

# IEEE 7<sup>th</sup> BIBE Invited Workshop Keynote: Nanobioinformatics: The Enabling Technology of Personalized Medicine

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**Linda K. Molnar**  
National Cancer Institute  
National Institutes of Health  
Bethesda, MD 20892  
molnarl@mail.nih.gov

## *Abstract—*

Medical practice is changing at a rapid pace due to the influx of biological information from novel technologies. The management and analysis of this information is critical to the development of personalized medicine. For example, informatics can be applied to the identification of single nucleotide polymorphisms that may correlate with disease, disease susceptibility, or adverse drug or stress reactions. In addition, many important medical conditions and risk factors are multigenic or, as a further complication, depend on interactions between gene products and the patterns of their expression and posttranslational modification and, therefore, can also benefit from informatics tools. More recently, nanotechnologies are predicted to have a radical impact on how we study, diagnose and treat disease. Researchers develop and apply nanotechnology to all aspects of drug development and patient care from streamlining the drug development process through miniaturization, increased sensitivity, high-throughput analysis and automation for target identification and validation; developing quantum dots for in vivo imaging; utilizing contrast and optical imaging agents and ultrasensitive biomarker detection for early detection and diagnosis; to developing a plethora of multifunctional, targeted drug delivery vehicles for treatment and, eventually, real-time therapeutic monitoring. For instance, there are already examples of multifunctional nanoparticles that target vascular peptides, growth factor receptors, and transmembrane proteins such as ion channels that are utilized for both cancer and cardiovascular disease recognition. Because of the incredible sensitivity, flexibility and throughput that nanotechnologies offer combined with the modularity of nanoparticle-based therapeutics, nanotechnology is poised to play a key role in personalized medicine. In order for this to occur, an informatics infrastructure for nanotechnology must be built. The foundation of this infrastructure is the development of ontologies and databases of the description and physical characterization of the nanoparticle-based diagnostics and therapeutics. Systematically identifying and analyzing essential information pertaining to physical, chemical, structural, mechanical, biological and other parameters is critical to understanding structure-function relationships and resultant medical applications and to making this information accessible to the clinical community. The realization of personalized medicine depends on bioinformatics to unravel patterns in complex data sets, precise technology for understanding and diagnosis, and interventions designed at the nanoscale to be specific as well as

effective---it depends, in short, on the integration of biotechnology, nanotechnology and informatics. Bioinformatics and nanobioinformatics are the cohesive forces that will bind these technologies together. Just as bioinformatics played a transformative role in the explosive growth of modern biology, nanobioinformatics has the potential to enable the application of nanotechnology-based diagnostics and therapeutics for personalized medicine.



Dr. Linda Molnar currently serves as a Program Officer in the Office of Technology and Industrial Relations (OTIR), Office of the Director, National Cancer Institute (NCI). In her role, she supports the management of grants and contracts for nanotechnology applications in cancer research for the NCI Alliance in Cancer Nanotechnology. She has a breadth of experience in collaborations and partnerships between academic institutions, large companies and biotechnology start-ups for the successful translation of fundamental research into applications and products. At NCI, she was instrumental in the successful launch of the Alliance in 2005. She has led the formation of a nanobioinformatics working group for the Alliance which facilitates data sharing both within and among the Centers for Cancer Nanotechnology Excellence (CCNEs). Her background includes the research and development of nanotechnology in a variety of applications and employments including NASA Ames Center for Nanotechnology, Caliper Technologies (now Caliper Life Sciences), and Rohm and Haas Company. She received her Ph.D. in Materials Science and Engineering from the Massachusetts Institute of Technology and her B.S. in Chemistry with Honors from the University of Pittsburgh (magna cum laude). Dr. Molnar has also completed the Wharton Management Program. She is the holder of 10 patents in the nanotechnology field and has published in leading journals.