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Reshaping Drug Discovery and Biomimicking Disease Models

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Introduction

Predicting a drug's effect before conducting human clinical trials is at the heart of the drug research and screening processes. The cost of drug discovery is continually rising due to the poor predictability of animal models and 2D cell culture. The fusion of tissue engineering and micro fabrication led to the creation of organ-on-a-chip technology, an alternative to conventional preclinical drug testing models. The ability of organ-on-a-chip technologies to imitate crucial human physiological functions that are necessary for comprehending the effects of drugs enhances preclinical safety and effectiveness testing. Preclinical testing success rates could be dramatically increased by organ-on-a-chip, allowing for better predictions of how the drug will perform in clinical trials. A micro engineered biomimetic device that imitates the structure and functionality of human tissue is referred to as an "organ on a chip." On a small platform, it combines engineering, cell biology, and biomaterial technologies. To reflect human physiology in vitro and overcome any barrier between in vivo and in vitro information, improvement shouldn't think twice about pertinence. In order to speed up the transition of technology from the academic lab bench to specialized product development institutions and an expanding market, biomedical engineers with a focus on device engineering are more essential than ever. Based on the available literature, this review examines the most recent advancements in organ-on-a-chip technology as well as its potential.

Description

Toxicity Assessment for the 21st Century and Pre-clinical Drug Screening aim to replace high-dose animal research for toxicity evaluation with human-relevant in vitro models. The limitations of in silico modeling, the evolutionary gap between laboratory animals and humans, and the mismatch between existing in vitro methods and the human body necessitate the creation of novel approaches for the safety screening of novel drugs. It is challenging to describe and track the physiological processes that characterize organ-exogenous factor interactions due to the interconnected tissues of animal models. Translational medical research ought to concentrate on the complexities of the human condition rather than using animal models. The biological relevance of conventional in vitro models to the intricate human body tissues is limited, despite the fact that they are straightforward, durable, and suitable for high-throughput research. By combining micro technology and biology, the organ-on-a-chip method replicates human physiology. The chip is a microfluidic device that manages solution volumes of up to millilitres using networks of hair-fine micro channels. Although these systems are simpler than genuine human tissues and organs, they may replicate human physiology and disease [1,2].

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The term "organ" refers to microscopic tissues created on microfluidic chips that may simulate the functions of various organs. The technology known as an organ-on-a-chip enables researchers to carry out experiments on tissues and cells that are not found in the body. Tubes that physically and biochemically replicate the in vivo environment contain them. The microscale enables direct monitoring of cell and tissue activities as well as improved control over the supportive environment for tissue. Organ-on-a-chip is a relatively new method for studying human disease and pathophysiology. 2D cell cultures, organoids, and organ-on-a-chip are the least important. Surprisingly, mice and Drosophila are used more frequently than manufactured tissues. Experiments become more difficult as biological complexity in model organisms grows. It is challenging to examine physiological processes in vivo in mice, humans, and other species despite advancements in in vivo imaging. 2D and 3D cell cultures, like spheroids and organoids, sacrifice in vivo relevance in order to make testing simpler. Organ-on-a-chip is a bridging technology that enables more precise microenvironments and advanced cell cultures [3-5].

Conclusion

As is frequently the case in biological science, the connection between form and function is crucial in this area of biomedical engineering. In biomedical engineering, significant advancements in micro and nano engineering can be attributed to the comprehension and application of this intricate interaction. Soft lithography is typically used to construct polydimethylsiloxane-based microfluidic devices (PDMS: Polydimethylsiloxane) Because of the usual advantages (strong cell culture compatibility, inexpensive fabrication, and easy flow management, for example), these experimental principles can achieve a unique architectural topology to simulate vital organ functions on a microscale chip. As a result, discoveries in the life sciences provide a wealth of information about how various biological units, such as an alveolus or nephron, require a particular topology to function effectively. These efforts are complemented by studies of cell culture, which permit the in-vitro identification, definition, and development of virtually every kind of cell. Because of this association of shape and capability, which basically emulates our ebb and flow comprehension of life, organ-on-a-chip research is very interesting

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