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**"Long-range mechanical force enables scaffold-free
Self-assembly of epithelial tubules"**

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In nature, self-assembly is a common process for biological systems to build large-scale architectures without positional cues from preexisting scaffolds or templates. Technologically, self-assembly has also been used to create biomimetic supra-molecular architectures. By contrast, examples of constructing functional cellular architectures through the principles of self-assembly are limited. Here, we show that epithelial cells in media containing type I collagen (COL) can self-assemble into >1cm-long, unbranched tubules in scaffold-free conditions. The tubules developed apicobasal polarity and formed lumens similar to those found *in situ*. The ability of the cells to form tubules depended on the initial and boundary conditions of the culturing systems, and could be hindered by cell-substrate interactions. Only culture systems containing a sufficient density of cells spread on low-adhesive substrates enabled the formation of single, long (> 0.5cm), unbranched tubules. Nucleation of linear cell-COL structures was found preceding tubule formation. Through a quantitative control on cell-COL interaction, we further found that the formation of linear cell-COL structure is mediated by long-range (~ 600 μ m) mechanical interaction (instead of chemical gradients) and that the stability of linear structures increased with their lengths. A mechanical feedback loop was identified, leading to a bi-stability of epithelial morphology: globular or tubular. Our findings illustrate a mechanical mechanism whereby cells can spontaneously form large-scale tubular patterns, and the feasibility of engineering functional tubules through scaffold-free self-assembly.