PAX2 gene
paired box 2

Normal Function
The PAX2 gene belongs to a family of genes that plays a critical role in the formation of tissues and organs during embryonic development. The members of the PAX gene family are 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 to specific areas of DNA and help control the activity (expression) of particular genes. On the basis of this action, PAX proteins are called transcription factors.

During embryonic development, the PAX2 gene provides instructions for producing a protein that is involved in the formation of the eyes, ears, brain and spinal cord (central nervous system), kidneys, urinary tract, and genital tract. After birth, the PAX2 protein is thought to protect against cell death during periods of cellular stress.

Health Conditions Related to Genetic Changes

Renal coloboma syndrome
More than 40 mutations in the PAX2 gene have been found to cause renal coloboma syndrome. Most mutations are specific to each affected family; however, one mutation has been found in multiple affected individuals. This mutation inserts one DNA building block (nucleotide) into the PAX2 gene (written as 619insG). Most mutations occur in the region of the protein that attaches to DNA, impairing its function as a transcription factor. A lack of functional PAX2 protein disrupts the formation of certain tissues (particularly the kidneys and eyes) during embryonic development, causing the signs and symptoms of renal coloboma syndrome.

Coloboma

Congenital anomalies of kidney and urinary tract
More than 20 mutations in the PAX2 gene have been found in people with abnormalities of the kidneys and other structures of the urinary system but without the eye problems of renal coloboma syndrome (described above). The urinary system abnormalities vary in severity and are grouped together as congenital anomalies of kidney and urinary tract (CAKUT). The most severe CAKUT abnormalities can cause kidney damage and life-threatening kidney failure.

The effects of CAKUT-associated PAX2 gene mutations are not fully understood, but it is likely that they impair the function of the PAX2 protein, disrupting formation of
the kidneys and urinary system during embryonic development. It is unclear why only structures of the urinary system are affected in these individuals.

Other disorders

*PAX2* gene mutations are also found in individuals with abnormalities of the optic nerve, which carries visual information from the eyes to the brain. These individuals do not have the kidney anomalies associated with renal coloboma syndrome (described above). As in renal coloboma syndrome, the *PAX2* gene mutations associated with eye abnormalities likely disrupt regulation of genes that help direct normal eye development. Researchers are working to understand why mutations in this gene can affect different organ systems in different people.

Chromosomal Location

Cytogenetic Location: 10q24.31, which is the long (q) arm of chromosome 10 at position 24.31

Molecular Location: base pairs 100,735,396 to 100,829,944 on chromosome 10 (Homo sapiens Updated Annotation Release 109.20190607, GRCh38.p13) (NCBI)

Credit: Genome Decoration Page/NCBI

Other Names for This Gene

- paired box gene 2
- paired box homeotic gene 2
- paired box protein 2

Additional Information & Resources

Educational Resources

- Developmental Biology (sixth edition, 2000): Transcription factors
  https://www.ncbi.nlm.nih.gov/books/NBK10023/#A763
- National Cancer Institute: Kaposi Sarcoma Treatment PDQ
• National Cancer Institute: Kidney Cancer
  https://www.cancer.gov/types/kidney

• National Cancer Institute: Wilms Tumor and Other Childhood Kidney Tumors Treatment PDQ

Clinical Information from GeneReviews
• PAX2-Related Disorder
  https://www.ncbi.nlm.nih.gov/books/NBK1451

Scientific Articles on PubMed
• PubMed
  https://www.ncbi.nlm.nih.gov/pubmed?term=%28PAX2%5BTIAB%5D%29+AND+%28%28Genes%5BMH%5D+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
• PAIRED BOX GENE 2
  http://omim.org/entry/167409

Research Resources
• Atlas of Genetics and Cytogenetics in Oncology and Haematology
  http://atlasgeneticsoncology.org/Genes/PAX2ID41642ch10q24.html

• ClinVar

• HGNC Gene Symbol Report

• Monarch Initiative
  https://monarchinitiative.org/gene/NCBIGene:5076

• NCBI Gene

• UniProt
  https://www.uniprot.org/uniprot/Q02962
Sources for This Summary

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/11093271

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/22213154

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/20301624

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/28398236 
  Free article on PubMed Central: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5412380/

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/11274636

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/12141441

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/29339962 
  Free article on PubMed Central: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5762175/

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/12970747

- OMIM: PAIRED BOX GENE 2 
  http://omim.org/entry/167409
  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/14566649

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/26410163

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