CHEM 537: Carbohydrate Biochemistry and Glycobiology
Instructor: Professor Anthony S. Serianni
Fall 2014

8:10-9:15 AM, MWF, 322 Jordan
November 14 – December 12, 2014

PART A: Monosaccharides, Oligosaccharides and Polysaccharides

Textbook
Biochemistry, 4th Edition, Voet/Voet, Wiley, 2011
Chapter 11: Sugars and Polysaccharides
Chapter 23: Other Pathways of Carbohydrate Metabolism

Supplemental Text (useful for course; on reserve in Chem/Phys Library)
M. E. Taylor and K. Drickamer, *Introduction to Glycobiology*, 3rd Ed., Oxford, 2011

Literature Reading: Distributed electronically

Topics:

- Aldoses and ketoses: structures, nomenclature, absolute configuration
- Cyclization: furanose and pyranose ring forms; anomeric configuration
- Anomerization (implications for saccharide binding proteins)
- Relative stabilities of cyclic forms
- Acyclic forms: *aldehydo* and *keto* forms, and their hydrates
- Ring conformation: conformational averaging
- Exocyclic conformations (C-O, *N*-acetyl, CH_2OH)
- Amphiphilic character of saccharides (implications for receptor binding)
- Saccharide solvation: H-bonding behaviors
- Monosaccharide derivatives:
  - Phosphate esters
  - Sulfate esters
  - Aminosugars
  - Deoxysugars
  - Alditols
  - Aldonic acids (lactones)
  - Uronic acids
  - Dicarbonyl sugars (osones)
  - α-ketoacids (sialic acid, KDO)
- Aldose-ketose isomerization (chemical, biological)
- Di- and oligosaccharide nomenclature
- Formation of glycosidic bonds: disaccharides (chemical, biological)s
- Mechanisms of glycoside bond formation and hydrolysis
- Phi/psi plots for glycosidic linkages
- Factors affecting linkage conformation; linkage flexibility and dynamics
- Diversity of glycosidic linkages
- Biological polysaccharides (homo and hetero)

Protein glycosylation (*N*-linked and *O*-linked)
Glycosaminoglycan structure (importance of sulfation)
Oligosaccharide structure determination (chemical and analytical methods)
Glycosyltransferases and glycosidases as reagents
Enzymic synthesis of oligosaccharides
Protein glycation (Amadori rearrangement, biological implications)
Biological interconversions of monosaccharides
Biosynthesis of sugar nucleotides

PART B: Glycobiology, Glycoconjugates and Glycoproteins

Textbook
Biochemistry, 4th Edition, Voet/Voet, Wiley, 2011
Chapter 23: Other Pathways of Carbohydrate Metabolism
Section 3: pp. 880-892

Supplemental Text
M. E. Taylor and K. Drickamer, *Introduction to Glycobiology*, 2nd Ed., Oxford, 2006

Literature Reading (Optional)
L. Lehle, S. Strahl and W. Tanner, Protein Glycosylation, Conserved from Yeast to Man: A Model Organism Helps Elucidate Congenital Human Diseases, *Angew. Chem. Intl. Ed. Engl.* **2006**, *45*, 6802-6818.

J. G. Leroy, Congenital Disorders of *N*-Glycosylation Including Disease Associated With *O*- as Well as *N*-Glycosylation Defects, *Pediatric Research* **2006**, *60*, 643-656.

P. M. Rudd, T. Elliott, P. Cresswell, I. A. Wilson and R.A. Dwek, Glycosylation and the Immune System, *Science* **2001**, *291*, 2370-2376.

A. Helenius and Markus Aebi, Intracellular Functions of *N*-Linked Glycans, *Science* **2001**, *291*, 2364-2369.

Topics:
Eucaryotic glycoproteins: structure, biosynthesis, and function of the N-linked "glyco" moiety, with emphasis on biosynthesis.

A. Structure
1. Structures of *N*-linked high-mannose, bi-, tri-, tetra-antennary complex, and hybrid saccharide moieties with common core structures.

B. Biosynthesis
1. Biosynthetic origin of sugar nucleotides required for biosynthesis of the saccharide moieties of glycoproteins.

2. Dolichol phosphate (Dol-P) as lipid intermediate in the assembly of oligosaccharide moieties (Dol-P-P-Oligo) in the endoplasmic reticulum (ER).

3. Dolichol cycle involving reactions on the cytosolic and lumenal sides of the endoplasmic reticulum.

4. Oligosaccharyltransferase (OST) reaction for the transfer of oligosaccharide to asparagine residues of nascent protein in the ER lumen.

5. Involvement of glucose residues of the saccharide moiety of nascent glycoprotein in processing (calnexin-calreticulin cycle) of saccharide moiety, protein folding, and transfer to Golgi complex.

6. Processing reactions in the Golgi complex leading to various saccharide structures of glycoproteins.

7. Selected methods for the release of saccharides from Dol-P and protein, and for characterizing the released saccharides.

C. Function: Congenital disorders of glycosylation (CDG)

1. Distinguishing Type-I CDGs at the dolichol cycle level from Type-II CDGs at the glycosylated protein level.

2. Detailed characterization of several CDGs at the Dol-P-P-saccharide level, the glycoprotein level, and the gene level.

Time permitting, *O*-linked glycans in eukaryotic glycoproteins (not proteoglycans), and glycolipids, will be discussed.

Testing and Grading

There will be four (4) Assignments administered during the course as follows:

Assignment 1: Collaborative, Open Book
Released November 20; Due November 24
15 points

Assignment 2: Collaborative, Open Book
Released November 25; Due December 2
25 points

Assignment 3: Collaborative, Open Book
Released December 3; Due December 10
30 points

Assignment 4: Non-Collaborative, Open Book
Released December 11; Due December 16
30 points