CAT gene

catalase

Normal Function

The CAT gene provides instructions for making pieces (subunits) of an enzyme called catalase. Four identical subunits, each attached (bound) to an iron-containing molecule called a heme group, form the functional enzyme.

Catalase is active in cells and tissues throughout the body, where it breaks down hydrogen peroxide (H$_2$O$_2$) molecules into oxygen (O$_2$) and water (H$_2$O). Hydrogen peroxide is produced through chemical reactions within cells. At low levels, it is involved in several chemical signaling pathways, but at high levels it is toxic to cells. If hydrogen peroxide is not broken down by catalase, additional reactions convert it into compounds called reactive oxygen species that can damage DNA, proteins, and cell membranes.

Health Conditions Related to Genetic Changes

Acatalasemia

At least 13 mutations in the CAT gene have been found to cause acatalasemia, a condition characterized by very low catalase activity. Many people with acatalasemia never have any related health problems, although the condition has occasionally been associated with open sores (ulcers) inside the mouth leading to the death of soft tissue (gangrene). Acatalasemia also appears to increase the risk of developing type 2 diabetes (the most common form of diabetes) and is a potential risk factor for other common, complex diseases.

The mutations that cause acatalasemia occur in both copies of the CAT gene in each cell, and they reduce the activity of catalase to less than 10 percent of normal. A shortage of this enzyme can allow hydrogen peroxide to build up to toxic levels in certain cells. For example, hydrogen peroxide produced by bacteria in the mouth may accumulate in and damage soft tissues, leading to mouth ulcers and gangrene. A buildup of hydrogen peroxide may also damage beta cells of the pancreas, which release a hormone called insulin that helps control blood sugar. Malfunctioning beta cells are thought to underlie the increased risk of type 2 diabetes in people with acatalasemia. It is unclear why some people have no health problems associated with a shortage of catalase activity.

A related condition called hypocatalasemia occurs when only one of the two copies of the CAT gene in each cell has a mutation. This single mutation reduces the activity of catalase by approximately half. Like acatalasemia, hypocatalasemia usually does not cause any health problems.
Other disorders

Common variations (polymorphisms) in the \textit{CAT} gene and in regions of DNA that regulate the gene's activity may be associated with the risk of developing certain common, complex diseases. For example, researchers are studying these polymorphisms as potential risk factors for type 2 diabetes and other disorders of blood sugar regulation. \textit{CAT} gene polymorphisms may also be associated with high blood pressure (hypertension), a skin condition called vitiligo, thinning of the bones (osteoporosis), and elevated levels of cholesterol and other fats (lipids) in the blood, which increase the risk of heart attack and stroke. However, it is unclear how polymorphisms in the \textit{CAT} gene impact catalase activity, and how changes in the activity of this enzyme might influence a person's risk of developing these diseases. A large number of genetic and lifestyle factors, many of which remain unknown, likely determine the risk of developing most common, complex conditions.

Chromosomal Location

Cytogenetic Location: 11p13, which is the short (p) arm of chromosome 11 at position 13

Molecular Location: base pairs 34,438,934 to 34,472,060 on chromosome 11 (Homo sapiens Updated Annotation Release 109.20200228, GRCh38.p13) (NCBI)

Credit: Genome Decoration Page/NCBI

Other Names for This Gene

- CATA_HUMAN
- EC 1.11.1.6
Additional Information & Resources

Educational Resources

  https://www.ncbi.nlm.nih.gov/books/NBK21520/

- The Online Macromolecular Museum: Catalase
  http://earth.callutheran.edu/Academic_Programs/Departments/BioDev/omm/catalase/cat1.htm

- University of California Santa Barbara ScienceLine: How does catalase break down hydrogen peroxide?
  http://scienceline.ucsb.edu/getkey.php?key=166

Scientific Articles on PubMed

- PubMed
  https://www.ncbi.nlm.nih.gov/pubmed?term=%28%28catalase%5BTI%5D%29+OR+%28acatalasemia%5BMAJR%5D%29%29+AND+%28%28Genes%5BMH%5D%29+OR+%28Genetic+Phenomena%5BMH%5D%29%29+AND+english%5Bla%5D+AND+human%5Bmh%5D+AND+%22last+1080+days%22+AND+NCBI

Catalog of Genes and Diseases from OMIM

- CATALASE
  http://omim.org/entry/115500

Research Resources

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

- ClinVar

- HGNC Gene Symbol Report

- Monarch Initiative
  https://monarchinitiative.org/gene/NCBIGene:847

- NCBI Gene

- UniProt
  https://www.uniprot.org/uniprot/P04040
Sources for This Summary

- OMIM: CATALASE
  http://omim.org/entry/115500

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/11117918

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/24025477

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/15771551

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/22617568

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/17158050

Reprinted from Genetics Home Reference:

Reviewed: September 2014
Published: March 31, 2020

Lister Hill National Center for Biomedical Communications
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