

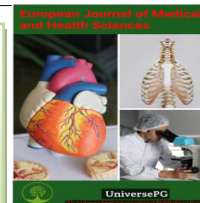


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## Boon and Bane of Transgenic Animal: A Brief Review

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### ABSTRACT

The progression of biotechnology and genetic engineering to produce transgenic animals by familiarizing the foreign DNA into the germ line of an animal has elevated the potential of biological research to an unprecedented level. This technology not only beneficial in human welfare, society and the environment but also harmful. At present, many transgenic species (goats, chickens, pigs, cows, mice, rabbits, sheep, etc.) are considered for research applications as well as latent profitable pharmaceutical productively. Transgenic animals are applied as the different models for the experiment of different diseases including HIV/AIDS, Alzheimer's, Cardiovascular, and Diabetes Mellitus, Angiogenesis, and Cancer disease. The main disadvantages of transgenic animals are mutagenesis and function disorders, ecological problems, antibiotic resistance, and population of clones.

**Keywords:** Transgenic animal, Monoclonal antibodies, Vaccines, Angiogenesis, Boon, Bane, and Cancer.

### INTRODUCTION

A transgenic animal refers to an animal that is altered by the starter of recombinant DNA through human interferences. It relates to the transgenes is that means a technique for insertion of cDNA which is created by specific mRNA (Messenger Ribonucleic Acid) into cells. The techniques applied to create transgenic animal by the direct manipulation of DNA (Gama and Bressan, 2011), (Rossana and Cristina, 2010) also have negative waves on human welfare, society, and environment. The two biologists (Watson and Crick) discovered the DNA in the 1950s and from this time the basic concepts of the transgenic animals by manipulating DNA have come. In early 1980, Gordon et al. first experimented with the gene addition with the aid of technology namely microinjection and from that time a new waywardness was come in genetics and molecular biology research field to drive forward (Bagle *et al.*, 2011). With the aid of various techniques

from cited reports, molecular biology and genetic engineering achieved impetus and the scientists started to develop the animals with some basic concepts. In addition, this technology added new invent in the economy and health sectors to develop the economic qualities and healthful treatments quickly. An example was noted that the transgenic animal (cattle) was prepared to yield a large amount of milk with healthy human proteins that may be used for the treatment of human emphysema and may also be beneficial in economic circumstances (Margawati, 2003).

This study helps by providing positive and negative influences of transgenic animals in society, human welfare, economic situation, environment, and medicinal field that also services the future direction of research on transgenic animal using molecular biology and genetic engineering (Shahen *et al.*, 2019).

### Production of transgenic animals

Three animal models that are aggressively used in the laboratory to formulate transgenic animals including (1) DNA microinjection, (2) Retrovirus-mediated gene transfer, and (3) cell-mediated gene transfer. Some steps are required to develop a satisfactory transgenic animal in the molecular research field, and these steps are given below and as displayed in **Fig 1** (Houdebine, 2009; Fee and Chand, 2005):

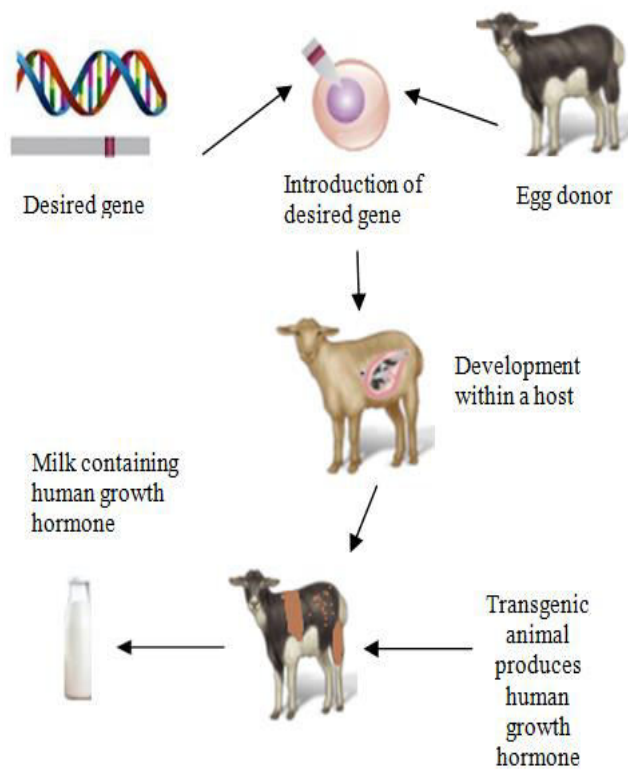
Step 1. Identification of the desired gene (DNA) and promoter sequences.

Step 2. The desired gene is then directly hosted into the nucleus of a donor egg by following apt methods.

Step 3. The engineered cells are then implanted into the host animals.

Step 4. Development of the desired cells within the host and able to provide the desired gene that has been stably and heritably incorporated into the newborn offspring's DNA.

Step 5. The gene is then able to continue its function in the new environment.



**Fig 1:** Production of transgenic animal.

### TRANSGENIC ANIMALS AND PRODUCTS FROM THEM

Numerous researches using transgenic species have already done to apply for the development of commercial pharmaceutical product that is displayed as **Table 1**.

**Table 1:** Products from transgenic animals

Animals	Products	References
Goats	Monoclonal Antibodies (MAbs), Ig fusion proteins, tPA (tissue Plasminogen Activator) and ATryn (recombinant human antithrombin III).	Fee and Chand, 2005; and Ormandy <i>et al.</i> , 2011
Chickens and Eggs	Vaccines; interferons, cytokines; Human Serum Albumin, insulin, MAbs.	Ormandy <i>et al.</i> , 2011
Pigs	Organs for xenotransplantation, human hemoglobin, human protein C.	Prather <i>et al.</i> , 2008; and Hunter <i>et al.</i> , 2005
Cows	Factors VIII and IX, protein C, recombinant antithrombin III (rATIII), rHSA, and human milk protein.	Ormandy <i>et al.</i> , 2011
Mice	Expression of malaria protein for vaccine development; MAbs, ATIII, beta interferon; cystic fibrosis transmembrane regulator; Factor X, HSA, tPA, myelin basic protein; prolactin; fibrinogen and antineoplastic urinary protein.	Ormandy <i>et al.</i> , 2011
Rabbits	Recombinant human C1 inhibitor, human erythropoietin, human alpha antitrypsin, human interleukin 2, tPA, alpha glucosidase, and human growth hormone.	Ormandy <i>et al.</i> , 2011
Sheep	Sheep milk includes fibrinogen (major constituent, with thrombin and Factor XIII) human Factor VII, Factor IX, activated protein C and alpha-1-antitrypsin.	Ormandy <i>et al.</i> , 2011; and Hunter <i>et al.</i> , 2005

## TRANSGENIC ANIMAL MODELS OF ASSORTED DISEASES

An animal model may be a living, a non-human animal used for research and investigation of human disease, for the aim of higher understanding the

disease without the added risk of causing harm to a person's being during the whole drug discovery and development process. There are different models of transgenic animals for various diseases.

**Table 2:** The transgenic animal models of various diseases

Disease	Models	References
HIV/AIDS	Tg26 HIVAN Mouse Model and 32 transgenic murine HIVAN models are developed that can express HIV-1 proteins.	Rosenstiel <i>et al.</i> , 2009; Joshi and Guidot, 2011
Alzheimer's disease	Amyloid pathology mouse models like PDAPP mice, Tg2576 mice, TAU transgenic mouse models like ALZ7 mice, 7TauTg mice and presenilin transgenic models like ApoE knockout.	Spires and Hyman, 2005; Schenk, 2002; and Götz <i>et al.</i> , 2014
Cardiovascular disease	Transgenic models of heart failure and hypertrophy like Gene over expression of Calmodulin, Gene mutation of alpha cardiac myosin heavy chain, Knockout and mutation of the ApoE gene model of transforming growth factor are developed.	Snaith, and Törnell, 2002; and Bader <i>et al.</i> , 2000
Diabetes Mellitus	Models of insulin secretion such as glucokinase, islet amyloid polypeptide, and hepatic glucose production in type 2 diabetes are developed. Beta receptor knockout mouse, uncoupling protein (UCP1) knockout mouse, acute and chronic models for the evaluation of anti-diabetic agents.	Srinivasan and Ramarao, 2007; Etuk, 2010; Henson and O'Brien 2006; and Kumar <i>et al.</i> , 2012
Angiogenesis	Mouse models of angiogenesis, arterial stenosis, atherosclerosis, thrombosis, thrombolysis and bleeding addresses techniques to evaluate vascular development.	Snaith and Törnell 2002
Cancer diseases	Transgenic knockout models like tumor progression and metastasis via E-cadherin. LACI transgenic model and LACZ transgenic model for mutagenicity assays. Transgenic rodent models expressing tumor associated antigens like MUC1 transgenic mice, oncogene transgenic mice use in immunotherapeutic strategies. Preclinical transgenic model of Matrix Metalloproteinase (MMP) inhibitors studies.	Bagle <i>et al.</i> , 2011; Pavlaki and Zucker, 2003; and Ramaswamy <i>et al.</i> , 2007

### ADVANTAGES OF TRANSGENIC ANIMALS

Transgenic animals contribute to human welfare. These animals can cause beneficial effect of human in the field of agriculture, medicine and industry.

#### A. Agricultural

**Breeding:** Propagation by the traditional way is a time consuming and difficult task. During developing molecular biology technology, developing traits in animals became feasible in a shorter time and with more exactitude. Furthermore, the farmer can get an undemanding way to increase yields (Lee *et al.*, 1997)

**Quality:** Transgenic cows can produce more milk. They can also produce milk with less lactose or cholesterol. Transgenic pigs and cattle contain more meat on them and in the case of transgenic sheep; they cultivate more wool (Wheeler, 2007).

**Disease resistance:** According to scientist effort, disease resistant animals are being tried to produce like influenza resistant pigs, whereas a very limited number of genes are at this time known to be accountable for resistance to diseases in farm animals (Margawati, 2003).

## B. Medical

**Xenotransplantation:** Because of the in need of a replacement heart, liver or kidney, an enormous number of patient die, where transgenic pigs may offer the transplant organs to beat the matter of shortfall (Hoagland *et al.*, 1997). Currently, a pig protein hinders xenotransplantation. This protein may originate contributor rejection. However research is ongoing to get rid of that pig protein and substitute it with a person's protein.

**Nutritional supplements and pharmaceuticals:** Some products for instance insulin, somatotropin, and blood anti-clotting factors may during a few minutes be or have by now been obtained from the milk of transgenic cows, sheep, or goats (Gunawan and Noor, 2006; and Islam *et al.*, 2020).

**Human gene therapy:** In human gene therapy, a traditional copy of a gene which will be transgenic is added to the genome of an individual who carries defective replicas of the gene. For instance, the A. I. Virtanen Institute in Finland produced a calf with a gene that creates the substance that promotes the expansion of red cells in humans.

**Industrial:** In the year of 2001, two scientists at Nexia Biotechnologies in Canada researched with spider genes and goats. They spliced spider genes into the cells of lactating goats. Then the goats commenced to manufacture not only silk along with their milk but also exude tiny silk strands from their body by the bucketful. When the polymer strands from the milk is extracted and weaved them into thread, the scientists can generate a light, tough, flexible material that could be used in such applications as military uniforms, medical micro-sutures, and tennis racket strings (Pust, 2010). Transgenic animals are toxicity-sensitive that are also created for testing chemical safety (Sharif *et al.*, 2019).

A wide range microorganism is engineered to supply a good sort of proteins, which successively can produce enzymes and these enzymes are often wont to speed up chemical reactions in several sorts of industries (Margawati, 2003; Alam *et al.*, 2017).

## DISADVANTAGES OF TRANSGENIC ANIMALS

**Accidental damage or reproduction problems:** Transgenic animals usually have shorter life spans and their survival rates also are low. However, an unexpected problem may arise within the time of mixing different species as at that case, thousands of genes would be interacting, not only one or two genetic elements of importance (Wessells, 2009).

**Mutagenesis and function disorders:** Within the time of production of transgenic animals, genetic mutations can occur which can end in diseases and disorders. Besides, mutagenesis can interrupt normal development or cause a medical circumstance. A situation caused by mutations in one or more genes is named a genetic disease (Oliver and Davies, 2005).

**Expensive and extensive:** The value of kit and animals is high. Also, it takes a short time to seek out the proper thanks to genetically modify the animal for whatever purpose. It doesn't happen overnight (Grandin and Johnson, 2009).

**Unintended adverse effects:** Genes have quite one function. A gene in one animal may function certain activities or not that the opposite one doesn't. This may cause problems within the genes that can't fully perform their function (Pahsini *et al.*, 2016).

**Nature is complex:** Nature is a particularly complex inter-dependent chain consisting of the many species linked during an organic phenomenon. Genetically modifying animals may have unalterable effects with unknown consequences (Islam and Islam, 2014).

**Effects on the environment:** Ecological complexes may be created through the newly produced transgenic animals by gene-splicing. The discharge of a brand new genetically concocted species would even have the likelihood of causing an imbalance within the ecology of a neighborhood just exotic species would do. An accident or an unknown result could cause several problems (Mercer *et al.*, 1999).

**Effects on human:** If we observe at the very fact that transgenic animal services viral vector that carries

functional gene secret the physical body, the repercussion remains unknown. There's no evidence on where functional genes are being placed. They'll even switch the important genes, in its place of mutated genes (Patra and Andrew, 2015). Thus, this might cause another health condition or disease to humans.

**Antibiotic resistance:** In transgenic animals, the genes are used for antibiotic resistance as "selectable markers." In the gene-splicing process, these markers helped identify cells that have haunted foreign genes. Without further experiments, the genes are still being expressed in animal tissues. The resistance genes could be transported to human or animal pathogens, creating them resistant to antibiotics (Rahman *et al.*, 2019). If genes needed to be transferred, it could exacerbate the intense unhealthiness of antibiotic-resistant disease organisms (Mepham, 2000).

**The population of clones:** The transgenic animals are a population of clones, vulnerable in very same ways. One disease or pest can wipe out the whole population quickly (Stewart, 2004).

**Ethical issues:** Transgene use in humans is currently fraught with issues. The transformation of genes into human cells has not been perfected yet. A crucial example is-patients developing T-cell leukemia after being treated with X-linked severe combined immunodeficiency (X-SCID) (Woods *et al.*, 2006). This was attributed to the close proximity of the inserted gene to the LMO2 promoter, which controls the transcription of the LMO2 proto-oncogene (Hacein-Bey-Abina *et al.*, 2003). In short, within the most sort of gene-splicing, the utilization of transgenes for purposes aside from to correct life-threatening genetic abnormalities may be a major bioethical issue.

## CONCLUSION

The science is updated gradually and produces alternative of the naturally occurring foods and animals for various beneficial purposes but uncertainly the values of nature are diminishing gradually. This review summarizes the production of transgenic

animals with their boon and bane in agriculture, medical, economy, and environment. Different types of species especially goats, chickens, pigs, cows, mice, rabbits, sheep, etc. are used to prepare models of transgenic animals for different beneficial events, but they may also provide some negative impact on human welfare. In a nutshell, this work opens new avenues for the transgenic animals to be used as a model of events may arises complications with their delighted beneficial effects.

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## CONFLICT OF INTEREST

The authors declare that they have no competing conflict of interests to publish under current issue of the journal.

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