KCNJ11 gene
potassium voltage-gated channel subfamily J member 11

Normal Function

The \textit{KCNJ11} gene provides instructions for making parts (subunits) of the ATP-sensitive potassium (K-ATP) channel. Each K-ATP channel consists of eight subunits. Four subunits are produced from the \textit{KCNJ11} gene, and four are produced from another gene called \textit{ABCC8}.

K-ATP channels are found in beta cells, which are cells in the pancreas that secrete the hormone insulin. The K-ATP channels are embedded in cell membranes, where they open and close in response to the amount of glucose in the bloodstream. Glucose is a simple sugar and the primary energy source for most cells in the body. Closure of the K-ATP channels in response to increased glucose triggers the release of insulin out of beta cells and into the bloodstream, which helps control blood sugar levels.

Health Conditions Related to Genetic Changes

\textbf{Congenital hyperinsulinism}

More than 30 mutations in the \textit{KCNJ11} gene have been found to cause congenital hyperinsulinism. This condition causes frequent episodes of low blood sugar (hypoglycemia), decreased energy, and irritability. Most of these mutations change single protein building blocks (amino acids) in the protein sequence, reducing or preventing activity of the K-ATP channels. Loss of K-ATP channel function leads to the constant release of insulin from beta cells. As a result, glucose is rapidly removed from the bloodstream. Without treatment, the hypoglycemia caused by congenital hyperinsulinism may result in serious complications such as intellectual disability and seizures.

\textbf{Permanent neonatal diabetes mellitus}

At least 30 mutations in the \textit{KCNJ11} gene have been identified in people with permanent neonatal diabetes mellitus. Individuals with this condition often have a low birth weight and develop increased blood sugar (hyperglycemia) within the first 6 months of life.

\textit{KCNJ11} gene mutations that cause permanent neonatal diabetes mellitus change single amino acids in the protein sequence. These mutations result in K-ATP channels that do not close, leading to reduced insulin secretion from beta cells and impaired blood sugar control.

\textbf{Gestational diabetes}
Other disorders

Other KCNJ11 gene mutations that have a relatively mild effect on K-ATP channel function as compared to that seen in permanent neonatal diabetes mellitus (see above) cause a condition called transient neonatal diabetes mellitus. Infants with this condition have hyperglycemia during the first 6 months of life, but their blood sugar returns to normal by age 18 months. However, affected individuals usually develop hyperglycemia again during adolescence or early adulthood. As in permanent neonatal diabetes mellitus, KCNJ11 gene mutations that cause transient neonatal diabetes mellitus also interfere with K-ATP channel closure and lead to a reduction in insulin secretion.

A normal variation (polymorphism) in the KCNJ11 gene is associated with an increased risk of type 2 diabetes, the most common form of diabetes. This variant leads to a change in the K-ATP channel, replacing the amino acid glutamic acid with the amino acid lysine at position 23, written as Glu23Lys or E23K. People with type 2 diabetes have hyperglycemia because the body does not respond correctly to the insulin secreted from beta cells. The same variant has also been associated with changes in the heart's response to stress, leading to an increased risk of heart failure. Although changes in the KCNJ11 gene can be associated with type 2 diabetes and heart failure, a combination of lifestyle, genetic, and environmental factors all play a part in determining the risk of these complex disorders.

Chromosomal Location

Cytogenetic Location: 11p15.1, which is the short (p) arm of chromosome 11 at position 15.1

Molecular Location: base pairs 17,385,246 to 17,389,346 on chromosome 11 (Homo sapiens Updated Annotation Release 109.20200228, GRCh38.p13) (NCBI)

Credit: Genome Decoration Page/NCBI

Other Names for This Gene

- ATP-sensitive inward rectifier potassium channel 11
- beta-cell inward rectifier subunit
- BIR
HHF2
IKATP
inward rectifier K(+) channel Kir6.2
inwardly rectifying potassium channel KIR6.2
KIR6.2
MGC133230
potassium channel, inwardly rectifying subfamily J member 11
potassium channel, inwardly rectifying subfamily J, member 11
potassium inwardly-rectifying channel, subfamily J, member 11
TNDM3

Additional Information & Resources

Educational Resources

Madame Curie Bioscience Database (Landes Bioscience, 2000-2011): Insulin Exocytosis in Pancreatic Beta Cells
https://www.ncbi.nlm.nih.gov/books/NBK6433/#A59214

Clinical Information from GeneReviews

Familial Hyperinsulinism
https://www.ncbi.nlm.nih.gov/books/NBK1375

Permanent Neonatal Diabetes Mellitus
https://www.ncbi.nlm.nih.gov/books/NBK1447

Scientific Articles on PubMed

PubMed
https://www.ncbi.nlm.nih.gov/pubmed?term=%28KCNJ11%5BTIAB%5D%29+AND+%28%28Genes%5BMH%5D%29+OR+%28Genetic+Phenomena%5BMH%5D%29%29+AND+english%5Bla%5D+AND+human%5Bmh%5D+AND+%22last+360+days%22%5Bdp%5D

Catalog of Genes and Diseases from OMIM

DIABETES MELLITUS, NONINSULIN-DEPENDENT
http://omim.org/entry/125853

DIABETES MELLITUS, TRANSIENT NEONATAL, 3
http://omim.org/entry/610582

POTASSIUM CHANNEL, INWARDLY RECTIFYING, SUBFAMILY J, MEMBER 11
http://omim.org/entry/600937
Research Resources

- Atlas of Genetics and Cytogenetics in Oncology and Haematology
  http://atlasgeneticsoncology.org/Genes/GC_KCNJ11.html

- ClinVar

- HGNC Gene Symbol Report

- Monarch Initiative
  https://monarchinitiative.org/gene/NCBIGene:3767

- NCBI Gene

- UniProt
  https://www.uniprot.org/uniprot/Q14654

Sources for This Summary

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/20878482

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/18767144

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/16609879

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/16416420

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/12540637

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/19254908

- OMIM: POTASSIUM CHANNEL, INWARDLY RECTIFYING, SUBFAMILY J, MEMBER 11
  http://omim.org/entry/600937
  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/17349054
  Free article on PubMed Central: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1847805/

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/19685080
  Free article on PubMed Central: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3771654/

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/21054355

Reprinted from Genetics Home Reference:

Reviewed: January 2014
Published: March 17, 2020

Lister Hill National Center for Biomedical Communications
U.S. National Library of Medicine
National Institutes of Health
Department of Health & Human Services