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3D Printing of Personalized Organs and Tissues.

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Authors: Kaiming Ye and Sha Jin, Department of Biomedical Engineering, Watson School of Engineering and Applied Science, Binghamton University, State University of New York, Binghamton, NY 13902-6000 Abstract: Creation of highly organized multicellular constructs, including tissues and organs or organoids, will revolutionize tissue engineering and regenerative medicine. The development of these technologies will enable the production of individualized organs or tissues for patient-tailored organ transplantation or cell-based therapy. For instance, a patient with damaged myocardial tissues due to an ischemic event can receive a myocardial transplant generated using the patients own induced pluripotent stem cells (iPSCs). Likewise, a type-1 diabetic patient can be treated with lab-generated islets to restore his or her physiological insulin secretion capability. These lab-produced, high order tissues or organs can also serve as disease models for pathophysiological study and drug screening. The remarkable advances in stem cell biology, tissue engineering, microfabrication, and materials science in the last decade suggest the feasibility of generating these tissues and organoids in the laboratory. Nevertheless, major challenges still exist. One of the critical challenges that we still face today is the difficulty in constructing or fabricating multicellular assemblies that recapitulate in vivo microenvironments essential for controlling cell proliferation, migration, differentiation, maturation and assembly into a biologically functional tissue or organoid structure. These challenges can be addressed through developing 3D organ and tissue printing which enables organizing and assembling cells into desired tissue and organ structures. We have shown that human pluripotent stem cells differentiated in 3D environments are mature and possess high degree of biological function necessary for them to function in vivo.