# Whistler Center Short Course Agenda

**Tuesday, October 21, 2014**

All Sessions Tuesday, October 21st are in STEW 206. “Meet the Whistler Center Faculty Reception” after the sessions in Purdue Memorial Union (2nd Floor) East Faculty Lounge. Purdue Memorial Union Building is the building located east of Stewart Center.

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
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<tbody>
<tr>
<td>8:00 a.m. - 8:30 a.m.</td>
<td>Registration STEW 206</td>
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<tr>
<td>8:30 a.m. - 9:40 a.m.</td>
<td>Introduction to structures and properties of polysaccharides, J. BeMiller</td>
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<tr>
<td>9:40 a.m. - 10:15 a.m.</td>
<td>Polysaccharide architecture, R. Chandrasekaran and S. Janaswamy</td>
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<td>10:15 a.m. - 10:35 a.m.</td>
<td>Break</td>
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<td>10:35 a.m. - 11:50 a.m.</td>
<td>Starch granule structure and properties, J. BeMiller</td>
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<tr>
<td>11:50 a.m. - 12:35 p.m.</td>
<td>Basic principles in rheology, M. Kale</td>
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<tr>
<td>12:35 p.m. - 2:00 p.m.</td>
<td>Lunch/Break</td>
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<tr>
<td>2:00 p.m. - 2:30 p.m.</td>
<td>Enzymatic and physical modification or conversion of starch, Y. Yao</td>
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<td>2:30 p.m. - 3:10 p.m.</td>
<td>Polyols and high-intensity sweeteners, Y. Yao</td>
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<tr>
<td>3:10 p.m. - 3:25 p.m.</td>
<td>Break</td>
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<tr>
<td>3:25 p.m. - 4:40 p.m.</td>
<td>Chemical modification of polysaccharides, J. BeMiller</td>
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<tr>
<td>5:00 p.m. - 7:00 p.m.</td>
<td>“Meet with Whistler Center Faculty Reception” – Purdue Memorial Union on 2nd floor - East Faculty Lounge. The Union Building is located directly East of Stewart Center.</td>
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Sessions 1A/1B and 6A/6B cover the same materials. They are not a continuation of the previous session. This allows more flexibility in choosing which session to attend. Please choose one morning and one afternoon session each day.

Drinks and refreshments are available in STEW 218D on Wednesday and Thursday. You may take them back to the classroom with you.

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**Wednesday, October 22, 2014 (All Sessions 2nd Floor of Stewart)**

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
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<tbody>
<tr>
<td>7:45 a.m. - 8:30 a.m.</td>
<td>Carbohydrate nutrition, B. Hamaker</td>
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<tr>
<td>8:30 a.m. - 11:30 a.m.</td>
<td>1A. - Advances in chemical and physical modifications of starch, J. BeMiller</td>
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<td></td>
<td>2A. - Beverage emulsions, encapsulation, G. Narsimhan and S. Janaswamy</td>
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<td></td>
<td>3A. – Food product reformulation: less sugar, less salt, less fat, more fibres, Stefano Renzetti, TNO, Netherlands</td>
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<td></td>
<td>4A. – Rheology of polysaccharides: Concepts and experimental techniques, M. Kale</td>
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<tr>
<td>11:30 a.m. - 1:00 p.m.</td>
<td>Lunch</td>
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<tr>
<td>1:00 p.m. - 4:00 p.m.</td>
<td>5A. – Complex carbohydrate structure analysis (non-starch), B. Reuhs</td>
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<td>6A. Hydrocolloids and functionality, J. Keller</td>
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<td></td>
<td>7A. - Polysaccharide-protein interactions, O. Jones</td>
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<tr>
<td>4:00 p.m. - 5:20 p.m.</td>
<td>Tour of Whistler Center Laboratories (optional) – Please meet in STEW 206 if you would like to go. You may leave your notebooks, etc. in STEW 206 as someone will be in the room during the tour.</td>
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**Thursday, October 23, 2014 (All Sessions 2nd Floor of Stewart)**

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
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<tr>
<td>8:30 a.m. - 11:30 a.m.</td>
<td>1B. – Advances in chemical and physical modifications of starch, J. BeMiller</td>
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<tr>
<td></td>
<td>6B. Hydrocolloids and functionality, J. Keller</td>
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<tr>
<td></td>
<td>9B. Extrusion and industrial products, O. Campanella</td>
</tr>
<tr>
<td>11:30 a.m. - 1:00 p.m.</td>
<td>Lunch</td>
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<tr>
<td>1:00 p.m. - 4:00 p.m.</td>
<td>11B. – Predictive modeling of multicomponent systems, G. Narsimhan</td>
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<td>12B. – Phenolics and CHOs in food and nutrition, M. Ferruzzi</td>
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<tr>
<td></td>
<td>13B. - Polysaccharide architecture and functionality including starch, R. Chandrasekaran and S. Janaswamy</td>
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<td>14B. – Carbohydrate digestion and sustained energy, B. Hamaker</td>
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</table>
Introduction to structures and properties of polysaccharides, J. BeMiller:

A. Chemical structures of polysaccharides
   1. Chirality of monosaccharides
   2. Monosaccharide ring structures
   3. Chair conformation of rings and its implication
B. Glycosidic linkages
C. Oligosaccharides
D. Polysaccharides
   1. Structures
      a. Introduction to chain conformations
      b. Branching
      c. Types of monomer units
      d. Classification by structure
      e. Polydispersity and polymolecularity
      f. Depolymerization
   2. Properties
      a. Dissolution
      b. Viscosity as a function of molecular shape and size
      c. Viscosity as a function of concentration
      d. Basics of solution rheology
      e. Gelation
         i. Formation of gels
         ii. Characteristics of gels

Polysaccharide architecture, R. Chandrasekaran and S. Janaswamy

A. Experimental techniques for determining molecular structures
   1. X-ray diffraction
   2. Electron diffraction
   3. Neutron diffraction
   4. Nuclear magnetic resonance spectroscopy
   5. Atomic force microscopy
B. X-ray analysis
   1. Diffraction principles
   2. Molecular modeling
   3. Fiber diffraction analysis
   4. Powder diffraction analysis
C. Neutral polysaccharides
   1. Molecular structures of cellulose, mannan and chitin
   2. Influence of substituents on physical properties
   3. Galactomannans
   4. Curdlan
   5. Arabinogalactan

Starch granule structure and properties, J. BeMiller

A. Structures of amylloses
B. Structures of amylopectins
C. Starch granules
   1. Appearance
   2. Organization
      a. Rings
      b. Crystallinities
c. Blocklets
d. Crystallite packing

D. Thermal properties of granules
   1. Gelatinization and gelatinization temperature range
   2. Pasting
   3. Retrogradation
   4. Gelation

E. Some differences between native starches

**Basic principles in rheology, M. Kale**

A. Basic definitions in rheology
B. Classification of materials from a rheological standpoint
C. Fundamental and empirical rheological methods
D. Applications of rheological data in product development, basic research and processing

**Enzymatic and physical modification or conversion of starch, Y. Yao**

A. Introduction of enzymes
B. Enzymatic starch degradation: *MW reduction to small sugars or oligosaccharides*
   1. Starch refining
   2. Cyclodextrin
   3. Maltooligosaccharides and isomaltooligosaccharides
   4. Debranched starch for making resistant starch
C. Enzymatic starch modifications: *no or minor MW reduction, or MW increase*
   1. Modification by beta-amylase and maltogenic alpha-amylase
   2. Increased branching by starch branching enzymes
   3. Alpha-glucan chain extension by amylucrase
D. Physical starch modifications
   1. Hydrothermal treatment
   2. Irradiation and microwave
   3. High pressure processing

**Polyols and high-intensity sweeteners, Y. Yao**

A. Sweetness
B. High intensity sweeteners
C. Economics of commercial sweeteners
D. Polyols
   1. Definition and natural occurrence
   2. Molecular structure and industrial manufacture
   3. Physico-chemical and sensory properties
   4. Food energy value and dental health
   5. Food applications
   6. Polyol table for food technologists

**Chemical modification of polysaccharides, J. BeMiller**

A. Reasons for modification
B. Ways to modify polysaccharides
C. Starch modification processes (means and effects of)
   1. Crosslinking
   2. Stabilization
   3. Octenylsuccinylation
   4. Acid treatments
   5. Oxidation
   6. Multiple modifications
7. General methods for derivatization
8. Graft copolymerization

D. Modified celluloses
   1. Water-soluble derivatives
   2. Hydrophobic derivatives

E. Guar gum derivatives
F. Alginates
G. Pectins
H. Minor derivatives

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Advanced Sessions, October 22-23, 2104

Carbohydrate nutrition, B. Hamaker – Session Outline Being Prepared

1A/1B - Advances in chemical and physical modifications of starch, J. BeMiller:

I. Chemical Modifications
   A. Factors affecting starch derivatization
      1. Surface pores and channels
      2. Location of reaction sites within granules
      3. Effect of the reaction medium on derivatization (changed)
      4. Effect of the average number of channels on corn starch derivatization
      5. Effects of reagent type on granular reaction patterns
      6. Effect of order of reagent addition on reaction efficiency
      7. Other factors affecting reaction patterns
   B. Differences in modification of amylose vs. amylopectin
   C. Starch chemical modification processes
      1. Standard process
      2. Reaction in aqueous alcohol slurries
      3. Dry or semi-dry reactions
      4. Reactive extrusion
      5. Reaction under high hydrostatic pressure

II. Non-chemical Modifications
   A. Thermal treatments
      1. Pregelatinized starch
      2. Cold-water-swelling/-soluble starch
      3. Heating of dry starch
      4. Heat-moisture treatments
         a. Microwave heating
      5. Annealing
   B. Non-thermal treatments
      1. Milling
      2. Sonication
      3. High-pressure treatments
         a. Instantaneous controlled pressure drop
         b. Use of high-pressure homogenizers
         c. Dynamic pulsed pressure
   C. Other claims of physically modified starch
      1. Pulsed electric field
      2. Osmotic pressure treatment
      3. Irradiation
         a. Gamma rays
         b. Ultraviolet rays
2A - Beverage emulsions, encapsulation, G. Narsimhan and S. Janaswamy:

A. Beverage emulsions formulation
B. Formation of beverage emulsions - homogenization
C. Different mechanisms of emulsion destabilization
   1. Creaming
   2. Brownian flocculation
   3. Disproportionation
   4. Coalescence

D. Interparticle forces
   1. van der Waals interaction
   2. Electrical double layer
   3. Steric interaction
   4. Depletion forces due to free macromolecules

E. Colloid stability
   1. Stability ratio
   2. Critical flocculation concentration

F. Destabilization due to shear and temperature

G. Particle characterization
   1. Particle size measurements - light scattering, coulter counter, microscopy
   2. Particle electrophoresis - zeta potential

H. Control release of drug molecules
I. Methods to increase the drug solubility
   1. Salt formation
   2. Co-solvents
   3. Complexation
   4. Surfactants
   5. Prodrugs
   6. Cocrystals

J. Methods for controlled release
K. Hydrocolloids as delivery vehicles

3A – Food product reformulation: less sugar, less salt, less fat, more fibres, Stefano Renzetti, TNO, Netherlands: Session Outline Being Prepared

4A - Rheology of polysaccharides: Concepts and experimental techniques, M. Kale:

A. Relevance of rheology in food science and industry
B. Concepts in rheology
   1. Viscosity
      i. Shear flow and viscosity
      ii. Extensional flow and viscosity
      iii. Measurement techniques
   2. Newtonian and non-Newtonian fluids
   3. Plastic fluids
      i. Concept of yield stress
      ii. Measurement of yield stress
   4. Time dependent inelastic fluids – Thixotropy and rheopexy
   5. Intrinsic viscosity – Concept, importance and measurement
C. Rheological models for different types of fluids
D. Viscoelasticity
   1. Spectrum of material properties
   2. Concept of viscoelasticity
   3. Modeling of viscoelastic behavior
   4. Measurement techniques, with an emphasis on characterization of gels
E. Overview of experimental techniques in rheology – Empirical measurements versus fundamental measurements
F. Application of concepts of rheology to product and process development
5A – Complex carbohydrate structure analysis (non-starch), B. Reuhs:

A. Origins of non-starch polysaccharides:
   1. Plant cell walls
   2. Bacterial culture
B. Initial extractions
C. Crude and fine separation
D. Structural analysis
   1. PAGE and MS
   2. GC and GC-MS
   3. NMR

6A/6B - Hydrocolloids and functionality, J. Keller:

A. History/Nomenclature
B. Basic Hydrocolloid Structural Types
C. Structure /Function Relationships
   1. Common functions: viscosity, gelling, fluid gel
   2. Overview of various functions
   3. Polymer Chain of Command (How to choose gums for applications)
D. Families of The Various Hydrocolloids
E. Structure, Chemistry, Properties & Applications of Each Family
   1. Exudates: Acacia, Tragacanth
   2. Extracts: Pectin, Carrageenan, Alginates, Chitin
   3. Seed Gums: LBG, Guar, Tara, Miscellaneous
   4. Microbial Gums: Xanthan, Gellan
   5. Cellulosics: CMC, MC, HPC, HPMC, MCC
   6. Synthetic: PVPP
F. Some Key Factors Influencing Gum Functionality
   1. Particle Size
   2. Synergy
   3. Nutraceuticals
   4. Availability
G. Some Case Studies For Gum Application

7A - Polysaccharide-protein interactions, O. Jones:

A. Relevance and applications of polysaccharide-protein interactions in food and pharma
B. Basic Polymer Physics to describe polysaccharides & proteins
   1. General Terminology
   2. Essential analytical approaches
C. Simple coacervation
   1. Defining coacervate phases
   2. Predicting phase behavior
      a. Interaction parameters
      b. Separation: Binodal & Spinodal
D. Thermodynamic incompatibility
   1. Historical perspective
   2. Predicting phase behavior
      a. Thermodynamic parameters
      b. General trends
      c. Polysaccharide/protein factors
   3. Using diagrams
E. Complex Coacervation
   1. Historical perspective
   2. Thermodynamics
3. Polysaccharide/protein factors

8A - Importance of water in the physical and textural shelf-stability of food products from powders to multi-component food, Stefano Renzetti, TNO, Netherlands Session Outline Being Prepared

9B - Extrusion and industrial products, O. Campanella: Session Outline Being Prepared

10B - Physical property testing of carbohydrates, O. Jones and L. Mauer: Session Outline Being Prepared

11B - Predictive modeling of multicompact systems, G. Narsimhan: Session Outline Being Prepared

12B - Phenolics and CHO's in food and nutrition, M. Ferruzzi: Session Outline Being Prepared

13B - Polysaccharide architecture and functionality including starch, R. Chandrasekaran and J. Srinivas:
   A. Morphology of polysaccharides
      1. Charge-based classification
      2. Chitosan
      3. Pectins
      4. Alginates
      5. Gellan family
      6. Carrageenans
      7. Xanthan
      8. Synergy between polysaccharides
   B. Amylose family
      1. Amylose A, B and V-forms
      2. Amylopectin
      3. Derivatives of amylose
   C. Starch
      1. Granule architecture
      2. Crystalline, semi-crystalline and amorphous regions
      3. Estimation of crystallinity
      4. A, B and C types
      5. Effect of crystallinity on functional properties

14B - Sustain energy, B. Hamaker: Session Outline Being Prepared