Notes from the Editor Emeritus

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Nothing in Biology Makes Sense Except in the Light of Evolution

"Nothing in biology makes sense except in the light of evolution" is the title of a famous paper published in 1973 by the one of the world's leading geneticists, Theodosius Dobzhansky.[1] In the light of evolution, everything in biology has a purpose. Vestiges of hair shafts have been found in animal fossils from as early as the Early Jurassic era, around 210 million years ago.[2] So, what is the purpose of the hair follicle, an apparently insignificant adnexal structure that has survived the process of natural selection for millions of years? At first sight, the answer appears to be obvious: to produce hair. But is that the full story?

Hair is commonly regarded as a unique mammalian feature, probably related to endothermy as insulation of the body surface. This property is important in fleeced animals, as for example in alpacas, llamas, guanacos, sheep, or ferrets, where the follicular units consist of a single longer primary follicle and a cluster of 10-20 smaller secondary follicles. In humans, however, the role of the hair in thermal insulation is negligible.

The reason for humans having thick terminal hairs on the scalp is pretty intuitive for us dermatologists who are familiar with the so-called "cancerization field" suffered by the scalp skin of men who have gone bald at a young age and failed to use adequate sunscreen protection. But what is the purpose of having millions of vellous hair follicles dispersed throughout the body that produce non-visible hair shafts or do not even produce hair shafts at all? In my opinion, one of the reasons is to serve as the main reservoir of cutaneous stem cells, with critical functions in response to injury.

Since the seminal paper of Cotsarelis et al. in 1990 in which the presence of epithelial stem cells was reported in a specific region of the hair follicle known as the bulge, subsequent studies have revealed hair follicles to be like a stem cell zoo, where different types of epithelial and mesenchymal stem cells reside at different levels of the follicle.[3,4] These stem cells are located in well-protected micro-environments known as "niches," kept well away from external aggressions. In particular, mesenchymal stem cells are situated at the dermal sheath, in the deepest portion of the follicles. These follicular stem cells are quiescent cells by definition (they divide rarely), but proliferate under two circumstances: when they start a new hair cycle and produce a new hair shaft (when telogen hair turns into anagen), and when a cutaneous wound is produced. Numerous studies have demonstrated that when such a wound takes place, epithelial stem cells from the bulge migrate to re-epithelialize the epidermis. However, the role of perifollicular mesenchymal stem cells seems to be even more important. After a dermal wound, these stem cells proliferate and differentiate into myofibroblasts (wound healing fibroblasts), participants in the dermal wound repair.

So, is the ultimate function of hair follicles to produce hair shafts, as we have normally been taught? A very interesting hypothesis paper published in 2001 by Jahoda argued that the cellular machinery of the hair follicle has a choice between trying to regenerate a new follicle or participating in wound healing, and that this "choice" depends on micro-environmental factors.[5]

Having been involved in the past few years in a couple of studies that involved the transplantation of hair follicle grafts into chronic leg wounds, I have observed a better healing response when punches are harvested from the scalp than from non-hairy areas.[6] Interestingly, I also observed that scalp punch grafts transplanted in the wound bed of chronic ulcers produce far less hair shafts (only a few) than would be expected if the same punches were transplanted in a normal scalp. In my opinion, and in agreement with the attractive and visionary hypothesis of Jahoda, the micro-environment of an injured wound bed sends molecular signals that direct the hair follicles to provide cells for repairing the wound and not for hair shaft production.

In conclusion, the evolutionary priority of the hair follicle is wound healing and not hair shaft production. We, as hair transplant surgeons, mostly treat patients with the aesthetic objective of covering thin or balding areas with more hair shafts. But we should not forget that hair follicles have other more interesting functions and that it would be easy for us to adapt our skills to treat other pathologies (e.g., chronic non-healing ulcers), more relevant from a medical point of view than baldness.[7] I hope these reflections stimulate other colleagues to question conventional thought and propose novel theories that, as Dobzhansky argued, only really make sense in the light of evolution.

References

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