CLCN1 gene
chloride voltage-gated channel 1

Normal Function

The CLCN1 gene belongs to the CLC family of genes, which provide instructions for making chloride channels. These channels, which transport negatively charged chlorine atoms (chloride ions), play a key role in a cell's ability to generate and transmit electrical signals. Some CLC channels regulate the flow of chloride ions across cell membranes, while others transport chloride ions within cells.

The CLCN1 gene provides instructions for making a chloride channel called ClC-1. These channels are abundant in muscles used for movement (skeletal muscles). For the body to move normally, skeletal muscles must tense (contract) and relax in a coordinated way. Muscle contraction and relaxation are controlled by the flow of certain ions into and out of muscle cells. ClC-1 channels, which span the cell membrane, control the flow of chloride ions into these cells. This influx stabilizes the cells' electrical charge, which prevents muscles from contracting abnormally.

ClC-1 channels are made of two identical protein subunits, each produced from the CLCN1 gene. Although each subunit forms a separate opening (pore) that allows chloride ions to pass through, the two proteins work together to regulate the flow of chloride ions into skeletal muscle cells.

Health Conditions Related to Genetic Changes

Myotonia congenita

More than 80 mutations in the CLCN1 gene have been identified in people with myotonia congenita. Most of these mutations cause the autosomal recessive form of the disorder, which is known as Becker disease. Autosomal recessive inheritance means two copies of the gene in each cell are altered. Becker disease results when CLCN1 mutations change the structure or function of both protein subunits that make up the CIC-1 channel. The altered channels greatly reduce the flow of chloride ions into skeletal muscle cells, which triggers prolonged muscle contractions. Abnormally sustained muscle contractions are the hallmark of myotonia.

CLCN1 mutations also cause the autosomal dominant form of myotonia congenita, which is known as Thomsen disease. Autosomal dominant inheritance means one copy of the altered gene in each cell is sufficient to cause the disorder. Studies suggest that the CLCN1 mutations responsible for Thomsen disease change one of the two protein subunits that make up the CIC-1 channel. The altered protein takes on new, but harmful, properties that disrupt the ability of both subunits to regulate chloride ion flow. Reduced movement of chloride ions into skeletal muscle cells leads
to myotonia, which underlies the stiffness and other muscle problems in people with myotonia congenita.

Because several \textit{CLCN1} mutations can cause either Becker disease or Thomsen disease, doctors usually rely on characteristic signs and symptoms to distinguish the two forms of myotonia congenita.

\textbf{Chromosomal Location}

\textbf{Cytogenetic Location:} 7q34, which is the long (q) arm of chromosome 7 at position 34
\textbf{Molecular Location:} base pairs 143,316,111 to 143,352,083 on chromosome 7 (Homo sapiens Updated Annotation Release 109.20190607, GRCh38.p13) (NCBI)

\textbf{Credit:} Genome Decoration Page/NCBI

\textbf{Other Names for This Gene}
\begin{itemize}
  \item chloride channel 1, skeletal muscle
  \item Chloride channel protein 1
  \item Chloride channel protein, skeletal muscle
  \item chloride channel, voltage-sensitive 1
  \item CIC-1
  \item CLC1
  \item CLCN1_HUMAN
  \item MGC138361
  \item MGC142055
  \item skeletal muscle chloride channel 1
\end{itemize}
Additional Information & Resources

Educational Resources
- Basic Neurochemistry (sixth edition, 1999): Mutations in the ClC1 muscle Cl-channel produce human disease
  https://www.ncbi.nlm.nih.gov/books/NBK28162/#A3035
- Neuromuscular Disease Center, Washington University: Becker Disease
  https://neuromuscular.wustl.edu/mother/activity.html#mcr
- Neuromuscular Disease Center, Washington University: Thomsen Disease
  https://neuromuscular.wustl.edu/mother/activity.html#mcd

Clinical Information from GeneReviews
- Myotonia Congenita
  https://www.ncbi.nlm.nih.gov/books/NBK1355

Scientific Articles on PubMed
- PubMed
  https://www.ncbi.nlm.nih.gov/pubmed?term=%28CLCN1%5BTIAB%5D%29+OR+%28CLC1%5BTIAB%5D%29+AND+english%5Bla%5D+AND+human%5Bmh%5D+AND+%22last+3600+days%22%5Bdp%5D

Catalog of Genes and Diseases from OMIM
- CHLORIDE CHANNEL 1, SKELETAL MUSCLE
  http://omim.org/entry/118425

Research Resources
- ClinVar
  https://www.ncbi.nlm.nih.gov/clinvar?term=CLCN1%5Bgene%5D
- HGNC Gene Symbol Report
- Monarch Initiative
  https://monarchinitiative.org/gene/NCBIGene:1180
- NCBI Gene
- UniProt
  https://www.uniprot.org/uniprot/P35523
Sources for This Summary

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/15786415

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/15162127

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/20301529

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/14639587

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/11917096

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/11933197

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/10690989

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/8857733

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https://ghr.nlm.nih.gov/gene/CLCN1

Reviewed: April 2007  
Published: September 10, 2019

Lister Hill National Center for Biomedical Communications  
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