Stem Cells, Ectodermal Organ Regeneration and the Evolution: From Regenerative Biology to Regenerative Medicine

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In Dec 2014, “the birth of birds” was chosen as one of the 10 major breakthroughs by Science. This is an acknowledgement to our integrative study on how feathered dinosaurs are transformed into birds. My contribution is on the Evo-Devo of feathers. Yet how are stem cell research related to the evolution of birds? As the first step of feather evolution, integument was compartmentalized into multi-units, and each unit has its own stem cells and cycle independently. With thousands of units (feather follicles) on the body surface, these feathers can start to evolve regional specific feathers. They include downy feathers in the body, flight feathers in the wing, and crown and tail feathers for insulation, flight, and communication respectively. Further, stem cell renewal allows the chicks to look very different from adult birds. Hormonal status and seasonal changes can modulate appendage phenotypes, leading to “organ metamorphosis”, with multiple ectodermal organ phenotypes generated from stem cells in the same follicles. These unique characters also allow us to study the macro-environmental physiological regulation of stem cell activities, and the micro-environmental follicular signals that guide feather morphogenesis. Therefore periodic patterning is an effective design that made all these possible. Following severe wounding, all skin appendages are lost. Here we show how hairs and feathers can be reconstituted through self-organization of dissociated progenitor cells, a progress in tissue engineering and regenerative wound healing.

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