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NUTRIGENOMIC REGULATION OF OOCYTE QUALITY AND FEMALE REPRODUCTIVE FUNCTION: MOLECULAR MECHANISMS AND ENVIRONMENTAL INTERACTIONS.

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Abstract Oocyte quality is a fundamental determinant of female reproductive competence and directly influences fertilization, embryonic development, and successful pregnancy outcomes. Emerging evidence in Nutrigenomics indicates that dietary components can regulate gene expression and metabolic pathways associated with ovarian physiology. Nutrient–gene interactions are known to influence essential cellular mechanisms including mitochondrial energy metabolism, chromosomal integrity, meiotic spindle formation, and oxidative stress responses, all of which contribute to the developmental competence of oocytes. Understanding these molecular interactions may provide insight into the role of nutrition in maintaining reproductive health and preventing fertility-related disorders. The objective of this study is to analyze the influence of nutrigenomic interactions on molecular pathways regulating oocyte quality and ovarian function, and to evaluate how diet-derived bioactive compounds modulate gene expression associated with reproductive health. Evidence from scientific studies demonstrates a significant relationship between nutrition, gene expression, and female reproductive physiology. Current research highlights that dietary components can influence molecular pathways involved in ovarian function and oocyte development. The selected studies were examined to evaluate the effects of nutritionally relevant bioactive molecules such as Folate (Vitamin B9), Vitamin D, and Coenzyme Q10 on mitochondrial activity, genomic stability, and hormonal regulation during oocyte maturation. The findings suggest that nutrigenomic mechanisms play a significant role in regulating ovarian cellular processes that determine oocyte competence. Nutrient-mediated modulation of gene expression may enhance mitochondrial efficiency, reduce oxidative stress, and maintain chromosomal stability, thereby supporting normal reproductive function.

Keywords

Nutrigenomics; Oocyte quality; Female reproductive health; Gene–diet interaction; Ovarian physiology; Mitochondrial metabolism; Fertility regulation.