

## TRANSGENIC PLANTS

A transgenic plant is a **modified organism** where genes are transferred from one organism to another through genetic engineering techniques. The first transgenic plant was created in 1994.

The purpose of producing a transgenic plant is to obtain a species that has ideal traits, high yield and quality.

Transgenic plants are **the ones, whose DNA is modified using genetic engineering techniques**. The aim is to introduce a new trait to the plant which does not occur naturally in the species. A transgenic plant contains a gene or genes that have been artificially inserted.

Transgenic plants include maize, rice, brinjal, cabbage, cauliflowers, potato, and tomato. The goal is to give the plant a new characteristic that does not arise naturally in the species.

### Methods Used for Gene Transfer

There are two methods used to transfer genes in plants. The two methods include:

#### 1. *Agrobacterium* mediates gene transfer

**Agrobacterium tumefaciens** is a plant pathogen. It is known to cause **crown gall disease**, which is swelling in plants just above the soil level. After infecting the plants, they transfer their genetic material to them, which eventually gets incorporated into the plant genome.

For genetic engineering, the bacterium is incorporated with a **Ti plasmid** with desirable genes and made to infect the plant.

The Ti plasmid is a tumour inducing circular plasmid that transfers the host chromosomes to the plants and is also responsible for causing the swelling.

#### 2. Particle bombardment / Gene gun method

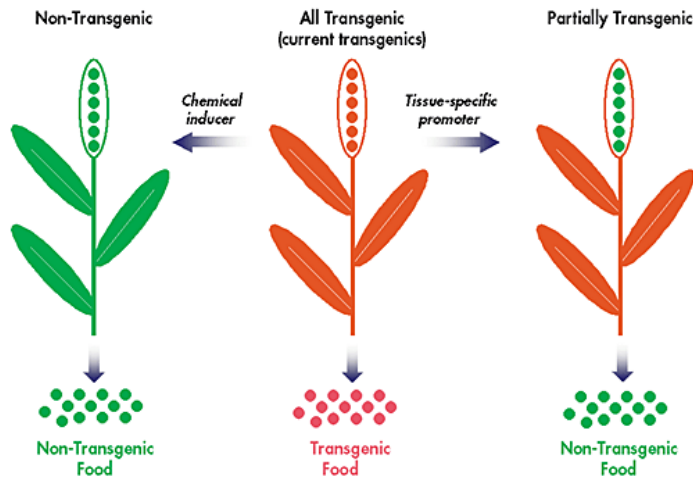
As the name suggests, in this method, the desired gene is coated in a gold or tungsten particle and bombarded into the plant cells. Once bombarded, the sequence is incorporated into the plant cells, which can be proliferated by tissue culture methods.

### **Applications of Transgenic Plants**

- **Resistance to biotic and abiotic stress:** Biotic stress is imposed on plants as a result of the action of living beings such as viruses, bacteria, pests and pathogens. To relieve the plants from such stress they are incorporated with disease-resistant genes, which gives a better yield and quality to the crops.
- **Abiotic stress,** as a result of changes in the environment, causes great damage to the plants. Soil composition, humidity, water level, and temperature are important factors for plant growth. Due to changes in the climate, all the factors seem to be altered. Thus, plants are incorporated with *stress-tolerant genes* for better production.
- **Increased nutritional value:** *Bio fortification* is the process of increasing the nutritional value of a crop. *Malnutrition* is a problem in developing countries. As a solution, plants are engineered to produce crops of better nutritional value.
- **Factories for production of recombinant proteins:** Recombinant human proteins have been produced using animal and microorganism systems, but due to some shortcomings it has been shifted to the plant system.
- **Vaccines and antibiotics** have been obtained from **transgenic plants**. However, this application is still in the development stage and has not been commercialised yet.

### **Examples of Transgenic Plants**

- **Golden rice:** *Golden rice* was produced to overcome the deficiency of vitamin A in children. Using the gene gun methods, rice species were incorporated with the phytoene synthase genes, which increases the vitamin A content of the rice grains.
- **Bt cotton:** *Bt cotton* is a genetically modified crop that is resistant to pest bollworm.
- **Flavr Savr:** *Flavr Savr* is a genetically modified *tomato crop* that has a longer shelf life due to delays in ripening and softening.
- Bt Brinjal



## TRANSGENIC ANIMALS

Transgenic animals are the animals with the **modified genome**.

A **foreign gene** is inserted into the genome of the animal to alter its DNA. This method is done to improve the **genetic traits** of the target animal.

The improvement of genetic traits was done by selective **breeding methods**.

In this, the animals with desired genetic characteristics were mated to produce an individual with **improved genetic characteristics**. Since this technique was **time-consuming and expensive**, it was later replaced by **recombinant DNA technology**.

**Transgenesis** is the phenomenon in which a foreign gene with desired characteristics is introduced into the genome of the target animal. The foreign gene that is introduced is known as **the transgene**, and the animal whose genome is altered is known as **transgenic**. These genes are passed on to the successive generations.

The transgenic animals are genetically engineered and are also known as **genetically modified organisms**. The first genetically modified organism was engineered in the year 1980.

## Methods for Creating Transgenic Animals

The transgenic animals are created by the following methods:

### Physical Transfection

In this method, the gene of interest is directly injected into the **pronucleus** of a **fertilized ovum**. It is the very first method that proved to be effective in mammals. This method was applicable to a wide variety of species. Other methods of physical transfection include **particle bombardment, ultrasound and electroporation**.

## **Chemical Transfection**

One of the chemical methods of gene transfection includes **transformation**. In this method, the target DNA is taken up in the presence of **calcium phosphate**. The DNA and calcium phosphate co-precipitates, which **facilitates DNA uptake**. The mammalian cells possess the ability to take up foreign DNA from the culture medium.

## **Retrovirus-Mediated Gene Transfer**

To increase the chances of expression, the gene is transferred by means of a vector. Since **retroviruses** have the ability to infect the host cell, they are used as vectors to transfect the gene of interest into the target genome.

## **Viral Vectors**

Viruses are used to transfect rDNA into the animal cell. The viruses possess the ability to infect the host cell, express well and replicate efficiently.

## **Bactofection**

It is the process by which the gene of interest is transferred into the target gene with the help of bacteria.

## **Examples of Transgenic Animals**

Following are the examples of transgenic animals:

### **Dolly Sheep**

Dolly the sheep was the **first mammal** to be cloned from an adult cell. In this, the udder cells from a 6-year-old **Finn Dorset white sheep** were injected into an **unfertilized egg** from a **Scottish Blackface ewe**, which had its nucleus removed.

The cell was made to fuse by electrical pulses. After the fusion of the nucleus of the cell with the egg, the resultant embryo was cultured for six to seven days. It was then implanted into another **Scottish Blackface ewe** which gave birth to the transgenic sheep, Dolly.

## **Transgenic Mice**

Transgenic mice are developed by injecting DNA into the oocytes or 1-2 celled embryos taken from **female mice**. After injecting the DNA, the embryo is implanted into the **uterus of receptive females**.

## **Applications Of Transgenic Animals**

The transgenic animals are created because of the benefits they provide to the man.

### **Normal Physiology and Development**

In transgenic animals, a **foreign gene** is introduced due to which the **growth factor** is altered. Hence, these animals facilitate the study of gene regulation and their effect on the everyday functions of the body.

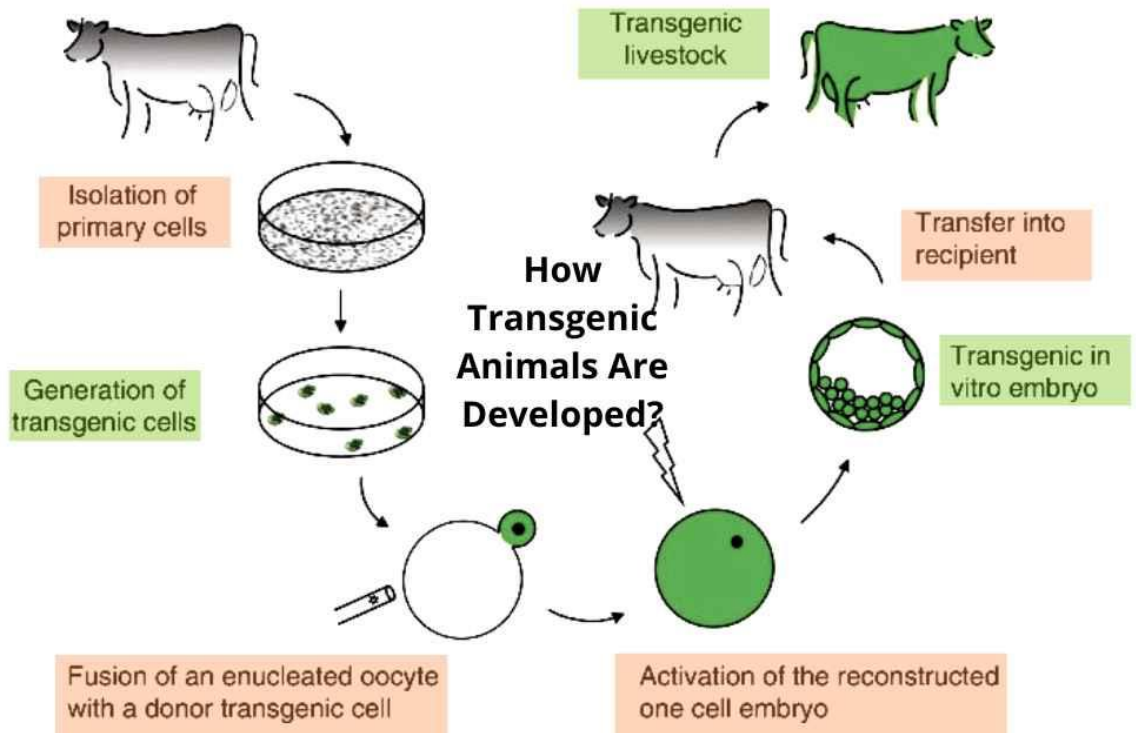
### **Study of Diseases**

**Transgenic animals** are specially designed to study the role of genes in the development of certain diseases. Moreover, in order to devise a **cure for these diseases**, the transgenic animals are used as **model organisms**.

These transgenic models are used in research for the **development of medicines**. For example, we have transgenic models for diseases such as **Alzheimer's and cancer**.

### **Biological Products**

A number of biological products such as **medicines and nutritional supplements** are obtained from transgenic animals. Research for the manufacture of medicines to treat diseases such as **phenylketonuria (PKU) and hereditary emphysema** is going on.



The first **transgenic cow, Rosie (1997)**, produced milk containing human protein (2.4 grams per litre). This milk contains the **human gene alpha-lactalbumin** and could be given to babies as an alternative to **natural cow milk**.

## Vaccine Safety

Transgenic animals are used as model organisms for testing the **safety of vaccines before they are injected into humans**. This was **conventionally done on monkeys**.