Preface

In recent years, bioanalytical chemistry has been playing an increasingly important role and this led it to occupy a unique and autonomous position within the analytical chemistry domain. Bioanalytical chemistry operates, indeed, in a decidedly interdisciplinary area where the basic concepts and typical methodologies of analytical chemistry strictly intersect with biochemistry, molecular biology and biotechnology, together with nanoscience and nanotechnology. Interestingly, such an impressive development of bioanalytical methods has followed two main paths, which are briefly summarised below.

On the one hand, there is the application and refinement of increasingly sophisticated and sensitive instrumental techniques that are based on the skilful use of advanced, but also very expensive, instrumentation providing bioanalytical information primarily based on the chemical–physical properties of biomolecules. In fact, remarkable bioanalytical applications have been recently made possible by applying advanced instrumental techniques such as chromatography, electrophoresis, spectroscopy and mass spectrometry.

On the other hand, new horizons have been opened by the equally impressive development of techniques and devices exploiting molecular recognition principles together with advanced transduction modes and unexpected miniaturisation capabilities offered by nanotechnologies.

These two faces of bioanalytical chemistry do not compete with each other but cover different specificities, showing different but complementary application capabilities.

The former includes purely instrumental methods aimed at maximising laboratory analysis capabilities, offering detection limits, accuracy and precision unthinkable until a few years ago. The second gathers biorecognition methods aimed at the development of low-cost analytical devices suitable for easy and rapid use, with high sensitivity and specificity. Such devices are made especially for decentralised analysis, as needed for point-of-care diagnostics in the biomedical field, for in-field environmental analysis or for online monitoring in the food and biotechnology production industry.

It is fascinating to see how the development of the analysis and sequencing of polynucleotides (DNA and RNA) often integrated the two paths mentioned earlier, since a continuously evolving combination of physical instrumental tools with sophisticated molecular processing and interactions led to significant advancements in our biological and biomedical knowledge. The role of technologies based and derived from the polymerase chain reaction is a really good example of this.

In light of the complexity and the growing importance of bioanalytical techniques, it is fundamental to provide future bioanalytical chemists with adequate knowledge and training tools. The importance of the availability of efficient, reliable and quick molecular diagnostic tools has been dramatically highlighted during

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the recent (and current at the time of writing) global crisis caused by the Covid-19 pandemic. This notwithstanding, in 2020 there is still a scarcity of didactic texts specifically dedicated to this sector. While a couple of excellent textbooks cover didactic needs concerning the bioanalytical application of what could be defined as "classical" instrumental techniques, the situation is completely different with regard to the bioanalytical applications of techniques based on molecular recognition and bio-nanotechnologies. In this specific field, a wide range of advanced texts aimed at expert researchers is indeed available; however, what is missing is the offer of didactic texts suitable for students. This deficiency looks particularly deleterious given the necessity of developing and validating a common interdisciplinary language, to be shared by the professionals who will be working in this area.

In order to try to fill this gap, this textbook is intended for graduate students attending courses in chemistry, biotechnology or material science, and the focus is mainly on giving an overview of the new technologies based on molecular recognition, sequencing and biosensing.

In order to limit the number of topics covered in the already content-rich six chapters that compose this book, it is taken for granted that the reader is already familiar with the basic concepts of analytical chemistry, from the knowledge of analytical data validation (such as calibration, accuracy, precision, sensitivity, detection and quantification limits) to the basic principles of modern instrumental techniques (i.e. spectroscopy, mass spectrometry, electrophoresis, electrochemical techniques, chromatography). In order to help the reader to fill eventual knowledge gaps or to facilitate a more in-depth study of specific topics of interest, a list of selected further readings is provided at the end of each chapter.

Despite the limits and specificity of the selected topics, we hope that this book, which does not want to be an exhaustive treatise of bioanalytical chemistry, may contribute to providing a clear foundational knowledge for the bioanalytical chemistry students, allowing them to understand the fascinating challenges behind the progress in this continuously evolving field.

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