Transgenic animals

A transgenic organism is a type of **genetically modified organism** (*GMO*). In its creation, genetic engineering methods are used to transfer certain genes from one organism to another. Such organisms are subsequently used primarily in research and medicine. The so-called **knock-out genes** also work in a similar way. **The first transgenic animal with human genes** was born in Belarus in 2006 within the framework of the Belarusian National Academy of Sciences. They were three kids, one of which died shortly after birth.

Examples of the use of transgenic organisms

- **Medicine** - synthesis of hormones and factors whose deficiency causes various diseases (Factor VIII, Insulin..). Genetically modified yeast synthesizes a given protein, which is then collected, modified and used to treat patients. Some proteins cannot be obtained from simple organisms, because their proper function requires complex *post-translational modifications* that only a **eukaryotic cell** is capable of. For the synthesis of these factors, dairy animals are already used today, the protein is extracted from their "milk".

Furthermore, attempts are being made to grow organs for transplantation within another organism.

- **Science** - by incorporating a human gene into the organism of a mouse, it is possible to monitor, for example, its mutations due to external influences or the **genotoxicity** of various substances. The ratio of genotype to external factors can also be observed in some phenotypic manifestations.

Gene construct

The pivotal point of the entire modification is the transferred **modified DNA** or gene construct. It is usually a synthetically produced DNA of the desired gene, equipped with an adequate *promoter*. Such a construct is multiplied in the laboratory and introduced into the target organism by several different procedures.

Methods of transmission of genetic information

Two basic procedures can be used: *in vitro* transfer, when the construct is introduced into isolated cells outside the host organism and subsequently these cells are transferred back to the host, or *in vivo* transfer, when they are modified directly the cells of the host organism.

The gene construct can be inserted into the body of an adult individual (=*transkaryotic organism*; also used in gene therapy in humans), into an embryo or into a specific cell line. The following procedures are used for specific transmission of genetic information:

- **Microinjection** - injection of a gene construct into a one-cell embryo. Most often to the male primary nucleus. The success rate of the method is approximately 25%, as it depends on chance where the desired DNA is embedded. Random insertional mutations or incorporation into sites of low expressivity may occur. In 75%, the DNA is not incorporated and is degraded.
- **Retroviral transfers** - the DNA gene is inserted into RNA a neutralized, modified viral particle. It is necessary to ensure that the virus only incorporates DNA but no longer creates new particles. Another problem with this method is the body's natural defense against particles.
- **Sperm transfer** - the gene construct is incorporated into sperm. Subsequently, the sperm is used for in vitro fertilization of the egg. Very unreliable technique.
- **Transfer of nuclei (cloning)** - transfer of the cell nucleus of an already verified transgenic organism into an enucleated oocyte.
- **Stem cells** - the principle of the method consists in the modification of embryonic stem cells and their subsequent introduction back into the developing embryo. We thus obtain a chimera composed of original and modified cells.
- **Liposomes** - DNA is enclosed in a vesicle formed by a phospholipid bilayer, which is able to interact with cell membranes and thus enables the introduction of the gene into the cell nucleus. By modifying membrane proteins, the type of cell that will be modified can be programmed.

Subsequent crossing and obtaining individuals with desired characteristics

The above-mentioned methods usually result in an individual with one modified allele, the gene is not found on the other chromosome at all (hemizygote) and is also usually a mosaic of unchanged and modified cells. Furthermore, it is also a question whether the modified cells are only of the somatic type, or whether the modification also affected germ cells.

To obtain a line with a completely modified genome in the homozygous state, further crossing is required. Most genes in this case follow the Mendelian type of inheritance.

In the first phase, chimeric individuals are crossed with **non-transgenic individuals** . The modified and unmodified line can be distinguished from each other by some **phenotypically traceable** dominant character, e.g. **coat color** (modification = black coat color; wild allele = white coat color) According to Mendelian inheritance, the modified allele is passed on to about 50% of the offspring. We select individuals with a phenotypic manifestation and check them using PCR or Southern blotting. These individuals should be heterozygotes for the modified gene. By subsequent crossing of heterozygous individuals, we obtain a homozygous generation, which can be further worked with.

Links

=Related Articles

- VANČURA, Francis, et al. *The first transgenic animals with human genes were born in Belarus* [online]. ©12/04/2006. [cit. 2012-01-02]. <http://www.belorusko.cz/view.php?cisloclanku=2006041101>.

- PETR, Jaroslav. *The first transgenic animals with human genes were born in Belarus* [online]. ©09.11.2003. [cit. 2012-01-02]. <http://www.osel.cz/463-transgenni-zvirata.html>.

- RESLOVÁ, Gabriela. *Methodology for transgenic mouse preparation* [online]. Charles University, 2011, Available from <https://www.natur.cuni.cz/biologie/zoologie/aktuality/reslova-g.-bp?student_welcome=1>.