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INSIDE JEB

Curl secret in cells

Merino sheep. Photo credit: Anita Grosvenor.

Depending on the current fashion, curly hair can be a blessing or a curse: people often spend a fortune taming unmanageable curls or sculpting luxurious waves. However, despite decades of research, it was still not clear why hair curls naturally. Duane Harland from AgResearch, New Zealand says that there were two competing theories. As individual hairs are made up of two different cell types – paracortical cells (which are packed with parallel keratin fibres) and orthocortical cells (which are packed with twisted keratin fibres) – one theory suggested that the longer orthocortical cells would line the outer side of the curve, with paracortical cells lining the inner side. The alternative theory suggested that there were more cells on the outer side of the curl, because the cells on that side of the hair follicle divided more, increasing the number of cells in the outer curve of the curl. 'But most of these theories have very limited or indirect evidence to back them up', says Harland. Having worked previously with Japan's Kao Corporation cosmetics company to learn more about the structure of human hair, Jolon Dyer and Stefan Clerens teamed up with Shinobu Nagase, Takashi Itou and Kenzo Koike to get to grips with the knotty problem of what makes hair curly.

However, human hair is too coarse to analyse its cell structure, so the team turned instead to fine curly merino sheep wool. They explain that the chemistry, structure and growth of all hair is essentially the same, so the lessons learned from sheep's wool will apply to human hair also.

Knowing the exact origin of the merino sheep whose wool was used in the study, David Scobie clipped a few full length locks from the winter coats of each animal before Harland, James Vernon and Joy Woods spent hours painstakingly cleaning and preparing over seven hundred 0.5 cm snippets from the base of individual fibres. 'We had to go to great lengths to make sure we were measuring the natural curvature programmed in during fibre development and not curvature imposed later while the wool was on the sheep's back or during washing and processing', he says. So the fibres were dried on a vibrating surface to ensure they didn't pick up any additional kinks. And Harland describes how manoeuvring the snippets onto microscope slides took a steady nerve. 'Grabbing the snippets with fine forceps was not an option because they were easily damaged…so we used the electrostatic force on the tip of fine forceps to accurately position them.' The team then measured the curvature of each wool snippet before staining it and transferring it to a confocal microscope to reveal the curl's cell structure.

After months of counting and measuring the cells on the inside and outside of each curly snippet, the team could see that the shorter paracortical cells lined the inside of the curve, while the longer orthocortical cells were located on the outside of the curl. So the curl was produced by the arrangement of the different cell types and not cells dividing more often on one side of the hair follicle to produce more cells on the outside of the curl. 'We have established clearly that cell type is important, as is cell length,' Harland says: and the same should hold true for human hair.

With the global hair care market estimated to be worth over $85 billion, the team is optimistic that their new discovery could contribute to the design of novel hair products. 'The improved knowledge of how features of hair contribute to its outward appearance and physical characteristics is essential background', says Harland.

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Harland, D. P., Vernon, J. A., Woods, J. L., Nagase, S., Itou, T., Koike, K., Scobie, D. A., Grosvenor, A. J., Dyer, J. M. and Clerens, S. (2018). Intrinsic curvature in wool fibres is determined by the relative length of orthocortical and paracortical cells. *J. Exp. Biol.* **221**, doi:10.1242/jeb.172312.

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