GBA gene

**glucosylceramidase beta**

**Normal Function**

The *GBA* gene provides instructions for making an enzyme called beta-glucocerebrosidase. This enzyme is active in lysosomes, which are structures inside cells that act as recycling centers. Lysosomes use digestive enzymes to break down toxic substances, digest bacteria that invade the cell, and recycle worn-out cell components. Based on these functions, enzymes in the lysosome are sometimes called housekeeping enzymes. Beta-glucocerebrosidase is a housekeeping enzyme that helps break down a large molecule called glucocerebroside into a sugar (glucose) and a simpler fat molecule (ceramide). Glucocerebroside is a component of the membrane that surrounds cells. It gets broken down when cells die and recycled as new cells are formed.

**Health Conditions Related to Genetic Changes**

**Gaucher disease**

More than 380 mutations in the *GBA* gene have been identified in people with Gaucher disease, a disorder with varied features that affect many parts of the body. Affected individuals can have enlargement of the liver and spleen (hepatosplenomegaly), blood cell abnormalities, and rarely, severe neurological problems. The mutations occur in both copies of the gene in each cell. Most of the *GBA* gene mutations responsible for Gaucher disease change single protein building blocks (amino acids) in beta-glucocerebrosidase, altering the structure of the enzyme and preventing it from working normally. Other mutations delete or insert genetic material in the *GBA* gene or lead to the production of an abnormally short, nonfunctional version of the enzyme.

Mutations in the *GBA* gene greatly reduce or eliminate the activity of beta-glucocerebrosidase in cells. As a result, glucocerebroside is not broken down properly. This molecule and related substances can build up in white blood cells called macrophages in the spleen, liver, bone marrow, and other organs. The abnormal accumulation and storage of these substances damages tissues and organs, causing the characteristic features of Gaucher disease.

**Parkinson disease**

Changes in the *GBA* gene are also associated with Parkinson disease and parkinsonism, which are similar disorders that affect movement. Characteristic features include tremors, and impaired balance and coordination (postural instability). People with Gaucher disease (described above) have mutations in both copies of
the *GBA* gene in each cell, while those with a mutation in just one copy of the gene are called carriers. People with Gaucher disease and people who are carriers of a *GBA* gene mutation have an increased risk of developing Parkinson disease or parkinsonism.

Symptoms of Parkinson disease and parkinsonism result from the loss of nerve cells that produce dopamine. Dopamine is a chemical messenger that transmits signals within the brain to produce smooth physical movements. It remains unclear how *GBA* gene mutations are related to these disorders. Studies suggest that changes in this gene may contribute to the faulty breakdown of toxic substances in nerve cells by impairing the function of lysosomes. Alternatively, the changes may increase the formation of abnormal protein deposits. As a result, toxic substances or protein deposits could accumulate and kill dopamine-producing nerve cells, leading to abnormal movements and balance problems.

**Dementia with Lewy bodies**

*GBA* gene mutations can increase the risk of developing dementia with Lewy bodies; however, some people with a mutation in the *GBA* gene may never develop this condition. Dementia with Lewy bodies is characterized by intellectual decline (dementia); visual hallucinations; sudden changes in attention and mood; and movement problems characteristic of Parkinson disease (described above) such as rigidity of limbs, tremors, and impaired balance and coordination.

Mutations in one copy of the *GBA* gene result in the production of an altered beta-glucocerebrosidase enzyme, although it is unclear how these mutations might lead to the formation of Lewy bodies. The abnormal enzyme may interfere with the function of lysosomes and the normal breakdown of a protein called alpha-synuclein, which increases the risk that these proteins accumulate and form Lewy bodies. Accumulation of these clusters in neurons throughout the brain impairs cell function and ultimately causes cell death. Over time, the loss of neurons increasingly impairs intellectual and motor function and the regulation of emotions, resulting in the signs and symptoms of dementia with Lewy bodies.
Chromosomal Location

Cytogenetic Location: 1q22, which is the long (q) arm of chromosome 1 at position 22

Molecular Location: base pairs 155,234,448 to 155,244,862 on chromosome 1 (Homo sapiens Annotation Release 109, GRCh38.p12) (NCBI)

Credit: Genome Decoration Page/NCBI

Other Names for This Gene

- acid beta-glucosidase
- algucerase
- beta-D-glucosyl-N-acylsphingosine glucohydrolase
- beta-glucocerebrosidase
- GBA1
- GLCM_HUMAN
- GLUC
- glucocerebrosidase
- glucocerebroside beta-glucosidase
- glucosidase, beta, acid
- glucosidase, beta; acid (includes glucosylceramidase)
- glucosphingosine glucosylhydrolase
- glucosylceramide beta-glucosidase
- imiglucerase
Additional Information & Resources

Educational Resources

• Dementia: A NICE-SCIE Guideline on Supporting People With Dementia and Their Carers in Health and Social Care (2007): Dementia
  https://www.ncbi.nlm.nih.gov/books/NBK55480/

• Dementia: A NICE-SCIE Guideline on Supporting People With Dementia and Their Carers in Health and Social Care (2007): Diagnosis and Assessment

• HuGENet Case Study: Glucocerebrosidase Gene Mutations and Parkinson’s Disease
  https://www.cdc.gov/genomics/hugenet/CaseStudy/PARKINSON/PARKview.htm

• NIH News Release: Researchers Uncover Genetic Clues to a Common Form of Age-Related Dementia (July 17, 2006)
  https://www.genome.gov/19517231/

Clinical Information from GeneReviews

• Gaucher Disease
  https://www.ncbi.nlm.nih.gov/books/NBK1269

Scientific Articles on PubMed

• PubMed
  https://www.ncbi.nlm.nih.gov/pubmed?term=%28%28GBA%5BTI%5D%29+OR+%28beta+glucosidase%5BTIAB%5D%29+OR+%28glucosylceramidase%5BTIAB%5D%29+OR+%28Glucocerebrosidase%5BTIAB%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+720+days+%22%5Bdp%5D

Catalog of Genes and Diseases from OMIM

• GLUCOSIDASE, BETA, ACID
  http://omim.org/entry/606463

Research Resources

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

• ClinVar
  https://www.ncbi.nlm.nih.gov/clinvar?term=GBA%5Bgene%5D

• HGNC Gene Family: Glycoside hydrolases
  https://www.genenames.org/cgi-bin/genefamilies/set/1650
Sources for This Summary

• Mata IF, Samii A, Schneer SH, Roberts JW, Griffith A, Leis BC, Schellenberg GD, Sidransky E, Bird
  TD, Leverenz JB, Tsuang D, Zabetian CP. Glucocerebrosidase gene mutations: a risk factor for
  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/18332251
  Free article on PubMed Central: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2826203/

• Nalls MA, Duran R, Lopez G, Kurzawa-Akanbi M, McKeith IG, Chinnery PF, Morris CM, Theuns
  Pickering-Brown S, Halliwell N, Davidson Y, Gibbons L, Harris J, Sheerin U, Bras J, Hardy J,
  Clark L, Marder K, Honig LS, Berg D, Maetzler W, Brockmann K, Gasser T, Novellino F, Quattrone
  A, Annesi G, de Marco EV, Rogaeva E, Masellis M, Black SE, Bilbao JM, Foroud T, Ghetti B,
  Trojanowski JQ, Hurtig HI, Tayebi N, Landazabal C, Knight MA, Keller M, Singleton AB, Wolfsberg
  TG, Sidransky E. A multicenter study of glucocerebrosidase mutations in dementia with Lewy
  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/23588557
  Free article on PubMed Central: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3841974/

• Orvisky E, Park JK, Parker A, Walker JM, Martin BM, Stubblefield BK, Uyama E, Tayebi N,
  Sidransky E. The identification of eight novel glucocerebrosidase (GBA) mutations in patients with
  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/11933202

• Pelled D, Trajkovic-Bodennec S, Lloyd-Evans E, Sidransky E, Schiffmann R, Futterman AH.
  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/15649698

• Sidransky E, Nalls MA, Aasly JO, Aharon-Peretz J, Annesi G, Barbosa ER, Bar-Shira A, Berg D,
  Bras J, Brice A, Chen CM, Clark LN, Condroyer C, de Marco EV, Dürre A, Eblan MJ, Fahn S, Farrer
  C, Kropp P, Lang AE, Lee-Chen GJ, Lesage S, Marder K, Mata IF, Mirelman A, Mitsui J, Mizuta
  I, Nicoletti G, Oliveira C, Ottman R, Orr-Urteger A, Pereira LV, Quattrone A, Rogaeva E, Rolfs A,
  Rosenbaum H, Rozenberg R, Samii A, Samaddar T, Schulte C, Sharma M, Singleton A, Spitz M,
  Tan EK, Tayebi N, Toda T, Troiano AR, Tsuchi S, Wittstock M, Wolfsberg TG, Wu YR, Zabetian CP,
  Zhao Y, Ziegler SG. Multicenter analysis of glucocerebrosidase mutations in Parkinson's disease. N
  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/19846850
  Free article on PubMed Central: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2856322/

• Sidransky E. Gaucher disease: complexity in a "simple" disorder. Mol Genet Metab. 2004 Sep-Oct;
  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/15464415

• Sidransky E. Heterozygosity for a Mendelian disorder as a risk factor for complex disease. Clin
  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/16965318

• Velayati A, Yu WH, Sidransky E. The role of glucocerebrosidase mutations in Parkinson disease
  s11910-010-0102-x. Review.
  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/20425034
  Free article on PubMed Central: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3529411/

Reprinted from Genetics Home Reference: