# Chapter 94
# Role of Bioinformatics in Nanotechnology: An Initiation towards Personalized Medicine

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## ABSTRACT

*Recent advancements in bio-computing and nano-technology accelerated the discovery of novel biomarkers in the emerging field of personalized medicine. Personalized medicine deals with disease detection and therapy from the molecular profile of each individual. Personalized medicine is also called as predictive medicine that uses genetic/molecular information to predict disease development, progression, and clinical outcome. In this chapter, we discuss the advantages of using nanotechnology to understand biological systems with an example of the biomarker discovery of cancer. Recent developments in bio computing served as the base for the identification of multiplexed probes in a nano particle. Together we have correlated the bio molecular signatures with clinical outcomes and we have also addressed an emerging field called bio-nano-informatics to suggest an individual therapy for cancer and other diseases.*

## INTRODUCTION

The nature of self-organization is a key feature of biological system and this feature provides a broader vision for the development of nanotechnology. Molecular diagnosis for identifying human diseases has witnessed an exponential growth in the last two decades and it laid the path for developing advanced technologies for molecular diagnosis and therapy (Ginsburg & McCarthy, 2001). Revolution in molecular diagnosis and therapy was based on discovering novel biomarkers for predicting disease behavior (Little et al., 2008; Jain et al., 2002). Molecular profiling and diagnostics deals with characterizing histological lesions which is heterogeneous in cellular and molecular level of a human disease (Allison et al., 2008). Current technologies like RT-PCR (real time-polymerase chain reaction) and gene microarrays were not

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designed for handling this kind of heterogeneity because they require a constructive preparation of cells and tissue specimen into a homogeneous solution, leading to a loss of valuable information regarding the 3D cellular environment and tissue morphology (Hepper et al., 1984; Liu et al., 2004).The development of nano technology has provided an additional opportunity for integrating morphological and molecular information, which is also followed by observing the correlation between the molecular and cellular changes in disease behavior. Specifically, bi conjugated quantum dots (QDs) have been used to quantify multiple biomarkers in cancer cells and tissue specimens (Steeg, 2008; Wu et al., 2008; Ferrari, 2005; Wang et al., 2008). Nanotechnology can be used for molecular imaging and therapy to improve the efficacy and toxicity profiles of chemotherapeutic agents (Nie et al., 2007; Chan & Nie, 1998; Alivisatos et al., 2004; Michal et al., 2005; Gao et al., 2005). At present, a major challenge in biomedical nanotechnology is to understand the mechanism of interaction between nano particles and biological regimens (blood, cells and organs) under *in vivo* physiological condition. However, the ultimate task is to overcome the inherent limitation to ensure the delivery of nano particles to diseased sites or organs (Gao et al., 2003; Xing et al., 2006; Xing et al., 2007; Yezhelyev et al., 2007; Ghazani et al., 2006). Another challenge is to generate critical studies for linking biomarkers with disease behaviors, such as rate of tumor progression and response of patient to radiation or drug therapy (Sinha et al., 2006; Davis et al., 2008; Jain, 1999; Jain, 2001; Jain, 1998). Finally, we insist on the integration of biomarkers and bio computing with nanotechnology for analyzing a high-throughput data of multiplexed molecular profiles in specimens of cells and tissues.

## BIOMARKERS AND THEIR APPLICATIONS

Bio molecular markers can be an altered or mutant gene, RNA, proteins, lipids, carbohydrates and small metabolites, which can be correlated with a biological behavior and its clinical outcome (Wang et al. 2007; Liotta et al. 2000). Most of the biomarkers are discovered on the basis of molecular profiling studies of association or correlation between a molecular signature and disease behavior. Initially, a study was conducted by Gloub *et al.* for classifying tumors on the basis of patterns in gene expression had reported. This study had provided a novel insight into tumor pathology by analyzing the stage and grade of tumor along with the understanding of clinical course and response to treatment (Petricoin et al., 2002; Negm et al., 2002; Ludwig & Weistein, 2005; Golub et al., 1999; Ross et al., 2000). Gene expression studies illustrate the fact that "Molecular signatures of each tumor are inflammatory factors of the original lesion with heterogeneity" (Alizadeh et al., 2000).

The first clinical correlation of gene expression patterns with clinical outcome was reported for the diffusion of B-cell lymphoma (Perou et al., 2000), which is a clinically proven disease with heterogeneity. Whereas, more number of patients had responded well to therapy and survived for a longer period. Hence, it was understood that the variability in a disease progression could be correlated with a specific pattern of a gene expression. Based on this concept, specific molecular portraits were analyzed for the tumor of each individual patient and later, the clinical study was validated by Perou et al. by using an array of clinical samples (Bittner et al., 2000, Dhanasekaran et al., 2001) and it served as the foundation for the discovery of specific expression patterns with the in prostrate, breast, liver and lung cancers (Paik et. al., 2004; Chen et al., 2007; Beer et al., 2002). Biomarkers are divided into predictive, prognostic and therapeutic markers. Prognostic biomarkers predict the natural course of an individual cancer. So, at present it possible to distinguish the indolent and aggressive tumors.