iPS Cells Accelerate Medical Progress

Professor Yamanaka was awarded the Nobel Prize in Physiology or Medicine in 2012, just six years after he had announced generation of iPS cells. This unusually quick recognition bespeaks the impact and sense of expectation produced by iPS cells.

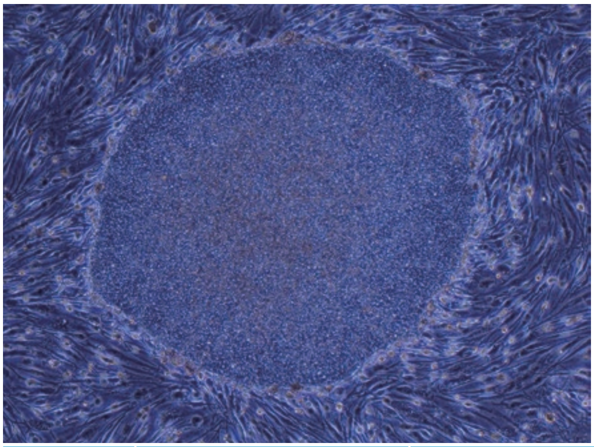
Regenerative medicine uses transplants of cells or tissues to improve the working of organs or tissues that have been lost or become dysfunctional. One of the keys in this endeavor has been induced pluripotent stem (iPS) cells, which have the capacity to change, or differentiate, into various cells in the body. Professor Shinya Yamanaka was the first to announce the generation of such cells in 2006, and in 2012 he was awarded the Nobel Prize in Physiology or Medicine for this accomplishment. Since that time he has continued efforts to develop and spread research in regenerative medicine and drug discovery using iPS cells, working to lower the risks, production time, and costs associated with these cells.

The Center for iPS Cell Research and Application (CiRA) at Kyoto University, where Professor Yamanaka serves as director, was established in 2010 as the world's first research institute specializing in iPS cells. It is characterized by an open lab style and active fundraising activities, and has more than 200 researchers, graduate students, and technicians. As Professor Yamanaka explains: “Research on medical applications of iPS cells in regenerative medicine and drug development requires time in units of decades. One of my jobs here is to establish a system that will allow CiRA to operate stably over the long term and to create an environment that enables researchers to concentrate fully on their research.”

CiRA is currently conducting a project to build a stock of iPS cells for regenerative medicine. They are generated from blood cells provided by volunteer donors whose cells are of a type relatively unlikely to cause transplant rejection. The iPS cells are stored and distributed to research institutes and companies that want to use them in regenerative medicine and for research in this field. Professor Yamanaka explains the significance of the project: “The time and cost required for regenerative medicine using iPS cells derived from a patient's own cells are huge, but with this system we can achieve substantial reductions in both. If other institutes use iPS cells whose quality is ensured by CiRA, the possibility of faster and less expensive clinical application also increases. This type of system is crucial for the industrialization of regenerative medicine using iPS cells.”

Today, research on regenerative medicine using iPS cells is progressing worldwide. Japan has been at the forefront in this field. One landmark, reached in 2014, was the surgical transplant of retinal pigment epithelial cells made from iPS cells into a patient with age-related macular degeneration, a currently incurable disease of the eyes. Japan is also approaching the stage of clinical application in Parkinson's disease, spinal cord injury, and some other diseases.

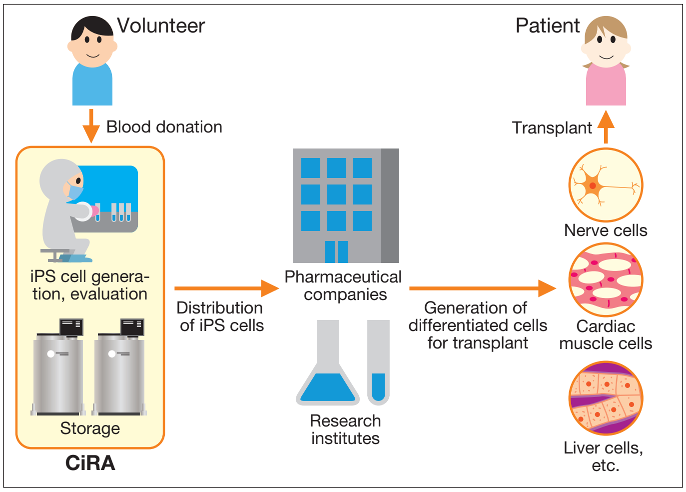
Japan has a record of outstanding achievements in basic research, and in recent years the pace of accomplishments in applied research is also on the rise. This combination of basic and applied research is an increasingly strong driver in the move toward industrialization of regenerative medicine. Professor Yamanaka declares, “The world is looking with expectation for the development of inexpensive treatments and new drugs using iPS cells, and Japan can surely make a contribution. We want to make steady progress toward achieving regenerative medicine and drug development that will give hope to people with intractable diseases.” iPS cell technology from Japan is accelerating the speed of such medical development.



	Induced pluripotent stem (iPS) cells	Embryonic stem (ES) cells
Method of generation	Generated from somatic cells such as skin and blood cells	Generated from embryos shortly after fertilization
Advantages	• Can change into various cells in the body • Can proliferate indefinitely • No immune rejection (in cases of autologous transplantation of iPS cell–derived somatic cells)	• Can change into various cells in the body • Can proliferate indefinitely
Disadvantages	• Quality is still variable	• Use of human embryos raises an ethical issue

1 | 2
3

1. iPS cells are stem cells generated by reprogramming somatic cells such as skin and blood cells with the introduction of a few factors. The stem cells have the capacity to change, or differentiate, into various cells in the body and to proliferate indefinitely. (Photo by Kyoto University Professor Shinya Yamanaka.) 2. Kyoto University's CiRA facility. 3. Both iPS cells and embryonic stem (ES) cells have the capacity to change, or differentiate, into various cells in the body and to proliferate indefinitely. Research is progressing steadily toward overcoming challenges that iPS cells face, such as variations in quality.



In the iPS Cell Stock for Regenerative Medicine project, blood is collected from healthy donors with human leukocyte antigen (HLA) types that are thought to be relatively unlikely to cause immune rejection. After clinical-grade iPS cells are generated and evaluated in the Facility for iPS Cell Therapy (FiT) at CiRA, they are cryopreserved. Distribution to other research institutes and companies has already begun, and FiT aims to have a stock of iPS cells that can be used for most of the Japanese population by the end of fiscal year 2022.

Shinya Yamanaka

Born in 1962 in Osaka Prefecture. Graduated from Kobe University School of Medicine in 1987, and earned a PhD from Osaka City University Graduate School of Medicine in 1993. After working in a postdoctoral position at the Gladstone Institutes and as a professor at the Nara Institute of Science and Technology, he became a professor at Kyoto University in 2004. Appointed director of the Center for iPS Cell Research and Application (CiRA) in 2010, and awarded the Nobel Prize in Physiology or Medicine in 2012.