Rise of the clone

Paul Kemp PhD tells us what's new in hair cloning

Hair cloning, or hair multiplication, which aims to provide patients with an almost unlimited number of new hairs, has been a "Holy Grail" of hair restoration for more than 40 years. The search began with various laboratories showing that rodent dermal papilla and culture expanded rodent dermal papilla cells were able to induce new hair growth in rodents. In 1999 Colin Jahoda's lab showed that isolated, non-expanded, human dermal papilla were able to induce brand new hair follicles in humans.

Several clinical trials have been carried out in the hope of combining these two findings in order to use expanded dermal papilla and other human follicle cells to induce new hair formation. The first trial was carried out by UK-based Intercytex and the Farjo Hair Institute with later trials carried out by the Aderans Research Institute (ARI) in the US. Currently, clinical trials are underway with Replicel in Canada and Shiseido in Japan and new studies are being developed by HairClone in the UK and Organ Technologies/Kyocera in Japan.

> Hair cloning, or hair multiplication has been a "Holy Grail" of hair restoration for over 40 years

The clinical trials carried out to date, while not producing hair growth as impressive as that seen in rodents, have provided critical insights. Most importantly, the trials have shown that cell based hair restoration could proceed in one of two different ways.

Firstly by hair regeneration – the formation of brand new hair follicles in bald scalp regions. Secondly, important clinical effects have been seen through a process of hair rejuvenation – the conversion of miniaturising shafts into thicker, more terminal, hair. When the clinical studies were carried out by Intercytex and ARI, both groups were unable to explain why hair regeneration hadn't been seen in their subjects to the degree observed in rodent studies.

However, new and incredibly powerful, analytical techniques such as full genome arrays and RNA-seq analysis is showing that human dermal papilla cells, unlike their rodent counterparts, completely change their expression profile when they are multiplied in culture. Importantly, Higgins et al (PNAS 2013 v110 pp19679-88) showed that, as well as being able to monitor these changes, they were not completely irreversible and could be reversed to a degree that enabled human hair regeneration.

The concept of hair cloning consists of four basic steps: 1) disassembling an existing terminal hair follicle 2) multiplying the required cell (or cell types) in culture 3) putting the multiplied cells into a suitable formulation and 4) re-implanting the cells or construct formulation back in the scalp in a balding region. Each of these steps are being developed in different ways by the various research groups and companies involved. Unlike in the past when companies used expansion methodologies developed to work on rodent cells and applied them directly to human cells in clinical trials, these new analytical techniques will enable the development of systems to efficiently multiply follicle cells and analyse whether they have a suitable expression profile before undertaking expensive and time-consuming human clinical studies.

As the work has progressed, it seems clear that there will be a divergence both between regenerative and rejuvenative hair cloning systems and the patients to which they will be the most appropriate, but hair cloning has never been closer. **AM**

Paul Kemp PhD has more than 30 years' experience in commercial cell therapy in both the US and UK and has developed cell-based therapies that have treated approximately one million people. In 2006, when at Intercytex, he worked with the Farjo Centre to run the world's first hair cloning clinical trial. He co-founded HairClone with the Farjos in 2017.