Cystic fibrosis transmembrane conductance regulator

Normal Function

The CFTR gene provides instructions for making a protein called the cystic fibrosis transmembrane conductance regulator. This protein functions as a channel across the membrane of cells that produce mucus, sweat, saliva, tears, and digestive enzymes. The channel transports negatively charged particles called chloride ions into and out of cells. The transport of chloride ions helps control the movement of water in tissues, which is necessary for the production of thin, freely flowing mucus. Mucus is a slippery substance that lubricates and protects the lining of the airways, digestive system, reproductive system, and other organs and tissues.

The CFTR protein also regulates the function of other channels, such as those that transport positively charged particles called sodium ions across cell membranes. These channels are necessary for the normal function of organs such as the lungs and pancreas.

Health Conditions Related to Genetic Changes

Congenital bilateral absence of the vas deferens

About 80 CFTR mutations have been identified in males with congenital bilateral absence of the vas deferens. Most affected males have a mild mutation in at least one copy of the gene in each cell. These mutations allow the CFTR protein to retain some of its function. Some affected males have a mild mutation in one copy of the CFTR gene in each cell and a more severe, cystic fibrosis-causing mutation in the other copy of the gene.

Mutations in the CFTR gene disrupt the function of the chloride channel, preventing the usual flow of chloride ions and water into and out of cells. As a result, cells in the male genital tract produce mucus that is abnormally thick and sticky. This mucus clogs the tubes that carry sperm from the testes (the vas deferens) as they are forming, causing them to deteriorate before birth. Without the vas deferens, sperm cannot be transported from the testes to become part of semen. Men with congenital bilateral absence of the vas deferens are unable to father children (infertile) unless they use assisted reproductive technologies.

Cystic fibrosis

More than 1,000 mutations in the CFTR gene have been identified in people with cystic fibrosis. Most of these mutations change single protein building blocks (amino acids) in the CFTR protein or delete a small amount of DNA from the CFTR gene.
The most common mutation, called delta F508, is a deletion of one amino acid at position 508 in the CFTR protein. The resulting abnormal channel breaks down shortly after it is made, so it never reaches the cell membrane to transport chloride ions.

Disease-causing mutations in the CFTR gene alter the production, structure, or stability of the chloride channel. All of these changes prevent the channel from functioning properly, which impairs the transport of chloride ions and the movement of water into and out of cells. As a result, cells that line the passageways of the lungs, pancreas, and other organs produce mucus that is abnormally thick and sticky. The abnormal mucus obstructs the airways and glands, leading to the characteristic signs and symptoms of cystic fibrosis.

Hereditary pancreatitis

Other disorders

A few mutations in the CFTR gene have been identified in people with isolated problems affecting the digestive or respiratory system. For example, CFTR mutations have been found in some cases of idiopathic pancreatitis, an inflammation of the pancreas that causes abdominal pain, nausea, vomiting, and fever. Although CFTR mutations may be a risk factor, the cause of idiopathic pancreatitis is unknown.

Changes in the CFTR gene also have been associated with rhinosinusitis, which is a chronic inflammation of the tissues that line the sinuses. This condition causes sinus pain and pressure, headache, fever, and nasal congestion or drainage. Other respiratory problems, including several conditions that partially block the airways and interfere with breathing, are also associated with CFTR mutations. These conditions include bronchiectasis, which damages the passages leading from the windpipe to the lungs (the bronchi), and allergic bronchopulmonary aspergillosis, which results from hypersensitivity to a certain type of fungal infection. Additional genetic and environmental factors likely play a part in determining the risk of these complex conditions.
Chromosomal Location

Cytogenetic Location: 7q31.2, which is the long (q) arm of chromosome 7 at position 31.2

Molecular Location: base pairs 117,480,025 to 117,668,665 on chromosome 7 (Homo sapiens Updated Annotation Release 109.20190905, GRCh38.p13) (NCBI)

Credit: Genome Decoration Page/NCBI

Other Names for This Gene

• ABC35
• ABCC7
• cAMP-dependent chloride channel
• CF
• CFTR_HUMAN
• cystic fibrosis transmembrane conductance regulator (ATP-binding cassette sub-family C, member 7)
• cystic fibrosis transmembrane conductance regulator, ATP-binding cassette (sub-family C, member 7)
• MRP7

Additional Information & Resources

Educational Resources

• Eurekah Bioscience Collection: Anion Conduction by CFTR
  https://www.ncbi.nlm.nih.gov/books/NBK6305/
• National Heart, Lung, and Blood Institute: Bronchiectasis
  https://www.nhlbi.nih.gov/health-topics/bronchiectasis
• National Institute of Diabetes and Digestive and Kidney Diseases: Pancreatitis
  https://www.niddk.nih.gov/health-information/digestive-diseases/pancreatitis
• The Human ATP-Binding Cassette (ABC) Transporter Superfamily: ABCC Genes
  https://www.ncbi.nlm.nih.gov/books/NBK3/#A191
Clinical Information from GeneReviews

- Cystic Fibrosis and Congenital Absence of the Vas Deferens
  https://www.ncbi.nlm.nih.gov/books/NBK1250

Scientific Articles on PubMed

- PubMed
  https://www.ncbi.nlm.nih.gov/pubmed?term=%28CFTR%5BTI%5D%29+AND+%28%28Genes%5BMH%5D%29+OR+%28Genetic+Phenomena%5BMH%5D%29%29+AND+english%5Blang%5D+AND+human%5Bmh%5D+AND+%22last+360+days%22

Catalog of Genes and Diseases from OMIM

- CYSTIC FIBROSIS TRANSMEMBRANE CONDUCTANCE REGULATOR
  http://omim.org/entry/602421

Research Resources

- Atlas of Genetics and Cytogenetics in Oncology and Haematology
  http://atlasgeneticsoncology.org/Genes/GC_CFTR.html
- CFTR2: Clinical and Functional Translation of CFTR
  https://cftr2.org/
- ClinVar
- HGNC Gene Symbol Report
- Monarch Initiative
  https://monarchinitiative.org/gene/NCBIGene:1080
- NCBI Gene
- UniProt
  https://www.uniprot.org/uniprot/P13569

Sources for This Summary

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