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SYNTHETIC ORGANOGENESIS: HOW FAR ARE WE FROM LAB GROWN HUMAN ORGANS?

In March 2021, the New York Times and hundreds of other news outlets reported that scientists have engineered human embryos in a lab with nothing but stem cells, generating excitement and spurring ethical debates. In these studies, using cellular and tissue engineering, human embryonic stem cells were coaxed to self-organize into a structure that strikingly resembles a human blastocyst, the embryonic stage just prior to implantation into the uterus. In fact, this approach is not new in the field. Over the past decade, we have been using human stem cells, and manipulated their chemical and mechanical microenvironment to generate all sorts of embryonic and organ structures. These so-called organoids hold a tremendous potential to answer longstanding questions of human embryonic development and to one day serve as a renewable source of patient-specific tissues. But how close are organoids and embryo models to the real thing? We employ synthetic biology, tissue engineering, and developmental biology approaches to develop embryo-mimetic models which we use to study some of the most fundamental questions about our own development. For instance: how do complex gene regulatory networks establish precise cell fates in a developing embryo? What are the molecular mechanisms that underlie embryo implantation and the successful establishment of pregnancy? How do signals transport across the developing embryo to establish complex gradients that pattern the unique human body plan? We aim to bridge the gap between organoids and real organogenesis, in hopes of making meaningful strides in modeling diseases and advancing regenerative medicine.

ABOUT THE SPEAKER

Mijo received a Ph.D. in Chemistry from the University of Chicago and Ph.D. in Physics from the Sorbonne Universities in Paris, where they combined coarse-grained computer simulations and experimental biophysical approaches to discover new mechanisms of cell membrane remodeling. Mijo then moved to Rockefeller University where, as a Junior Fellow of the Simons Society of Fellows, participated in the earliest stages of synthetic embryogenesis: a new field that uses stem cells to model human embryonic development. Now at Columbia, Mijo's lab comprises a diverse group of chemical and biological engineers, geneticists, physicists, and synthetic biologists, all with the common goals of discovering the basic mechanisms of human development, of devising new approaches in reconstructing human organ formation in a lab, and of elucidating its failure. Notably, Mijo won the Chancellor's Prize from the Sorbonne Universities, they were the recipient of the AAAS/Science prize for Young Scientists in Cellular and Molecular biology, and in 2021 Mijo received the NIH Director's New Innovator Award.