Protein Nanotechnology: Protocols, Instrumentation and Applications

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Tuan Vo-Dinh (Ed.)
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This book will be noticed by those alarmed by the word ‘nanobiotechnology’ and anyone fearing the “grey goo” scenario first hinted at by nanotechnology theorist Dr. K. Eric Drexler in his 1986 book “Engines of Creation”. This was developed further in Michael Crichton’s “Prey” and more recently taken to the extreme by the media. But science fiction writers and readers will be disappointed if they are hoping to find doomsday material. This newly published volume, edited by Dr Vo-Dinh (a physicist by education and the author of over 300 research papers and of 5 books on spectroscopy and chemical analysis) is aimed at a broad scientific audience and provides an overview of the area of protein nanobiotechnology. It starts with an easy-to-read introduction, which is suitable for the general audience with or without a scientific background and it should calm down readers with a nervous predisposition to runaway self-replicating nano-machines, followed by a collection of nineteen articles, covering various aspects of protein analysis, protein engineering and protein based tools, technologies and nanosensors.

The main body of this volume may not be readily comprehended by the general reader and is more likely to suit readership with the relevant background in molecular biology, biochemistry, chemistry or physics. An initial scan of the Index, which goes from “Alzheimer’s disease” to “X-ray” via “Nanowires”, “Self-assembled monolayers” and “Tissue engineering”, is guaranteed to strike fear into hearts and minds of a general audience, to whom these represent alarming symbols of modern, uncontrollable science and technology developments. However, those reading further will discover nothing of the kind. Far from it, this book provides a detailed and well-referenced snapshot of the state-of-the-art in protein chemistry and physics as well as the realistic capabilities and practical applications of ‘nano’ and ‘nanobio’ technologies.

I found this book to be slightly biased towards optical and spectroscopic methods, which is not surprising taking into account the scientific background of the Editor. Four articles, which are written by or contributed to by Dr Vo-Dinh cover a range of technologies and sensors utilising fluorescence, Raman scattering and near-filed optical microscopy and describe their applications to protein analysis (not necessarily at nano-scale) and medical diagnostics. The remaining 15 articles cover basic protein biochemistry (folding and misfolding, 3-D structure, crystallisation), biomolecular interactions (at the ‘macro’ scale such as protein affinity reagents and immunoassays, as well as at ‘micro’ and ‘nano’ scales, such as particle- and microarray-based multiplex sensors, molecularly imprinted polymers), carbon nanotubes and their biosensor applications, scanning force and scanning electrochemical microscopy for molecular biosensing.

Some might argue that this book is a rather artificial collection of loosely related papers, but I would disagree strongly. This is a well balanced work with contributions from 50 experts from different but overlapping fields, which connects traditional approaches and techniques of studying proteins with the rapidly growing range of their ‘nano’ uses and applications. This book will provide a stimulating read and a good point of reference to an open minded scientist wishing to expand into the fascinating, interdisciplinary and largely unexplored ‘hyperspace’ of nanobiotechnology.

Mikhail Soloviev
School of Biological Sciences
Royal Holloway, University of London
United Kingdom

Microarrays in Clinical Diagnostics

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Thomas Joos and Paolo Fortina (Eds.)
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Microarray technology has developed into a well-established technology used in many laboratories all over the
world. The need to characterise genetic alterations is one of the highest priorities for the future of medicine.

High density DNA microarray technology has played a key role in the analysis of whole genomes and their gene expression patterns. The ability to study many thousands of individual genes using oligonucleotide or cDNA arrays is now widespread with applications ranging from the profiling of gene expression patterns in whole organisms or tissues to the comparison of healthy and pathological samples. Additionally, the technology allows the rapid detection of point mutations, insertions or deletions, loss of heterozygosity, or gene amplification. Furthermore, alterations in DNA methylation patterns which may cause diseases can be studied by microarray analysis.

However, despite the success of DNA microarrays, it is obvious that biological function is executed by biomolecules such as proteins. Therefore, protein biochips are emerging to follow DNA microarrays as a possible screening tool. Methods which are needed for identification and quantification, and for studying protein-protein interactions, enzyme-substrate interactions, and small molecule interactions are currently being developed. However, several requirements in diagnostics such as sensitivity, specificity, high throughput, cost effectiveness and turn-around time need to be improved.

Joos and Fortina have assembled a collection of competent and leading contributors who give a comprehensive survey of the different technologies now in use and, additionally, provide detailed method sections enabling scientists in design and performance of microarray experiments.

The first major part of the book is focused on DNA microarrays and comprises nine independent articles. Most of the methods are focused on the detection and analysis of single nucleotide polymorphisms (SNPs), which is of major interest in molecular medicine. Current medical and diagnostic questions such as SNPs in breast cancer, methylation profiles in normal and tumor cell lines or detection of severe acute respiratory syndrome (SARS) coronavirus infection are addressed.

These molecular approaches fall into three different strategies: (1) target or whole genome amplification coupled with PCR; (2) probe amplification based on ligase chain reaction or rolling circle amplification; and (3) signal amplification using 3-D dendrimer labelling systems, enzymatic cascade reporters or invader assay.

Several technology platforms such as the “Universal DNA Microarray”, Luminex, or the “Tag Array” are presented as examples of target and probe amplification strategies. These approaches show the flexibility to make the transition from clinical trial to diagnostic laboratory. Furthermore, highly sensitive methods based on signal amplification, which attend the requirements in clinical diagnostics were presented. Technical improvements concerning either probe preparation or experimental performance are also shown.

The second part of the book comprises eight articles addressing the growing importance of aspects of the protein level such as tissue-specific protein expression, protein activity, protein-protein interactions, and antibody profiles. Protein arrays comprised of immobilised proteins is an emerging biochip format, which is used to determine antibody specificity and antibody profile from serum samples. An alternative way to profile proteins is the use of antibody arrays which correspond to an immunoassay in micro format. Antibody arrays are discussed as assay to profile the protein content in serum and as a tool for measuring protein expression levels. This section of the book is completed by elucidation of aspects of validation and quality control of protein microarray-based methods.

The editors manage to cover the diverse DNA and protein microarray-based assays used in laboratories and research institutes. Presenting state-of-the-art technologies with diagnostic focus combined with detailed step-by-step protocols, tips on troubleshooting and avoiding known pitfalls, the reader is enabled to design and perform microarray experiments for DNA and protein analysis. The choice of authors points towards the interdisciplinary character of microarray technology implicating the growing influence on clinical diagnostics.

Angelika Lucking
Protagen AG
Dortmund, Germany

Molecular Morphology in Human Tissues: Techniques and Applications

Advances in Pathology, Microscopy and Molecular Morphology
Gerhard W. Hacker and Raymond Tubbs (Eds.)
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Molecular morphology is a field that has evolved from the advances made in immunology, biochemistry and molecular biology. Collectively, these fields have developed techniques which enable researchers to investigate the location of peptides, proteins, DNA and RNA within cells, tissues and organs through microscopic visualization. This characterization of tissue and cells by the presence of specific molecules is of great interest clinically in the field of diagnostics, for example in allowing the reliable diagnosis of a malignant tumour, and at the research level, in order to ascertain the function of cell types within an organ based on the presence or absence of particular proteins. As the techniques in this field are drawn from such diverse areas of biology it is difficult to keep up with developments made, thus this book was designed to fulfill this niche, providing not only the theory behind the techniques currently available but also...