



## The Role of Nutrition in Genetic Expression

Attempting to recognize carriers and modify specific heritable traits is nothing new. Genetic selection based on selective breeding has been used for years to produce cattle that give more milk, swine that reach market weight faster, horses that run faster and companion animals that feature the right color haircoat or structural conformation, just to name a few. The selections are based on the phenotype of the animal, that is, the observable expression of the animals' genetic potential. Some of the limitations to attempting to manipulate a heritable feature or condition using phenotype are that animals may be carriers of one or more of the genes involved, but the expression may be masked by other genes, or by interactions with the environment. One of the environmental influences that can alter genetic expression, and hence phenotype, is nutrition. No single act or influence alters the environment of the cells of the body more than the ingestion of food.<sup>6</sup>

The past decade has seen a rapid growth of knowledge regarding the way nutrient modification can alter the expression of genetic potential. Genes encode for the production of proteins. The DNA is translated to RNA, then into functional proteins, such as enzymes. These enzymes produce, shape and refine everything from toenails to chemical messengers in the brain. Survival in our dynamic environment requires constant adjustments in this cellular machinery by fine-tuning the translation of DNA. Dietary constituents can govern the expression of genes at any number of points, from transcription through RNA processing, translation, mRNA stability and posttranslational points, causing an increase or decrease in expressed proteins. The end result is a modification in the phenotypic expression. Some examples include the stimulatory effect of dietary lactose on intestinal lactase production and the inhibition of fatty acid synthase complex by dietary fats.<sup>1,6</sup>

A deficiency of essential nutrients also can modify genetic expression. Since translation of RNA into proteins requires specific amino acids, the lack of any of these essential amino acids can result in compromised protein synthesis and, potentially, reduced growth. Zinc is a nutrient required for RNA synthesis. A deficiency of dietary zinc has long been known to cause growth inhibition, skin and hair abnormalities, compromised immune function and multiple other problems. More recently, the use of differential display technology has allowed the discovery that zinc is critical for control of genes expressing cholecystokinin (CCK) and uroguanylin.<sup>2</sup> Zinc deficiency results in overproduction of these hormones. Cholecystokinin affects pancreatic secretion and satiety. The overproduction of CCK may explain the compromised pancreatic function and anorexia associated with zinc deficiency.<sup>2</sup> The uroguanylin hormone activates

cGMP in intestinal cells, leading to increased fluid secretion into the intestinal lumen. This finding explains a possible mechanism for the secretory diarrhea associated with zinc deficiency in children. 2

In addition to the role nutrition plays on the expression of normal genes, nutrition can play a role in modulation of phenotype of genetic diseases. A classic example in humans is restriction of dietary phenylalanine to prevent mental retardation in infants with phenylketonuria. 1 However, many genetic diseases are not so "black and white" in their expression. Susceptibility to cancer and heart disease, for example, appear to have genetic components. Many of these conditions, while genetically induced, are modified by environmental influences. Among these, the role of nutrition is increasingly being recognized. In humans, fat intake increases the risk of heart disease and certain types of cancer, while dietary fiber and antioxidants may reduce the risk of these same conditions. Nutritional modulation of several genetic diseases in veterinary patients has already been reported. In puppies, hip joint laxity was reduced by restricting food intake during growth. 3 Taurine-responsive dilated cardiomyopathy appears to be a genetic disease of cats that has responded to increased dietary taurine. 4,5 Copper-storage hepatopathy in Bedlington terriers can be managed by copper chelating agents.

Advances in molecular biology and genetics have created entire new opportunities in the field of nutrition. For almost every disease process, be it as common as obesity or as rare as inborn errors in metabolism, resolution of the problem can be approached through examining the genetic underpinning of the anomaly and attempting to understand how specific dietary ingredients may modulate the expression of the genotype. New examples of nutritional influence on genetic expression likely will continue to be discovered in ever-increasing frequency in the coming years.

## REFERENCES

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