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Deoxyribonucleic acid imprinted biosensor technology

Dear Readers

In recent years, molecularly imprinted polymers (MIPs) have attracted much attention due to many of its potential applications including sensors, separation, catalysis, drug delivery and waste management. To prepare MIPs, functional monomers initially self-assemble around the template molecule via interaction between functional groups on both the template and the monomers. The self-assembled functional monomers are subsequently cross-linked in the presence of cross-linkers. Thereafter, the template molecules are removed from the MIPs, thereby leaving behind cavities/imprinted-structures that can specifically recognize and rebind with the template molecules, an analogy to the "key to lock" model. Hence, MIPs have the ability to mimic biological functions through their three-dimensional cavities of specific size, shape, and functionality for mimetic recognition of target molecules and have already shown valuable applications in the separation and recognition of glucose, cholesterol, hemoglobin, peptides, proteins, antibody, and double-stranded deoxyribonucleic acid (DNA).

The high selectivity and affinity of MIPs for the template molecule offers a promising approach to develop a new generation of biosensors including sequence-specific DNA biosensors. Compared to other types of biosensors, which use biologically active molecules such as single-stranded DNA (ssDNA) immobilized onto the electrode surface as sensing elements, biosensors based on MIPs offer three advantages: (1) high affinity and selectivity to the imprinted template (i.e., the target molecules); (2) superior stability compared with those using natural biomolecules in the biosensor structure; and (3) ease of fabrication and adaptation for various types of biosensors.

The conventional methods for the analysis of specific gene sequences are based on either direct sequencing or DNA hybridization. Because of the simplicity, DNA hybridization is more commonly used in the diagnostic laboratory than the direct sequencing method. In DNA hybridization, the target gene sequence is identified by a DNA probe that can form a double-stranded hybrid with its complementary nucleic acid with high efficiency and extremely high specificity in the presence of a mixture of many different, non-complementary, nucleic acids. DNA probes are single-stranded oligonucleotides, labeled with either radioactive or non-radioactive material, to provide detectable signals for DNA hybridization. Radioactive labels are extremely sensitive, but have the obvious disadvantage of short shelf life, risks associated with exposure of personnel to radiation, cost, storage and disposal problems. On the other hand, non-radioactive probes, such as enzymatic or luminescence labels are less sensitive and flexible in terms of design and application. However, large-scale, routine clinic screening based on gene diagnostics is limited by the currently available technologies. Therefore, it can be anticipated that DNA imprinting technology may have potential to develop future advanced DNA biosensors with an ease of fabrication, low cost, high affinity & selectivity, and superior stability.

With kindest regards,

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