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Popular Article

Transgenic Animals and Their Benefits in Livestock Production

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Abstract

Transgenic animals are those animals that have been altered through the transfer or deletion of genes into or from the organism under consideration. They are used in safety testing, pharming, biological and medical research, agriculture, and xenotransplantation. This alien gene of interest is prepared by various gene editing techniques and incorporated through various vectors like bacterial plasmids, cosmids and yeast artificial chromosomes. The gene with the vectors is inserted to the host cell through different gene insertion methods like heat shock, electroporation, viruses, gene gun, microinjection, and liposomes. Transgenesis may be done through the gonads, sperm, fertilized eggs and embryo by DNA microinjection, retroviruses, stem cells, and cloning. If this technology can alleviate welfare and ethical issues, it will be the most promising technology in the future.

Introduction

Transgenic animals are created by deliberately inserting a gene into the genome of an animal. An animal that gains new genetic information from the addition of foreign DNA is described as **Transgenic** while the introduced DNA is called the **Transgene**.

Methods of gene transfer in transgenesis

Various gene editing techniques are used for preparing the foreign gene of interest. For example- recombinant DNA technology, and novel technologies for gene transfer like Transcription activator-like effector nucleases (TALENs), Zinc-finger nucleases (ZFNs), and CRISPR/cas9 (clustered regularly interspaced short palindromic repeats). The gene of interest can be incorporated by using different methods like transgenic vectors, microinjection, electroporation, heat shock, viruses, gene gun and liposomes.

Methods of Transgenesis

There are several methods which can be used to produce transgenic farm animals which will later serve as bioreactors. The most commonly adopted traditional transgenesis technique is Somatic Cell Nuclear Transfer (SCNT) where nuclear donors can be genetically modified somatic cells or stem cells.

a. **Retroviral vectors** that infect the cells of an early-stage embryo prior to implantation into a receptive female.

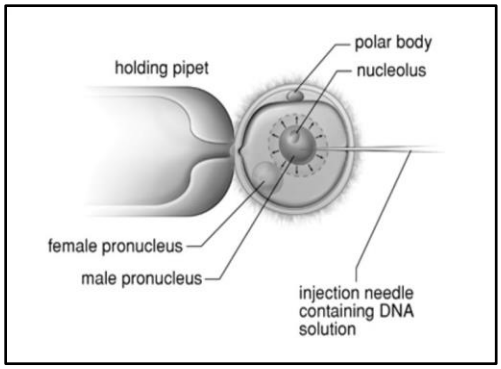
Table 1. Some common vectors used for transgenesis technology

VECTOR	ORIGIN	INSERT SIZE
Multicopy plasmids	Multicopy plasmids	up to 20 kb
Lambda vectors	Bacteriophage λ	up to 30 kb
Cosmid	Bacteriophage λ	up to 40 kb
P1 artificial chromosome	Bacteriophage P1	80-90 kb
Bacterial artificial chromosome (BAC)	arge Bacterial plasmid	100-300 kb
Yeast artificial chromosome (YAC)	Yeast chromosome	100-1000 kb

Limitations of this method include

- Size limit on the amount of DNA inserted (usually 9-15 kb)
- Unable to replicate in early embryonic cells and lower efficiency than the natural.
- Increased frequency of mosaicism.
- Possible interference by integrated retroviral sequences in transgene expression.

a. DNA microinjection into the enlarged sperm nucleus (the male pronucleus) of a fertilized egg.



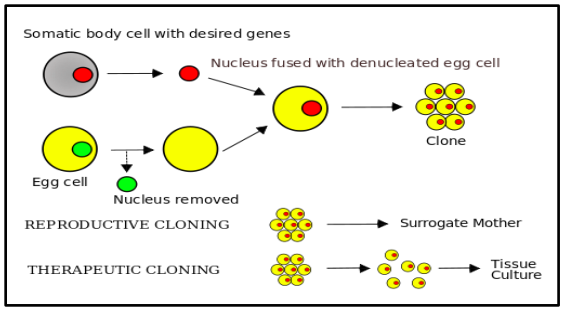
Advantages:

- Technical simplicity and widely used
- applicable to a wide range of species

Limitations:

- Low embryo survival
- Low integration frequencies of the injected DNA into the genome

b. Transfer of diploid **somatic nuclei** into an enucleated oocyte i.e. **Somatic Cell Nuclear Transfer (SCNT) method**



Limitations of SCNT

- Inefficiency due to stresses placed on both egg cell and the introduced nucleus.
- Trying to use one-cell embryos

c. Introduction of genetically engineered **embryonic stem cells** into an early stage developing embryo prior to implantation into a receptive female.

<u>Benefits in Livestock Production:</u> Table 2 depicts various biological products produced from different species of transgenic animals.

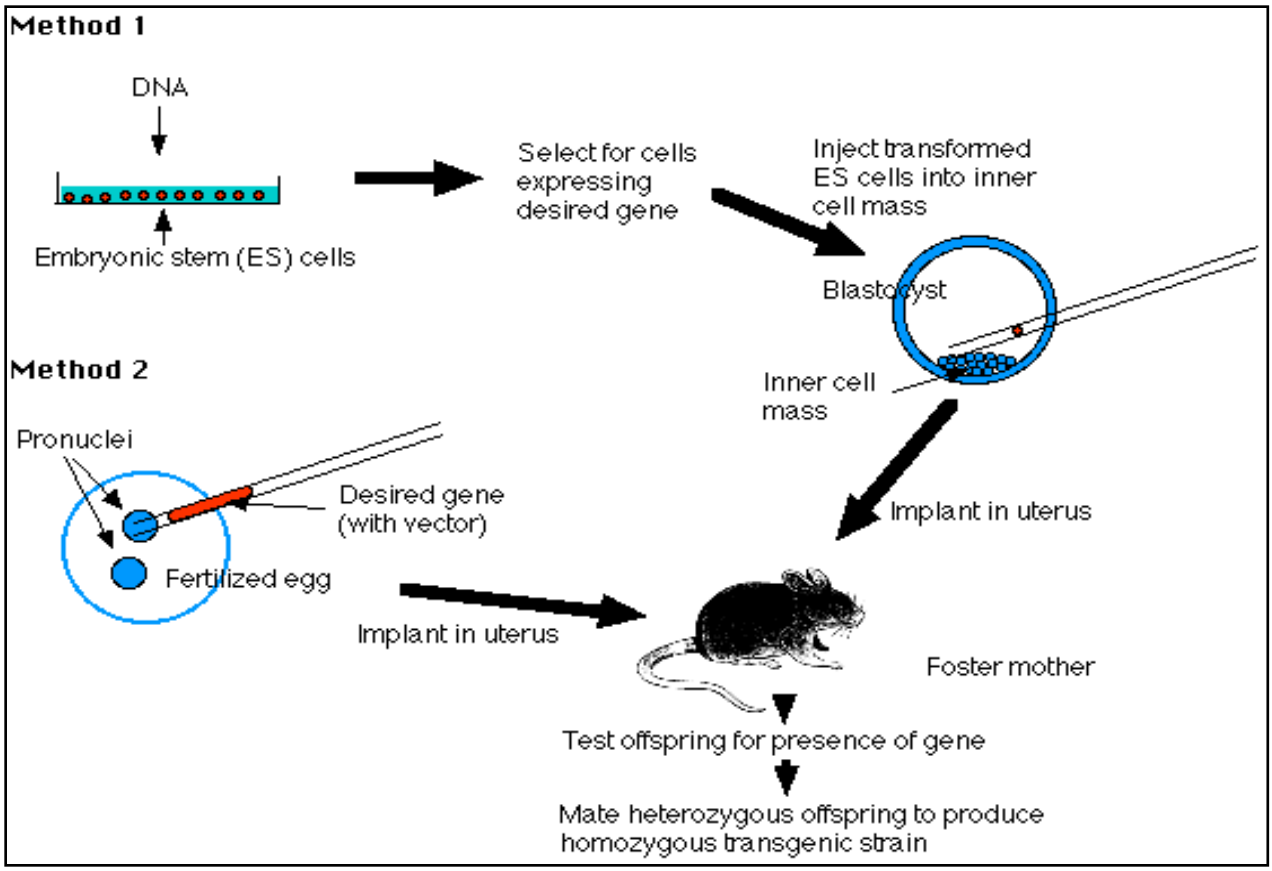


Table 2. Different transgenic animals used for production of various biological products

Transgenic Animal	Product
Goat	Monoclonal Antibodies (MAbs), Ig fusion proteins, tPA (tissue Plasminogen Activator) and Atryn® (recombinant human antithrombin III).
Pigs	Organs for xenotransplantation, human hemoglobin, human protein C.
Cows	Factors VIII and IX, protein C, recombinant antithrombin III (rATIII), rHSA, and human milk protein.
Mice	Expression of malaria protein for vaccine development; MAbs, ATIII, beta interferon; Factor X, HSA, tPA, prolactin; fibrinogen and antineoplastic urinary protein
Sheep	Factor IX, activated protein C and alpha-1-antitrypsin.

Conclusion

Animal transgenesis technology will be a promising technology in the near future to replace conventional use of drugs. This will be accomplished through the creation of disease-resistant animals and other methods of improving production potential of animals. It will also assist in improving human health by filling organ gap and production of important pharmaceutical products to treat human diseases. Animal welfare and ethics are the major issues which make the acceptance of the technology controversial and the efficiency of transgenesis is low. Therefore, the efficiency of transgenesis should be enhanced by the innovation of other efficient technique with a high level of ethical values and keeping the welfare of animals.

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