality of the discussions (whether the student knows the research paper in detail).

Students must:

- Read the research paper before class.
- Deliver information that is rich in content, full of thought, insight and analysis.
- Make clear connections to previous or current content or to real-life situations.
- To get full points, participate in all paper discussions.
- Attend all paper discussions (unexcused absences will be graded “0”). In the case of excused absences, students will have to write a short (500-1000 words) report on the research paper.

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	200 points
Comprehensive final	150 points
10 homework assignments	200 points
Journal club	150 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 ⁻
83.40 - 86.69%	B ⁺
80.00 - 83.39%	B
76.70 - 79.99%	B ⁻
73.40 - 76.69%	C ⁺
70.00 - 73.39%	C
66.70 - 69.99%	C ⁻
63.40 - 66.69%	D ⁺
60.00 - 63.39%	D
56.70 - 59.99%	D ⁻
56.66% 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.** For students that have excused absences (personal illness, family emergency, or university sponsored functions,), the lowest quiz grades for up to two quizzes will be dropped. In all cases,

documentation for excused absences will be required. Any student who arrives late for an exam loses that amount of time to work on the 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 exams. Graphing calculators, cell phones, tablets or laptops may **NOT** be used during exams.

Handwritten notes by the student are allowed for each exam. Notes have to be written by the student him/herself, not by someone else. The notes cannot be written in Word or any other software program. They cannot be printed or copied from a textbook, webpage, research paper, or the like.

An incomplete grade will **NOT** be given to a student with a failing grade. No incomplete grades 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 await 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/ (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 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

Date	Event
January 15 th , Mon 2018	Dr. Martin Luther King Day
January 16 th , Tue, 2018	First day of classes
February 12 th , Mon 2018	Lincoln’s birthday
March 12-16 th , Mon-Fri 2018	Spring Break
May 7 th -11 th , Mon-Fri 2018	Final exam week
May 11 th , Fri 2018	Graduate commencement
May 12 th , Sat 2018	Undergraduate commencement

Detailed lecture schedule (tentative).

Date	Topic	Readings and deadlines
1/17	Course introduction	
1/19	1. Protein structure, targeting, folding and degradation.	
1/22	2. Prion disease, Alzheimers.	http://www.nature.com/scitable/topicpage/protein-misfolding-and-degenerative-diseases-14434929
1/24	Journal Club 1	Homework 1
1/27	3. Simple sugars, starch, glycogen, glycolysis, gluconeogenesis.	
1/29	4. Diabetes.	http://www.nature.com/scitable/topicpage/g-protein-coupled-receptors-pancreatic-islets-and-14257267
1/31	5. Nucleic acids, mutations and Huntington's disease.	
2/2	6. Gene therapy.	http://www.nature.com/scitable/topicpage/huntington-s-disease-the-discovery-of-the-851 http://www.nature.com/scitable/content/huntington-s-disease-genetics-lends-a-hand-13997 CRISPR paper (Western Online) Homework 2
2/5	Journal Club 2	
2/7	7. Transcription and RNA processing	
2/9	8. Nuclear receptors, transcription factors, and coactivators	
2/12	Lincoln's birthday: No classes	
2/14	9. The glucocorticoid receptor, asbestosis.	Homework 3
2/16	Journal Club 3	
2/19	10. Membrane transport	
2/21	11. Cystic fibrosis.	http://www.nature.com/scitable/content/mechanisms-of-disease-new-insights-into-cystic-16454
2/23	Exam I	
2/26	12. Intro to immunity.	Chapter 1 (Thrive in Immunology) Homework 4
2/28	13. Recognition of the innate and adaptive immune systems.	Chapter 2.1, 2.2
3/2	14. Activation of the adaptive immune system.	Chapter 2.3
3/5	15. Destruction by the innate immune system.	Chapter 3.1
3/7	16. Destruction by the adaptive immune system.	Chapter 3.2
3/9	17. Immune Deficiency, HIV/AIDS	Chapter 4.1 Homework 5
3/12-3/16	Spring break: No classes	
3/19	Journal Club 4	
3/21	18. Autoimmunity, Hashimoto's Thyroiditis	Chapter 4.2
3/23	19. Immune sensitivities	Chapter 4.3
3/26	20. Chronic inflammation, inflammatory bowel disease	Chapter 1.2
3/28	21. Tumor immunity	Chapter 4.5 Homework 6

3/30	Journal Club 5	
4/2	Exam II	
4/4	22. What is cancer? DNA structure and stability, mutations versus repair	Chapter 1 and 2 (Molecular Biology of Cancer)
4/6	23. Regulation of gene expression	Chapter 3
4/9	24. Growth factor signaling.	Chapter 4.1
4/11	25. Oncogenes and kinases as drug targets	Chapter 4.2, 4.3 http://www.nature.com/scitable/topicpage/genetic-regulation-of-cancer-891 http://www.nature.com/scitable/ebooks/cancer-16550193 Unit 2
4/13	26. The cell cycle	Chapter 5 Homework 7
4/16	27. Growth inhibition and tumor suppressor genes	Chapter 6
4/18	Journal Club 6	
4/20	28. Apoptosis	Chapter 7 Homework 8
4/23	29. Cancer stem cells	Chapter 8
4/25	30. Metastasis	Chapter 9
4/27	31. Tumor Immunology	Chapter 12.1-12.5 Chapter 4.5 (Thrive in Immunology)
4/30	32. Immunotherapy	Chapter 12.6-12.10 (Molecular Biology of Cancer) Homework 9
5/2	Journal Club 7	
5/4	33. Technology and drug and diagnostic development	Chapter 14 http://www.nature.com/scitable/topicpage/gleevec-the-breakthrough-in-cancer-treatment-565 Homework 10
5/7-5/11	Final exam week	

SYLLABUS IS SUBJECTED TO CHANGE WITH NOTICE

Last Updated on January 22nd, 2018 by Dr. Mette Soendergaard, Department of Chemistry, Western Illinois University.

CHEM 425 Laboratory

Instructor contact

Mette Soendergaard, Ph.D.

E-mail: m-soendergaard@wiu.edu

Office phone: 298-1714

Office: Currens Hall 540A

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

TA: Jamie Greathouse

E-mail: jr-greathouse@wiu.edu

Office: Currens Hall 540B

Laboratory meeting time and place:

TH 11 AM-12 PM Currens 552 (pre-lab lecture).

TH 12-1:50 PM. Currens 535 (lab).

Objective

The laboratories are designed to introduce techniques and principles of biochemistry in studying human disease.

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 an unexcused missed lab session.

During certain lab exercises the students will be required to wear additional protective clothing such as gloves and lab coats. These will be supplied by the instructor.

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 and other material 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, cell phones, tablets, laptops or equivalent may **NOT** be used during exams.

Handwritten notes by the student are allowed for each exam. Notes have to be written by the student him/herself, not by someone else. The notes cannot be written in Word or any other software program. They cannot be printed or copied from a textbook, webpage, research paper, or the like.

Pre-Lab Quizzes

Pre-lab quizzes are due prior to each lab period. Quizzes are available on Western Online, and will cover material needed to complete each lab exercise. Quizzes cannot be taken after the beginning of the lab period. Failure to complete a quiz within the given amount of time, will result in full loss of points (5 points per quiz).

Lab reports

Lab reports are to be typed. The reports are due electronically as directed by the instructor (see lab schedule). 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 (May 4th, 2018), 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. Lab reports should be written in passive tense. For example, do not use “I”, “we”, “our group”, “the instructor” etc. Utilize documents on Western Online to help you write the lab reports. *There are guides for using citations and references properly, a checklist for items that should be included in each lab report, as well as a sample lab report.*

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. You should include your actual results in the abstract, as well as a conclusion based on your results. It is not enough to summarize the background, or various methods used.

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 should also describe the background of each of the methods used in the experiment. For example, how does the polymerase chain reaction (PCR) work? You should describe the theory behind these methods in detail. 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?” For example, writing “1 mL of the buffer was taken up by a P1000 pipette, and the solution was put into a microcentrifuge tube containing 0.5 mL of diH₂O labeled with the group number”, is too much unnecessary detail. Instead, you

could write “1 mL of buffer was mixed with 0.5 mL diH₂O”. 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. Begin with a summary of the overall goal of the experiments. What were you trying to accomplish, and which methods did you use? 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 the results 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. Ex. “*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.*” You should show figures close to where these are referenced in the text. Do not have all the text at the beginning of the results section, and all of the figures at the end (or *vice versa*).

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. (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!**

Attendance

You are expected to attend ALL of the lab meetings punctually. If it should be necessary to miss a lab, please notify the instructor in writing (by e-mail), before the fact if possible. The only acceptable excuses for missing a lab are personal illness, 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 advance, or as soon as possible in case of emergency. All other absences, excused or unexcused, will be considered a "missed" lab period and the student will receive zero points for the missed lab. **There will be no makeup labs.** In case of an excused absence, data may be obtained from a lab partner or the instructor, and the absent student may write a lab report using that material.

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.

Lab schedule (tentative)

Date	Activity	Lab Manual	Pre-Lab Quiz Due Date	Lab Report Due Date (points)
1/17	No lab			
1/25	Intro	1		2/1 (10)
2/1	Mammalian cell culture technique	2A	2/1	
2/8	MTT assay: Dose response IC ₅₀	2B	2/8	
2/15	Trypan Blue assay	2C	2/15	
2/22	Modified ELISA: Dose response EC ₅₀	2D	2/22	
3/1	Data analysis	2E	3/1	3/8 (70)
3/8	Lab Midterm			40
3/15	Spring Break: No lab			
3/22	Plasmid purification	3A	3/22	
3/29	Endotoxin removal and gel electrophoresis	3B	3/29	
4/5	Transfection	3C	4/5	
4/12	Microscopy	3D	4/12	
4/19	Microscopy and data analysis	3E	4/19	4/26 (70)
4/26	No Lab			
5/3	Lab Final			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 January 13th, 2018 by Dr. Mette Soendergaard, Department of Chemistry, Western Illinois University.