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Review

Biosensors in forensic analysis. A review

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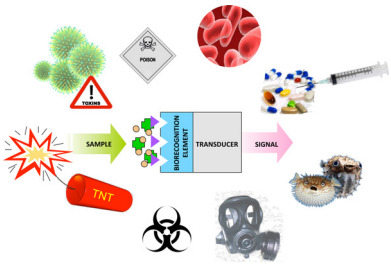
HIGHLIGHTS

- The role of biosensors in forensic analysis is critically reviewed.
- The different transduction modes of the biorecognition event are considered.
- The target analytes involved in forensic toxicological analysis are treated.
- Biosensors useful for detection of chemical and biological weapons are commented.
- Tables with the characteristics of biosensors for forensic analysis are provided.

GRAPHICAL ABSTRACT



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ABSTRACT

Forensic analysis is an important branch of modern Analytical Chemistry with many legal and socially relevant implications. Biosensors can play an important role as efficient tools in this field considering their well known advantages of sensitivity, selectivity, easy functioning, affordability and capability of miniaturization and automation. This article reviews the latest advances in the use of biosensors for forensic analysis. The different methodologies for the transduction of the produced biological events are considered and the applications to forensic toxicological analysis, classified by the nature of the target analytes, as well as those related with chemical and biological weapons critically commented. The article provides several Tables where the more relevant analytical characteristics of the selected reported methods are gathered.

Contents

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Paloma Yáñez-Sedeño obtained her Ph.D. (1983) from Complutense University of Madrid. In 1988 she gained a position of Assistant Professor in the Faculty of Chemistry of the University Complutense, and occupied the Academic Secretary at the Department of Analytical Chemistry from 1988 to 1992. Since 2008, she is a full Professor of Analytical Chemistry at the Complutense University of Madrid. Her research interests focus on electroanalysis, nanostructured electrodes, enzyme biosensors and immunosensors. She has over 120 publications including peer-reviewed papers, book chapters and text books. She has conducted fourteen Research Projects dedicated to the determination of additives, drugs and toxic compounds in food, and monitoring of doping substances, low molecular-weight hormones, and marker proteins of obesity and related diseases. She is currently Treasurer of the Spanish Royal Society of Chemistry.

Lourdes Agüí studied Chemistry in the Complutense University of Madrid, being graduated in 1992. Years later, in 1998, she earned her PhD at the same university. During her doctoral studies, she combined research and teaching activities at this University, where she also served organizational tasks. Also noteworthy during this period, her collaboration with different companies to carry out survey. During her postdoctoral period, she enjoyed two nationally recognized scholarship that allowed a stay at the Lab of Prof. Joseph Wang in New Mexico State University. Back after a few years as a senior lecturer, became an Assistant Professor in the Complutense University, in the Department of Analytical Chemistry of the Faculty of Chemistry, a position that continues today. Her researches focus on the use of miniaturized systems (carbon fibers) for the development of electrochemical sensors and flow coupling systems (FIA, HPLC) with electrochemical detection, and in the use of nanostructured electrodes for the design and developing of biosensors and immunosensors with application to the determination of doping substances. These investigations have yielded to date, more than 50 scientific publications including reviews and book chapters. Prof. Lourdes Agüí belongs, as a partner, to the Spanish Society of Analytical Chemistry (SEQA) and the Spanish Royal Society of Chemistry (RSEQ).

Reynaldo Villalonga was born in 1970 in Matanzas, Cuba. He studied Chemistry at the University of Havana, where he graduated with his Gold Diploma in 1993. During 1994 he worked on protein structures at the National Center for Genetic Engineering and Biotechnology and then joined the Laboratory of Bioinorganic Chemistry at the University of Havana. In 1996 he moved to the University of Matanzas, where he founded the Enzyme Technology Group and started works on neoglycoenzymes. He completed his Ph.D. degree in neoglycoenzyme synthesis in 2001 and was appointed as Full Professor and Founding Director of the Center for Enzyme Technology at the University of Matanzas in 2007. In 2010 he moved to the Complutense University of Madrid, Spain, where he held a Ramón y Cajal Research Professorship. He was a visiting Professor at the University of Naples "Federico Segundo", McGill University, Toyama Prefectural University, Firenze University, Vigo University and Joseph Fourier University. His research is focused on neoglycoenzymes, carbohydrate chemistry, drug delivery systems, biosensors and nanotechnology. He has been recognized with several honors and awards including seven prizes from the Cuban Academy of Sciences, the Development Cooperation Prize of Belgium (2001), the Third World Academy of Sciences Award for Young Chemist (2004), the National Award in Chemical Sciences (2006), the Prize of the Cuban Ministry of Science (2007), the Prize of Ministry of Higher Education (2004, 2007), the Japanese Society for the Promotion of Science Fellowship (2004, 2008) and the Carolina Foundation Fellowship (2007). Since 2001 he has promoted and organized the Latin American Network for Enzyme Technology "RELATENZ".

José M. Pingarrón obtained his Ph.D. (1981) from Complutense University of Madrid. Between 1982 and 1983, he did postdoctoral training at the École Nationale Supérieure de Chimie de Paris. Since 1994, he is a full Professor of Analytical Chemistry at the Complutense University of Madrid. José M. Pingarrón headed the Department of Analytical Chemistry at the Faculty of Chemistry between 1998 and 2006 and he was the President of the Spanish Society of Analytical Chemistry between 1998 and 2001. Professor Pingarrón is the recipient of the Faculty of Chemistry Medal, the Complutense University of Madrid Medal and the research award on Analytical Chemistry of the Spanish Royal Society of Chemistry. His research interests focus on analytical electrochemistry, nanostructured electrochemical interfaces and electrochemical and piezoelectric sensors and biosensors. He has over 270 publications including peer-reviewed papers, book chapters and text books. He is currently Vice-President of the Spanish Royal Society of Chemistry and is its representative in the Division of Analytical Chemistry of the European Association for Chemical and Molecular Sciences. Professor Pingarrón is Associate Editor of Electroanalysis journal and belongs to the Editorial Advisory Boards of the Journal of Electroanalytical Chemistry, Talanta, Analyst, Chemical Sensors and ChemElectroChem and Member of the Analytical Chemistry Division Committee of IUPAC. Moreover, Professor Pingarrón is co-founder of the "spin-off" company Inbea Biosensores S.L.

1. Introduction

Forensic chemical analyses are a frequent practice mainly in the toxicology field. In order to accomplish this task, various screening analytical methods able to detect the presence of one or several compounds with high impact or special interest in the corresponding samples have been proposed in the last years. Many of these methods are based on immunoassays using antigen-antibody reactions in which the antigen is, in general, the analyte to be detected. ELISA (enzyme linked immunosorbent assay) or RIA (radio immunoassay) methodologies are widely used in this field, although their application to biological samples is limited practically to urine or serum [1]. These methods possess important advantages such as rapidity, scarce sample manipulation and high sensitivity, but exhibit also significant disadvantages regarding the occurrence of false positives and negatives, the shortage of procedures with quantitative application and, sometimes, the lack of specificity. Because of that, the results provided by these methods require very often a further confirmation with other more complex analytical methodologies generally based on some instrumental technique such as chromatographic techniques hyphenated with mass spectrometry [2]. However, many of the above mentioned drawbacks can be overcome by the use of immunosensors. The development of these affinity biosensors has