FACT SHEET

Genetic Engineering

Genetic engineering (or Transgenesis) is a fast growing area in the field of animal research. It is used mainly to improve the efficiency of production of animals for human consumption, and also in medical research to identify and manipulate the role of genes in human physiology as a means to alleviate genetic disorders.

Genetic Manipulation (Transgenesis)

Transgenesis is the process of transferring or removing one or more genes in order to produce a particular trait in the recipient species. The recipient animal should then be able to successfully reproduce offspring that carry the trait. An animal that has undergone this process is said to have been 'genetically modified.' In the case of mammals, the process usually involves direct injection of foreign DNA into the nucleus of a cell during its early embryonic stage. Its first success was in 1985[1].

There are several of reasons for this type of research:

1. To improve productivity of agricultural animals eg. Enhanced wool production in sheep, increased growth of animals used for food.
2. To counter obstacles in animal research, such as removal of a protein that causes rejection if a part of that animal is transplanted to another animal (xenotransplantation), or to create animals with a pre-disposition to disease, which will allow them to be used as 'models' for such things as cystic fibrosis, multiple sclerosis, and other diseases.
3. For the production of therapeutic products, such as pharmaceuticals in milk or human insulin which can be produced by transgenic bacteria.
4. Production of crops that have been genetically manipulated to produce larger and hardier yields.

Wastage of lives

The success rate of creating a transgenic animal is often as low as 1-2%. This is because only one in ten injected and transferred embryos survive at all, and then only one in ten of the survivors carries the required transgene. Of these transgenic animals, only half actually express the transgene. In the remainder, the gene may be activated in non-target tissue, or may activate at an abnormal time within the animal's development. Because of the low success rates and the high costs involved in producing transgenic animals researchers have looked toward cloning.

Animal suffering

In the creation of transgenic animals, animals suffer from the processes of surgical embryo retrieval and embryo transfer. During the microinjection process for example, the host mother must be injected with hormones to ensure she is at the right stage of ovulation. The significant manipulation of the animal's ovulation and oestrus cycle that takes place to ensure the availability of adequate embryos can lead to over-stimulation of the ovaries causing painful ovarian cysts or enlarged ovaries.

Animals can also become considerably stressed from the exposure to additional hormones, collection of eggs and implanting of the fertilised eggs.

Due to a lack of efficiency in the microinjection process, genes can often fail to reach the right target cells within the embryo and can cause painful abnormalities or even death.

The presence of a transgene may also affect the animal's ability to perform normal behaviour. Beltsville pigs for example (genetically modified to express additional growth hormones), experienced such extreme welfare problems that normal behaviour was impossible for them. They suffered from lethargy, lameness, lack of coordination, thickened skin, gastric ulcers, severe synovitis, degenerative joint disease, pericarditis and endocarditis, cardiomegaly, paraketosis, nephritis and pneumonia[3].

Cloning

Clones are produced by nuclear transplantation, whereby nuclei from the cells of one animal are transferred to unfertilized eggs from which the nucleus has been removed. The process results in a group of individuals that are genetically identical.

A number of problems have been identified in cloned animals, including abnormalities of tissue growth both before and after birth, extended gestation periods, increased still births and perinatal deaths[4]. It is unknown however, whether these abnormalities occur due to the nuclear transfer process itself.

The most famous case of cloning is Dolly the sheep who was announced the first cloned mammal in February 1997 by the Roslin Institute in Scotland. Her birth was so significant because she had been created using genetic information from the mammary tissue of an adult sheep, rather than from an embryonic cell – a process that was previously thought to be impossible. Dolly was the only successful clone from 277 attempts. She was euthanased by lethal injection February 2003 after she was found to have a progressive lung disease. She was also believed to have been suffering from premature arthritis. Only weeks earlier, Matilda – Australia's first cloned sheep – also died unexpectedly. Unfortunately her body was

cremated before an autopsy was carried out and so the cause of death remains unknown. The deaths of these two relatively young sheep raised concern about the safety of cloning.

It has been suggested that cloning techniques may one day enable the production of 'spare parts' which could be used for the treatment of damaged or diseased tissue and organs in humans. This is known as therapeutic cloning and involves the use of stem cells.

Xenotransplantation

Xenotransplantation is the transplantation of cells, tissue or organs from one species to another and is one of the reasons that transgenesis is performed.

One of the biggest obstacles to the "successful" transplantation of foreign organs, tissue or cells into another species is the need to overcome rejection. The introduced cells/tissue/organ is recognized by the recipient as being foreign and is therefore attacked by the recipient's immune system. The strong response can sometimes not be controlled by merely suppressing the immune system and is then referred to as hyperacute rejection.

In order to overcome the hyperacute rejection, source animals are genetically modified by inserting human genes so that the human recipient's immune system is tricked into not recognizing it as being foreign. Alternatively, the source animal may have a gene removed. The most likely source animal for human transplants is the pig. 'GAL-knockout' genetically modified pigs have been modified to remove a galactose sugar which triggers an immunological response in humans.

References

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