EPIGENOMICS IN AQUACULTURE: PROSPECTS AND CHALLENGES

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SUMMARY

Epigenetics is a fast developing area of biology that deals with the study of heritable changes in gene function that cannot be explained by changes in the nucleotide sequence of DNA (i.e., that they do not arise from mutations, for example). Three major types of epigenetic modifications are recognized: 1) DNA methylation of certain regions of the genome, including regulatory regions and gene bodies, 2) histone modifications and histone variants, and 3) the action of non-coding RNAs. Heritable epigenetic control of gene expression means that a certain gene expression pattern can be acquired and maintained, and inherited not only from mother to daughter cells during mitosis but also from parents to offspring during the formation of gametes by meiosis. Thus, a hallmark of epigenetic modifications, once acquired, is that they can be inherited. Epigenetic regulation of gene expression allows that the same genome shared by all cells of a given species can be expressed to form the different cell types that constitute an adult organism, each with a specific program of gene expression. In addition, several important biological processes such as chromosome inactivation and parental imprinting rely on the proper establishment of epigenetic marks. Importantly, epigenetic mechanisms provide organisms with the capacity to integrate environmental information, to modify the expression of the genome and to generate thus a particular phenotype.

The application of epigenetics in some areas such as cancer research, developmental biology and neurobiology is booming in the recent years. In other areas such as ecology and evolutionary biology is just starting. In the latter, for example, it has been recognized that epigenetic variation can explain phenotypic variation in gene expression that previously could not be accounted for by just measuring genetic variation.

In recent times, the potential of epigenetics in plant and animal production is being realized. In contrast to mammals, where fertilization and embryonic development occurs internally, in birds fertilization is internal while embryonic development is external, and in aquatic animals in general both fertilization and embryonic development is external. Thus, aquatic animals used in aquaculture production, including fish, mollusks and crustaceans, provide an excellent ground where to study the influences of the early environment on gene expression through epigenetic mechanisms. Control of the paternal conditions during gamete formation, and of the environment, particularly during fertilization, embryonic and larval development, appear as important aspects where to study how epigenetic modifications can have lifelong lasting consequences in the expression of genes responsible not only for essential biological processes, but also that can be relevant when viewed in a production context. In this lecture, we review some of the epigenetic modifications found in different aquatic organisms important for aquaculture with an eye on the potential use of this new understanding brought by epigenetics towards increasing or improving aquatic animal production.

This study was supported by Consolider-Ingenio 2010 grant “Aquagenomics” (CSD2007-00002), and by Spanish Ministerio de Economía y Competitividad grant “Epigen-Aqua” (AGL2010-15939) to FP.

Keywords: Epigenetics, DNA methylation, Histone modifications, Non-coding RNAs, Animal production, Fish farming