

## FROM NUTRITION TO NUTRIGENOMICS

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### ABSTRACT

*Nutrigenomics is the study of how foods affect our genes and how individual genetic differences can affect the way we respond to nutrients in the food we eat. Nowadays, many techniques are being used in this field. Some of these are microarray, proteomics, epigenetics and metabolomics. With the help of these techniques, many diseases and cancers have been detected and it has also given new information concerning the physiological effect of different dietary proteins of omega-3 polyunsaturated fatty acids (PUFA) and dietary conditioning of colon cancer. The increased need for the use of personalized nutrition in patients is increasing and research is being made on all its possible effects. In a current analysis on thirty eight nutrigenomic genes, it seems that a definite association between genes and several diet related diseases is lacking. The science of Nutrigenomics started with the Human genome project of 1990's which sequenced the entire DNA in the human genome. The study of Nutrigenomics requires understanding of how nutrients act at the molecular level which in turn involve a multitude of nutrient-related interactions at the gene, protein and metabolic levels.*

**Keywords:** Epigenetics, Genome, Metabolomics, Proteomics, PUFA

### I. INTRODUCTION

The term "Nutrigenomics" was first described in 2001 by Pelegrin and then it appeared in 2002 in a review by Van Ommen and Steruon. Majeed and Prakash (2006) discussed the role of Nutrigenomics in health and diseases. To overcome diet related diseases and promote health, Krishnaswamy (2008) found that it is essential to develop and



FIG 1

implement Food Based Dietary Guidelines (FBDG). Earlier, most of the population was unaware about their dietary

habits which resulted in a number of diseases but now with the study of Nutrigenomics, one is able to understand the effect of food on ones genes and thus prevent many diseases. Studies in nutritional area have increased the understanding of how to maintain healthy a group of individuals and thus improve health of the entire world. If we can learn the language of our genes and control the messages and instructions they give our body and our metabolism, we can radically alter how food interacts with our body, lose weight and optimize our health.

## II. TECHNIQUES

There are several techniques which are used in this field. Some of them are:

### 2.1 Microarray technology

It is the main tool of transcriptomics and has allowed new information concerning the physiological effect of different dietary proteins of omega-3 polyunsaturated fatty acids and dietary conditioning of colon cancer. DNA microarray technology has successfully evaluated the interactions between diet and genes measured as changes in genetic expression. Even normal and tumorous cells can be distinguished as in Fig.2.

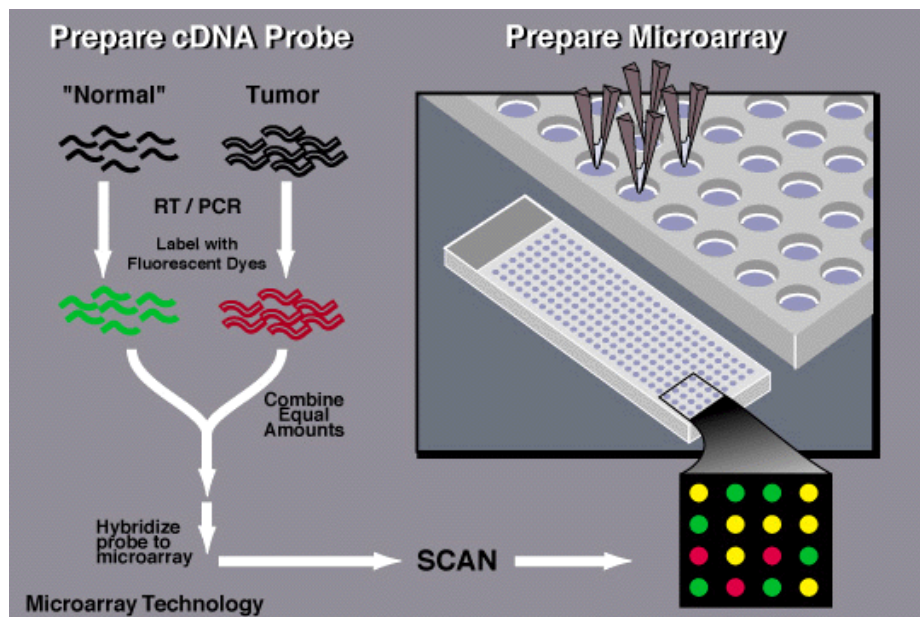


FIG 2

### 2.2 Proteomics

The use of proteomics tool revealed new information concerning the protein composition of egg and poultry meat proteins and the safe use of transgenic crops in animal nutrition. It is the large scale experimental analysis of proteins and is also used in protein purification. The study of proteomics has been well shown in Fig.3.

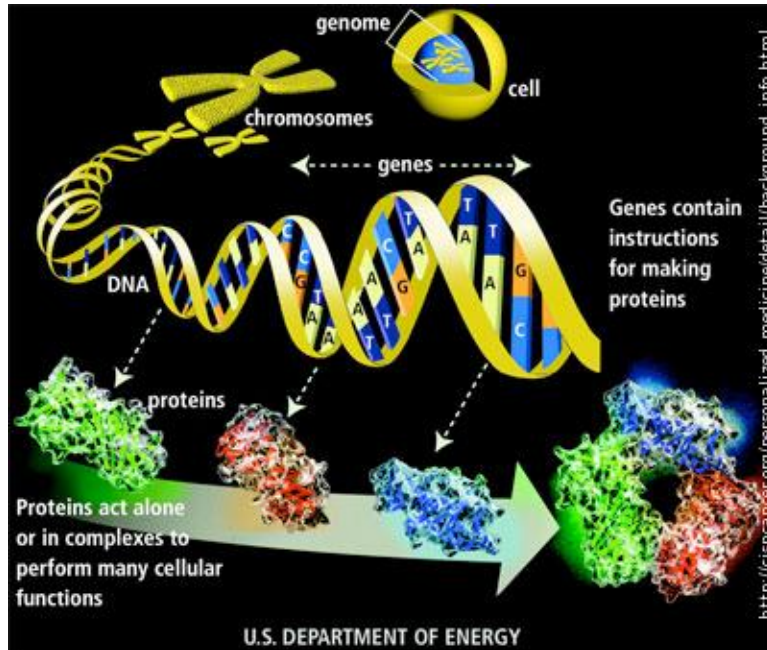


FIG 3

2.3 Metabolomics

It is the scientific study of a set of metabolites present within an organism, cell or tissue. It has provided metabolomic information which has in turn given us new information about cellular biology.

What is metabolomics?



Metabolites are any small organic molecule or chemical (amino acids, sugars, drugs, etc.)  
Metabolomics is the study of metabolites

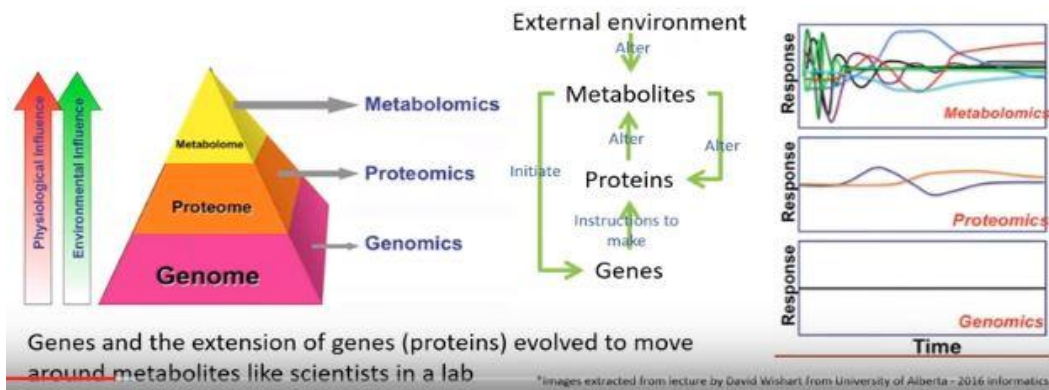


FIG 4

III. PRINCIPLES

The science of Nutrigenomics is based on four principles:

- Diet can be a serious risk factor for a number of diseases for some individuals under certain circumstances.
- Substances in the diet can act on the human genome, either directly or indirectly to alter gene structure or



expression.



FIG 5

- Individual genetic makeup or genotype can influence the balance between health and disease.
- Genes that are regulated by the dietary factors can play a role in the onset, incidence, progression or severity of chronic diseases.

IV. APPLICATIONS

4.1 In Cancer: - Our dietary habits are a modifiable environmental factors that influence cancer risk & tumors behaviour. Diet influences about 30-40% of all cancer cases. It has been found that excess body weight & our sedentary life style has been responsible for one-fifth to one-third of most common cancers such as colon, breast, & kidney cancer . The various dietary factors that contribute the increase in rate of cancer are :-

1. Excessive consumption of red meat is found to be associated with increased risk of colorectal cancer.

Pro-cancer			Anti-cancer		
Dietary component	Polymorphic gene/phenotype1	Cancer site	Dietary component	Polymorphic gene/phenotype1	Cancer site
Heterocyclic amines	NAT2, (NAT1), CYP1A2; (CYP1A1)	Colorectal, breast, other sites	Cruciferous vegetables	CYP1A2, GST	Colorectal, other
Polycyclic hydrocarbons	CYP1A1, GSTM1	Gastrointestinal tract Nasopharyngeal	Fruits and vegetables	CYP1A2, GST	Many sites
Nitrosamines	CYP2E1	Stomach	Calcium/vitamin D	Vitamin D receptor	Colorectal, prostate
Aflatoxins	GSTM1, EPHX	Liver, Kidney	Retinoids	Retinoic acid receptor variants	Acute promyocytic Leukemia, skin, head, neck, breast
Alcohol	ADH (ALDH, CYP2E1)	Liver	Folate, methionine	MTHFR, Methionine synthase	Colorectal cervix

FIG 6

2. Specific dietary components like salts & preservatives are possible carcinogens for gastric cancer.

Several steps should be taken regarding our diet to prevent the cancer. These are :

Long Chain polyunsaturated fatty acids (LC-PUFA) shows beneficial effect in cancer prevention as they affect physiological body processes including growth, reproduction, innate & acquired immunity.

Omega-3-fatty acids inhibit growth of colonic tumor in both invitro & invivo system.

3. Fruits & vegetables contain various bioactive component that prevent carcinogenesis by increasing detoxification processes.

4.2 In anti-ageing: Ageing of cells occur due to accumulation of excess free radicals formed due to lack of proper nutrition to the cells and external factors like UV rays, pollution, stress etc. DNA analysis is instrumental in identifying the right concoction of nutrients needed to eliminate the excess free radicals present in a cell.



FIG 7

4.3 Single nucleotide polymorphism (SNP) has resulted in continued expression of lactase gene into adulthood.

## V. IMPLEMENTATION

According to a recent survey in Greece on general population and health professional samples, it was found that there is an increased need for involving nutrigenomic science.

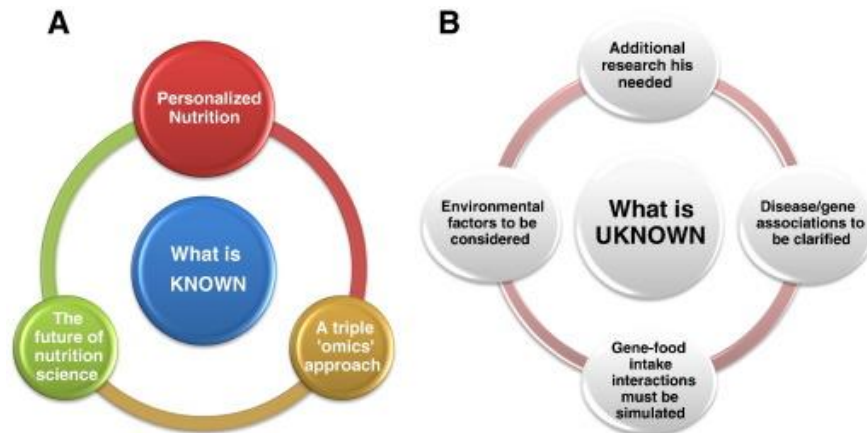


FIG 8

At the time of survey only 11.5% of respondents were advised to undertake a nutrigenomic test but at present, this percentage has increased tremendously. Thus, within this science of nutrigenomics, many more sciences and aspects are being involved to understand how our DNA & genetic code affect our need for certain nutrients & help in maintaining optimal health throughout our life . It helps to identify the genes that influence the risk of diet-related diseases.

## VI. DIET ALTERS EXPRESSION OF GENETIC INFORMATION

It has been found that nutritional factors have a major influence on gene expression and metabolism. This can be well seen in case of the bees. The queen bee is not born genetically different than her worker bees but she is fed on a special diet of royal jelly while the workers are fed on pollen and nectar. This makes the queen bee fertile and worker bees sterile. Thus, diet is altering expression of genetic information. Other example is of cancer. Our dietary habits are a modifiable environmental factors that influence cancer risk & tumor behavior.

Diet influences about 30-40% of all cancer cases. It has been found that excess body weight & our sedentary life style has been responsible for one-fifth to one-third of most common cancers such as colon, breast, & kidney cancer . This can be explained from Fig.9.

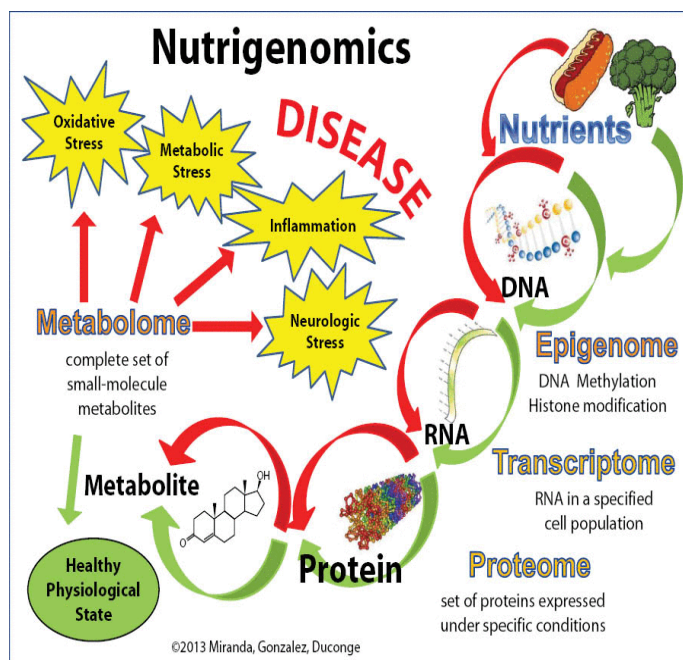
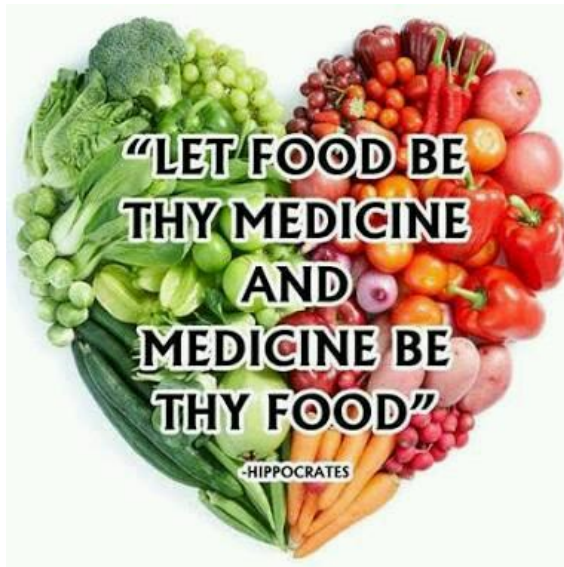


FIG 9

## VII. CONCLUSION

From the above, it can be concluded that what you eat directly influences the genetic messages your body receives. These messages in turn control all the molecules that constitute your metabolism. If you can learn the language of your genes and control the messages they give your body, you can alter how food interact with your body and in turn optimize your health.



**FIG 10**

Our country has some of the highest Coronary Heart Disease (CHD) rates in the world, with urban rates being three times higher than rural areas. Rates of obesity and diabetes increasing dramatically in urban areas. Thus, there is a great need to look up into the matter and care for our health and the future of our country.

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