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# Research Progress and Application Prospect of IPS Cells

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***ABSTRACT***

Differentiated somatic cells can be reprogrammed into induced pluripotent stem cells (iPS cells) by introducing specific transcription factors. This technique avoids immune rejection and ethical problems in stem cell research. A great revolution in the field of science. As with embryonic stem cells (ES cells), iPS cells are able to self-renew and maintain undifferentiated state. In vitro, iPS cells can be induced to differentiate into a variety of mature cells, therefore, iPS cells in theoretical research and clinical applications are extremely valuable. IPS cell differentiation and transplantation in the treatment of blood diseases have a great use, iPS cells can treat nervous system diseases, to provide in vitro disease model, to study the mechanism of disease formation, screening new drugs and the development of new to provide a new treatment The The use of iPS cells as a nuclear donor cell, with the appropriate receptor cells after fusion can be directly obtained transgenic animals. Not only can improve the genetic nature of animals, but also can break the boundaries of species and get the new animal traits that cannot achieve by using traditional mating methods. The research of iPS cells has been widely concerned, and it is the research hotspot in cell biology and molecular biology. In this paper, the definition of iPS cells, the acquisition of iPS cells, the history of development, the significance of research, the progress of research, the application of iPS cells, and the problems of iPS cells were reviewed.

***KEYWORDS:*** Inducible pluripotent stem cell; Embryonic stem cell; Transcription factor reprogramming differentiation

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## 1. Preface

### 1.1. Overview of iPS cells

IPS cells reproduce differentiated somatic cells into induced pluripotent stem cells (iPS cells) by introducing specific transcription factors. Specific transcription factors are Oct4, Sox2, c-Myc and Klf4 4 factors (these four factors, also known as Yamanaka factor) can effectively convert fetal mouse embryonic cells (mouse embryonic fibroblast, MEF cells) and mouse tail fibroblasts induce morphogenesis and growth characteristics similar to ES cell clones, iPS cells. IPS cells also allow common somatic cells to 'initialize' to make them stem cell function. 'IPS cells' have similar functions to embryonic stem cells, and without the need to make embryos, cells from stem cells can be produced from cells of any tissue or even skin cells. IPS cells and embryonic stem cells can produce all the cells in addition to the embryos, and if they are used for medical treatment, theoretically can cure all the diseases - all the bad tissues are removed and replaced with the normal tissue that grows.

### 1.2. Study the significance of iPS cells

Successful establishment of iPS cells, the application of iPS cells to treat disease is the ultimate goal of people. IPS cells can be used not only for differentiation and transplantation, but also to provide in vitro disease models to facilitate the study of disease formation mechanisms, screening new drugs and developing new treatments. The establishment of human iPS cells is recognized as one of the most important advances in science and technology in 2007. This technology not only establishes individual pluripotent stem cell lines from somatic cells, but also addresses the problem of immune rejection in cell transplantation therapy. The mechanism of cell reprogramming, and the mechanism of individual-specific disease pathogenesis provide a powerful approach. In the field of stem cell research, the emergence

of iPS cell technology is undoubtedly a landmark breakthrough, a variety of somatic cells in vitro culture and induction can be transformed into a multi-directional differentiation of stem cells, and proved that several known transcription factors can differentiate and reverse the somatic cells to undifferentiated state, indicating the huge plasticity of cells.

# 2. Advances in iPS Cell Research

## 2.1. Establishment of iPS cells

Somatic cell nuclear transfer or cell fusion can reprogram highly differentiated somatic cells, cell reprogramming refers to the process of transitioning mature cells from a differentiated state to an undifferentiated state [3]. Studies have shown that mouse embryos are early in 2-cell stage to 4-cell stage, each blastomere is likely to have shown a different developmental tendencies [4]. After that, the cells are constantly diverging in different directions. Regardless of the extent of cell differentiation, they are identical to undifferentiated cells in their genetic makeup. However, in their development process, their genomes have undergone many epigenetic modifications, indicating that in the oocytes and ES cells may contain some factors that can start cell reprogramming, can induce somatic cell epigenetic changes and re-change acquired developmental pluripotency, like re-initiation of fertility as fertilized eggs.

### 2.1.1 Four factors

So, can direct application of the relevant transcription factors on the somatic cell reprogramming and reverse the development potential of undifferentiated cells, and thus show the ES cells as much potential? Takahashi and Yamanaka [4] selected 24 transcription factors that were abundantly expressed in mouse early embryonic ES cells or tumor cells. By screening and combining, we found Oct4, Sox2, c-Myc and Klf4 4 factors (these four factors Also known as the Yamanaka factor) can effectively induce fetal mouse fibroblasts (MEF cells) and mouse tail tip fibroblasts to form morphological and growth characteristics similar to ES cell clones, iPS cells. Moreover, these iPS cells express ES cell-specific marker genes.

Why is the introduction of only a few factors that can induce somatic cells to reprogram and have plurality? According to the results of the current research, it can be seen that the pluripotency of ES cells is regulated by the transcription factor network and epigenetics, but in fact, the expression of several genes can induce pluripotent somatic cells. The effects of Oct4/Sox2/Klf4/Klf4/c-Myc and Oct4/Sox2/Nanog/Lin28 on pluripotency regulation were introduced in this paper. The key role of Oct4, Sox2 and Nanog transcription factors which were used in ES cells, played by the maintenance of sex has been well known. Oct4 is a vital factor in pluripotency regulation, and Oct4 is absent, and ES cells are not available at all. To maintain pluripotency, Oct4 expression levels must also be strictly controlled [6], Oct4 deficient or excessive ES cell differentiation. Oct4 regulates many genes in need of synergism with Sox2. Sox2 expression is not limited to pluripotent cells, but it is also important for early embryonic development and inhibition of differentiation. The lack of Sox2 embryos cannot form epiblast, which blocks the function of Sox2 in ES cells differentiation [6]. Nonog transcription is regulated by Oct4 and Sox2 [7], and its absence will lead to spontaneous differentiation of cells into primordial endodermal cells [8]. Genome-wide analysis revealed that Oct4, Sox2 and Nanog co-control a number of target genes in mouse and human ES cells, in which many of the gene products are important transcription factors for development. Oct4, Sox2 and Nanog transcription factors together to form the ES cell regulation system, which involves self-regulation and feed forward and other mechanisms. C-myc is a well-known proto-oncogene that plays a role in the self-renewal of certain adult stem cells. C-myc is a major downstream gene of the Lif/STAT3 and Wnt signaling pathways [9], both of which are important for the maintenance of pluripotency. Klf4 has the dual character of oncogene and tumor suppressor genes [10]. Its overexpression can maintain the expression of Oct4 and inhibit the differentiation of ES cells [11]; it can coordinate Oct4 and Sox2, thereby regulating the transcription of certain genes [12]. Lin28 is a negative regulatory gene that controls the development of many cells in many species [13]. In human and mouse ES cells, the expression of Lin28 decreased with the differentiation of ES cells.

### 2.1.2 Optimization of the system

The early establishment of iPS cells was performed by using retrovirus-mediated expression of four Yamanaka factors, followed by culturing the cells in ES cell culture medium and screening for the activation of pluripotency-related promoters with resistance genes such as Oct4 and Nanog promoter, and the pluripotency of iPS cells was identified after obtaining iPS cells with similar cell morphology.

These methods are very inefficient to construct iPS cells [14], cell pluripotency, and have inherent safety problems, such as viral insertion of mutations in c-Myc carcinogenicity, making it still unusable for clinical treatment. In order to solve these safety problems and improve the efficiency of iPS cell system, people have improved the construction of iPS cells in many ways.

#### 2.1.2.1 Transposon technology

British and Canadian scientists did not use viral vectors for the first time to develop safer induction of multifunctional dry (iPS cells) [15]. Their research work is based on a method developed by the Kyoto University scientist in the mountains, two years ago. Yamamoto and his colleagues implanted four genes into skin cells and were induced into pluripotent stem cells, making a major breakthrough in stem cell research. However, the vector used for their transplantation is a retrovirus, which means that this approach may increase the risk of cancer in patients using iPS cells. In order to avoid this technical flaw, the British and Canadian scientists used the transgenic crop commonly used 'transposon' technology, which can be called 'transposon' gene sequence inserted into the target genome. Researchers have experimented with skin cells from mice and humans, and the results show that the recombinant cell lines are fully characterized by embryonic stem cells [16].

#### 2.1.2.2 Reduce the risk of cancer

Japanese scientists have only two transplanted genes to cultivate human induced pluripotent stem cells (iPS cells), Japan's Gyeongbuk University Professor Okano's research team, only used to cultivate iPS cells used in the four induction genes in two, which are '0ct3/4' gene and 'Klf4k' gene, also successfully cultivated iPS cells. Because in addition to the use of retrovirus as a vector for gene transplantation, the factors that cause the risk of cancer in iPS cells are also associated with a gene called 'c-Myc' in the four induction genes used by previous researchers related. So, the latest Japanese scientists can also reduce the risk of cancer after iPS cell transplantation.

#### 2.1.2.3 Efficient and rapid establishment of iPS cells

Our scientists quickly establish human iPS cells from amniotic cells. Our scientists have made significant progress in the field of iPS cell research after the first time in the world for the first time in mice that have been developed by the induction of pluripotent stem cells (example: iPS cells) [18]. For the first time, rapid establishment of iPS cells, the time required only 6 days, for the current human iPS cell related reports in the shortest. Recently published in the international authority of the magazine 'Human Molecular Genetics Journal' on the results of this is by the Chinese Academy of Sciences Shanghai Academy of Life Sciences/Shanghai Jiaotong University School of Medicine Institute of Health Science Jin Ying researcher led the stem cell research group and Shanghai Xinhua Hospital Professor Chen Fang Cooperation done. According to a researcher introduced by Jin Ying [19], scientists have succeeded in inducing somatic cells of mice, rats, macaques, pigs and humans into iPS cells, and induction techniques have also undergone significant innovations such as reducing the number of exogenous transcription factors. The use of non-integrated virus, plasmid method and so on. "At present, the study of human-induced pluripotent stem cells is still in its infancy, and the donor cells are only confined to a small number of cell types such as human foreskin fibroblasts, epidermal cells and hair follicle cells. The reason to make these become more troublesome is the time required to reprogram the iPS cells is relatively long (usually 16 to 35 days) and the efficiency is low, which greatly increases the risk of cell variation in the process." Kim said, "So, the topic of how do you find an ideal human somatic cell source, is the focus of the world's scientists focus on the subject." According to reports, Dr. Li Chunliang doctoral researcher under the guidance of Jin Ying, pregnant women from prenatal diagnosis of the remaining amniotic cells found in a special group [20]. They were genetically induced by four factors induced by virus, the morphological changes were observed on the second day after infection, and the clones of human embryonic stem cells were similar on the fourth day. Researchers on the establishment of eight human induced pluripotent stem cells for further identification and found that these cells can be long-term stable in vitro and in vitro long-term passaged karyotype normal, maintain self-renewal, protein and transcription levels of high expression of pluripotent marker gene. The main application of induction of pluripotent stem cells is differentiation and cell transplantation. Researchers in accordance with international standards to try the amniotic fluid-derived iPS cells in vitro and in vivo differentiation potential, the results found that iPS cells can be divided into neurotropic cells, including a variety of human cells.

### 2.1.3 To improve the efficiency of iPS cell preparation

#### 2.1.3.1 Blocking of genes

Since the discovery of iPS cells, scientists have successfully introduced multiple somatic cells into iPS cells by introducing transcription factors, but the low induction efficiency has been a major obstacle to iPS technology. Transcription factor c-Myc is a proto-oncogene, people try to remove this gene to reduce carcinogenicity, however, c-Myc removal of carcinogenicity, although reduced, the induction efficiency is even lower. In September 2009, Hong et al. found that the removal of c-Myc after the gene with siRNA blocking a gene called p53, can be skin cells into iPS cells, the success rate increased to about 10%, about the original conversion rate of 100 times. Studies have shown that p53 is a regulator of cellular procedures and the key factor of rearrangement, which relates to the level of conversion efficiency. DNA chip analysis showed that there were 34 genes involved in p53 regulation in mouse and human

fibroblasts, and the functional analysis of these genes showed that, blocking the p53-p21 pathway not only improves the efficiency of iPS cell transformation but also reduces the carcinogenicity of iPS. More importantly, the silence of p53 gene can be used not only for viral vector induction technology, but also for plasmid or protein-induced transformation of the technology is also feasible.

#### 2.1.3.2 Synergies

Peking University Professor Deng Hongkui in the induction of human iPS cells, screening a series of related genes and found that p53 gene interference small RNA and gene can be synergistic effect, the iPS cell induction efficiency increased nearly 100 times, even without proto-oncogene C-Myc, can also efficiently and stably induce the formation of human iPS cells.

#### 2.1.3.3 Induction of adipose-derived stem cells

In September 2009, Stanford University researchers, Sun et al., found that Humanadipose stem cells (hASCs) were more likely to be induced as iPS cells than skin fibroblasts, and that iPS cells were safer. They found that in adipose-derived stem cells and skin fibroblasts, respectively, to be able to encode four transcription factors after the gene, about one in ten of the skin fibroblasts into iPS cells, and the ratio of adipose-derived stem cells transformed into iPS cells reached 2%, is the former 20 times. Four transcription factors (Oct4, Sox2, Klf4 and c-Myc) involved in the induction of iPS cells were not substantially expressed or expressed in skin fibroblasts. The expression levels of two transcription factors in adipose-derived stem cells are higher than those of dermal fibroblasts, suggesting that adipose-derived stem cells are more likely to be induced in the initial state. Induced by adipose - derived stem cells of iPS cells can be differentiated into the human body of nerve cells, muscle cells and intestinal epithelial cells. In addition, the use of adipose stem cell culture iPS cells do not need to raise cells, which undoubtedly improve its safety. Because hASCs provide a better somatic cell source for iPS cells, when appropriate, when iPS cells are used in clinical treatment, appropriate donor cell types can be selected, which ensures high induction efficiency and improves the safety of iPS cells.

#### 2.1.3.4 iPS cells induce oxygen in the environment

The oxygen concentration of the culture environment also has an effect on the induction efficiency of iPS cells [22]. Yamanaka et al. found that stem cells in the body were always concentrated in places where oxygen was relatively small, and they reduced the oxygen concentration of the culture environment from 21% to 5% when iPS cells were cultured with human skin cells and found that iPS cells generating efficiency can be increased to the original 2.5 times to 4.2 times. But if further reduce the oxygen concentration to 1%, it will be counterproductive part of the cell death. Inducing mouse skin cells, it is also possible to verify that the 5% oxygen concentration is most appropriate. Thus, they believe that higher quality iPS cells can be efficiently obtained by reducing the oxygen concentration in the culture environment and using a culture method with less cell carcinogenesis. In October 2009, the research team led by Dr. Ding Sheng, a researcher at the Scripps Institute in the United States, focused on the study of the transformation of the fibrous cells that produce connective tissue fibroblasts. The combination of chemical substances is the most effective in promoting the transformation of fibroblasts into stem cells, which is 100 times more efficient than traditional methods. Subsequently, the researchers also locked a new compound called Thiazovivi, this compound with SB43142 and PD0325901 in combination, can improve the efficiency of 200 times, while the transformation cycle from the original to 4 weeks shortened to 2 weeks.

#### 2.1.3.5 Effect of additives

December 2009, the Chinese Academy of Sciences, Guangzhou Institute of Biomedical and Health Pei Duanqing led the research team another way, the research direction into the extracellular environment of a medium composition, by adding vitamin C in the culture process can increase iPS induction efficiency 10 times, and through mouse and human cell experiments found that the culture of vitamin C can promote the expression of related genes to promote somatic cells into the reprogrammed state. They used careful experimental design to prove that external factors play an important role in iPS. In addition, Harvard University researchers also found that the addition of specific compounds can increase the efficiency of somatic cell-induced iPS by more than 100 times. In the induction process, they used four kinds of genetic genes, and added seven kinds of compounds that could hinder the synthesis of specific proteins. The results showed that the introduction efficiency of the genes was 0.01% – 0.05% without the addition of the compounds. After adding a protein called ‘Balpric acid’ protein synthesis inhibitor, the introduction of efficiency rose to 9.6% to 14%. At the same time, the latest report also found that butyrate treatment can significantly improve human iPS induction efficiency.

## 2.2. Application of iPS cells

### 2.2.1 iPS cells in the treatment of blood diseases

Xu et al [1] induced iPS cells into endothelial progenitor cells, and then transplanted into the liver with hemophilia mice, so that the symptoms of bleeding more than the disease has been effectively improved. Hanna et al. reprogrammed the diseased mouse mandibular fibroblasts into iPS cells then replaced the pass globin gene with the human wild p A. globin gene by homologous recombination, followed by the genetically modified iPS cells then differentiation into hematopoietic progenitor cells (HPs), and the purified HPs were transplanted into hps/llps male mice, and Has effectively inhibited the symptoms of sickle red blood cell anemia. Japan has made platelets with human iPS cells. The professor of stem cell biology at the University of Tokyo, Japan, recently succeeded in culturing platelets with human induced pluripotent stem cells (iPS cells), which is the first time in the world. Chinese and other researchers and the use of Japanese University of Kyoto professor in the same way. The human skin cells were implanted into the iPS cells. In the development of iPS cells, the researchers added human bone marrow cells and cells to promote cell proliferation and other substances results iPS cells into platelet progeny megakaryocytes; after megakaryocytes further differentiation into platelets. Platelets are one of the important components of mammalian blood, with contraction of blood vessels, the formation of thrombosis, to help stop bleeding and other functions. The platelets used in the surgery are now collected mainly by blood donation, in which case the platelets can only be stored for a few days and are very inconvenient. The researchers said, the results of this study also show that, technically speaking, it is possible to cultivate human erythrocytes and leukocytes with iPS cells.

### 2.2.2 Promote the mechanism of tumor

First, genetic abnormalities accumulate epigenetic abnormalities are important factors for tumorigenesis and progression. The normal cells that carry the tumor susceptibility gene or have a genetic background with tumor orientation were reprogrammed into iPS cells [24], induced to differentiate into cells of a specific tissue type, and the presence of the tumor was observed in a culture dish to identify key tumors Inhibitory factors and factors of environmental formation.

Second, the results of nuclear transplantation techniques have shown that reprogramming the tumor cells themselves as stem cells is quite difficult, that is, tumor cells are resistant to reprogramming, and that the emergence of iPS technology brings hope for this operation.

Third, the tumor cells have a specific genetic background, if they can be re-programmed by the iPS technology for stem cells, will remove the tumor-specific epigenetic state, by induction of differentiation into the normal phenotype of cells, the relationship between epigenetic changes and tumorigenesis under the background of genetics.

Fourth, in recent years, an important breakthrough in the field of tumor research is the identification and identification of cancer stem cells, but still cannot be efficient and high purity of tumor stem cells in vitro expansion and long-term culture, thus hindering the tumor stem cell biology unique characteristics of the analysis, and the development of therapeutic research for cancer stem cells is slow, if the iPS technology can be divided into short-lived state of tumor cells reprogrammed into tumor stem cells, will give the field of cancer research has brought great opportunities for development.

### 2.2.3 Somatic cell nuclear transfer technology

The use of iPS cells as a nuclear donor cell, with the appropriate receptor cells after fusion can be directly obtained transgenic animals. Therefore, the combination of iPS cell induction technology and animal transgenic technology not only can improve the genetic nature of animals, but also can break the boundaries of species, access to traditional mating methods cannot get the new animal traits. In 2010, two research teams in China established the pig's iPS cell line for the first time in the world, filling the gap between mice and humans. The research team from Pei Duanqing, Guangzhou Institute of Biomedicine and Health, Chinese Academy of Sciences isolated the fibroblasts from the embryos of the Tibetan miniature pig and introduced the transcription factor into the fibroblasts by retrovirus, which successfully induced the iPS cell line 11. 'The study group of Shanghai Institute of Biochemistry and Cell Biology, Chinese Academy of Sciences was able to successfully reprogram the porcine adult cells into pluripotent stem cells using the expression vector of the lentiviral expression system (Tet-on/of system), which was further screened and identified and finally obtained to meet the pluripotent stem cells Standard pig iPS cell line 11. This is the first time in the world to produce domesticated ungulate animal pluripotent stem cells. Pigs are physically different from humans, so the establishment of pig iPS cells is of great significance:

First, we can use the induction of stem cells to modify the pig's immune-related genes, so that the pig's organs are compatible with the human immune system;
Second, many human diseases are caused by gene expression disorders, and we can modify the genes of pigs in

stem cells and develop pigs carrying the same genetic barriers and then use this pig model to develop a method of treating the disease;

Third, the use of iPS technology to produce an accurate transgenic pig, to improve its tolerance to a disease, thereby improving the animal husbandry. Recently, there is no such report in cattle, sheep and other large animals. If we can build iPS cells of these animals and apply them to produce gene targeting or transgenic animals, it is necessary to improve the efficiency of transgenic animals. To create a broader world.

# 3. Problems and Prospects

## 3.1. iPS cells face problems

After nearly five years of long and short-term development, iPS cell technology has made remarkable progress. A breakthrough result has brought us joy, but also brought new challenges, cell reprogramming is expected to usher in a new wave of research. Although iPS cells have attractive application prospects, however, future iPS cell research is also faced with many urgent problems:

First, efficiency issues. At present, the rate of induction of iPS cells is still very low, which is related to the way genetic integration of the site, epigenetics and other factors. This has become the biggest bottleneck restricting iPS from laboratory to clinical. Therefore, how to improve the efficiency of iPS cell preparation is still a common concern.

Second, security issues. Now the induction of iPS cells is usually through the retrovirus as the carrier, several oncogenes into differentiated cells to induce it to become iPS cells, and this method may be due to foreign gene into the cell genome, interfere with the expression of endogenous genes, thus inducing cancer.

Third, the mechanism of the problem. The pluripotency of cells is regulated by the transcription factor network and epigenetics, and how do a few transcription factors rely on a complex task to induce pluripotent cells? It is also one of the important tasks to study the molecular mechanism, regulation mechanism and in vitro differentiation mechanism of somatic cell reprogramming.

## 3.2. Prospects for iPS cells

Since the birth of iPS cell technology, has been a great concern and extensive research, has now become the focus of research and discussion of life science research, iPS cells and ES cells compared to avoid immune rejection and ethical issues, has many advantages in the study of transgenic animals, iPS cells can act as transgenic target cells, which can transfer foreign genes into iPS cells by certain transgenic techniques, or genetic modification of iPS cells for gene targeting or gene knockout. The willingness to achieve iPS intracellular gene transformation, efficient, targeted production of transgenic animals. Through the study of animal models, scholars have made the necessary supplement to the study of human diseases. Before the advent of iPS technology, it is hard to imagine an accurate observation of the pathology of some hereditary or degenerative diseases in petri dishes, and the emergence of iPS technology makes these no longer difficult. Recently, Park et. al used iPS technology successfully established 10 kinds of human hereditary or degenerative disease origin of stem cell lines, including adenosine deaminase deficiency associated with severe combined immunodeficiency disease (ADA-SCID), Huntington's disease (HD) , Parkinson's disease (PD) and adolescents with type I diabetes (JDM). [23]. These disease-specific iPS cells carry the genetic defects of the disease itself, but can be effectively normalized to differentiate into a variety of cell types. These cell lines provide a material basis for the formation of normal and pathological tissues under in vitro conditions. In addition, it also provides a cellular model for the testing and screening of disease therapeutic drugs, providing unprecedented hope for basic research and clinical disease treatment.

In the view of the important role and potential of iPS in disease research, the Harvard University Stem Cell Research Institute launched a program to establish a disease-specific iPS cell bank in 2008, as well as the other four universities (Kyoto University, Gyeongye University, University of Tokyo and physicochemical Institute) established the iPS Cell Research Center. Facing with these rapid development, due to the large population of China, with extremely rich disease resources, for our unique disease population to establish disease-specific iPS cell pool should be mentioned as soon as possible on the agenda. Especially for some rare or unique hereditary diseases, preserving the cell seeds that can be studied for differentiation is far more valuable than preserving DNA.

The establishment of human iPS cells is recognized as one of the most important advances in science and technology in 2007. This technology not only establishes individual pluripotent stem cell lines from somatic cells, but also addresses the problem of immune rejection in cell transplantation therapy. The mechanism of cell reprogramming, and the mechanism of individual-specific disease pathogenesis provide a powerful approach. In the field of stem cell research, the emergence of iPS cell technology is undoubtedly a landmark breakthrough, a variety of somatic cells in

vitro culture and induction can be transformed into a multi-directional differentiation of stem cells, and proved that several known transcription factors can differentiate somatic cells and reverse to undifferentiated state, indicating the huge plasticity of cells. IPS technology expand the horizons and imagination of human beings, the researchers consider that without the iPS stage, the use of transgenic or non-transgenic approach to a source of convenient somatic cells directly reprogrammed into another somatic cells, to be used directly in the treatment of human diseases. In vivo studies have shown that pancreatic exocrine cells can be directly reprogrammed into endocrine cells by introduction of specific transcription factors. In addition, there are similar biological processes in the regeneration of many lower animal tissues or organ injuries. Therefore, continue to focus on and study the theory and key technologies of iPS, will give the development of normal development model, tumor research, tissue repair and regeneration and bio-pharmaceutical and many other biomedical fields to bring new opportunities for development.

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