

Special Topics in Organic Chemistry

Biorenewable Polymers – 8833

Course Summary:

The course is directed at reviewing advanced chemical principles of biorenewable polymers including polysaccharides and lignin with a special emphasis on chemical derivatization, reactivity, and conformational analysis. Students are introduced to current concepts in conformational analysis of carbohydrates, chemical derivatization of carbohydrates and lignin, and the conversion of these biopolymers into biocomposites and biofuels.

Course Objectives:

1. To provide an advanced understanding of the chemical properties of carbohydrates and lignin with a special emphasis on wood polysaccharides.
2. To understand the basic principles of conformational analysis of carbohydrates and the application of these concepts to plant polysaccharides such as starch, cellulose, and xylan.

Course Outline:

- I. Introduction
 - (a) Nomenclature of mono, oligo, polysaccharides and lignin subunits
 - (b) Overview of plant polysaccharides and lignin
- II. Fundamental chemistry of mono- and oligosaccharides
 - (a) Conformational analysis of mono and oligosaccharides
 - Stereo-electronic effects: Anomeric effect, exo-anomeric effect, endo anomeric effect
 - (b) Mutarotation and stability of pyranose, furanose, and acyclic forms

- III. Chemistry of Carbohydrate Hydroxyl Groups
 - (a) Reactions at the anomeric center
 - Synthesis of thio and alkenyl glycosides, and glycosyl halides
 - (b) Reactions of non-anomeric hydroxyl groups
 - Selective protection/deprotection of C-2 – C-6 hydroxyl groups.
- IV. Overview of Synthesis of Oligosaccharides/Polysaccharides
 - 1,2-cis and trans glycopyranosides
 - Modification of polysaccharides

V. Isolation and chemical structure of lignin

VI. Student Seminars describing the fundamental chemistry, conformation, synthesis/derivatization, reaction mechanisms and application of biomass to:

- a. Integrated Biorefinery
- b. Pretreatment Chemistry Lignocellulosics
- c. SSF/CBP Conversion of Biomass to BioEthanol
- d. Third Generation Biofuels from Biomass
- e. Gasification/Fischer Tropsch Chemistry of Biomass to Biofuels
- f. Nanocellulosic Composites
- g. Nano Starch/Hemicelluloses
- h. Chitin
- i. CMC
- j. Lignin to Biofuels or Biomaterials
- k. Starch to Biofuel or Biomaterial

Note: Dr. Ragauskas will provide each student a list of key papers for each presentation/paper and technical focus once each student selects a biopolymer.

Grading:

Assignment	10%
Mid term exam:	20%
Term paper and presentation:	50%
Final:	20%

Principal Journals:

Carbohydrate Research, Cellulose, Pure Applied Chem., Starch, Carbohydrate Polymers, Can. J. Chem., Holzforschung, J. Wood Chem. Technol., Angew. Chem. Int. Ed. Engl., Ind. Eng. Chem. Res., Nord. Pulp Pap. Res. J., Acta Chem. Scand., Green Chemistry, JCS Perkin 1, J. Am. Chem., J. Food Chem., J. Org. Chem., Tetrahedron Lett., Tetrahedron, Biotechnology and Bioengineering, Journal of Biotechnology, Enzyme and Microbial Technology, Industrial Biotechnology, Biofuels, Bioproducts and Biorefining, BioEnergy Research, Science, Nature

Molecular Model Kits

Many students find model kits useful when studying organic chemistry/spectroscopy. You do not need an expensive kit. A small selection of atoms and bonds is useful.

LECTURE ATTENDANCE: It is required that you attend all lectures.

STUDENT ID NUMBERS: All work submitted for grading must include your name.

REGRADES: *If you want any work regraded you must make a written request and return the assignment within one week to the instructor. Work will not be regraded after this deadline.*

CLASS NOTES : Class notes and reference papers will be available at the beginning of each class.

MIDTERM (20% OF FINAL GRADES): A closed book mid-term exam will be assigned to each student worth 20% of the final grade. You must take the exam at the assigned time. All exams are closed to textbooks, class-notes and electronic devices (unless otherwise stated prior to the exam). The only valid reason for missing an exam are illness and official GA Tech business. Make-ups can only be given if advance notification is given or upon presentation of a doctor's note.

REVIEW PAPER, PRESENTATION, AND CRITIQUE: Each student will be assigned a biopolymer topic to review and will present to the class a presentation and paper. (Upon selection of each topic Ragauskas will provide a scope for the paper/presentation and recommended papers) The review paper will contribute 50% to the final grade, with the presentation accounting 30% and the paper accounting 20%. Each presentation will be 1.5 hours in duration and will be presented via MS Power-Point presentation format. A week prior to each student's presentation the student will submit a draft copy of the presentation to Ragauskas for an initial review and feedback. No scanned material is permitted in either the report or presentation, plagiarism will not be tolerated. It is anticipated the presentation and paper will reflect a state-of-the-art review in the selected topic area, as such the bulk of the reviewed material will originate from research publications no more than 5 years old.

FINAL EXAM (20% OF FINAL GRADES): A closed book, final-exam will be given to each student during finals week worth 20% of the final grade. You must take the exam at the assigned time. All exams are closed to textbooks, class-notes and electronic devices (unless otherwise stated prior to the exam). The only valid reasons for missing an exam are illness and official GA Tech business.

RETURNED WORK: All graded assignments will be returned as soon as possible. Work not picked up in lecture will be available form outside of the instructor's office door in the IPST Building.

MATERIAL COVERED/STUDENT RESPONSIBILITIES: You are responsible for all material presented in lectures and in assigned readings. You are also responsible for announcements made in class, which will also be posted on the www page or distributed by email. You must check the web site and you *prism.gatech.edu* email account on a

regular basis. Note: there are potential problems associated with automatic forwarding of messages from *prism* to other email addresses; check your *prism* account even if you have it set up to forward email elsewhere.

WORKING IN GROUPS: Most learning takes place *outside* of the classroom. Although lectures should put things in perspective, working through the textbook, and solving the problems is when you will come to terms with the material. We encourage you to work together on these reading and problem assignments. For most students, it is actually unwise to try to work alone. Although you might study in groups, remember that you are ultimately responsible for your learning. Everybody can benefit from team work. You will learn through teaching. Office hours are available for individual instruction. No *new* information will be introduced during office hours. Come prepared to ask *and answer* problems.

COMPETITION AND GRADING: Formal education often puts students in competition with each other for good grades. We do not believe that competition for grades, and the exclusion of everything else, is the most effective way to foster student development. Although grades will be assigned based on a numerical score which judges attainment on exams, We hope that the course is structured such that if you show a desire to learn, put *the effort in, and have some intellectual ability, you can get the grade you want. With this in mind, please take the time to read the Grades, Expectations and Minimum Requirements section, and decide what you want from the course.*

CANCELLATION OF CLASSES: If class is cancelled by Georgia Institute of Technology owing to campus closing, the entire schedule for the course will be delayed by one lecture. This will move all exams and Homework due dates back by one lecture.

TIME COMMITMENTS: We all have extensive demands on our time. For each lecture you should aim to put in *at least* another two hours of your own time. You will need to spend much more time preparing for the mid-term exam and your term paper. Some students will require more, some less.

GRADES, EXPECTATIONS AND MINIMUM REQUIREMENTS

adapted from J. H. Williams in *The Teaching Professor*, (Aug 1993)

"D" -50%- Some demonstration of detailed knowledge of biopolymers chemistry reactions.

"C" -60%- Detailed knowledge of structure, bonding and chemistry of biopolymers including lignin and polysaccharides. Understand the basics if monosaccharide chemistry and conformational analysis.

"B" -70%- Requirements for a "C", plus some demonstrated success of multistep reaction mechanisms involved in the synthesis of oligosaccharides conformational analysis of these structures. Understands current literature in biopolymer chemistry

“A” -85%- Requirements for a “B”, plus: write consistently good complete pathways for multistep bleaching/pulping reactions, excellent knowledge of lignin/polysaccharide chemistry research literature, able to critically analyze literature results and propose good mechanisms reactions involving biomass polymers.

“A” students have virtually perfect performance. Their commitment to the class resembles that of the teacher. They always read the assignment, and their attention to detail is such that they occasionally catch the teacher’s mistakes (we all make them!). An “A” student is CREATIVE, COMMITTED, ORGANIZED, and CURIOUS, has a RETENTIVE MIND (and exercises it), has a WINNING ATTITUDE, and SHOWS INITIATIVE.” “V” audit - same as for “S” , “S”atisfactory (S/U) - Exams 1-5 to a “C” level (no drops), Final not required, or “D” including Final

If every student gets 85+%, everyone gets an “A”

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“WORD – Past Tests/Exams”

If you want word just ask! The *processes* by which you can solve the problems will be *exactly* the same as those in the book. Occasionally, an exam question will be taken directly from the text.

SOME STUDY TIPS

Understand and Rationalize. Read the notes, assigned literature papers, prepare your own summaries. Study in groups. ***Keep up to date! Ask Questions!!***

STUDENT CLASS ACCOMMODATIONS

Students with disabilities who require reasonable accommodations to fully participate in course activities or meet course requirements are encouraged to register with ADAPTS-Disability Services Program at (404)894-2564 or www.adapts.gatech.edu and contact me to discuss access issues.

GEORGIA TECH ACADEMIC HONOR CODE: Please visit www.honor.gatech.edu

When copying any written material use "Quote and attribute any words that are not your own." Do not cut and paste more than 1 % of a paper; any percentage more than this will be considered plagiarism. This includes the use of "word." (With "word" being any material a student may have acquired from a previous semester of this class.) With "word" being any material a student may have acquired from a previous semester of your class. Use of any previous semester course materials is allowed for this course; however, I remind you that while they may serve as examples for you, they are not guidelines for

any tests, quizzes, homework, projects, or any other course work that may be assigned during the semester.

For Tests: Cheating off of another person's test or quiz is unethical and unacceptable. Cheating off of anyone else's work is a direct violation of the GT Academic Honor Code, and will be dealt with accordingly. For any questions involving these or any other Academic Honor Code issues, please see me or consult www.honor.gatech.edu.