

## GEPHE SUMMARY

ATP4A ( <a href="https://www.gephebase.org/search-criteria?/and+GeneGephebase=^ATP4A^#gephebase-summary-title">https://www.gephebase.org/search-criteria?/and+GeneGephebase=^ATP4A^#gephebase-summary-title</a> )	Gephebase Gene	GP00001920	GepheID
Published	Entry Status	Courtier	Main curator

## PHENOTYPIC CHANGE

Physiology ( <a href="https://www.gephebase.org/search-criteria?/and+TraitCategory=^Physiology^#gephebase-summary-title">https://www.gephebase.org/search-criteria?/and+TraitCategory=^Physiology^#gephebase-summary-title</a> )	Trait Category
Digestion (absence of stomach) ( <a href="https://www.gephebase.org/search-criteria?/and+Trait=^Digestion (absence of stomach)^#gephebase-summary-title">https://www.gephebase.org/search-criteria?/and+Trait=^Digestion (absence of stomach)^#gephebase-summary-title</a> )	Trait
presence of stomach and gastric acid production	Trait State in Taxon A
loss of stomach and no gastric acid production	Trait State in Taxon B
Taxon A	Ancestral State
Intergeneric or Higher ( <a href="https://www.gephebase.org/search-criteria?/and+TaxonomicStatus=^Intergeneric or Higher^#gephebase-summary-title">https://www.gephebase.org/search-criteria?/and+TaxonomicStatus=^Intergeneric or Higher^#gephebase-summary-title</a> )	Taxonomic Status

Taxon A #1	Latin Name
Gadus morhua ( <a href="https://www.gephebase.org/search-criteria?/and+Taxon and Synonyms=^Gadus morhua^#gephebase-summary-title">https://www.gephebase.org/search-criteria?/and+Taxon and Synonyms=^Gadus morhua^#gephebase-summary-title</a> )	
Atlantic cod	Common Name
Atlantic cod; Gadus morhua Linnaeus, 1758	Synonyms
species	Rank
cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Deuterostomia; Chordata; Craniata; Vertebrata; Gnathostomata; Teleostomi; Euteleostomi; Actinopterygii; Actinopteri; Neopterygii; Teleostei; Osteoglossocephalai; Clupecocephala; Euteleostomorpha; Neoteleostei; Eurypterygia; Ctenosquamata; Acanthomorphata; Paracanthomorphacea; Zeiogadaria; Gadariae; Gadiformes; Gadoidei; Gadidae; Gadus	Lineage
Gadus () - (Rank: genus) ( <a href="https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=8048">https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=8048</a> )	Parent
8049 ( <a href="https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=8049">https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=8049</a> )	NCBI Taxonomy ID
No	is Taxon A an Intraspecies?

Taxon B	Latin Name
Danio rerio ( <a href="https://www.gephebase.org/search-criteria?/and+Taxon and Synonyms=^Danio rerio^#gephebase-summary-title">https://www.gephebase.org/search-criteria?/and+Taxon and Synonyms=^Danio rerio^#gephebase-summary-title</a> )	
zebrafish	Common Name
Brachydanio rerio; Brachydanio rerio frankei; Cyprinus rerio; Danio frankei; Danio rerio frankei; zebrafish; leopard danio; zebra danio; zebra fish; Cyprinus rerio Hamilton, 1822; Danio rerio (Hamilton, 1822); Brachidanio rerio	Synonyms
species	Rank
cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Deuterostomia; Chordata; Craniata; Vertebrata; Gnathostomata; Teleostomi; Euteleostomi; Actinopterygii; Actinopteri; Neopterygii; Teleostei; Osteoglossocephalai; Clupecocephala; Otomorpha; Ostariophysii; Otophysi; Cypriniphysae; Cypriniformes; Cyprinoidei; Cyprinidae; Danio	Lineage
Danio () - (Rank: genus) ( <a href="https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=7954">https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=7954</a> )	Parent
7955 ( <a href="https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=7955">https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=7955</a> )	NCBI Taxonomy ID
No	is Taxon B an Intraspecies?

Taxon A #2	Latin Name
Gasterosteus aculeatus ( <a href="https://www.gephebase.org/search-criteria?/and+Taxon and Synonyms=^Gasterosteus aculeatus^#gephebase-summary-title">https://www.gephebase.org/search-criteria?/and+Taxon and Synonyms=^Gasterosteus aculeatus^#gephebase-summary-title</a> )	
three-spined stickleback	Common Name
three-spined stickleback; three spined stickleback; Gasterosteus aculeatus Linnaeus, 1758	Synonyms
species	Rank
cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Deuterostomia; Chordata; Craniata; Vertebrata; Gnathostomata; Teleostomi; Euteleostomi; Actinopterygii; Actinopteri; Neopterygii; Teleostei; Osteoglossocephalai; Clupecocephala; Euteleostomorpha; Neoteleostei; Eurypterygia; Ctenosquamata; Acanthomorphata; Euacanthomorphacea; Percormorphaceae; Eupercaria; Perciformes; Cottioidi; Gasterosteales;	Lineage

Gasterosteidae; Gasterosteus

Parent

Gasterosteus () - (Rank: genus)

(<https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=69292>)

NCBI Taxonomy ID

69293

(<https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=69293>)

is Taxon A an Intraspecies?

No

### Taxon A #3

Latin Name

Oreochromis niloticus

(<https://www.gephebase.org/search-criteria?/and+Taxon and>

Synonyms=^Oreochromis niloticus^#gephebase-summary-title)

Common Name

Nile tilapia

Synonyms

Oreochromis nilotica; Tilapia nilotica; Nile tilapia; Oreochromis niloticus (Linnaeus, 1758)

Rank

species

Lineage

cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Deuterostomia; Chordata; Craniata; Vertebrata; Gnathostomata; Teleostomi; Euteleostomi; Actinopterygii; Actinopteri; Neopterygii; Teleostei; Osteoglossocephalai; Clupecocephala; Euteleostei; Neoteleostei; Eurypterygia; Ctenosquamata; Acanthomorphata; Euacanthomorphacea; Percormorphaceae; Ovalentaria; Cichlomorphae; Cichliformes; Cichlidae; African cichlids; Pseudocrenilabrinae; Oreochromini; Oreochromis

Parent

Oreochromis () - (Rank: genus)

(<https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=8139>)

NCBI Taxonomy ID

8128

(<https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=8128>)

is Taxon A an Intraspecies?

No

## GENOTYPIC CHANGE

ATP4A	Generic Gene Name	P20648 ( <a href="http://www.uniprot.org/uniprot/P20648">http://www.uniprot.org/uniprot/P20648</a> )	UniProtKB Homo sapiens
ATP6A	Synonyms	()	GenebankID or UniProtKB
9606.ENSPO0000262623	String		
( <a href="http://string-db.org/newstring.cgi/show_network_section.pl?identifier=9606.ENSPO0000262623">http://string-db.org/newstring.cgi/show_network_section.pl?identifier=9606.ENSPO0000262623</a> )			
	Sequence Similarities		
Belongs to the cation transport ATPase (P-type) (TC 3.A.3) family. Type IIC subfamily.			
	GO - Molecular Function		
GO:0005524 : ATP binding ( <a href="https://www.ebi.ac.uk/QuickGO/term/GO:0005524">https://www.ebi.ac.uk/QuickGO/term/GO:0005524</a> )			
GO:0000287 : magnesium ion binding ( <a href="https://www.ebi.ac.uk/QuickGO/term/GO:0000287">https://www.ebi.ac.uk/QuickGO/term/GO:0000287</a> )			
GO:0005391 : sodium:potassium-exchanging ATPase activity ( <a href="https://www.ebi.ac.uk/QuickGO/term/GO:0005391">https://www.ebi.ac.uk/QuickGO/term/GO:0005391</a> )			
GO:0008900 : potassium:proton exchanging ATPase activity ( <a href="https://www.ebi.ac.uk/QuickGO/term/GO:0008900">https://www.ebi.ac.uk/QuickGO/term/GO:0008900</a> )			
	GO - Biological Process		
GO:0034220 : ion transmembrane transport ( <a href="https://www.ebi.ac.uk/QuickGO/term/GO:0034220">https://www.ebi.ac.uk/QuickGO/term/GO:0034220</a> )			
GO:0015991 : ATP hydrolysis coupled proton transport ( <a href="https://www.ebi.ac.uk/QuickGO/term/GO:0015991">https://www.ebi.ac.uk/QuickGO/term/GO:0015991</a> )			
GO:0030007 : cellular potassium ion homeostasis ( <a href="https://www.ebi.ac.uk/QuickGO/term/GO:0030007">https://www.ebi.ac.uk/QuickGO/term/GO:0030007</a> )			
GO:0006883 : cellular sodium ion homeostasis ( <a href="https://www.ebi.ac.uk/QuickGO/term/GO:0006883">https://www.ebi.ac.uk/QuickGO/term/GO:0006883</a> )			
GO:1990573 : potassium ion import across plasma membrane ( <a href="https://www.ebi.ac.uk/QuickGO/term/GO:1990573">https://www.ebi.ac.uk/QuickGO/term/GO:1990573</a> )			
GO:0036376 : sodium ion export across plasma membrane			

(<https://www.ebi.ac.uk/QuickGO/term/GO:0036376>)

GO - Cellular Component

GO:0005886 : plasma membrane (<https://www.ebi.ac.uk/QuickGO/term/GO:0005886>)

GO:0005887 : integral component of plasma membrane

(<https://www.ebi.ac.uk/QuickGO/term/GO:0005887>)

GO:0005615 : extracellular space (<https://www.ebi.ac.uk/QuickGO/term/GO:0005615>)

Presumptive Null

Yes ([https://www.gephebase.org/search-criteria?/and+Presumptive Null=^Yes^#gephebase-summary-title](https://www.gephebase.org/search-criteria?/and+Presumptive+Null=^Yes^#gephebase-summary-title))

Molecular Type

Gene Loss ([https://www.gephebase.org/search-criteria?/and+Molecular Type=^Gene Loss^#gephebase-summary-title](https://www.gephebase.org/search-criteria?/and+Molecular+Type=^Gene+Loss^#gephebase-summary-title))

Aberration Type

Deletion ([https://www.gephebase.org/search-criteria?/and+Aberration Type=^Deletion^#gephebase-summary-title](https://www.gephebase.org/search-criteria?/and+Aberration+Type=^Deletion^#gephebase-summary-title))

Deletion Size

-

Molecular Details of the Mutation

Absence of the gene in the genome sequence - high synteny

Experimental Evidence

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

Main Reference

Recurrent gene loss correlates with the evolution of stomach phenotypes in gnathostome history. (2014) (<https://pubmed.ncbi.nlm.nih.gov/24307675>)

Authors

Castro LF; Gonçálves O; Mazan S; Tay BH; Venkatesh B; Wilson JM

Abstract

The stomach, a hallmark of gnathostome evolution, represents a unique anatomical innovation characterized by the presence of acid- and pepsin-secreting glands. However, the occurrence of these glands in gnathostome species is not universal; in the nineteenth century the French zoologist Cuvier first noted that some teleosts lacked a stomach. Strikingly, Holocephali (chimaeras), dipnoids (lungfish) and monotremes (egg-laying mammals) also lack acid secretion and a gastric cellular phenotype. Here, we test the hypothesis that loss of the gastric phenotype is correlated with the loss of key gastric genes. We investigated species from all the main gnathostome lineages and show the specific contribution of gene loss to the widespread distribution of the agastric condition. We establish that the stomach loss correlates with the persistent and complete absence of the gastric function gene *kit-H(+)/K(+)-ATPase* (*Atp4A* and *Atp4B*) and pepsinogens (*Pga*, *Pgc*, *Cym*)--in the analysed species. We also find that in gastric species the pepsinogen gene complement varies significantly (e.g. two to four in teleosts and tens in some mammals) with multiple events of pseudogenization identified in various lineages. We propose that relaxation of purifying selection in pepsinogen genes and possibly proton pump genes in response to dietary changes led to the numerous independent events of stomach loss in gnathostome history. Significantly, the absence of the gastric genes predicts that reinvention of the stomach in agastric lineages would be highly improbable, in line with Dollo's principle.

Additional References

## RELATED GEPHE

Related Genes

4 (*ATP4B*, *pepsinogen A1*, *pepsinogen A2*, *pepsinogen A3*) ([https://www.gephebase.org/search-criteria?/or+Taxon ID=^8049^/and+Trait=Digestion/or+Taxon ID=^69293^/and+Trait=Digestion/or+Taxon ID=^8128^/and+Trait=Digestion/or+Taxon ID=^7955^/and+Trait=Digestion/and+groupHaplotypes=true#gephebase-summary-title](https://www.gephebase.org/search-criteria?/or+Taxon+ID=^8049^/and+Trait=Digestion/or+Taxon+ID=^69293^/and+Trait=Digestion/or+Taxon+ID=^8128^/and+Trait=Digestion/or+Taxon+ID=^7955^/and+Trait=Digestion/and+groupHaplotypes=true#gephebase-summary-title))

Related Haplotypes

No matches found.

## EXTERNAL LINKS

## COMMENTS