# Replicating human tissues in vitro for regenerative, personalized and precision medicine

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Precision and personalized medicine are the current paradigms steering transformation of medical practice. Central to this revolution are Tissue and Organ on Chip (TOC/OoC) devices, microfluidic systems that emulate organ-level physiology in controlled, dynamic microenvironments using cultured human tissues or organs. These devices offer a promising platform to study human physiology in a tissue-specific context, develop disease models, and potentially replace animal testing in drug development.
However, a key challenge lies in accurately replicating the functions of native tissues within these devices. Native tissues possess specific morphoanatomical features with well-defined three-dimensional (3D) microarchitectures and tissue-specific properties. Current tissue engineering efforts strive to recreate these structural features to enhance the reliability and robustness of TOC/OoC devices in mimicking organ responses. Bottom-up tissue engineering and 3D bioprinting are promising strategies to address these challenges. Bottom-up approaches involve biofabrication of large tissue constructs by sintering micrometric tissue building blocks, creating scaffold-free microtissues that closely resemble native tissue structure. Meanwhile, 3D bioprinting leverages inkjet technologies to print complex heterocellular tissues of any shape and dimension, using scaffold-free or scaffold-based micro-modules as building blocks. Despite these advances, limitations persist in fully replicating the complexity of native tissues within TOC/OoC devices. Challenges include accurately recapitulating cellular and chemical complexity, as well as the regulatory functions of the native extracellular matrix (ECM).
In this lecture, the potential of TOC/OoC devices in personalized medicine and precision medicine will be explored. These devices hold promise for diverse applications in disease modeling and treatment scenarios, including tumors, rare diseases, pulmonary disorders, and skin diseases. By providing realistic human cell and tissue models, they facilitate tailored clinical trials, drug testing, and disease research. Ongoing advancements in tissue engineering and microfluidic technologies aim to enhance the fidelity of these devices, furthering their impact on healthcare and therapeutic development.

## REFERENCES

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