Understanding the molecular basis behind hair morphology: development of new strategies to modulate hair from the follicle

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Understanding human hair biology and finding the genetic basis responsible for hair shape, colour and texture as well as for hair follicle (HF) aging, commonly perceived as hair graying will allow the development of new hair cosmetics able to modulate the levels of target genes and, ultimately, able to shape and colour hair according to our will. This is the main work goal of the BBRG people dedicated to hair research.

Scalp hair is an essential and defining element of our physical appearance with significant psychological and social impacts in our daily-life. Although HFs show a common morphology they give rise to shafts with an amazing natural variability of size, colour and shape that can be changed. However, common chemical hair styling processes are also known to induce changes in hair cuticle and cortex, damaging the fiber and in some extreme cases threatening human health [1]. The cosmetic industry has traditionally focused on the development of products or procedures to change hair fiber as it exits from the skin surface [1]. Due to the potential damage to the hair fiber, there is a huge interest in understanding the genetic basis associated with hair morphology, exploring whether hair appearance can be modified as the fiber is generated in the HF [2].

In the literature, some genes have already been associated with hair morphology and aging. Because an altered gene function is many times associated with a 'dose effect' on the protein product activity, and also due to the lack of public available information, we undertook two global high-throughput approaches to compare the levels of gene expression among Caucasian and African HFs, and among pigmented and grey HFs. Grasping complex mechanisms requires a global and parallel analysis of different cellular processes, often involving the interaction between different cell types; the microarray was the platform chosen to achieve a more integrated vision of the complex cellular events shape in the hair follicle. Based on the information available from the literature and on the team's unpublished results from the high-throughput gene transcript analysis, the work is now directed towards screening chemical libraries to find compounds able to alter the transcript levels and/or protein activities of highly interesting genes from the hair morphology point of view and to develop a targeted transfollicular delivery system able to specifically and efficiently deliver those compounds.

The promising results obtained so far will sustain new strategies for hair colour and shape modulation or even delaying rather than hiding the natural aging process by acting directly on the follicle. Innovation in haircare will be grounded in the most recent advances in HF biology and in follicle-targeted delivery for the development of new products that consumers can safely use at home.

[1] Cruz, CF, Costa, C, Gomes, AC, Matamá, T, Cavaco-Paulo, A, Human hair and the impact of cosmetic procedures: a review on cleansing and shape-modulating cosmetics, *Cosmetics* 3(3), 26-48, 2016.

[2] Matamá, T, Gomes, AC, Cavaco-Paulo, A, Hair Coloration by Gene Regulation: Fact or Fiction?, *Trends in Biotechnology* 33 (12), 707–711, 2015.