



PAX3 gene

paired box 3

Normal Function

The *PAX3* gene belongs to a family of PAX genes that plays a critical role in the formation of tissues and organs during embryonic development. The PAX gene family is also important for maintaining the normal function of certain cells after birth. To carry out these roles, the PAX genes provide instructions for making proteins that attach (bind) to specific areas of DNA. By attaching to critical DNA regions, PAX proteins help control the activity of particular genes. On the basis of this action, PAX proteins are called transcription factors.

During embryonic development, the *PAX3* gene is active in cells called neural crest cells. These cells migrate from the developing spinal cord to specific regions in the embryo. The protein made from the *PAX3* gene directs the activity of other genes that signal neural crest cells to form specialized tissues or cell types such as some nerve tissue and pigment-producing cells called melanocytes. Melanocytes produce the pigment melanin, which contributes to hair, eye, and skin color. Melanocytes are also found in certain regions of the brain and inner ear.

Studies suggest that the PAX3 protein is also necessary for the normal development of bones in the face and skull (craniofacial bones) and elsewhere in the body, and for the formation of muscle tissue (myogenesis).

Health Conditions Related to Genetic Changes

Craniofacial-deafness-hand syndrome

At least one *PAX3* gene mutation has been identified in individuals with craniofacial-deafness-hand syndrome, a condition characterized by distinctive facial features, profound hearing loss, and abnormalities of the hand muscles that can restrict movement. The mutation replaces a single protein building block (amino acid) called asparagine with another amino acid called lysine at position 47 in the PAX3 protein (written as Asn47Lys or N47K). This mutation appears to affect the ability of the PAX3 protein to bind to DNA. As a result, the PAX3 protein cannot control the activity of other genes and cannot direct the neural crest cells to form specialized tissues. A lack of specialization of neural crest cells leads to the impaired growth of craniofacial bones, nerve tissue, and muscles seen in craniofacial-deafness-hand syndrome.

Waardenburg syndrome

Several dozen *PAX3* gene mutations have been identified in people with Waardenburg syndrome, a group of genetic conditions that can cause hearing loss

and changes in coloring (pigmentation) of the hair, skin, and eyes. Specifically, *PAX3* gene mutations can cause Waardenburg syndrome types I and III.

Some of these mutations change single amino acids in the *PAX3* protein. Other mutations lead to an abnormally small version of the *PAX3* protein. Researchers believe that all *PAX3* gene mutations have the same effect: they prevent the *PAX3* protein from binding to DNA and regulating the activity of other genes. As a result, melanocytes do not develop in certain areas of the skin, hair, eyes, and inner ear, leading to hearing loss and the patchy loss of pigmentation that are characteristic features of Waardenburg syndrome. Additionally, loss of *PAX3* protein function disrupts development of certain bones and muscles, producing abnormalities of the arms and hands in people with Waardenburg syndrome type III.

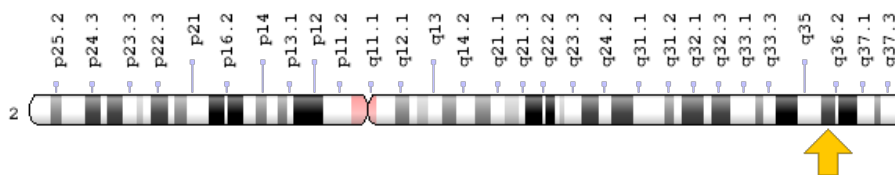
Cancers

A rearrangement of genetic material involving the *PAX3* gene is associated with a cancer of muscle tissue called alveolar rhabdomyosarcoma, which typically affects adolescents and young adults. This genetic change is somatic, which means that it is not inherited and occurs only in the cells that give rise to cancer. The rearrangement causes the *PAX3* gene to be fused with the *FOXO1A* gene (also called *FKHR*) on chromosome 13. The fused *PAX3-FOXO1A* gene has an increased ability to activate genes involved in myogenesis and can prevent cell death. As a result, muscle cell growth becomes uncontrolled, which can lead to this cancer of muscle tissue.

Chromosomal Location

Cytogenetic Location: 2q36.1, which is the long (q) arm of chromosome 2 at position 36.1

Molecular Location: base pairs 222,199,887 to 222,298,996 on chromosome 2 (Homo sapiens Annotation Release 108, GRCh38.p7) (NCBI)



Credit: Genome Decoration Page/NCBI

Other Names for This Gene

- CDHS
- HUP2
- paired box gene 3 (Waardenburg syndrome 1)

- paired box homeotic gene 3
- paired domain gene 3
- paired domain gene HuP2
- PAX3/FKHR fusion gene
- PAX3_HUMAN
- WS1

Additional Information & Resources

GeneReviews

- Waardenburg Syndrome Type I
<https://www.ncbi.nlm.nih.gov/books/NBK1531>

Scientific Articles on PubMed

- PubMed
<https://www.ncbi.nlm.nih.gov/pubmed?term=%28PAX3%5BTI%5D%29+AND+english%5Bla%5D+AND+human%5Bmh%5D+AND+%22last+1800+days%22%5Bdp%5D>

OMIM

- PAIRED BOX GENE 3
<http://omim.org/entry/606597>
- RHABDOMYOSARCOMA 2
<http://omim.org/entry/268220>

Research Resources

- Atlas of Genetics and Cytogenetics in Oncology and Haematology
<http://atlasgeneticsoncology.org/Genes/PAX3ID70ch2q35.html>
- ClinVar
<https://www.ncbi.nlm.nih.gov/clinvar?term=PAX3%5Bgene%5D>
- HGNC Gene Family: Paired boxes
<https://www.genenames.org/cgi-bin/genefamilies/set/675>
- HGNC Gene Family: PRD class homeoboxes and pseudogenes
<https://www.genenames.org/cgi-bin/genefamilies/set/521>
- HGNC Gene Symbol Report
https://www.genenames.org/cgi-bin/gene_symbol_report?q=data/hgnc_data.php&hgnc_id=8617

- NCBI Gene
<https://www.ncbi.nlm.nih.gov/gene/5077>
- UniProt
<http://www.uniprot.org/uniprot/P23760>

Sources for This Summary

- Anderson J, Gordon A, Pritchard-Jones K, Shipley J. Genes, chromosomes, and rhabdomyosarcoma. *Genes Chromosomes Cancer*. 1999 Dec;26(4):275-85. Review.
Citation on PubMed: <https://www.ncbi.nlm.nih.gov/pubmed/10534762>
- Anderson J, Ramsay A, Gould S, Pritchard-Jones K. PAX3-FKHR induces morphological change and enhances cellular proliferation and invasion in rhabdomyosarcoma. *Am J Pathol*. 2001 Sep; 159(3):1089-96.
Citation on PubMed: <https://www.ncbi.nlm.nih.gov/pubmed/11549601>
Free article on PubMed Central: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1850440/>
- Birrane G, Soni A, Ladas JA. Structural basis for DNA recognition by the human PAX3 homeodomain. *Biochemistry*. 2009 Feb 17;48(6):1148-55. doi: 10.1021/bi802052y.
Citation on PubMed: <https://www.ncbi.nlm.nih.gov/pubmed/19199574>
- Bondurand N, Pingault V, Goerich DE, Lemort N, Sock E, Le Caignec C, Wegner M, Goossens M. Interaction among SOX10, PAX3 and MITF, three genes altered in Waardenburg syndrome. *Hum Mol Genet*. 2000 Aug 12;9(13):1907-17.
Citation on PubMed: <https://www.ncbi.nlm.nih.gov/pubmed/10942418>
- Buckingham M, Relaix F. PAX3 and PAX7 as upstream regulators of myogenesis. *Semin Cell Dev Biol*. 2015 Aug;44:115-25. doi: 10.1016/j.semcdb.2015.09.017. Epub 2015 Sep 28. Review.
Citation on PubMed: <https://www.ncbi.nlm.nih.gov/pubmed/26424495>
- OMIM: PAIRED BOX GENE 3
<http://omim.org/entry/606597>
- Potterf SB, Furumura M, Dunn KJ, Arnheiter H, Pavan WJ. Transcription factor hierarchy in Waardenburg syndrome: regulation of MITF expression by SOX10 and PAX3. *Hum Genet*. 2000 Jul;107(1):1-6.
Citation on PubMed: <https://www.ncbi.nlm.nih.gov/pubmed/10982026>
- OMIM: RHABDOMYOSARCOMA 2
<http://omim.org/entry/268220>
- Sommer A, Bartholomew DW. Craniofacial-deafness-hand syndrome revisited. *Am J Med Genet A*. 2003 Nov 15;123A(1):91-4.
Citation on PubMed: <https://www.ncbi.nlm.nih.gov/pubmed/14556253>
- Wang Q, Fang WH, Krupinski J, Kumar S, Slevin M, Kumar P. Pax genes in embryogenesis and oncogenesis. *J Cell Mol Med*. 2008 Dec;12(6A):2281-94. doi: 10.1111/j.1582-4934.2008.00427.x. Epub 2008 Jul 4. Review.
Citation on PubMed: <https://www.ncbi.nlm.nih.gov/pubmed/18627422>
Free article on PubMed Central: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4514106/>
- Wollnik B, Tükel T, Uygüner O, Ghanbari A, Kayserili H, Emiroglu M, Yüksel-Apak M. Homozygous and heterozygous inheritance of PAX3 mutations causes different types of Waardenburg syndrome. *Am J Med Genet A*. 2003 Sep 15;122A(1):42-5.
Citation on PubMed: <https://www.ncbi.nlm.nih.gov/pubmed/12949970>

Reprinted from Genetics Home Reference:
<https://ghr.nlm.nih.gov/gene/PAX3>

Reviewed: August 2016
Published: March 20, 2018

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