WNK1 gene

WNK lysine deficient protein kinase 1

Normal Function

The *WNK1* gene provides instructions for making multiple versions (isoforms) of the WNK1 protein. The different WNK1 isoforms are important in several functions in the body, including blood pressure regulation and pain sensation.

One isoform produced from the *WNK1* gene is the full-length version, called the L-WNK1 protein, which is found in cells throughout the body. A different isoform, called the kidney-specific WNK1 protein or KS-WNK1, is found only in kidney cells. The L-WNK1 and KS-WNK1 proteins act as kinases, which are enzymes that change the activity of other proteins by adding a cluster of oxygen and phosphorus atoms (a phosphate group) at specific positions.

The L-WNK1 and KS-WNK1 proteins regulate channels in the cell membrane that control the transport of sodium or potassium into and out of cells. In the kidneys, sodium channels help transport sodium into specialized cells, which then transfer it into the blood. This transfer helps keep sodium in the body through a process called reabsorption. Potassium channels handle excess potassium that has been transferred from the blood into kidney cells. The channels transport potassium out of the cells in a process called secretion, so that it can be removed from the body in urine.

The L-WNK1 protein increases sodium reabsorption and decreases potassium secretion, whereas the KS-WNK1 protein has the opposite effect. Sodium and potassium are important for regulating blood pressure, and a balance of L-WNK1 protein and KS-WNK1 protein in the kidneys helps maintain the correct levels of sodium and potassium for healthy blood pressure.

Another isoform produced from the *WNK1* gene, called the WNK1/HSN2 protein, is found in the cells of the nervous system, including nerve cells that transmit the sensations of pain, temperature, and touch (sensory neurons). The WNK1/HSN2 protein appears to regulate channels in the cell membrane that can transport negatively charged chlorine atoms (chloride ions). These channels maintain the proper amount of chloride inside cells, which is important for controlling the activation (excitation) of the neurons.

Health Conditions Related to Genetic Changes

Hereditary sensory and autonomic neuropathy type II

Mutations in the *WNK1* gene are responsible for one type of hereditary sensory and autonomic neuropathy type II (HSAN2) called HSAN2A. People with HSAN2A lose

the ability to feel pain or sense hot and cold. More than a dozen mutations in the *WNK1* gene have been identified in people with HSAN2A. All of these mutations lead to an abnormally shortened WNK1/HSN2 protein that is probably nonfunctional. People with HSAN2A have a reduction in the number of sensory neurons; however, the role that the abnormal WNK1/HSN2 protein plays in that loss is unclear. The loss of sensory neurons results in the signs and symptoms of HSAN2A.

WNK1 gene mutations involved in HSAN2A do not appear to affect the L-WNK1 or KS-WNK1 isoforms.

Pseudohypoaldosteronism type 2

At least two mutations in the *WNK1* gene have been found to cause pseudohypoaldosteronism type 2 (PHA2), a condition characterized by high blood pressure (hypertension) and high levels of potassium in the blood (hyperkalemia). The mutations involved in this condition delete large numbers of DNA building blocks (nucleotides) from the *WNK1* gene. These deletions lead to increased activity of the *WNK1* gene and excess L-WNK1 protein. An increase in L-WNK1 protein abnormally increases sodium reabsorption and blocks potassium secretion, resulting in hypertension and hyperkalemia.

WNK1 gene mutations involved in PHA2 do not appear to affect the KS-WNK1 or WNK1/HSN2 isoforms.

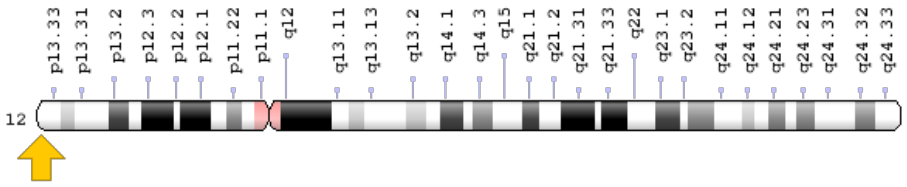
Other disorders

Studies have associated normal variations in the *WNK1* gene with an increased risk of high blood pressure (hypertension) in people without PHA2 (described above). A combination of genetic variations and environmental factors likely influence the development of this complex condition.

Chromosomal Location

Cytogenetic Location: 12p13.33, which is the short (p) arm of chromosome 12 at position 13.33

Molecular Location: base pairs 752,579 to 911,452 on chromosome 12 (Homo sapiens Updated Annotation Release 109.20190607, GRCh38.p13) (NCBI)



Credit: Genome Decoration Page/NCBI

Other Names for This Gene

- HSAN2
- HSN2
- KDP
- p65
- PPP1R167
- PRKWNK1
- prostate-derived sterile 20-like kinase
- protein kinase with no lysine 1
- protein kinase, lysine deficient 1
- PSK
- serine/threonine-protein kinase WNK1
- WNK1_HUMAN

Additional Information & Resources

Educational Resources

- Molecular Biology of the Cell (fourth edition, 2002): Ion Channels and the Electrical Properties of Membranes
  https://www.ncbi.nlm.nih.gov/books/NBK26910/
- Undiagnosed Diseases Network: Gene Page
  https://undiagnosed.hms.harvard.edu/genes/wnk1/

Clinical Information from GeneReviews

- Hereditary Sensory and Autonomic Neuropathy Type II
  https://www.ncbi.nlm.nih.gov/books/NBK49247
- Pseudohypoaldosteronism Type II
  https://www.ncbi.nlm.nih.gov/books/NBK65707

Scientific Articles on PubMed

- PubMed
  https://www.ncbi.nlm.nih.gov/pubmed?term=%28WNK1%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+1800+days%22%5Bdp%5D

Catalog of Genes and Diseases from OMIM

- PROTEIN KINASE, LYSINE-DEFICIENT 1
  http://omim.org/entry/605232

Research Resources

- Atlas of Genetics and Cytogenetics in Oncology and Haematology
  http://atlasgeneticsoncology.org/Genes/GC_WNK1.html
- ClinVar
  https://www.ncbi.nlm.nih.gov/clinvar?term=WNK1%5Bgene%5D
- HGNC Gene Symbol Report
  https://www.genenames.org/data/gene-symbol-report/#!/hgnc_id/HGNC:14540
- Monarch Initiative
  https://monarchinitiative.org/gene/NCBIGene:65125
- NCBI Gene
  https://www.ncbi.nlm.nih.gov/gene/65125
- UniProt
  https://www.uniprot.org/uniprot/Q9H4A3

Sources for This Summary

- Bercier V. WNK1/HSN2 isoform and the regulation of KCC2 activity. Rare Dis. 2013 Sep 19;1: e26537. doi: 10.4161/rdis.26537. eCollection 2013.
  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/25003007
  Free article on PubMed Central: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3933052/
- Chávez-Canales M, Zhang C, Soukaseum C, Moreno E, Pacheco-Alvarez D, Vidal-Petiot E, Castañeda-Bueno M, Vázquez N, Rojas-Vega L, Meermeier NP, Rogers S, Jeunemaitre X, Yang CL, Ellison DH, Gamba G, Hadchouel J. WNK-SPAK-NCC cascade revisited: WNK1 stimulates the activity of the Na-Cl cotransporter via SPAK, an effect antagonized by WNK4. Hypertension. 2014 Nov;64(5):1047-53. doi: 10.1161/HYPERTENSIONAHA.114.04036. Epub 2014 Aug 11.
  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/25113964
- Gamba G. Regulation of the renal Na+-Cl- cotransporter by phosphorylation and ubiquitylation. Am J Physiol Renal Physiol. 2012 Dec 15;303(12):F1573-83. doi: 10.1152/ajprenal.00508.2012. Epub 2012 Oct 3. Review.
  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/23034942
  Free article on PubMed Central: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3532472/
- Huang CL, Kuo E. Mechanisms of disease: WNK-ing at the mechanism of salt-sensitive hypertension. Nat Clin Pract Nephrol. 2007 Nov;3(11):623-30. Review.
  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/17957199
- Lazrak A, Liu Z, Huang CL. Antagonistic regulation of ROMK by long and kidney-specific WNK1 isoforms. Proc Natl Acad Sci U S A. 2006 Jan 31;103(5):1615-20. Epub 2006 Jan 20.
  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/16428287
  Free article on PubMed Central: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1360592/

- Newhouse S, Farrall M, Wallace C, Hoti M, Burke B, Howard P, Onipinla A, Lee K, Shaw-Hawkins S, Dobson R, Brown M, Samani NJ, Dominiczak AF, Connell JM, Lathrop GM, Kooner J, Chambers J, Elliott P, Clarke R, Collins R, Laan M, Org E, Juhanson P, Veldre G, Viigimaa M, Eyheramendy S, Cappuccio FP, Ji C, Iacone R, Strazzullo P, Kumari M, Marmot M, Brunner E, Caulfield M, Munroe PB. Polymorphisms in the WNK1 gene are associated with blood pressure variation and urinary potassium excretion. PLoS One. 2009;4(4):e5003. doi: 10.1371/journal.pone.0005003. Epub 2009 Apr 4.
  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/19347040
  Free article on PubMed Central: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2661139/
- OMIM: PROTEIN KINASE, LYSINE-DEFICIENT 1
  http://omim.org/entry/605232
- Shekarabi M, Girard N, Rivière JB, Dion P, Houle M, Toulouse A, Lafrenière RG, Vercauteren F, Hince P, Laganiere J, Rochefort D, Faivre L, Samuels M, Rouleau GA. Mutations in the nervous system--specific HSN2 exon of WNK1 cause hereditary sensory neuropathy type II. J Clin Invest. 2008 Jul;118(7):2496-505. doi: 10.1172/JCI34088.
  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/18521183
  Free article on PubMed Central: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2398735/
- Verpoorten N, De Jonghe P, Timmerman V. Disease mechanisms in hereditary sensory and autonomic neuropathies. Neurobiol Dis. 2006 Feb;21(2):247-55. Epub 2005 Sep 23. Review.
  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/16183296
- Vidal-Petiot E, Elvira-Matelot E, Mutig K, Soukaseum C, Baudrie V, Wu S, Cheval L, Huc E, Cambillau M, Bachmann S, Doucet A, Jeunemaitre X, Hadchouel J. WNK1-related Familial Hyperkalemic Hypertension results from an increased expression of L-WNK1 specifically in the distal nephron. Proc Natl Acad Sci U S A. 2013 Aug 27;110(35):14366-71. doi: 10.1073/pnas.1304230110. Epub 2013 Aug 12.
  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/23940364
  Free article on PubMed Central: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3761585/
- Wilson FH, Disse-Nicodème S, Choate KA, Ishikawa K, Nelson-Williams C, Desitter I, Gunel M, Milford DV, Lipkin GW, Achard JM, Feely MP, Dussol B, Berland Y, Unwin RJ, Mayan H, Simon DB, Farfel Z, Jeunemaitre X, Lifton RP. Human hypertension caused by mutations in WNK kinases. Science. 2001 Aug 10;293(5532):1107-12.
  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/11498583

Reprinted from Genetics Home Reference:
https://ghr.nlm.nih.gov/gene/WNK1

Reviewed: April 2017
Published: September 10, 2019

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