Key innovations in stem-cell technology will advance medicine

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A scientist at the Gladstone Institutes has made two significant stem-cell discoveries that advance medicine and human health by creating powerful new approaches for using stem cells and stem-cell-like technology.

In two papers being published on April 25 in the Proceedings of the National Academy of Sciences, Sheng Ding, PhD, reveals novel and safer methods not only for transforming embryonic stem cells into large numbers of brain cells with multiple uses, but also for transforming adult skin cells into so-called neural stem cells—cells that are just beginning to become brain cells. Dr. Ding last month joined Gladstone, a leading and independent biomedical-research organization, where he is expected to make a significant contribution to the institute's exemplary stem-cell research.

"This work is an example of what we're expecting from Dr. Ding, one of the world's top chemical biologists in stem-cell science," said Deepak Srivastava, MD, who directs cardiovascular and stem-cell research at Gladstone. "Dr. Ding's perspective as a chemist brings a new approach to our stem-cell work here at Gladstone."

Embryonic stem cells—"pluripotent" cells that can develop into any type of cell in the human body—hold tremendous promise for regenerative medicine, in which damaged organs and tissues can be replaced or repaired. Many in the science community consider the use of stem cells to be key to the future treatment and eradication of a number of diseases, including some on which Gladstone research focuses, such as heart disease, diabetes and Parkinson's disease.

In the first of the two papers, Dr. Ding describes new methods to use embryonic stem cells to develop large numbers of neural stem cells, which are early-stage cells that can later develop into a variety of types of brain cells. With traditional stem-cell development techniques, neural stem cells remain at this early stage for only a short time—and so cannot produce enough new cells to be practical for biomedical use.

But Dr. Ding's new method uses a cocktail of chemicals, first to induce embryonic stem cells to become neural stem cells and then later to arrest the cells from further development. This ability to hold neural stem cells in an intermediate state has enormous implications for cell therapy and for basic biomedical research. Such tissue-specific cells—which have already begun to develop into brain or muscle cells, for example—are limited in number, life span and an ability to develop into any of a variety of cell types that might be required for therapy or research.

In his second paper, Dr. Ding builds on the induced pluripotent stem (iPS) cell technology discovered by Gladstone senior investigator Dr. Shinya Yamanaka, in order to overcome some of the other challenges of working with embryonic stem cells. Because iPS cells are generated from a patient's own skin cells to act like stem cells, they offer a variety of benefits over embryonic stem cells. For example, iPS cells can be ideal for a personalized approach to drug discovery and for rejection-free transplantation, while they wholly avoid the ethical concerns of embryonic stem cells.

In this groundbreaking cellular-reprogramming research, Dr. Ding focuses on reprogramming skin cells into neural stem cells using the existing iPS technology—but with a twist. Dr. Ding never lets the cells enter the pluripotent state of iPS cells, in which they could develop into any type of cell. Instead he uses yet another cocktail of factors to transform the skin cells directly into neural stem cells. Avoiding the pluripotent state is important because it avoids the potential danger that "rogue" iPS cells could develop into a tumor if used to replace or repair damaged organs or tissue. And as with Dr. Ding's embryonic stem-cell research, this cell-reprogramming work also makes it possible to create a far greater number of cells for research or regenerative purposes.

"These cells are not ready yet for transplantation," Dr. Ding said. "But this work removes some of the major technical hurdles to using embryonic stem cells and iPS cells to create transplant-ready cells for a host of diseases."

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