

GLYCOSCIENCE

GLYCOCONJUGATE RESEARCH—GLYCOSCIENCE—AND THE STUDY OF THE HUMAN GENOME ARE CONVERGING IN A NEW SYNERGY THAT IS ACCELERATING OUR UNDERSTANDING OF LIFE PROCESSES AND DISEASES. SEIKAGAKU IS APPLYING THIS KNOWLEDGE IN THE DEVELOPMENT OF NOVEL THERAPEUTICS.

Sugar Chains are Essential to Basic Life Functions

The word “sugar” is used as a collective term for substances consisting primarily of carbohydrates, which are made from carbon and water. (Depending on their sizes, these substances are classified into monosaccharides, oligosaccharides and polysaccharides.) Sugar chains (linearly connected sugars) are generally found linked to proteins and lipids, and known as “glycoconjugates.”

Sugars perform a wide range of functions and are indispensable for life. A well-known example is their role in the generation and storage of energy as glucose and glycogen. Sugars also have protective functions. Hyaluronic acid, which is a glycoconjugate sugar, has been known to support integrity of tissues by maintaining appropriate hydration between cells.

Ongoing advances in glycoconjugate research are uncovering the wide-ranging functions of sugar chains in biological phenomena at all stages of human development, from conception and organ development to tissue repair. Sugar chains produced in different parts of the body at different times participate in many life processes by facilitating exchanges of biological information and substances.

However, there are pathogens, such as the influenza virus, the cholera bacterium, and the *E. coli* O157 bacterium, that take advantage of the widespread presence of sugars by grabbing them as handles to invade the body. In order to stop this process of infection, the identification of target sugar chains and the development of drugs that interfere in this process have become urgent in health promotion at the global level.

Discovering involvement of sugar chains in cancers was an important medical advance. Some cancer cells produce abnormal sugar chains and use them to their advantage in growth, invasion and metastasis. Sugar chains are also responsible for the determination of each individual's blood group and are thus profoundly involved in transfusion and tissue compatibility in organ transplantation.

From conception until death, sugar chains are involved in all biological phenomena, normal and abnormal. Understanding life processes involving sugar chains is crucial for the future development of the health industry.

Sugar chains composed of sialic acid, N-acetyl glucosamine, galactose, mannose and other sugars form projections like branches from the surfaces of cells. They perform many functions together with the proteins that give the body its structure. They appear to be primarily used in recognition and interactions among cells. Spreading cancer cells and the pathogens seeking to enter the cell often use these sugar chains.

Glycoscience Applied to “Systems Biology”

Current interest in biological research focuses mainly on genetics and proteins. In the past 50 years since the discovery of the DNA double helix, scientists have been struggling to read this blueprint for life. It was imagined that we would be able to understand the “symphony of life” at the cellular level if only we could read the DNA “score.”

The reality has not been that simple. DNA is the molecule that carries genetic information in the form of sequences of four bases, and RNA forms complementary sequences from the DNA bases. The RNA base sequences, in turn, are used for synthesizing proteins. However, to complete protein molecules, sugar chains, phosphates and other substances must often be added. Indeed, it is estimated that sugar chains are added to about one-half of the proteins formed in animal cells. It is also known that sugar chains are the keys that control the three-dimensional shapes and functions of proteins.

To understand the drama of life, it is not enough simply to read the DNA code, or blueprint. We must also clarify the functions of proteins and sugar chains as the machinery made from the blueprint, or the “musicians,” if you will, of the symphony of life.

Approaches of biological research have changed as we move from the genomic (gene-related) era into the post-genomic (beyond genes) era. Advances in many fields of research have made it necessary to understand biological phenomena as an integral system, which led to the concept of “systems biology.”

Systems biology seeks to clarify how the various aspects of life are woven together into a complex drama of life by studying life as an integral system. From the perspective of systems biology, understanding functions of sugar chains is now seen as increasingly important to an understanding of the mysteries of biological phenomena.

The growing importance of glycoconjugate research offers new opportunities for Seikagaku Corporation, which has devoted over half a century to glycoscience and been a pioneer in the use of glycoscience to create new drugs.

