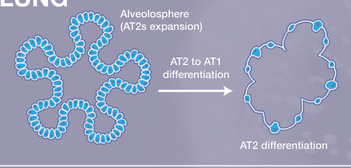
Dynamic modeling in organoids

Organoids are three-dimensional cultures composed of many cell types. They may be derived from stem cells or patient tissues, including tumors of a represented organ or tissue. This poster summarizes key examples in which organoids have been used to model aspects of human disease and potential therapeutic applications.

Cell Stem Cell

INFECTION

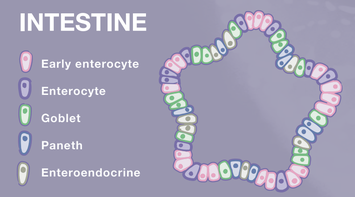
LUNG



Human alveolospheres have been used to recapitulate SARS-CoV-2 infection, which resulted in a loss of surfactants and AT2 cell death.

Interferon treatment recapitulated these features of SARS-CoV-2 infection.[1]

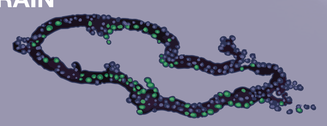
INTESTINE



SARS-CoV-2 productively infected proliferating cells and enterocytes in organoids derived from human small intestine.

Infection significantly upregulated genes related to cellular response to virus.[2]

BRAIN

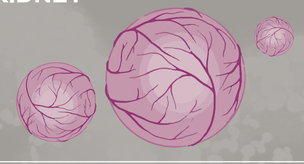


Brain choroid plexus organoids have been used to show that SARS-CoV-2 can disrupt epithelial integrity and barrier function.

Virus infection disrupted the blood-cerebrospinal fluid barrier.[3]

REGENERATION

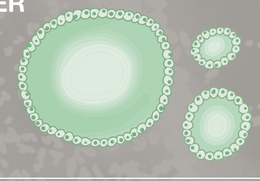
KIDNEY



Long-term establishment of normal renal organoids can lead to pioneering replacement strategies.

Since kidney organoids can replicate the complex architecture of the organ, they can be used as excellent models for tissue engineering studies.[7]

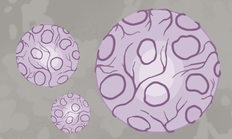
LIVER



A CRISPR screen using engineered biliary epithelial cell (BEC) organoids identified regulators of liver regeneration after injury.

Use of BEC organoids also led to the identification of heterogeneity, which could support liver regeneration.[8]

LYMPHO-ORGANOID



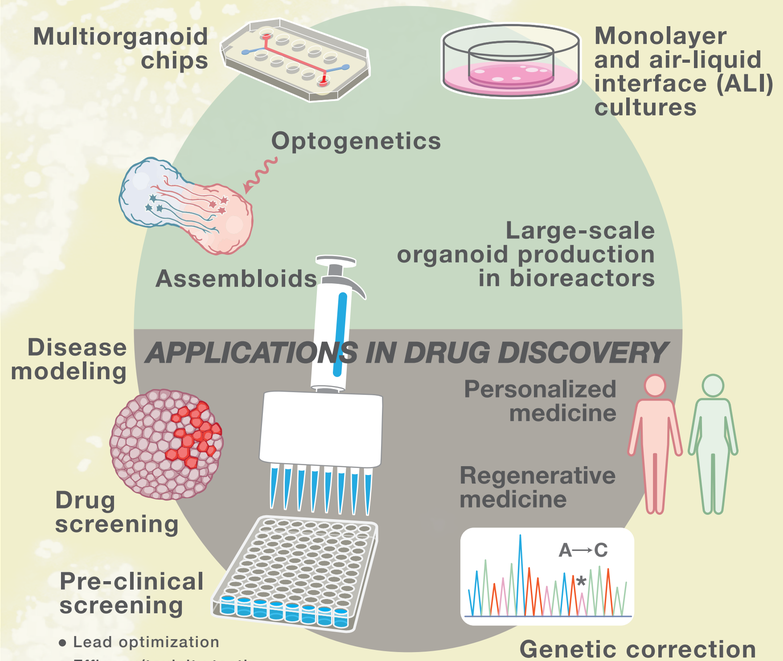
Upon transplantation, lympho-organoids integrated into the endogenous lymphatic drainage system.

Transplanted organoids supported activation of antigen-specific immune responses, acquiring the properties of native lymphoid tissues.[9]

EMERGING MEDICAL TRENDS

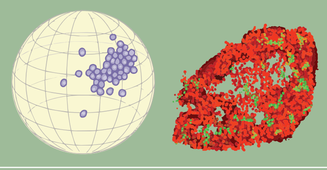
The science and culture of organoids has matured to the extent that there are now several applications in the discovery of human therapeutics.

SECOND GENERATION MANIPULATIONS



CANCER

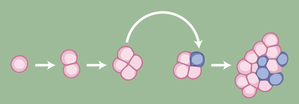
BRAIN TUMOR



Cortical organoids have been used as an experimental platform for studying properties of tumor cells.

Transplantation of labeled glioma brain tumor cells into cortical organoids revealed tumorigenic properties of radial glia-like cells.[4]

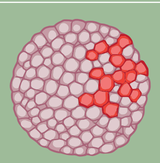
COLON CANCER



Colorectal cancer organoids have been used to study metastatic colonization.

The intrinsic plasticity of metastatic cells, which is indispensable for long-term metastatic outgrowth, was demonstrated.[5]

METASTASIS

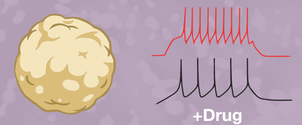


Lung organoids have been used to create a screening platform to test treatments for metastasis.

Labeled primary ovarian cancer cells incorporated in these lung organoids matched clinical response in patients.[6]

CONGENITAL DISORDERS

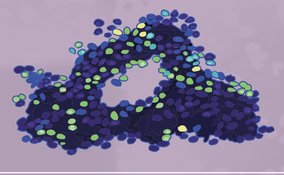
ANGELMAN SYNDROME



Patient-derived cortical organoids were used to model neuronal maturation and showed neuronal hyperexcitability.

Drugs directed at potassium channels corrected this phenotype, suggesting that channelopathies may underlie epilepsy in Angelman syndrome.[10]

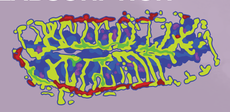
MICROCEPHALY



Patient-derived cerebral organoids with specific mutations may be used to model aspects of microcephaly.

Organoids from patients with abnormal spindle-like microcephaly (ASPM)-associated dysfunction showed disrupted cortical development and neuronal function.[11]

CONGENITAL MALABSORPTION



Malabsorption of macronutrients in the intestine requires drastic interventions.

Intestinal organoids demonstrated the role of enteroendocrine cells and secreted peptides in this condition.[12]

Poster designed by Paul Osimo. Concept and content by Prithi Rajan, *Cell Stem Cell*.
Watermark adapted from Qian et al. (2016), *Cell*.

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A more relevant model | By combining a high degree of physiological relevance with the convenience and tools of *in vitro* experimentation, organoids are providing powerful model systems for studying various human tissues. In many cases, organoid systems enable researchers to study human biology directly in human tissues by helping to overcome the technical or ethical hurdles that would be involved with the study of certain primary tissues. Also contributing to the adoption of organoids across a wide array of research areas is the growing list of tools for manipulating organoids, including CRISPR-Cas9 genome editing, organoid-derived monolayer culture, and differentiation at the air-liquid interface.

STEMCELL Technologies supports organoid researchers with high-quality cell culture media and kits that enable robust establishment, expansion, maintenance, and differentiation of organoid cultures.

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