PREFACE

I am very pleased to act as editor of this book, *Aptamers in Bioanalysis*. Aptamers started as therapeutic agents and in very few years they have become a hot topic in analytical chemistry. In our laboratory we are working on realizing reliable sensors and biosensors, and aptamers appear as optimal components for their assembling. Aptamers appear in this application as a new class of ligands with exceptional binding constants (micromolar to picomolar range). Aptamers are also entering many analytical applications, such as, in the technologies based on separation science (various chromatographic techniques or capillary electrophoresis). Many new exciting analytical problems can be solved with these new compounds.

The increasing presence of contaminants in food, air, or drinking water that are capable of causing intoxication, diseases, or chronic illness has led to the need for analytical systems capable of rapid, and often multianalyte, measurements of complex samples. This need also exists in the medical field where multiparameter diagnostic systems are increasingly required to detect all the well-known and the more recently discovered biomarkers for different diseases. Unfortunately for medical practitioners, disease-related biomarkers are either physiologically present in minute quantities or severely contaminated by nonspecific compounds in a patient's bloodstream or body fluid. Hence, highly sensitive as well as specific recognition elements are required for effective detection of such biomarkers.

When the detection system requires a biomolecular recognition event, antibody-based detection methodologies are still considered the standard assays in environmental, food, and clinical analysis. These assays are well established, and they have been demonstrated to reach the desired sensitivity and selectivity. However, the use

of antibodies in multianalyte detection methods and in the analysis of very complex samples encounter some limitations derived mainly from the nature and synthesis of these protein receptors. In order to circumvent some of these drawbacks, other recognition molecules are being explored as alternatives.

The awareness that nucleic acids, RNA in particular, can assume stable secondary structures and that they can be easily synthesized and functionalized, has opened the door for aptamers in several applications.

The main advantage is overcoming the use of animals or cell lines for the production of the molecules. Moreover, antibodies against molecules that are not immunogenic are difficult to generate. Aptamers, on the contrary, are isolated by in vitro methods that are independent of animals: an in vitro combinatorial library can be generated and exploited against any target. In addition, generation of antibodies in vivo means that the animal immune system selects the sites on the target protein to which the antibodies bind. The in vivo parameters restrict the identification of antibodies that can recognize targets only under physiological conditions limiting the extension to which the antibodies can be functionalized and applied.

Moreover, the aptamer selection process can be manipulated to obtain aptamers that bind to a specific region of the target, with specific binding properties, and in different binding conditions. After selection, aptamers are produced by chemical synthesis and purified to a very high degree eliminating the batch-to-batch variation found when using antibodies. By chemical synthesis, modifications in the aptamer can be introduced enhancing the stability, affinity, and specificity of the molecules. Often the kinetic parameters of an aptamer-target complex can be changed for higher affinity or specificity. Another advantage over antibodies can be seen in the higher temperature stability of aptamers; in fact, antibodies are large proteins sensitive to temperature that can undergo irreversible denaturation. On the contrary, aptamers are very stable and they can recover their native active conformation after denaturation.

The selection process itself, with the amplification step, gives some advantages to aptamers with respect to other "nonnatural" receptors, such as oligopeptides, which cannot be amplified during their selection procedure. Therefore, once again the polymerase chain reaction appears as the magic tool to solve the problem of obtaing highly selective ligands. Our colleagues in genetics departments are working to overcome this issue and in the future we will be happy to obtain from libraries other nice ligands of different nature, like polypeptides or polysaccharides, rather than oligonucleotides!

We now have a new class of biosensors, aptasensors, which use aptamers as highly selective recognition elements. As receptor molecules, aptamers allow widespread applicability to a diverse array of target analytes due to their analyte-impartial synthetic generation process. Aptasensors realized on micro- and nanoscale platforms afford many potential advantages, such as miniaturized construction; rapid, sensitive, and specific detection; high throughput; reduced

costs; and minimized material consumption. Thus, micro- and nanoaptasensors are highly attractive for a broad range of applications, such as proteomics, metabolomics, environmental monitoring, counterterrorism, and clinical diagnostics and therapeutics.

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