Chapter 11
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 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 nanotechnology 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.
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