Cornea organoids from human induced pluripotent stem cells

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Video Abstract

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Abstract

A group of scientists collaborating across the US has developed a new tool to help understand eye diseases: cornea organoids, miniaturized corneas that can be grown in the lab using human stem cells. The cornea forms the outermost surface of the eye, and many disorders affecting eyesight arise from defects in this tissue, including some inherited forms of blindness. Traditional cell culture experiments have fallen short when trying to study these conditions because they don't adequately capture the complex arrangement of cells and extracellular matrix found in the cornea. But organoids do, opening the door for new discoveries that could change how we treat eye disorders. To create this 3D model system, the researchers started with human stem cells to capture the earliest stages of development. By adding specific factors to the culture medium, the scientists were able to direct the cells into becoming cornea cells. Gene expression experiments confirmed the cells had turned off genes normally associated with stem cells and had turned on the genes that mark cornea cell types. And the stem cells didn't just adopt a new identity – they self-assembled into tiny cornea-like structures. When the team stained the organoids to see which proteins were there, they found that the cells were arranged in a configuration that matches the human cornea. The organoids had even accumulated collagen fibrils in a pattern similar to the true organ. Being able to watch stem cells turn into eye cells – and then self-assemble into a cornea-like structure – allows researchers to better pinpoint the factors leading to the development of eye diseases. This model system also provides a platform for drug screens and may perhaps even be used one day to grow replacement tissue for damaged eyes.