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Transgenic Animals as Bioreactors: Prospects and Applications

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Abstract

Transgenic animals are genetically modified to serve as bioreactors for the synthesis of useful recombinant proteins. These animals facilitate the large-scale and economical manufacture of complex biopharmaceuticals by expressing foreign genes in particular tissues, such as milk, eggs, or blood. The production of medicinal proteins, vaccines, industrial enzymes, and veterinary biologics has increased thanks to developments in molecular biology and gene-editing technology. The FDA and EMA have approved a number of transgenic animal-derived pharmaceuticals, such as antithrombin and C1 esterase inhibitor, indicating their safety and effectiveness. Ongoing advancements and rising demand for biologics demonstrate their growing significance despite ethical and legal obstacles. All things considered, transgenic animals offer a viable and sustainable foundation for upcoming industrial and healthcare production.

Keywords: Transgenic animals, Animal bioreactors, Recombinant protein production, Industrial enzymes

Introduction

Transgenic animals are genetically altered to generate foreign proteins in tissues like milk, blood, or eggs, such as therapeutic and pharmaceutical chemicals. This method, sometimes referred to as "animal bioreactors" or "pharming," combines genetic engineering with animals' innate capacity to produce proteins. Cows, goats, lambs, and rabbits can now effectively generate complex human proteins because to developments in molecular biology and gene-delivery methods. Large amounts of physiologically active proteins with the appropriate post-translational modifications can be produced using these systems, frequently at a cheaper cost than cell-culture techniques. The increasing potential of transgenic animals for large-scale biopharmaceutical manufacturing is demonstrated by successful clinical

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applications and better gene-editing technologies, despite ethical, regulatory, and biosafety hurdles.

What Are Transgenic Animals?

Transgenic animals are organisms whose genome has been deliberately transformed by the insertion of one or more alien genes—called transgenes—into their DNA. These transgenes originate from a different species (or occasionally a different individual) and are incorporated into the animal's DNA by genetic engineering techniques, including viral vectors, stem cells, or microinjection. After being incorporated, these alien genes are expressed in the animal's cells, enabling it to make new proteins or exhibit characteristics it would not otherwise have. This means transgenic animals can be modified to produce important biological substances—for example, therapeutic proteins such as human clotting factors or hormones—in tissues such as milk, blood, or eggs (Shakweer et al., 2023). Figure 1 shows the main techniques used to generate transgenic animals.

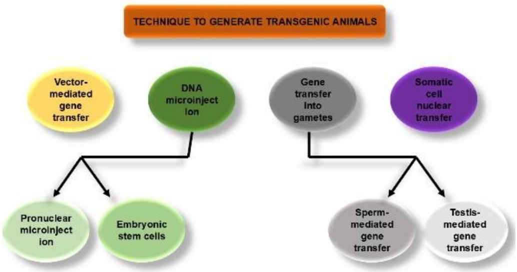

Fig. 1: Main techniques used to generate transgenic animals

How Transgenic Animals Become Bioreactors?

Transgenic animals become bioreactors by inserting a foreign gene, linked to a tissue-specific promoter, into their genome using techniques like microinjection or cloning. The gene is expressed in specific tissues (such as mammary glands), leading to secretion of the recombinant protein into milk, blood, or eggs. These proteins are then harvested and purified for therapeutic or industrial use.

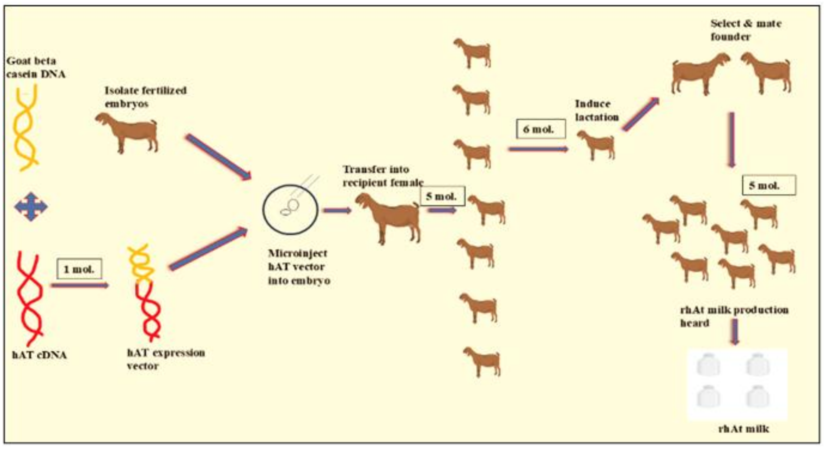

Fig 2: Production of Recombinant Therapeutic Protein in the Milk of a Transgenic Animal

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Applications

1. Human Therapeutic Drugs Produced by Transgenic Animals

Transgenic mice are commonly utilised in research and early-stage drug development because they are easy to genetically manipulate. Larger animals, such as goats, cows, sheep, and rabbits, have been modified to produce human hormones, namely insulin and human growth hormone, through milk secretion. One significant accomplishment is recombinant human antithrombin (ATryn®), which is manufactured in the milk of transgenic goats and has been licensed by the FDA to treat individuals with inherited antithrombin deficiencies. Transgenic animals are also used to generate therapeutic antibodies for cancer, autoimmune, and infectious disease treatments. They also act as excellent platforms for enzyme replacement therapy for uncommon hereditary disorders including lysosomal storage diseases. These enzymes require sophisticated post-translatio ations, including glycosylation, which mammalian cells naturally perform(Houdebine, 2018).

2. Commercially Approved Medicines

Several biopharmaceuticals derived from transgenic animals have acquired FDA and EMA approval, demonstrating the safety and efficacy of this technique. Notable examples include ATryn®, which is generated in transgenic goat milk to treat antithrombin deficiency, and Ruconest®, which is produced in transgenic rabbit milk to treat hereditary angioedema. These results demonstrate transgenic animals' potential as safe, scalable bioreactors for manufacturing life-saving biologics.

Table 1: Some prescription drugs created by transgenic animals (Shakweer et al., 2023)

Drug	Disease	Animal
Alpha-lactalbumin	Anti-infection	Cow
Human protein C	Thrombosis	Pig, Sheep
Fibrinogen	Wound healing	Cow &sheep
Glutamic acid decarboxylase	Type 1 diabetes	Mouse, goat
Human serum albumin (HAS)	Maintains blood volume	Mouse, Cow
msp-1	Malaria	Mouse
CFTR	Cystic fibrosis	Sheep, mouse
Human calcitonin	Osteoporosis	Rabbit
Lactoferrin	Tract infection, infectious arthritis	Cow

3. Vaccine Production

Transgenic animals offer a robust platform for the large-scale production of vaccine antigens for both human and veterinary applications. Cows, goats, chickens, and fish can be genetically altered to produce viral or bacterial antigens in milk, eggs, or other tissues.

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Transgenic chickens that manufacture vaccine proteins in egg white and dairy animals that produce antigens in milk provide scalable and cost-effective alternatives to cell culture systems. This method is notably useful for quick vaccine production, pandemic preparedness, and cost-effective vaccination in resource-constrained environments (Kiros et al., 2012).

4. Industrial Enzymes

Transgenic animals are being investigated as scalable and cost-effective sources of industrial enzymes. Animals can create vast amounts of valuable enzymes used in food processing, textiles, and environmentally friendly biodegradation by expressing enzyme genes in milk or eggs. This method promotes sustainable industrial practices and provides an effective substitute for microbial systems, particularly for complicated enzymes.

5. Veterinary Medicine

Transgenic animals serve as effective bioreactors for manufacturing low-cost veterinary vaccinations, antibodies, and therapeutic proteins. Milk and egg-based systems in cows, goats, and hens allow for large-scale, cost-effective production of species-specific biologics for livestock, pets, and aquaculture. This technology promotes enhanced animal health, disease control, and rapid response to new zoonotic illnesses, particularly in resource-limited areas (Houdebine, 2018).

Prospects (Future Possibilities)

Transgenic animals can produce therapeutic proteins on a larger scale and at a lower cost than conventional bioreactors; they can also provide rapid-response platforms for producing vaccines and antibodies during pandemics; new expression systems in milk, eggs, blood, silk, and aquatic tissues are expanding production options; modern gene-editing tools like CRISPR and TALENs allow faster and more precise genetic modifications; these innovations will enhance the manufacture of hormones, enzymes, and monoclonal antibodies; and animal bioreactors may also support sustainable production with lower energy and chemical requirements (Clark & Whitelaw, 2003).

References-

Clark, J. and Whitelaw, B. (2003). A future for transgenic livestock. *Nature Reviews Genetics*, *4*(10), 825–833. https://doi.org/10.1038/nrg1183

Houdebine, L.-M. (2018). Production of pharmaceutical proteins by transgenic animals: -EN- -FR- Production de protéines pharmaceutiques par des animaux transgéniques -ES- Producción de proteínas farmacéuticas mediante animales transgénicos. *Revue Scientifique et Technique de l'OIE*, *37*(1), 131–139. https://doi.org/10.20506/rst.37.1.2746

Kiros, T. G., Levast, B., Auray, G., Strom, S., Van Kessel, J. and Gerdts, V. (2012). The Importance of Animal Models in the Development of Vaccines. In S. Baschieri (Ed.), *Innovation in Vaccinology* (pp. 251–264). Springer Netherlands. https://doi.org/10.1007/978-94-007-4543-8_11

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Monzani, P. S., Adona, P. R., Ohashi, O. M., Meirelles, F. V. and Wheeler, M. B. (2016). Transgenic bovine as bioreactors: Challenges and perspectives. *Bioengineered*,*7*(3),123–131. https://doi.org/10.1080/21655979.2016.1171429

Shakweer, W. M. E., Krivoruchko, A. Y., Dessouki, Sh. M. and Khattab, A. A. (2023). A review of transgenic animal techniques and their applications. *Journal of Genetic Engineering and Biotechnology*, *21*(1), 55. https://doi.org/10.1186/s43141-023-00502-z

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