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Applied Science BTEC Nationals: Genetics and Genetic Engineering

Vinay Sagar*

Department of Veterinary Sciences, Anna University, Chennai, Tamil Nadu, India

Opinion Article

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***For Correspondence:**
Vinay Sagar, Department of Veterinary Sciences, Anna University, Chennai, Tamil Nadu, India

E-mail: sagar.vinay@gmail.com

DESCRIPTION

Genetically modified animals are animals that have been genetically modified for a variety of purposes including producing drugs, enhancing yields, increasing resistance to disease, etc. The vast majority of genetically modified animals are at the research stage while the number close to entering the market remains small. The process of genetically engineering mammals is a slow, tedious, and expensive process. As with other genetically modified organisms (GMOs), first genetic engineers must isolate the gene they wish to insert into the host organism. This can be taken from a cell containing the gene or artificially synthesized. If the chosen gene or the donor organism's genome has been well studied it may already be accessible from a genetic library. The gene is then combined with other genetic elements, including a promoter and terminator region and usually a selectable marker.

A number of techniques are available for inserting the isolated gene into the host genome. With animals DNA is generally inserted into using microinjection, where it can be injected through the cell's nuclear envelope directly into the nucleus, or through the use of viral vectors. The first transgenic animals were produced by injecting viral DNA into embryos and then implanting the embryos in females. It is necessary to ensure that the inserted DNA is present in the embryonic stem cells. The embryo would develop and it would be hoped that some of the genetic material would be incorporated into the reproductive cells. Then researchers would have to wait until the animal reached breeding age and then offspring would be screened for presence of the gene in every cell, using PCR, Southern hybridization, and DNA sequencing. New technologies are making genetic modifications easier and more precise. Gene targeting techniques, which creates double-stranded breaks and takes advantage on the cells natural homologous recombination repair systems, have been developed to target insertion to exact locations. Genome editing uses artificially engineered nucleases that create breaks at specific points. There are four families of engineered

nucleases: mega nucleases, zinc finger nucleases, transcription activator-like effector nucleases (TALENs), and the Cas9-guideRNA system (adapted from CRISPR). TALEN and CRISPR are the two most commonly used and each has its own advantages. TALENs have greater target specificity, while CRISPR is easier to design and more efficient. The development of the CRISPR-Cas9 gene editing system has effectively halved the amount of time needed to develop genetically modified animals. Humans have domesticated animals since around 12,000 BCE, using selective breeding or artificial selection (as contrasted with natural selection). The process of selective breeding, in which organisms with desired traits (and thus with the desired genes) are used to breed the next generation and organisms lacking the trait are not bred, is a precursor to the modern concept of genetic modification Various advancements in genetics allowed humans to directly alter the DNA and therefore genes of organisms. In 1972, Paul Berg created the first recombinant DNA molecule when he combined DNA from a monkey virus with that of the lambda virus. The first genetically modified animal to be commercialized was the GloFish, a Zebra fish with a fluorescent gene added that allows it to glow in the dark under ultraviolet light. It was released to the US market in 2003. The salmon were transformed with a growth hormone-regulating gene from a Pacific Chinook salmon and a promoter from an ocean pout enabling it to grow year-round instead of only during spring and summer.