**Glycomics/Glycobiology**

Glycomics is a field that is a logical offshoot of the fields of genomics and proteomics and is considered as a sub-discipline of metabolomics. Glycobiology is the study of the structure, function and structure-function relationships of carbohydrates known to carry and store significant biological information crucial in virtually all physiological and pathophysiological processes.

The DNA blueprint of a cell, the genome, encodes the proteome. Intron and exon splicing complicates the structural proteomics and the function of each protein (functional proteomics) is complicated by our inability to translate linear sequence to folded protein structure and to predict protein function from folded structure. The proteome is directly responsible for the synthesis of the metabolome (all natural products). The proteome is further complicated by posttranslational modification, the most frequent of which is glycosylation. Over 60% of human proteins are glycosylated yet the structure and function of this glycosylation is relatively unexplored. Moreover, every animal cell is surrounded by a complex coating of carbohydrates known as the glycocalyx that is critical in signaling and in cell-cell interaction. The fields of structural glycomics and functional glycomics are being studied in the BCME Constellation.

Figure. The glycocalyx of an animal cell containing membrane bound glycolipids, glycoproteins and proteoglycans is shown.
**Stem Cell Glycomics:** The embryonic stem cell is a pluripotent cell line, isolated from the inner cell mass of an embryo, and is capable of differentiating into all types of cells making up an organism. Thus, the study of embryonic stem cells is important to understand the basic science of developmental biology and also for the practical application of creating cell lines, tissues and organs that can be used in the fields of tissue engineering and regenerative medicine. The glycocalyx of the embryonic stem cell is assumed to be simpler than a differentiated cell as it does not require cell-cell communication with a complex array of other cell types common in a complex organism. As a stem cell differentiates down various lineages into various cell types, its communication tasks become more complex and so must its glycome. Furthermore, the glycocalyx of a cell and the glycans in its surrounding comprising the extracellular matrix form a glyconiche that can serve to control the growth and differentiation of a stem cell. Work in the BCME constellation is focused on understanding how the glycome changes as an embryonic stem cell differentiates and how the glyconiche of a stem cell controls its growth and differentiation.

![A](image1.png)  
**Figure.** Differentiation of an embryonic stem cell can be followed by the transcript level of mRNA corresponding to markers that characterize its state of differentiation.

The transcript levels of mRNA, encoding biosynthetic enzymes involved in glycan biosynthesis in the Golgi, can also be determined by qPCR. The levels of these proteins are determined by quantitative Western blotting analyses and their activity are determined. The product of this biosynthesis, glycans such as the glycosaminoglycan chains of proteoglycans are determined by structural glycomic analysis.
Figure. Biosynthesis of glycosaminoglycans in the Golgi relies on 18 types of enzymes and affords very complex glycan structures.

The functions of glycans in the glycocalyx and extracellular matrix with different structures on controlling stem cell differentiation are determined using cell-based microarray technologies.
Figure. A cell-based microarray can be used with immunofluorescence to detect the state of cell differentiation and how added signaling molecules, such as glycans can impact the state of differentiation.

**Structural Glycomics in animal cells related to physiology/pathophysiology:** The normal physiology of cells within an animal organism is regulated through signaling. This signaling can be autocrine, paracrine or endocrine, and it can be through growth factors, chemokines, hormones, or through cell-cell contact. This complex signaling frequently involves the participation of the gycocalyx and extracellular matrix and is critical for normal physiological function. In addition to normal physiological processes, much pathophysiology is associated with the subversion of the normal glycome or an abnormal glycome. For example, in malaria, the normal glycome of the mosquito and the human hosts are subverted by the parasite to gain entry and infect. An understanding of the similarity between the mosquito and human glycome could offer novel therapeutic approaches to the prevention of this disease.
Figure. The glycan receptor in the human liver and the mosquito midgut for the plasmodium parasite are structurally similar glycosaminoglycans.