

## GEPHE SUMMARY

<p>hemoglobin; HBB-T1 and T2 paralogues (<a href="https://www.gephebase.org/search-criteria?/and+Gene+Gephebase=~hemoglobin;+HBB-T1+and+T2+paralogues^#gephebase-summary-title">https://www.gephebase.org/search-criteria?/and+Gene+Gephebase=~hemoglobin;+HBB-T1+and+T2+paralogues^#gephebase-summary-title</a>)</p> <p>Published</p>	<p>Gephebase Gene</p> <p>Entry Status</p>	<p>GP00000476</p> <p>Martin</p>	<p>GepheID</p> <p>Main curator</p>
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## PHENOTYPIC CHANGE

<p>Physiology (<a href="https://www.gephebase.org/search-criteria?/and+Trait+Category=~Physiology^#gephebase-summary-title">https://www.gephebase.org/search-criteria?/and+Trait+Category=~Physiology^#gephebase-summary-title</a>)</p> <p>Hypoxia response (<a href="https://www.gephebase.org/search-criteria?/and+Trait=~Hypoxia+response^#gephebase-summary-title">https://www.gephebase.org/search-criteria?/and+Trait=~Hypoxia+response^#gephebase-summary-title</a>)</p> <p>Peromyscus maniculatus -low elevation</p> <p>Peromyscus maniculatus - high elevation</p> <p>Taxon A</p> <p>Intraspecific (<a href="https://www.gephebase.org/search-criteria?/and+Taxonomic+Status=~Intraspecific^#gephebase-summary-title">https://www.gephebase.org/search-criteria?/and+Taxonomic+Status=~Intraspecific^#gephebase-summary-title</a>)</p>	<p>Trait Category</p> <p>Trait</p> <p>Trait State in Taxon A</p> <p>Trait State in Taxon B</p> <p>Ancestral State</p> <p>Taxonomic Status</p>	<p>Taxon A</p> <p>Peromyscus maniculatus (<a href="https://www.gephebase.org/search-criteria?/and+Taxon+and+Synonyms=~Peromyscus+maniculatus^#gephebase-summary-title">https://www.gephebase.org/search-criteria?/and+Taxon+and+Synonyms=~Peromyscus+maniculatus^#gephebase-summary-title</a>)</p> <p>North American deer mouse</p> <p>North American deer mouse; Peromyscus maniculatus (Wagner, 1845); MSB Mamm 74965; MSB:collector:Mamm:74965; Peromyscus maniculatus</p> <p>species</p> <p>cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Deuterostomia; Chordata; Craniata; Vertebrata; Gnathostomata; Teleostomi; Euteleostomi; Sarcopterygii; Dipnotetrapodomorpha; Tetrapoda; Amniota; Mammalia; Theria; Eutheria; Boreoeutheria; Euarchontoglires; Glires; Rodentia; Myomorpha; Muroidea; Cricetidae; Neotominae; Peromyscus</p> <p>Peromyscus () - (Rank: genus) (<a href="https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=10040">https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=10040</a>)</p> <p>10042 (<a href="https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=10042">https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=10042</a>)</p> <p>No</p>	<p>Latin Name</p> <p>Common Name</p> <p>Synonyms</p> <p>Rank</p> <p>Lineage</p> <p>Parent</p> <p>NCBI Taxonomy ID</p> <p>is Taxon A an Intraspecies?</p>	<p>Taxon B</p> <p>Peromyscus maniculatus (<a href="https://www.gephebase.org/search-criteria?/and+Taxon+and+Synonyms=~Peromyscus+maniculatus^#gephebase-summary-title">https://www.gephebase.org/search-criteria?/and+Taxon+and+Synonyms=~Peromyscus+maniculatus^#gephebase-summary-title</a>)</p> <p>North American deer mouse</p> <p>North American deer mouse; Peromyscus maniculatus (Wagner, 1845); MSB Mamm 74965; MSB:collector:Mamm:74965; Peromyscus maniculatus</p> <p>species</p> <p>cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Deuterostomia; Chordata; Craniata; Vertebrata; Gnathostomata; Teleostomi; Euteleostomi; Sarcopterygii; Dipnotetrapodomorpha; Tetrapoda; Amniota; Mammalia; Theria; Eutheria; Boreoeutheria; Euarchontoglires; Glires; Rodentia; Myomorpha; Muroidea; Cricetidae; Neotominae; Peromyscus</p> <p>Peromyscus () - (Rank: genus) (<a href="https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=10040">https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=10040</a>)</p> <p>10042 (<a href="https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=10042">https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=10042</a>)</p> <p>No</p>	<p>Latin Name</p> <p>Common Name</p> <p>Synonyms</p> <p>Rank</p> <p>Lineage</p> <p>Parent</p> <p>NCBI Taxonomy ID</p> <p>is Taxon B an Intraspecies?</p>
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## GENOTYPIC CHANGE

<p>HBB</p> <p>ECYT6; CD113t-C; beta-globin</p> <p>9606.ENSP00000333994 (<a href="http://string-db.org/newstring.cgi/show_network_section.pl?identifier=9606.ENSP00000333994">http://string-db.org/newstring.cgi/show_network_section.pl?identifier=9606.ENSP00000333994</a>)</p> <p>Belongs to the globin family.</p> <p>GO:0046872 : metal ion binding (<a href="https://www.ebi.ac.uk/QuickGO/term/GO:0046872">https://www.ebi.ac.uk/QuickGO/term/GO:0046872</a>)</p> <p>GO:0020037 : heme binding (<a href="https://www.ebi.ac.uk/QuickGO/term/GO:0020037">https://www.ebi.ac.uk/QuickGO/term/GO:0020037</a>)</p> <p>GO:0005344 : oxygen carrier activity (<a href="https://www.ebi.ac.uk/QuickGO/term/GO:0005344">https://www.ebi.ac.uk/QuickGO/term/GO:0005344</a>)</p> <p>GO:0043177 : organic acid binding (<a href="https://www.ebi.ac.uk/QuickGO/term/GO:0043177">https://www.ebi.ac.uk/QuickGO/term/GO:0043177</a>)</p>	<p>Generic Gene Name</p> <p>Synonyms</p> <p>String</p> <p>Sequence Similarities</p> <p>GO - Molecular Function</p>	<p>P68871 (<a href="http://www.uniprot.org/uniprot/P68871">http://www.uniprot.org/uniprot/P68871</a>)</p> <p>0</p>	<p>UniProtKB Homo sapiens</p> <p>GenebankID or UniProtKB</p>
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GO:0019825 : oxygen binding (<https://www.ebi.ac.uk/QuickGO/term/GO:0019825>)  
 GO:0031721 : hemoglobin alpha binding  
 (<https://www.ebi.ac.uk/QuickGO/term/GO:0031721>)  
 GO:0030492 : hemoglobin binding (<https://www.ebi.ac.uk/QuickGO/term/GO:0030492>)  
 GO - Biological Process

GO:0006898 : receptor-mediated endocytosis  
 (<https://www.ebi.ac.uk/QuickGO/term/GO:0006898>)  
 GO:0007596 : blood coagulation (<https://www.ebi.ac.uk/QuickGO/term/GO:0007596>)  
 GO:0008217 : regulation of blood pressure  
 (<https://www.ebi.ac.uk/QuickGO/term/GO:0008217>)  
 GO:0042542 : response to hydrogen peroxide  
 (<https://www.ebi.ac.uk/QuickGO/term/GO:0042542>)  
 GO:0043312 : neutrophil degranulation  
 (<https://www.ebi.ac.uk/QuickGO/term/GO:0043312>)  
 GO:0015701 : bicarbonate transport (<https://www.ebi.ac.uk/QuickGO/term/GO:0015701>)  
 GO:0098869 : cellular oxidant detoxification  
 (<https://www.ebi.ac.uk/QuickGO/term/GO:0098869>)  
 GO:0042744 : hydrogen peroxide catabolic process  
 (<https://www.ebi.ac.uk/QuickGO/term/GO:0042744>)  
 GO:0015671 : oxygen transport (<https://www.ebi.ac.uk/QuickGO/term/GO:0015671>)  
 GO:0010942 : positive regulation of cell death  
 (<https://www.ebi.ac.uk/QuickGO/term/GO:0010942>)  
 GO:0051291 : protein heterooligomerization  
 (<https://www.ebi.ac.uk/QuickGO/term/GO:0051291>)  
 GO:0030185 : nitric oxide transport (<https://www.ebi.ac.uk/QuickGO/term/GO:0030185>)  
 GO:0070527 : platelet aggregation (<https://www.ebi.ac.uk/QuickGO/term/GO:0070527>)  
 GO:0045429 : positive regulation of nitric oxide biosynthetic process  
 (<https://www.ebi.ac.uk/QuickGO/term/GO:0045429>)  
 GO:0050880 : regulation of blood vessel size  
 (<https://www.ebi.ac.uk/QuickGO/term/GO:0050880>)  
 GO:0070293 : renal absorption (<https://www.ebi.ac.uk/QuickGO/term/GO:0070293>)

GO - Cellular Component

GO:0005829 : cytosol (<https://www.ebi.ac.uk/QuickGO/term/GO:0005829>)  
 GO:0070062 : extracellular exosome (<https://www.ebi.ac.uk/QuickGO/term/GO:0070062>)  
 GO:0005576 : extracellular region (<https://www.ebi.ac.uk/QuickGO/term/GO:0005576>)  
 GO:0005615 : extracellular space (<https://www.ebi.ac.uk/QuickGO/term/GO:0005615>)  
 GO:0072562 : blood microparticle (<https://www.ebi.ac.uk/QuickGO/term/GO:0072562>)  
 GO:0071682 : endocytic vesicle lumen  
 (<https://www.ebi.ac.uk/QuickGO/term/GO:0071682>)  
 GO:0031838 : haptoglobin-hemoglobin complex  
 (<https://www.ebi.ac.uk/QuickGO/term/GO:0031838>)  
 GO:0005833 : hemoglobin complex (<https://www.ebi.ac.uk/QuickGO/term/GO:0005833>)  
 GO:1904813 : ficolin-1-rich granule lumen  
 (<https://www.ebi.ac.uk/QuickGO/term/GO:1904813>)  
 GO:1904724 : tertiary granule lumen (<https://www.ebi.ac.uk/QuickGO/term/GO:1904724>)

Mutation #1

No (<https://www.gephebase.org/search-criteria?/and+Presumptive Null=`No`#gephebase-summary-title>) Presumptive Null  
 Coding (<https://www.gephebase.org/search-criteria?/and+Molecular Type=`Coding`#gephebase-summary-title>) Molecular Type  
 SNP (<https://www.gephebase.org/search-criteria?/and+Aberration Type=`SNP`#gephebase-summary-title>) Aberration Type  
 Nonsynonymous SNP Coding Change  
 Ala62Gly; Gly72Ser; Ser128Ala; Ala135Ser Molecular Details of the Mutation  
 Candidate Gene (<https://www.gephebase.org/search-criteria?/and+Experimental Evidence=`Candidate Gene`#gephebase-summary-title>) Experimental Evidence

	Taxon A	Taxon B	Position
Codon	-	-	-
Amino-acid	Ala	Gly	62

Main Reference

Evolutionary and functional insights into the mechanism underlying high-altitude adaptation of deer mouse hemoglobin. (2009) (<https://pubmed.ncbi.nlm.nih.gov/19667207>)  
 Authors  
 Storz JF; Runck AM; Sabatino SJ; Kelly JK; Ferrand N; Moriyama H; Weber RE; Fago A

Abstract

Adaptive modifications of heteromeric proteins may involve genetically based changes in single subunit polypeptides or parallel changes in multiple genes that encode distinct, interacting subunits. Here we investigate these possibilities by conducting a combined evolutionary and functional analysis of duplicated globin genes in natural populations of deer mice (*Peromyscus maniculatus*) that are adapted to different elevational zones. A multilocus analysis of nucleotide polymorphism and linkage disequilibrium revealed that high-altitude adaptation of deer mouse hemoglobin involves parallel functional differentiation at multiple unlinked gene duplicates: two alpha-globin paralogs on chromosome 8 and two beta-globin paralogs on chromosome 1. Differences in O<sub>2</sub>-binding affinity of the alternative beta-chain hemoglobin isoforms were entirely attributable to allelic differences in sensitivity to 2,3-diphosphoglycerate (DPG), an allosteric cofactor that stabilizes the low-affinity, deoxygenated conformation of the hemoglobin tetramer. The two-locus beta-globin haplotype that

predominates at high altitude is associated with suppressed DPG-sensitivity (and hence, increased hemoglobin-O(2) affinity), which enhances pulmonary O(2) loading under hypoxia. The discovery that allelic differences in DPG-sensitivity contribute to adaptive variation in hemoglobin-O(2) affinity illustrates the value of integrating evolutionary analyses of sequence variation with mechanistic appraisals of protein function. Investigation into the functional significance of the deer mouse beta-globin polymorphism was motivated by the results of population genetic analyses which revealed evidence for a history of divergent selection between elevational zones. The experimental measures of O(2)-binding properties corroborated the tests of selection by demonstrating a functional difference between the products of alternative alleles.

Additional References

Epistasis among adaptive mutations in deer mouse hemoglobin. (2013) (<https://pubmed.ncbi.nlm.nih.gov/23766324>)

#### Mutation #2

No (<https://www.gephebase.org/search-criteria?/and+Presumptive Null=~No^#gephebase-summary-title>)

Presumptive Null

Coding (<https://www.gephebase.org/search-criteria?/and+Molecular Type=~Coding^#gephebase-summary-title>)

Molecular Type

SNP (<https://www.gephebase.org/search-criteria?/and+Aberration Type=~SNP^#gephebase-summary-title>)

Aberration Type

Nonsynonymous

SNP Coding Change

Ala62Gly; Gly72Ser; Ser128Ala; Ala135Ser

Molecular Details of the Mutation

Candidate Gene (<https://www.gephebase.org/search-criteria?/and+Experimental Evidence=~Candidate Gene^#gephebase-summary-title>)

Experimental Evidence

	Taxon A	Taxon B	Position
Codon	-	-	-
Amino-acid	Gly	Ser	72

Evolutionary and functional insights into the mechanism underlying high-altitude adaptation of deer mouse hemoglobin. (2009) (<https://pubmed.ncbi.nlm.nih.gov/19667207>)

Main Reference

Storz JF; Runck AM; Sabatino SJ; Kelly JK; Ferrand N; Moriyama H; Weber RE; Fago A

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Abstract

Additional References

Epistasis among adaptive mutations in deer mouse hemoglobin. (2013) (<https://pubmed.ncbi.nlm.nih.gov/23766324>)

#### Mutation #3

No (<https://www.gephebase.org/search-criteria?/and+Presumptive Null=~No^#gephebase-summary-title>)

Presumptive Null

Coding (<https://www.gephebase.org/search-criteria?/and+Molecular Type=~Coding^#gephebase-summary-title>)

Molecular Type

SNP (<https://www.gephebase.org/search-criteria?/and+Aberration Type=~SNP^#gephebase-summary-title>)

Aberration Type

Nonsynonymous

SNP Coding Change

Ala62Gly; Gly72Ser; Ser128Ala; Ala135Ser

Molecular Details of the Mutation

Candidate Gene (<https://www.gephebase.org/search-criteria?/and+Experimental Evidence=~Candidate Gene^#gephebase-summary-title>)

Experimental Evidence

	Taxon A	Taxon B	Position
Codon	-	-	-
Amino-acid	Ser	Ala	128

Evolutionary and functional insights into the mechanism underlying high-altitude adaptation of deer mouse hemoglobin. (2009) (<https://pubmed.ncbi.nlm.nih.gov/19667207>)

Main Reference

Storz JF; Runck AM; Sabatino SJ; Kelly JK; Ferrand N; Moriyama H; Weber RE; Fago A

Authors

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Additional References

Epistasis among adaptive mutations in deer mouse hemoglobin. (2013) (<https://pubmed.ncbi.nlm.nih.gov/23766324>)

Mutation #4

No (<https://www.gephebase.org/search-criteria?/and+Presumptive Null=~No^#gephebase-summary-title>)

Presumptive Null

Coding (<https://www.gephebase.org/search-criteria?/and+Molecular Type=~Coding^#gephebase-summary-title>)

Molecular Type

SNP (<https://www.gephebase.org/search-criteria?/and+Aberration Type=~SNP^#gephebase-summary-title>)

Aberration Type

Nonsynonymous

SNP Coding Change

Ala62Gly; Gly72Ser; Ser128Ala; Ala135Ser

Molecular Details of the Mutation

Candidate Gene (<https://www.gephebase.org/search-criteria?/and+Experimental Evidence=~Candidate Gene^#gephebase-summary-title>)

Experimental Evidence

	Taxon A	Taxon B	Position
Codon	-	-	-
Amino-acid	Ala	Ser	135

Main Reference

Evolutionary and functional insights into the mechanism underlying high-altitude adaptation of deer mouse hemoglobin. (2009) (<https://pubmed.ncbi.nlm.nih.gov/19667207>)

Authors

Storz JF; Runck AM; Sabatino SJ; Kelly JK; Ferrand N; Moriyama H; Weber RE; Fago A

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Additional References

Epistasis among adaptive mutations in deer mouse hemoglobin. (2013) (<https://pubmed.ncbi.nlm.nih.gov/23766324>)

RELATED GEPHE

Related Genes

2 (EPAS1, hemoglobin; HBA-T1 and T2 paralogues) (<https://www.gephebase.org/search-criteria?/or+Taxon ID=~10042^/and+Trait=Hypoxia response/and+groupHaplotypes=true#gephebase-summary-title>)

Related Haplotypes

No matches found.

EXTERNAL LINKS

## COMMENTS

Needs curation @Epistasis @SeveralMutationsWithEffect