Varioustypes of transducing elements and their applications in Bio-Nanotechnology

Abstract

Nanotechnology plays an important role in the development of biosensors. The sensitivity and performance of biosensors is being improved by using nanomaterials for their construction. Transducers form a key component of any sensing system. The use of nanomaterials has allowed the introduction of many new signal transduction technologies in biosensors. Because of their submicron dimensions, nanosensors, nanoprobes and other nanosystems have allowed simple and rapid analyses in vivo. Portable instruments capable of analyzing multiple components are becoming available. This work compiles various types of transducing elements and their application in bio-nanotechnology.

Introduction

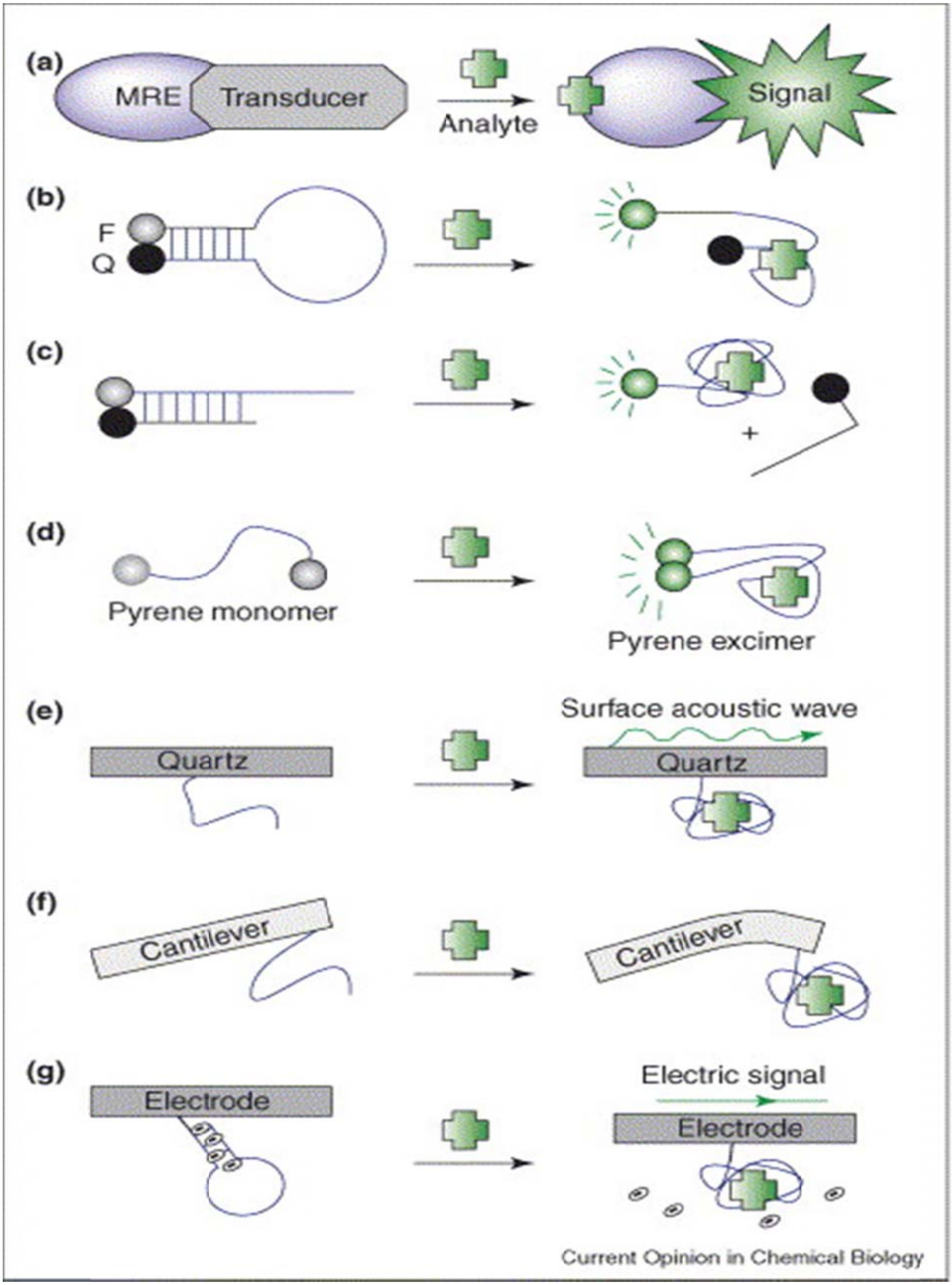
Nanotechnology helps in development of small, highly-efficient and inexpensive sensors, with broad applications. These offer significant advantages over conventional sensors. This includes greater sensitivity and selectivity, lower production costs, reduced power consumption as well as improved stability.

Due to above mentioned characteristics, bio nano-sensors are gaining lot of attraction in diagnosis and other areas of sensing where minute quantities of analyte are undetectable by conventional sensors. DNA detection using biosensors is also gaining attention as non-pcr methods for detection can be implied using bio transducers.

Biosensor: A biosensor is a device used to detect the presence of an analyte in biological systems. It consists of two parts:

1. Molecular recognition element: it is the molecule or compound which reacts with the analyte or binds to the analyte and confirms its presence by sending a signal in the form of light, heat, sound, mechanical deformation etc.
2. Transducer: it is the device which is attached to the molecular recognition element which transforms the signal of any form i.e. heat, light, mechanical strain etc. to a perceivable electrical signal.

In this report the importance of transducers is specifically discussed. Various types of transducing elements, their principle and applications in biotechnology are briefly explained.



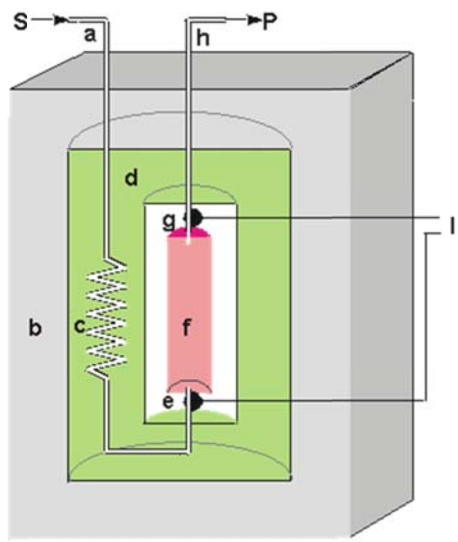
[Source:Nucleic acid aptamers and enzymes as sensors,Naveen K Navani, Yingfu Li, 1996]

Transducer	Application	Reference
Calorimetric Transducer	The reaction of the herceptin drug with cancers cell surface protein HER2 in breast is an exothermic reaction and can be detected using a calorimetric transducer.	Se-Chul Park, Eun-Jin Cho, "A calorimetric biosensor and its application for detecting a cancer cell with optical imaging", World Congress on Medical Physics and Biomedical Engineering 2006, IFMBE Proceedings Volume 14, 2007, pp 637-640
Electrochemical Transducer	Measuring conc. of glucose (directly proportional to current)	DorotheeGrieshaber, Robert MacKenzie, "Electrochemical Biosensors - Sensor Principles and Architecture", Utilization of Electrochemical Sensors and Biosensors in Biochemistry and Molecular Biology)
Magnetic Transducer	Detecting a specific cell	http://archives.sensorsmag.com/articles/1299/14_1299/
Piezoelectric Transducer	For detection of antigen antibody interaction	http://www.wisegeek.org/what-is-a-piezoelectric-transducer.htm
Optical Transducer	To detect the presence of bacteria in food or clinical samples.	http://www.sciencedirect.com/science/article/pii/S073497500400028X
Mechanical Transducer	To detect single-base mismatchesin oligonucleotide hybridization.	Javier Tamayo, Priscila M. Kosaka, "Biosensors based on nanomechanical systems",Chem. Soc. Rev.,2013

CALORIMETRIC TRANSDUCER

A calorimetric transducer, as the name suggests, converts heat changes into electrical signals. Therefore, many endothermic or exothermic biochemical reactions can be detected using a calorimetric biosensor. The transducer consists of a thermistor which is a resistor whose resistance varies with the change in temperature and is able to detect very small changes in temperature. This way it serves as a beacon for the presence of an analyte. The reactions are carried out in a controlled and closed reactor to ensure minimum amount of heat loss.

Most of the enzyme catalyzations are exothermic in nature. And hence the heat evolved can be carefully noted by the change in current in the installed circuit. The following picture shows a calorimetric transducer:



[Source:[www.facebook.com/l.php?u=http%3A%2F%2Fwww.lsbu.ac.uk%2Fwater%2Fenztech%2Fcalorimetric.html&h=fAQERuTZg]

The enzyme is made to enter the highly controlled system through a. Then it passes to the heat exchanger c. Through the first thermistor e, it reaches the reactor where it is made to react with the anlyte. Then, it is removed out from h, passing through the thermistor g(made of the same material). The change in the resistance of the two thermistors are noted which confirms the occurrence of the reaction.

In breast cancer, a surface protein HER2 is overexpressed. HERCEPTIN is a drug which is actually a monoclonal antibody which reacts with breast cells having overexpressed HER2. The reaction of the drug with the protein is an exothermic reaction and can be detected using a calorimetric transducer and hence cancer detection is possible.

Source:
http://nptel.ac.in/courses/118107015/13