

Review

Nanotechnology in clinical laboratory diagnostics

Kewal K. Jain*

Jain PharmaBiotech, Blaesiring 7, CH-4057 Basel, Switzerland

Received 26 January 2005; received in revised form 7 March 2005; accepted 8 March 2005

Available online 10 May 2005

Abstract

Nanotechnology—the creation and utilization of materials, devices, and systems through the control of matter on the nanometer—has been applied to molecular diagnostics. This article reviews nanobiotechnologies that are clinically relevant and have the potential to be incorporated in clinical laboratory diagnosis. Nanotechnologies enable the diagnosis at single cell and molecule level and some of these can be incorporated in the current molecular diagnostics such as biochips. Nanoparticles, such as gold nanoparticles and quantum dots, are the most widely used but various other nanotechnologies for manipulation at nanoscale as well as nanobiosensors are reviewed. These technologies will extend the limits of current molecular diagnostics and enable point-of-care diagnosis as well as the development of personalized medicine. Although the potential diagnostic applications are unlimited, most important current applications are foreseen in the areas of biomarker research, cancer diagnosis and detection of infectious microorganisms.

© 2005 Elsevier B.V. All rights reserved.

Keywords: Nanotechnology; Nanobiotechnology; Nanodiagnostics; Nanoparticles; Molecular diagnostics; Clinical laboratory; Nanobiosensors; Nanochip; In vitro diagnostics; In vivo diagnostics; Microfluidics; Nanofluidics

Contents

1. Introduction	38
2. Nanotechnologies for clinical laboratory diagnosis	39
2.1. Nanotechnologies on biochips	39
2.2. Nanoarrays for molecular diagnostics	39
2.3. Nanoparticle protein chip	40
2.4. Nanoparticles for molecular diagnostics	40
2.4.1. Gold particles	40
2.4.2. Quantum dots	40
2.4.3. Magnetic nanoparticles	41
2.5. Study of chromosomes by AFM	41
2.6. Applications of nanopore technology for molecular diagnostics	42

* Tel./fax: +41 61 692 44 61.

E-mail address: jain@pharmabiotech.ch.

2.7.	DNA–protein and –nanoparticle conjugates	42
2.8.	Cantilever arrays	43
2.9.	Resonance light scattering technology	43
2.10.	Nanobarcodes	44
2.11.	Biobarcode assay for proteins	44
2.12.	Nanoparticle-based colorimetric DNA detection method	44
2.13.	Nanoparticle-based Up-converting Phosphor Technology	45
2.14.	Surface-Enhanced Resonant Raman Spectroscopy	45
2.15.	Nanobiosensors.	46
2.15.1.	Nanowire biosensors	46
2.15.2.	Ion Channel Switch biosensor technology	46
2.15.3.	Electronic nanobiosensors	46
2.15.4.	Viral nanosensor	47
2.15.5.	PEBBLE nanosensors	47
2.15.6.	Optical biosensors	47
2.15.7.	Nanoshell biosensors.	47
2.15.8.	Future issues in the development of nanobiosensors.	48
3.	Applications of nanodiagnostics.	48
3.1.	Use of nanocrystals in immunohistochemistry	49
3.2.	Glucose monitoring in vivo by nanosensors	49
3.3.	Detection of disease biomarkers	50
3.4.	Detection of single nucleotide polymorphisms	50
3.5.	Detection of disease genes	50
3.6.	Detection of microorganisms.	50
3.6.1.	Detection of bacteria	50
3.7.	Detection of viruses	51
3.8.	Cancer diagnosis.	51
4.	Concluding remarks.	52
4.1.	Rationale of nanotechnology for clinical laboratory diagnostics	52
4.2.	Future prospects of application of nanotechnology in clinical laboratory diagnostics	52
	References	53

1. Introduction

Nanomolecular diagnostics is the use of nanobiotechnology in molecular diagnostics and can be termed “nanodiagnostics” [1]. Nanotechnology is the creation and utilization of materials, devices, and systems through the control of matter on the nanometer (1 billionth of a meter)-length scale. Various nanotechnologies and their applications in life sciences are described in detail elsewhere under the term ‘nanobiotechnology’ [2]. Numerous nano-devices and nanosystems for sequencing single molecules of DNA are feasible. Given the inherent nanoscale of receptors, pores, and other functional components of living cells, the detailed monitoring and analysis of these components will be made

possible by the development of a new class of nanoscale probes.

Because of the small dimension, most of the applications of nanobiotechnology in molecular diagnostics fall under the broad category of biochips/microarrays but are more correctly termed nanochips and nano-arrays. Nanotechnology-on-a-chip is a general description that can be applied to several methods. Some of these do not use nanotechnologies but merely have the capability to analyze nanoliter amounts of fluids.

It is difficult to classify such a wide range of nanotechnologies but those with potential applications in molecular diagnostics are listed in Table 1. Molecular diagnostic technologies are used in biological research, detection of bioterrorism agents, clinical diagnostics, drug discovery and development, as well

Download English Version:

<https://daneshyari.com/en/article/9888087>

Download Persian Version:

<https://daneshyari.com/article/9888087>

[Daneshyari.com](https://daneshyari.com)