Special Topics in Organic Chemistry
Biorenewable Polymers – 8833/4803
2008

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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.

Week	Topics
1	Introduction Role of biopolymers now and the future Carbohydrate/lignin nomenclature Chemistry of Mono and Oligosaccharides
2	Chemistry of Mono and Oligosaccharides
3	Chemistry of Mono and Oligosaccharides
4	Chemistry of Carbohydrate Hydroxyl Groups
5	Chemistry of Carbohydrate Hydroxyl Groups ***Homework Assignment***
6	Synthesis of oligosaccharides/polysaccharides
7	Synthesis of oligosaccharides/polysaccharides ***Mid-term Exam***
8	Synthesis of oligosaccharides/polysaccharides
9	Isolation, Structure, and Chemistry of Lignin
10	Isolation, Structure and Chemistry of Lignin
11	Student Seminar
12	Student Seminar
13	Student Seminar
14	Student Seminar
15	Student Seminar
16	Student Seminar
17	Exam Week - Final Exam