



Gene therapy for the treatment of cystic fibrosis

Project Description

The project focuses on the development and commercialization of an innovative gene therapy medicinal product for the treatment of cystic fibrosis.



Problem

Cystic fibrosis is the most prevalent inherited genetic disorder, that is primarily characterized by progressive and severe impairment of respiratory function, recurrent pulmonary infections, and chronic inflammation, ultimately leading to life-threatening complications with an overall mortality rate reaching **50–60%**.

Cause

The disease is caused by mutations in the **cystic fibrosis transmembrane conductance regulator (CFTR)** gene, leading to structural and functional defects of the CFTR protein — a membrane channel responsible for the active transport of chloride ions and acting as a regulator of sodium ion absorption.

Solution

Development of a gene therapy product based on **DNA vectors VTvaf17-CFTR, VTvaf17-AQ1, and VTvaf17-AQ3**, encoding the respective proteins — the cystic fibrosis transmembrane conductance regulator and aquaporins 1 and 3, which play key roles in the pathogenesis of cystic fibrosis.

Product and Its Advantages

The developed medicinal product is based on the concept of replacing defective genes with healthy ones. The delivery of functional genes into the patient's body is achieved through the use of next-generation non-viral DNA vectors.

1 Efficacy

The optimized size of DNA vectors ensures highly efficient penetration into target cells, resulting in effective gene expression and therapeutic action.

2 Safety

The vectors contain no antibiotic resistance genes or viral genomic sequences, providing a superior safety profile and minimizing potential adverse effects.

3 Multiplicative Effect

The inclusion of the CFTR, AQ1, and AQ3 genes in the formulation provides a synergistic and multiplicative therapeutic effect, addressing multiple pathological mechanisms simultaneously.



Competitive Landscape

A review of the scientific literature and official ClinicalTrials.gov database indicates that there are currently no approved gene therapy products for cystic fibrosis based on the use of safe non-viral vectors.

Existing Therapies

Four targeted CFTR-modulating drugs are currently available on the market: Orkambi, Trikafta/Kaftrio, Kalydeco, and Symdeko/Symkevi.

Limitations

Existing therapies are effective only for **specific CFTR mutations** and therefore do not provide a comprehensive or universal solution to the disease.

Our Advantage

Our gene therapy approach directly restores **functional CFTR expression** regardless of the mutation type, using **non-viral DNA vectors** that ensure broad applicability, enhanced safety, and long-term therapeutic efficacy.



Completed Project Stages

1

DNA Vector Development

A base DNA vector **VTvaf17** has been developed, along with therapeutic DNA vectors carrying the **CFTR**, **AQ1**, and **AQ3** genes derived from it.

2

Producer Strain Deposition

Original producer strains for DNA vector synthesis have been created and deposited in specialized repositories.

3

Intellectual Property Protection

All required **patent procedures have been completed** to secure intellectual property rights for the developed technologies.

4

Laboratory Manufacturing and Research

Laboratory-scale and pilot production protocols have been developed, and preliminary preclinical in vitro studies have been **successfully conducted**.



Intellectual Property



Patent Protection

Patents have been obtained for all designated DNA vectors, ensuring comprehensive protection of the project's intellectual property.



Licensing

Licensing and reassignment of intellectual property rights are planned in favor of the joint project company, enabling shared ownership and commercialization.



Access to Producer Strains

The project company will receive formal authorization letters granting non-exclusive access to deposited samples of producer strains stored in certified repositories.





Upcoming Stages

Final Stage of Development

Preclinical studies on animal models to determine the optimal method of delivering the genetic construct into target cells and to define the most effective DNA vector composition.

Preclinical Study Package

Evaluation of approved dosages, delivery methods, and formulation parameters of the medicinal product using animal models.

Phase I–II Clinical Trials

Comprehensive clinical evaluation of the gene therapy product in patients diagnosed with cystic fibrosis.

Regulatory Approval and Market Launch

Obtaining a marketing authorization for production and commercialization of the new gene therapy product, followed by product launch.



Prospects and Potential

1

Innovative Approach

Development of a fundamentally new method for the treatment of cystic fibrosis based on advanced gene therapy technologies.

2

Improved Quality of Life

Significant potential to enhance treatment efficacy and extend life expectancy for patients through long-lasting therapeutic benefits.

3

Economic Potential

Market entry with a unique gene therapy product offering substantial commercialization opportunities and optimal investment payback timelines.

4

Advancement of Biotechnology

Promotion and acceleration of biotechnology development, fostering innovation and technological independence in the biomedical sector.

Description of Gene Functions

CFTR (Cystic Fibrosis Transmembrane Conductance Regulator)

The *CFTR* gene encodes a protein that functions as a chloride ion channel across epithelial cell membranes. This gene plays a pivotal role in the pathogenesis of cystic fibrosis.

Mutations in the *CFTR* gene lead to defective or absent CFTR protein, resulting in impaired ion transport, accumulation of thick mucus, and consequently chronic infections and inflammation in the respiratory system.

In preliminary studies, equilibrium potential measurements in *CFTE29o-* cells transfected with the **VTvaf17-CFTR** vector demonstrated the appearance of chloride ion currents, whereas no such currents were observed in non-transfected control cells. These results confirm successful transfection and functional CFTR expression in human epithelial cells.

AQ1 and AQ3

The *AQ1* and *AQ3* genes belong to the aquaporin family and encode membrane proteins involved in various biological processes, including the regulation of water transport across cell membranes.

The functional activity of the developed gene therapy formulation has been confirmed experimentally by assessing changes in the expression levels of CFTR, aquaporin-1, and aquaporin-3 proteins in lysates of human tracheal epithelial cells (*CFTE29o-*), human neuroblastoma cells (*SH-SY5Y*), and primary cultures of human bladder smooth muscle cells (*HbDMSC*) following transfection with **VTvaf17-CFTR**, **VTvaf17-AQ1**, and **VTvaf17-AQ3** DNA vectors. The results of these studies demonstrate the efficacy of the gene therapy DNA vectors and confirm the feasibility of their practical therapeutic application.