Organoids

An organoid is a miniaturized and simplified version of an organ produced in vitro in three dimensions that show realistic micro-anatomy. They are derived from one or a few cells from a tissue, embryonic stem cells, or induced pluripotent stem cells, which can self-organize in three-dimensional culture owing to their self-renewal and differentiation capacities.

Organoids are currently the most promising tool to closely mimic human diseases and simultaneously overcome several limitations of 2-D cell culture models [1)]

Human brain organoid technology, which was first described in 2013, recapitulates the characteristics of brain development with a high degree of spatial and temporal fidelity and accurately reproduces brain microstructure. Brain organoids are becoming increasingly valuable for studying normal cortical neurogenesis and various congenital human brain diseases, and have gradually facilitated the translation of basic science research to clinical applications. For example, glioma organoids have been used to study tumor biology and drug response, and are progressively being applied to investigate other neurosurgery-associated diseases [2)]

The technique for growing organoids has rapidly improved since the early 2010s, and it was named by The Scientist as one of the biggest scientific advancements of 2013 [3)].

Stem cell-derived 3D-organoid culture has provided new alternatives for transplantation and regenerative medicine. Scholars have combined organoids with tissue engineering technology to improve reproducibility, the accuracy of constitution and throughput, and genetic correction to achieve a more personalized therapy [4)].

Organoids with region-specific architecture could facilitate the repair of injuries of the central nervous system. Xu et al. showed that human astrocytes can be directly reprogrammed into early neuroectodermal cells via the overexpression of OCT4, the suppression of p53 and the provision of the small molecules CHIR99021, SB431542, RepSox and Y27632. They also report that the activation of signalling mediated by fibroblast growth factor, sonic hedgehog and bone morphogenetic protein 4 in the reprogrammed cells induces them to form spinal-cord organoids with functional neurons specific to the dorsal and ventral domains. In mice with complete spinal-cord injury, organoids transplanted into the lesion differentiated into spinal-cord neurons, which migrated and formed synapses with host neurons. The direct reprogramming of human astrocytes into neurons may pave the way for in vivo neural organogenesis from endogenous astrocytes for the repair of injuries to the central nervous system [5)].

see Brain organoids.

see Glioma organoids

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