New Nanobiotechnological Approaches For The Diagnostic Of Infectious And Cardiovascular Diseases

M.-Pilar Marco, Carme Pastells, Pablo Salvador, Gloria Colom, Nuria Sanvicens and Nuria Pascual

Applied Molecular Receptors Group (AMRg). Institute for Advanced Chemistry of Catalonia (IQAC) of the Spanish Council for Scientific Research (CSIC). CIBER de Bioingeniería, Biomateriales y Nanomedicina.
pilar.marco@cid.csic.es

Future trends in medicine demand for rapid, reliable diagnostic technologies able to assist doctors on a more personalized and efficient medicine. At the same time, the so-called “omic” technologies have accelerated the number of candidate biomarkers discovered pointing to a future in which the heath status or disease of an individual will be established based on molecular signatures or footprints showing if there is any alteration on the biomarker expression profiles. Biotechnology, microtechnology and more recently nanotechnology are the most promising emerging technologies of the last decades. At the interface of these sciences lies the nanobiotechnology (or the micro/nanobiotechnology) which makes use of the knowledge from these fields to create biological micro/nanosystems and biofunctional devices. The Nanobiotechnology and Biomolecular Diagnostics research line of the CIBER-BBN supports research in this direction with a clear aim to translate the results into the clinical arena. With this final goal, several ongoing projects are addressing the possibility to develop a new generation of improved diagnostic devices and biosensing systems based on novel nanobiotechnological approaches.

Examples illustrating the use of nanoparticles, nanostructured materials and microelectronic devices to create functional biohybrid materials for the detection of bioactive substances will be presented in this oral communication. Thus, reliable methods for rapid, selective detection of pathogens for diagnosing infectious diseases, being necessary single-cell detection for certain types of body fluids (ex. blood or cerebrospinal fluid) and microorganisms (Pseudomonas aeruginosa, Staphylococcus aureus, etc), causing nosocomial diseases. On the other hand, cardiovascular diseases (CVD) are a major cause of death in Europe. The disease develops through a series of consecutive steps in which several validated and candidate biomarkers have been identified. Development of diagnostic methods able to simultaneously detect a panel of representative biomarkers of each of these stages would allow early-diagnosis before heart failure occurs. Regarding multiplexation, an interesting approach is the use of nanoparticles with distinct optical or electrical properties, such nobel metal nanoparticles, quantum dots (QDs) or other types of nanoparticles that show great potential for multiplexation. As an example, a fluorescent quantum dot (QD)-based antibody array has been developed to detect *Escherichia coli* in serum samples. The microarray reaches a detectability of 1CFU mL^{-1}, three order of magnitude lower than the ELISA (enzyme-linked immunosorbent assay) using the same immunoreagents[1,2]. On the other hand, the localized surface plasmon resonance of noble metal nanorods with different aspect ratio allows envisaging the possibility to develop cost-effective multiplexed devices[3]. Similarly, in respect to electrochemical nanoprobes made of metal sulfides with distinct redox potentials. Finally, strategies for creating universal diagnostic devices based on DNA-directed immobilization approaches will also be discussed.

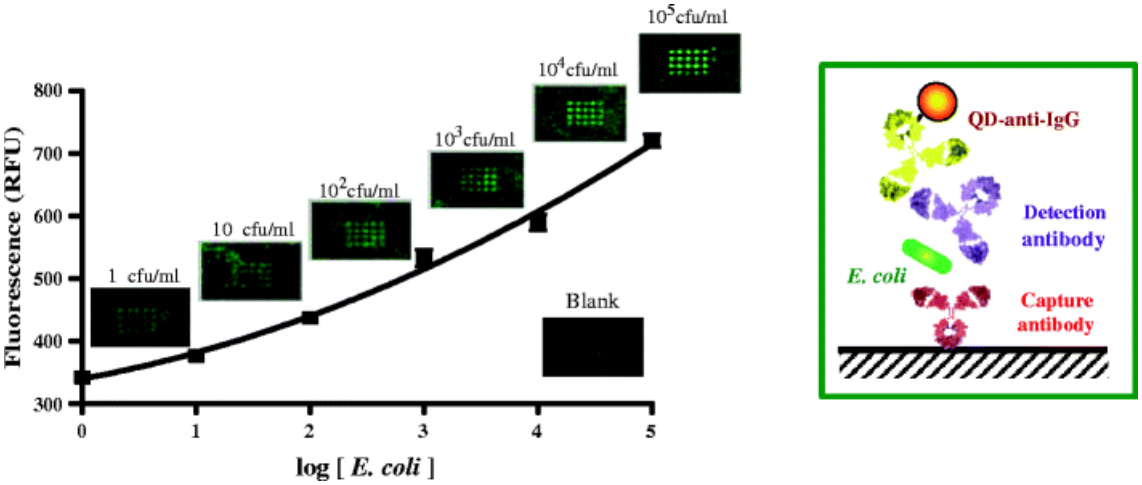
References

(1) Sanvicens, N.; Pascual, N.; Fernandez-Arguelles, M. T.; Adrian, J.; Costa-Fernandez, J. M.; Sanchez-Baeza, F.; Sanz-Medel, A.; Marco, M. P. Analytical and Bioanalytical Chemistry **399**, 2011, , 2755.

(2) Sanvicens, N.; Pastells, C.; Pascual, N.; Marco, M. P. TrAC - Trends in Analytical Chemistry **28,** 2009, 1243.

(3) Mannelli, I.; Marco, M. P. Analytical and Bioanalytical Chemistry **399**, 2011, 1923.

Figures



Dose-response curve for E. coli O157:H7 in a sandwich array-based assay. The standard curve was fitted to a quadratic polynomial equation as indicated by Herman et al [20] and the LOD was calculated using the statistical approach reported by Long and Winefordner [21]. Results correspond to the average and standard deviation of four assays run on 4 different days in duplicate (n = 12)