Chapter 6
The Applications of Omics Technologies and the Challenges of Ethics in Nutritional Sciences

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ABSTRACT

During the past two decades, there have been numerous developments in the genetic and genomic technologies enabling us to understand complex biological systems in an integrative manner through holistic approaches in research. Since the sequencing of the human genome, efforts are made to identify the number of the genes and their functions. The tools for determining the functionality of the genes are just beginning to appear. Initially the methodologies to identify functionality of the genes were largely based on comparative studies between model organisms. The very high number of genes with unknown functions demanded the need to develop new methods and technologies that may be helpful in assigning functions to the identified genes. Advancements in computing techniques and software opened the door for new technologies to be able to take an applied approach by studying biomolecules needed for proper functioning of the cell and take a holistic approach in biomedical research. Besides genomics, several other technologies are developed in the last decade that take an 'omics' approach, i.e., an integrated approach in the study of cell function. It is hoped that the applied integrative omics approaches may be helpful in establishing cause and effect relationships between genotype and phenotype. These 'omics' approaches include the integration of genomics, proteomics, transcriptomics, metabolomics and other omic technologies to do the non-targeted studies of biomolecules involved in the proper functioning of the cells and their responses to environmental changes. The applications of these technologies have been also utilized in the field of nutrition for studies on how nutrients and other metabolites effect the proper functioning of the cell. With these emerging techniques to understand the molecular functioning of the body, it is envisaged that they might be helpful to give personalized medical care and dietary advice to people based on their individual genotypes in the future. Whilst nutritional genomics is a rapidly growing field in the nutritional sciences focusing on the diet-gene relationships, there is an increasing understanding that other technologies will also be crucial in understanding the whole biological processes

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involved in metabolism of food. In this chapter I wish to outline the use of contemporary technologies that are involved in establishing the intricate linkages between diet and the genes, and the ethical challenges they raise in their applications.

HUMAN GENOME TO APPLIED OMICS

Although sequencing of the human genome revolutionized biomedical research, the fundamental limitation of the human genome is that it just provides the blueprint and potentiality of the organism. But it doesn't tell what actually takes place, what genes are expressed and how proteins are encoded. Even if we are able to identify all the genes, inactivating all genes and then studying them for different properties and phenotypes is an enormous task which is not possible to be completed in the near future. Furthermore, the mutations in important genes are lethal, meaning that such mutations can't be obtained or studied. Therefore new techniques are emerging such as transcriptomics, metabolomics, and proteomics to study the functionality of the genes in response to changing conditions. Thus the functionality of the genes can be established by linking it to the expression of the known genes that are co-expressed.

Whilst genomics and genomic variation has taken the forefront of the biomedical research and drug development, it is important to realize that the genomic approaches are not necessarily dependent on the sequenced human genome. Human genome is dynamic and the genetic variation basically is seen in two aspects, one in the responsiveness to drugs and food, second in genetic predisposition to diseases. Most of the applied omics technologies used in nutritional science studies focus on the first aspect. Nevertheless, in the case of nutrition, human genetic variation is not as easy as it seems. Genetically determined inborn metabolic and biochemical factors need to be differentiated from the variations that are also caused by life cycle (growth, pregnancy and old age etc) and lifestyle factors (socio-economic conditions, environmental stressors, etc.).

The use of applied genomics has two main deliverables, one that result in the identification and selection of specific biomolecules that control or represent a biological process, and second that use the complete set of biomolecules to assess the response or the quality of the transcriptome, proteome or metabolome. Another aspect of new omics technologies lies in their design and applications. Some of the technologies are developed for disease specific applications, identifying surrogate biomarkers for late onset diseases for example, and some are food specific applications, such as identifying toxicants or micronutrients which upon exposure may be lethal to life.

FUNCTIONAL FOODS

Functional foods were developed at a particular sensitive time in the eighties when genetic modification in foods was beginning to bring distrust and discontent among ordinary public. The development of functional foods was based on the premise of providing additional health value to the foods through alteration of physical structure and chemical composition of food products in order to achieve particular effects in the body functions. Functional foods encapsulated public health agenda as the supporters suggested that they not only will satisfy individual consumer needs for healthy food but also will contribute to the reduction in the food related illnesses (TAB1999). There is no legal definition of functional foods, except for their claims about enhancing nutritional value of food, such that when consumed will have positive effects on the body. The claims made by