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Organoids Emergence in Cellular Systems Revolutionizes Disease Models

Laurel Stephen*

Department of Surgery, University of Toronto, Ontario, Canada

Introduction

Through well-established protocols, cell models have made it possible to investigate the characteristics of human diseases without having to deal with the ethical restrictions that come with post-mortem studies or the costs that come with researching animal models. The problems with using human embryonic stem cells (hESCs) were solved by cell reprogramming techniques like induced pluripotent stem cell (iPSC) technology. In addition, iPSCs made significant contributions to human medicine in areas such as regenerative, therapeutic and diagnosis. The two-dimensional (2D) models made it possible to cultivate cells *in vitro* in monolayers; however, the three-dimensional (3D) cell culture system surpassed them. The multi-layered 3D cell culture respects cellular morphology and polarity more closely and allows for greater cell–cell contact. It is able to resemble conditions more closely *in vivo* and is closer to the structure of human tissues, like organoids. Organoids are three-dimensional cellular structures that resemble native tissue architecture and function. They are used to study organ development, disease modeling and drug discovery and are created *in vitro* from stem cells or differentiated cells like epithelial or neural cells. New insights into the pathogenesis of cancer, metabolic diseases and brain disorders are provided by organoids, which have developed into a potent tool for comprehending the cellular and molecular mechanisms underlying human physiology. Even though organoid technology is on the rise, there are some drawbacks that need to be addressed.

Description

The powerful tool known as cellular disease modeling is utilized in the research of various diseases underlying mechanisms and the creation of novel treatments. Cancer, neurodegeneration and infectious diseases are just a few examples of the genetic and acquired diseases that can be studied with these models. One of the main advantages of cellular disease modeling is that it makes it possible to study diseases in a controlled environment in ways that can't be done in a living organism. For example, it lets you introduce specific genetic mutations or environmental factors to see how they affect cells. Moreover, cell illness displaying can likewise be utilized to concentrate on complex irresistible infections that include numerous pathways and collaborations between various cell types. It is possible to discover the underlying mechanisms of the disease and test the efficacy of new treatments by studying the effects of various viruses or bacteria on the cells. This provides insights into the disease process [1].

The paradigm of the field of stem cell biology was altered when transcription factors were used to induce a state of pluripotence resembling that of an embryo using differentiated murine fibroblasts. One of the most normally involved models for concentrating on cell infections includes the utilization of iPSCs. Human iPSCs can be obtained from a variety of somatic tissue cell types and can be transformed into any specialized cell type in the human body by utilizing particular factors that determine the fate of the cells. Moreover, iPSCs can likewise be utilized to concentrate on hereditary illnesses, especially those with inconceivable hereditary foundations, which can give bits of knowledge into the hidden components of the sickness or when the interpretation of creature models is restricted. In addition, they can be a useful model for investigating interactions between genotype-specific parasites and host species.

Organoids technology is able to replicate the intricate cellular interactions and microenvironment of native tissues, making it possible to examine disease-specific mechanisms in a context that is more physiologically relevant than traditional 2D cell culture or animal models. Inflammatory bowel disease can be studied with organoids derived from intestinal stem cells, while neurodegenerative disorders can be studied with organoids derived from neural stem cells. Additionally, organoids can be used to investigate how genetic variations or environmental factors affect organ development and function, shedding light on the underlying mechanisms of human disease. The creation and induction of relevant molecular, cellular and structural characteristics in *in vitro* models of human organs was made possible by bioengineered organoids and 3D bioprinting, which revolutionized the field of tissue engineering and regenerative medicine [2].

The possibility of patterning human tissues made up of various cell types and a similar physiological microenvironment that can be maintained for extended periods of time through tissue and organ engineering is encouraging. Additionally, this may aid in the future development of organoids with increased vascularization and homogeneity. Bioengineered organoids with improved reproducibility and tissue structure can be created by combining the self-organizing organoid properties of cells with bioengineering. The poly lactide-co-glycolide copolymer (PLGA) fiber microfilaments, for instance, can be used as a floating scaffold to produce EBs that are longer. The neuroectoderm formation and cortical development of the cerebral organoids, including the spatial organization of the polarized cortical plate and radial elements, were well-defined as a result.

The technology known as three-dimensional bio printing makes it possible to create intricate models of various cell types of tissues and organs. Models can be constructed using a variety of materials, bioactive molecules and printing techniques for functional 3D structures [3].

Organoids, tissue constructs and even functional organs are examples of these structures. Models with high accuracy, functionality, repeatability and reproducibility are also attainable. It is possible to precisely define the external and internal geometry, spatial organization and cellular orientation of the formed tissues using 3D bioprinting technology in order to replicate the structure and function of their biological counterparts. In addition, it can create vascular networks in organoids or enable the proper perfusion of nutrients and the interconnection of various organ regions for proper tissue development or repair. Extrusion, inkjet, laser, dual head printing and light-mediated stereo lithography are some of the bio printing techniques. Cells printed on basic matrix bio inks like hydrogels make up the 3D bio printing process. Due to the use of tissue organoids with a variety of applications, such as drug screening (testing the efficacy and toxicity of drugs) or patient-derived xenografts, bio inks printable biomaterials used in 3D printing are crucial to precision medicine. As a result, *in vitro* models for drug discovery and development that are more physiologically relevant can be created using 3D bio printing [4].

***Address for Correspondence:** Laurel Stephen, Department of Surgery, University of Toronto, Ontario, Canada, E-mail: laurelstephen89@mail.com*

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In a nutshell, the 3D bioprinting of organoids, which improves the formation of bones and muscles, may have an impact on regenerative medicine and organoid technology, which will have a significant impact on clinical limitations. Additionally, the 3D bioprinting of organoids may facilitate the study of tumorigenesis, the specificities of the microenvironment, the cellular and functional changes in the cerebral cortex, or the expedited treatment of patients with tissue or organ impairments, cancer, or other aging-related conditions. In recent decades, the use of culture systems has developed significantly. In this article, we discussed the most recent understanding of various cell culture systems, as well as the benefits and drawbacks of each. The benefits and drawbacks of using organoid systems as *in vitro* models were the focus of this review. Organoid technology made it easier for culture systems to use to model diseases *in vitro* and lifted ethical restrictions on using animals. Organoids have enormous potential for tissue biology research, disease modelling (including genetic, infectious and cancerous diseases) and alternative cell-based therapy [5].

Conclusion

They also have the potential to reduce the use of animal models and the ethical issues that go along with that. However, as previously mentioned, these models still require enhancements to realize their full potential. Despite the potential of organoid technology, it must be closely monitored. In order for tissue engineering to enable the production of tissues and organs that can be used in transplants without raising ethical concerns, standardization in the culture process and reaching a level of production at scale are fundamental requirements. In spite of their limitations, the potential and versatility of organoids are undeniable and their use has grown significantly in recent years in a variety of scientific fields. This review provides a comprehensive examination of future perspectives on the use of organoid technology in research. This technology for 3D culture makes it possible to model a variety of diseases. It could be used in regenerative medicine, gene editing and immunotherapy, which would allow researchers to study targeted therapies that are more effective.

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Conflict of Interest

None.

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