# BIOTECHNOLOGY AND ITS APPLICATIONS

# TRANSGENIC ANIMALS

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Recombinant DNA technology is used to introduce foreign genes in to the genomes of the animal. Animals that have had their DNA manipulated to possess and express an extra (foreign) gene are known as transgenic animals. The genome of their animals has been changed and they can carry genes from other species. Examples of transgenic animals include rats, rabbits, pigs, sheep, cow, monkey and fish although over **95% transgenic animals are mice**.

**Why are these transgenic animals being produced?**

**The two most common reasons are:**

Some transgenic animals are produced for specific economic trait.

Other transgenic animals are produced as disease models (animals genetically manipulated to exhibit disease symptoms so that effective treatment can be studied).

| S. No. | Transgenic Animals | Useful application |
|---|---|---|
| 1 | Cow, Sheep, Goat | Therapeutic : human proteins in their milk |
| 2 | Pig | Organ transplantation without risk of rejection |
| 3 | Rabbits | Molecular farming or gene farming. |
| 4 | Mouse | Contains a human gene that causes breast cancer. This enables the researchers to study the very early development of cancer. |
| 5 | Fish (Common Carp, Catfish, salmon, gold fish, Zebra fish, Rainbow trout) | They contain human growth hormone (HGH) They attain a size twice of that shown by nontransgenic fish |
| 6 | Chicken | It contains good quality of food. |

**Polly and Molly** (Born 1997), two **ewes,** were the **mammals** to have been successfully cloned from an adult somatic cell and to be **transgenic** animals at the same time.

**Dolly the sheep** was the first animal (mammal) to be successfully cloned from an adult somatic cell where there was no genetic modification carried out on the adult donor nucleus. Polly and Molly, like Dolly the sheep, were cloned at the **Roslin Institute** in **Edinburgh, Scotland**.

The first transgenic sheep to produce **-1-antitrypsin** was **Tracy**.

**ANDi** (Transgenic Monkey) was the first genetically modified monkey. The **GFP (green fluorescent protein)** gene was inserted into the monkey's chromosome.

## Application of transgenic animals:

### 1. Medicine

(i) **Normal physiology and development**: Transgenic animals can be specifically designed to allow the study of how genes are regulated, and how they affect the normal functions of the body and its development, e.g. study of complex factors involved in growth such as insulin-like growth factor.

(ii) **Study of disease**: Many transgenic animals are designed to increase our understanding of how genes contribute to the development of disease. These are specially made to serve as models for human diseases so that investigation of new treatments for diseases is made possible. Today transgenic models exist for many human diseases such as cancer, cystic fibrosis, rheumatoid arthritis and Alzheimer's.

(iii) **Biological products**: Medicines required to treat certain human diseases can contain biological products, but such products are often expensive to make. Transgenic animals that produce useful biological products can be created by the introduction of the portion of DNA (or genes) which codes for a particular product such as human protein ( -1-antitrypsin) used to treat emphysema. Similar attempts are being made for treatment of phenylketonuria (PKU) and cystic fibrosis. In 1997, the first transgenic cow, **Rosie**; produced human protein-enriched milk (2.4 grams per litre). The milk contained the human alpha-lactalbumin and was nutritionally a more balanced product for human babies than natural cow-milk.

(iv) **Vaccine safety**: Transgenic mice are being developed for use in testing the safety of vaccines

before they are used on humans. Transgenic mice are being used to test the safety of the polio vaccine. If successful and found to be reliable, they could replace the use of monkeys to test the safety of batches of the vaccine.

(v) **Chemical safety testing**: This is known as toxicity/safety testing. The procedure is the same as, that used for testing toxicity of drugs. Transgenic animals are made that carry genes which make them more sensitive to toxic substances than non-transgenic animals. They are then exposed to the toxic substances and the effects studied. Toxicity testing in such animals will allow us to obtain results in less time.

## 2. Agriculture

(i) **Breeding**: Farmers have always used selective breeding to produce animals that exhibit desired traits (e.g. increased milk production, high growth rate). Traditional breeding is a time-consuming, difficult task. When technology using molecular biology was developed, it became possible to develop traits-in animals in a shorter time and with more precision. In addition, it offers the farmer an easy way to increase yields.

(ii) **Quality**: Transgenic cows exist that produce more milk or milk with less lactose or cholesterol, pigs and cattle that have more meat on them, and sheep that grow more wool. In the past, farmers used growth hormones to spur the development of animals but this technique was problematic, especially since residue of the hormones remained in the animal product.

(iii) **Disease resistance**: Scientists are attempting to produce disease-resistant animals, such as influenza resistant pigs, but a very limited number of genes are currently known to be responsible for resistance to diseases in farm animals.

## 3. Industrial Applications:

In 2001, two scientists at Nexia Biotechnologies in Canada introduced spider genes into the cells of lactating goats. The goats began to manufacture silk along with their milk and secrete tiny silk strands from their body. By extracting polymer strands from the milk and weaving them into thread, the scientists can create a light, tough, flexible material that could be used in such applications as military uniforms, medical microsutures, and tennis racket strings.

## Application of Recombinant DNA Technology/Genetic engineering

1. **Molecular Analysis of Diseases:** DNA research has helped in understanding the molecular basis of diseases like sickle cell anaemia, thalassemias, etc.
2. **Production of Proteins in Abundance:** Using recombinant DNA technique several proteins have been produced in abundance for curing the diseases. These are insulin, growth hormone, interferons, vaccines, erythroprotein and blood clotting factors.
3. **Laboratory Diagnostic Application:** rDNA technology makes the diagnosis of many diseases (e.g. AIDS) simple and quick.
4. **Gene Therapy:** The genetic diseases like sickle cell anaemia can be cured through gene therapy.
5. **Prenatal Diagnosis of Diseases:** DNA collected from the amniotic fluid surrounding the foetus can be used for predicting the genetic diseases.
6. **Application of forensic Medicine:** rDNA technology has greatly helped to identify criminals by DNA fingerprinting and settle the disputes of parenthood of children.
7. **Agricultural Application:** rDNA technology is used for developing transgenic plants which resist drought and diseases and increase their productivity. It imporves quality of food.
8. **Industrial Application:** Enzymes synthesized by rDNA technology are used to produce sugars, cheese and detergents.
9. **Application to Animals:** It is used for developing test tube babies to overcome infertility and production of transgenic animals.
10. **Evolution:** rDNA technique is of great use in joining several missing links in the evolution. This is done by amplifying the DNA of extinct animals.

## Other Applications of Genetic engineering

1. **To improve renewable fuel production:**

- Enhanced or engineered microorganisms for fermentation of ethanol, other fuels.
- Engineered microorganisms or plants to manufacture enzymes used in fuel production.
- Improved algal strains for biofuel production.
- Selected or engineered plant species with favourable traits for use as improved biofuel feedstock.

2. **Bioremediation:**

- Bioremediation is the use of **microoraganism** metabolism to remove pollutants.
  **In situ** bioremediation involves treating the contaminated material at the site, while **ex situ** involves the removal of the contaminated material to be treated elsewhere.
- **Pseudomonas putida** or **super bugs** was developed by A.M. Chakarvorty and is used for **clearing oil spills**.