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World first: Chinese scientists create pig stem cells. Discovery has far-reaching implications for animal and human health

Scientists have managed to induce cells from pigs to transform into pluripotent stem cells – cells that, like embryonic stem cells, are capable of developing into any type of cell in the body. It is the first time in the world that this has been achieved using somatic cells (cells that are not sperm or egg cells) from any animal with hooves (known as ungulates).

The implications of this achievement are far-reaching; the research could open the way to creating models for human genetic diseases, genetically engineering animals for organ transplants for humans, and for developing pigs that are resistant to diseases such as swine flu.

The work is the first research paper to be published online today (Wednesday 3 June) in the newly launched *Journal of Molecular Cell Biology* [1].

Dr Lei Xiao, who led the research, said: “To date, many efforts have been made to establish ungulate pluripotent embryonic stem cells from early embryos without success. This is the first report in the world of the creation of domesticated ungulate pluripotent stem cells. Therefore, it is entirely new, very important and has a number of applications for both human and animal health.”

Dr Xiao, who heads the stem cell lab at the Shanghai Institute of Biochemistry and Cell Biology (Shanghai, China), and colleagues succeeded in generating induced pluripotent stem cells by using transcription factors to reprogramme cells taken from a pig’s ear and bone marrow. After the cocktail of reprogramming factors had been introduced into the cells via a virus, the cells changed and developed in the laboratory into colonies of embryonic-like stem cells. Further tests confirmed that they were, in fact, stem cells capable of differentiating into the cell types that make up the three layers in an embryo – endoderm, mesoderm and ectoderm – a quality that all embryonic stem cells have. The information gained from successfully inducing pluripotent stem cells (iPS cells) means that it will be much easier for researchers to go on to develop embryonic stem cells (ES cells) that originate from pig or other ungulate embryos.

Dr Xiao said: “Pig pluripotent stem cells would be useful in a number of ways, such as precisely engineering transgenic animals for organ transplantation therapies. The pig species is significantly similar to humans in its form and function, and the organ dimensions are largely similar to human organs. We could use embryonic stem cells or induced stem cells to modify the immune-related genes in the pig to make the pig organ compatible to the human immune system. Then we could use these pigs as organ donors to provide organs for patients that won’t trigger an adverse reaction from the patient’s own immune system.

“Pig pluripotent stem cell lines could also be used to create models for human genetic diseases. Many human diseases, such as diabetes, are caused by a disorder of gene expression. We could modify the pig gene in the stem cells and generate pigs carrying the same gene disorder so that they would have a similar syndrome to that seen in human patients. Then it would be possible to use the pig model to develop therapies to treat the disease.

“To combat swine flu, for instance, we could make a precise, gene-modified pig to improve the animal’s resistance to the disease. We would do this by first, finding a gene that has anti-swine flu activity, or inhibits the proliferation of the swine flu virus; second, we can introduce this gene to the pig via pluripotent stem cells – a process known as gene ‘knock-in’. Alternatively, because the swine flu virus needs to bind with a receptor on the cell membrane of the pig to enter the cells and proliferate, we could knock out this receptor in the pig via gene targeting in the pig induced pluripotent stem cell. If the receptor is missing, the virus will not infect the pig.”

In addition to medical applications for pigs and humans, Dr Xiao said his discovery could be used to improve animal farming, not only by making the pigs healthier, but also by modifying the growth-related genes to change and improve the way the pigs grow.

However, Dr Xiao warned that it could take several years before some of the potential medical applications of his research could be used in the clinic.

The next stage of his research is to use the pig iPS cells to generate gene-modified pigs that could provide organs for patients, improve the pig species or be used for disease resistance. The modified animals would be either “knock in” pigs where the iPS or ES cells have been used to transfer an additional bit of genetic material (such as a piece of human DNA) into the pig’s genome, or “knock out” pigs where the technology is used to prevent a particular gene functioning.

Commenting on the study, the journal’s editor-in-chief, Professor Dangsheng Li, said: “This research is very exciting because it represents the first rigorous demonstration of the establishment of pluripotent stem cell in ungulate species, which will open up interesting opportunities for creating precise, gene-modified animals for research, therapeutic and agricultural purposes.”

(ends)

[1] Generation of pig induced pluripotent stem cells with a drug-inducible system. *Journal of Molecular Cell Biology*. doi:10.1093/jmcb/jmp003

Notes:
A pdf of the full research paper is available at:
http://www.oxfordjournals.org/our_journals/jmcb/mjp003.pdf

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