

## University of Maryland Baltimore County

Chem. 435/635 – Biochemistry of Complex Carbohydrates – Fall 2013

Instructor: C. Allen Bush – Room 243 Chemistry ext. 5-2506

Text: "Introduction to Glycobiology" Third edition (2011)

by M.E. Taylor and K. Drickamer

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- 1. Basic chemistry of carbohydrates. (Text Chapter 1)
  - Monosaccharides, stereochemistry, chemical functionality.
  - Glycosides, disaccharide linkage, oligosaccharides, polysaccharides
- 2. N-linked Glycoproteins (Text Chapter 2)
  - Constituent monosaccharides, Covalent glycopeptide linkages, Microheterogeneity
  - Asparagine N-linked glycopeptides. Glycosylation of Recombinant glycoproteins and antibodies (IgG).
  - High Mannose chains – IgM, Complex antenna chains - sialic acids.
  - Glycosidase digestion of N-linked glycopeptides
  - exo- and endoglycosidases, endo H, endo F, endo  $\beta$ -galactosidase, peptide N-glycanase
- 3. O-linked Glycoproteins (Text Chapter 3)
  - O-glycosidic linkage in serum glycoproteins
  - Mucin glycoproteins
  - antifreeze glycoproteins, ovarian cyst mucins, blood group substances.
  - O- $\beta$ -GlcNAc in cytoplasmic and nuclear proteins
  - Glycosaminoglycans and Proteoglycans – Chondroitin, hyaluronic acids, Heparin, dermatan. Cartilage, basement membrane and cell surface proteoglycans.
- 4. Glycolipids and Plasma Membranes (Text Chapter 4)
  - Carbohydrates at the outer surface of cells. Membrane glycoproteins. Red cell glycophorin, band 3.
  - Glycolipids. sphingosine, ceramides
  - Gangliosides, globosides, human milk oligosaccharides
  - Tumor antigens. Lewis blood groups. Sialyl Lewis<sup>X</sup> type, Embryonic antigens
  - Role of Lewis oligosaccharides in inflammation and tumor metastasis.
  - Glyco-phosphatidyl Inositol anchors. Membrane glycoprotein anchors compared with peptide anchors. Trypanosome variant surface glycoprotein glycan structure.
- 5. Biosynthesis of Complex Carbohydrates (Text Chapter 5 )
  - Biosynthesis of N-linked glycoproteins. endoplasmic reticulum, golgi, lipid-linked oligosaccharide, dolichol.

- Oligosacharyl transferase
- Processing of the oligosaccharide, resynthesis.
- Cellular targeting of the glycoprotein.
- Role of glycosylation in protein folding.
- Biosynthesis of O-linked glycoproteins. Mucins.
- 6. Analysis of complex carbohydrates – Glycomics (Text Chapter 6)
  - Chromatography. HPLC, GC analysis of sugar composition.
  - Oligosaccharide fractionation by HPLC
  - Methylation analysis, Smith degradation.
  - Mass spectrometry for structure determination.
  - NMR analysis by  $^1\text{H}$  and  $^{13}\text{C}$  spectroscopy.
- 7. Conformations of Oligosaccharides and Polysaccharides (Text Chapter 7)
  - Conformation and Dynamics of Oligosaccharides.
  - Glycosidic dihedral angles
  - x-ray crystallography, NMR spectroscopy, conformational modeling
- 8. Protein-Carbohydrate interaction –
  - Lectins decode the information stored in complex carbohydrates
  - Plant lectins, Con-A, ricin, blood typing, mitogenic stimulation
  - Bacterial adhesion, polysaccharides and bacterial lectins.
  - S- and C-type animal lectins. Soluble lectins and tissue-specific differentiation.
  - Selectins and inflammatory response.
  - Humoral and cell associated lectins from invertebrates.
- 9. Bacterial Cell Surface Carbohydrates
  - Cell wall peptidoglycan, cell wall polysaccharides, capsules
  - extracellular polysaccharides, lipopolysaccharides, endotoxin, lipid A, O-antigens
  - Genes in the synthesis of bacterial polysaccharides: glycosyl transferases, membrane transport proteins, polymerases.
  - Bacterial adhesion in pathogenesis. Bacterial polysaccharide vaccines.
- 10. Chemical and enzymatic synthesis of complex oligosaccharides and glycopeptides.
  - Chemical reactions for glycosylation. Protecting groups. Regioselectivity and stereoselectivity.
  - Enzymatic glycosylation, mechanisms of glycosyltransferases. Transglycosylation by genetically engineered glycosidases