TheScientist

ORGANOIDS: THE NEW FRONTIER

Scientists grow organoids—3D self-organizing miniature organ structures—in cell culture to mimic complex tissues. Organoids derived from human pluripotent stem cells are powerful tools for reducing dependence on animal models at early research stages. As organoid technology advances, scientists use organoids in creative ways to learn about human development and disease. In doing so, they advance a wide range of research applications, including tissue and organ regeneration, drug screening, and precision medicine.

KIDNEY ORGANOIDS

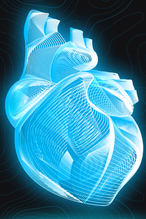
The kidney is an exceptionally complex organ, made up of over 25 different cell types organized into an elaborate, specialized structure. Advanced technologies such as single-cell sequencing and bioinformatics allow researchers to create increasingly complex kidney organoids with more specialized cells and architectural intricacy, and less variability. For example, scientists used single cell transcriptomics to identify biomarkers of organoid maturity, which improves kidney organoid reproducibility, disease modeling, and drug screening.[1]

INNER EAR ORGANOIDS

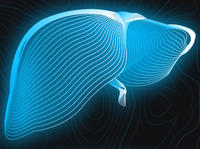
To understand the molecular basis of human inner ear developmental defects, researchers grow inner ear organoids derived from induced pluripotent stem cells (iPSCs). However, the extent to which current models represent human inner ear development is still being established. A recent preprint study describes how scientists used single cell RNA sequencing and multiplexed immunostaining to examine how closely these organoids mimic human inner ear development.[2] They found that the organoid cells differentiated into the major inner ear cell types, validating the approach as a relevant model for studying inner ear development and disease.

CARDIAC ORGANOIDS

Researchers explore cardiac organoids as a strategy for repairing injured heart tissue. Various biomaterials support organoid growth, maintenance, and integration into heart tissue following transplantation. Among the most promising of these are decellularized scaffolds and hydrogels, which are biodegradable, biocompatible, and can be created to closely mimic the structural components of heart tissue. Yet, regenerating the injured heart poses a unique challenge: electrical conductivity. Scientists recently bioengineered cardiac organoids with electrically conductive, biocompatible silicon nanowires and found that they improved heart function after transplantation into cardiac injured rats.[3]



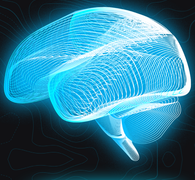
LIVER ORGANOIDS



3D bioprinting is a robust technique for mimicking the liver's architecture and function using computer modeling, bioink, and bioprinting technologies. Bioprinting liver organoids allows scientists to control the spatial distribution of cells to recapitulate the structure and function of the human liver. Researchers are on an ongoing quest to refine liver organoid bioprinting strategies, exploring a combination of cell types, multi-material bioinks, and printing strategies that come closer and closer to approximating the microenvironment of the liver and providing a reliable model for studying liver development, disease, and drug therapy.[4]

BRAIN ORGANOIDS

As researchers create brain organoids that are architecturally and functionally more intricate, there is an increased need to optimize their culture conditions to maximize growth and lifespan. Conventional bioreactors enable 3D brain organoid growth by constantly stirring cells in a stable and controlled environment, but such bioreactors are limited by the need to use large fluid volumes. Scientists explore microfluidic chips as alternatives to conventional bioreactors, which enable greater control over fluid flow, oxygen and nutrient exchange, chemical cues for guiding stem cell differentiation and migration, cell co-cultures, and microenvironment patterning.[5,6]



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