LABEL-FREE BIOSENSORS

Label-free biosensors use biological or chemical receptors to detect analytes (molecules) in a sample. They give detailed information on the binding selectivity, affinity, and, in many cases, the stoichiometry, kinetics, and thermodynamics of an interaction. Although they can be powerful tools in the hands of a skilled user, there is often a lack of knowledge regarding the best way to utilize label-free assays to screen for biologically active molecules and to accurately and precisely characterize molecular recognition events.

This book reviews both established and newer label-free techniques. It is intended to give both the expert user and the general reader insight into the field from expert opinion leaders and practitioners of these techniques. Chapters also contain worked examples that are written to guide the reader through the basics of experimental design, setup, assay development, and data analysis.

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Label-Free Biosensors

TECHNIQUES AND APPLICATIONS

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CAMBRIDGE
UNIVERSITY PRESS

CAMBRIDGE UNIVERSITY PRESS
Cambridge, New York, Melbourne, Madrid, Cape Town, Singapore, São Paulo, Delhi

Cambridge University Press
32 Avenue of the Americas, New York, NY 10013–2473, USA

www.cambridge.org
Information on this title: www.cambridge.org/9780521711517

First published 2009

Printed in the United States of America

A catalog record for this publication is available from the British Library

Library of Congress Cataloging in Publication data

Label-free biosensors : techniques and applications / edited by Matthew A. Cooper.
p. ; cm.
Includes bibliographical references and index.
ISBN 978-0-521-88453-2 (hardback) – ISBN 978-0-521-71151-7 (pbk.) 1. Biosensors.
I. Cooper, M. A. (Matthew A.)
[DNLM: 1. Biosensing Techniques – methods. QT 36 L116 2009]
R857.B54L33 2009
610.28′4 – dc22 2008026569

ISBN 978-0-521-88453-2 hardback
ISBN 978-0-521-71151-7 paperback

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Preface

Over the past two decades the benefits of biosensor analysis have begun to be recognized in many areas of analytical science, research, and development, with analytical systems now used routinely as mainstream research tools in many laboratories in many fields. Simplistically, biosensors can be defined as devices that use biological or chemical receptors to detect analytes (molecules) in a sample. They give detailed information on the binding affinity and in many cases also the binding stoichiometry, thermodynamics, and kinetics of an interaction. Label-free biosensors, by definition, do not require the use of reporter elements (fluorescent, luminescent, radiometric, or colorimetric) to facilitate measurements. Instead, a receptor molecule is normally connected in some way to a transducer that produces an electrical signal in real time. Other techniques such as isothermal titration calorimetry (ITC), nuclear magnetic resonance (NMR), and mass spectrometry require neither reporter labels nor surface-bound receptors. In all cases detailed information on an interaction can be obtained during analysis while minimizing sample processing requirements. Unlike label- and reporter-based technologies that simply confirm the presence or absence of a detector molecule, label-free techniques can provide direct information on analyte binding to target molecules typically in the form of mass addition or depletion from the surface of a sensor substrate or via changes in a physical bulk property (such as the heat capacity) of a sample. Until recently, label-free technologies have failed to gain widespread acceptance due to technical constraints, low throughput, high user expertise requirements, and cost. Whereas they have proved to be powerful tools in the hands of a skilled user, they have not always been readily adapted to everyday lab use in which simple-to-understand results are a prerequisite. Despite this limitation, the potential today for label-free approaches to complement or even displace other detection technologies has never been higher.

This book covers established label-free technologies and emerging developments in label-free detection systems, their underlying technology principles, and end-user case studies that reveal the power and limitations of such biosensors. The chapters are intended to give both the expert user and the general reader interested in the technologies and applications behind label-free biosensors an insight into the field from expert opinion leaders and practitioners. As such, most chapters contain one or more worked examples that guide the reader through

the basics of experimental design, setup, assay development, and data analysis. The book is heavily weighted toward applications using optical biosensors and surface plasmon resonance (SPR) instrumentation. This is primarily because of the overwhelming bias in the installed base of optical biosensors due to their early commercialization and uptake. Other label-free technologies conspicuous by their absence from this volume include analytical ultracentrifugation, nuclear magnetic resonance spectroscopy, and mass spectroscopy. These will be covered as part of a new cluster of titles on bioanalytical techniques and applications.

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May 2008

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