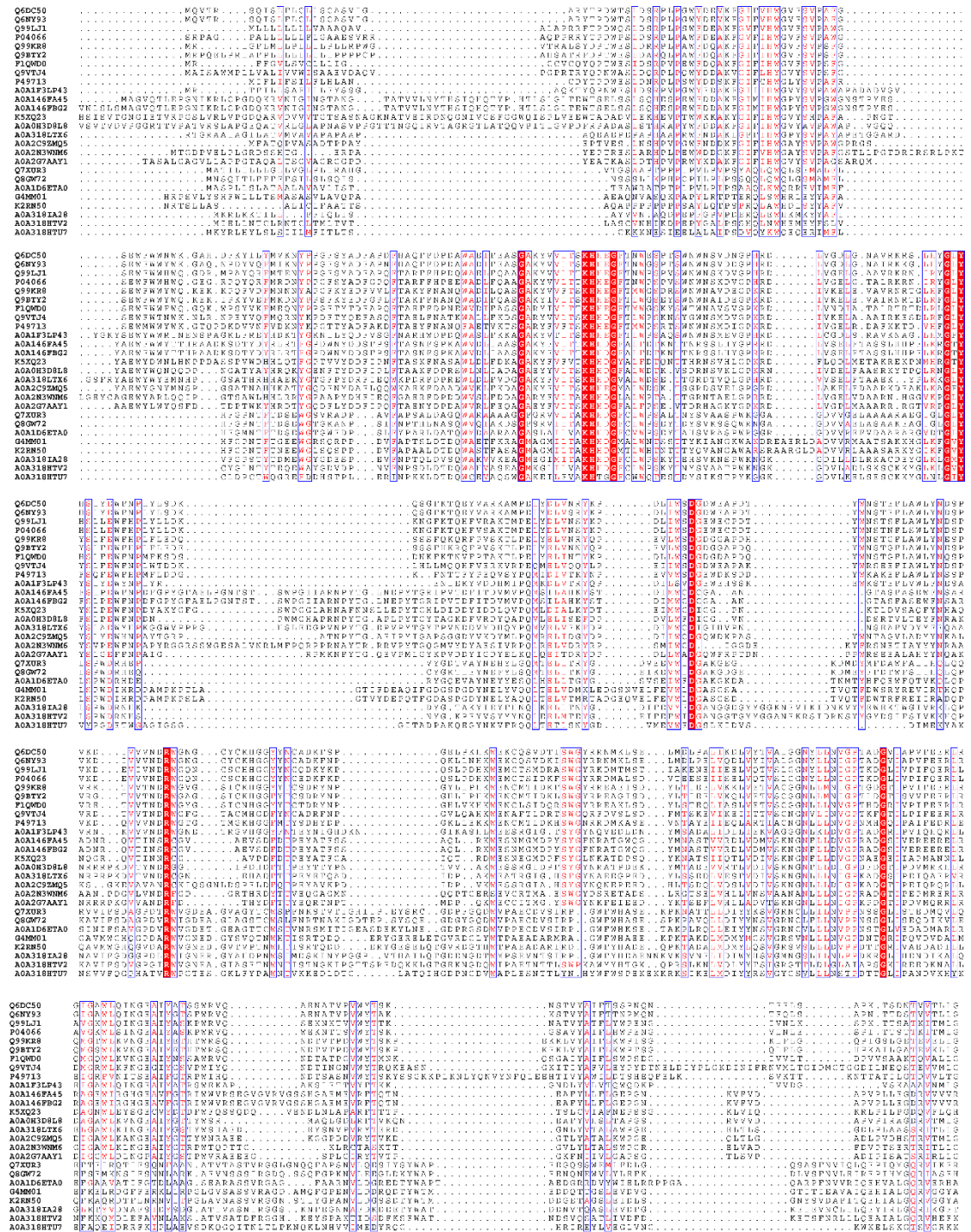


# Supplementary Figure 1



Supplementary Figure 1. Multiple sequence alignment of the  $\alpha$ -L-fucosidase homologs in the three subfamilies. The sequences are corresponding in Figure 3.

## Supplementary Figure 2

### A

sp Q9BTY2 FUCO2_HUMAN	M R P Q E L P R L A F P L L L L L L L L
	ATG CGG CCC CAG GAG CTC CCC AGG CTC GCG TTC CCG TTG CTG CTG TTG CTG TTG CTG CTG
sp Q99KR8 FUCO2_MOUSE	- - - - - M R L G F L M L L P L L L L
	--- --- --- --- --- ATG CGC TTG GGG TTC CTG ATG CTT CTG CCG CTG CTG CTG CTG
sp Q9BTY2 FUCO2_HUMAN	L P P P P C P A H S A T R F D P T W E S
	CTG CCG CCG CCG CCG TGC CCT GCC CAC AGC GCC ACG CGC TTC GAC CCC ACC TGG GAG TCC
sp Q99KR8 FUCO2_MOUSE	P L L R P W G V T R A L S Y D P T W E S
	CCG CTC CTG AGG CCT TGG GGG GTC ACG AGA GCC CTT AGC TAT GAC CCC ACT TGG GAA TCT
sp Q9BTY2 FUCO2_HUMAN	L D A R Q L P A W F D Q A K F G I F I H
	CTG GAC GCC CGC CAG CTG CCC GCG TGG TTT GAC CAG GCC AAG TTC GGC ATC TTC ATC CAC
sp Q99KR8 FUCO2_MOUSE	L D R R P L P A W F D Q A K F G I F I H
	CTG GAC AGA CGC CCG CTG CCA GCC TGG TTC GAC CAG GCC AAG TTC GGC ATC TTT ATC CAC
sp Q9BTY2 FUCO2_HUMAN	W G V F S V P S F G S E W F W W Y W Q K
	TGG GGA GTG TTT TCC GTG CCC AGC TTC GGT AGC GAG TGG TTC TGG TGG TAT TGG CAA AAG
sp Q99KR8 FUCO2_MOUSE	W G V F S V P S F G S E W F W W Y W Q K
	TGG GGA GTG TTC TCC GTG CCC AGC TTT GGT AGT GAA TGG TTC TGG TGG TAT TGG CAA AAG
sp Q9BTY2 FUCO2_HUMAN	E K I P K Y V E F M K D N Y P P S F K Y
	GAA AAG ATA CCG AAG TAT GTG GAA TTT ATG AAA GAT AAT TAC CCT CCT AGT TTC AAA TAT
sp Q99KR8 FUCO2_MOUSE	E K K P Q F V D F M N N N Y A P G F K Y
	GAG AAG AAA CCC CAG TTT GTG GAC TTT ATG AAC AAT AAT TAT GCT CCT GGT TTT AAG TAT
sp Q9BTY2 FUCO2_HUMAN	E D F G P L F T A K F F N A N Q W A D I
	GAA GAT TTT GGA CCA CTA TTT ACA GCA AAA TTT TTT AAT GCC AAC CAG TGG GCA GAT ATT
sp Q99KR8 FUCO2_MOUSE	E D F V V L F T A K Y F N A N Q W A D I
	GAA GAT TTT GTA GTG CTA TTT ACA GCC AAG TAT TTT AAT GCA AAC CAG TGG GCA GAT ATT
sp Q9BTY2 FUCO2_HUMAN	F Q A S G A K Y I V L T S K H H E G F T
	TTT CAG GCC TCT GGT GCC AAA TAC ATT GTC TTA ACT TCC AAA CAT CAT GAA GGC TTT ACC
sp Q99KR8 FUCO2_MOUSE	L Q A S G A K Y V V F T S K H H E G F T
	CTC CAG GCC TCT GGT GCC AAA TAT GTG GTC TTC ACT TCT AAA CAT CAC GAA GGC TTT ACA
sp Q9BTY2 FUCO2_HUMAN	L W G S E Y S W N W N A I D E G P K R D
	TTG TGG GGG TCA GAA TAT TCG TGG AAC TGG AAT GCC ATA GAT GAG GGG CCC AAG AGG GAC
sp Q99KR8 FUCO2_MOUSE	M W G S D R S W N W N A V D E G P K R D
	ATG TGG GGC TCA GAC CGT TCT TGG AAC TGG AAT GCA GTC GAT GAG GGG CCA AAG AGG GAC
sp Q9BTY2 FUCO2_HUMAN	I V K E L E V A T R N R T D L R F G L Y
	ATT GTC AAG GAA CTT GAG GTA GCC ATT AGG AAC AGA ACT GAC CTG CGT TTT GGA CTG TAC
sp Q99KR8 FUCO2_MOUSE	I V K E L E V A V R N R T G L H F G L Y
	ATT GTC AAG GAG CTT GAG GTG GCT GTG AGG AAC AGG ACT GGC TTG CAC TTT GGT CTG TAC
sp Q9BTY2 FUCO2_HUMAN	Y S L F E W F H P L F L E D E S S S F H
	TAT TCC CTT TTT GAA TGG TTT CAT CCG CTC TTC CTT GAG GAT GAA TCC AGT TCA TTC CAT
sp Q99KR8 FUCO2_MOUSE	Y S L F E W F H P L F L E D Q S S S F Q
	TAT TCT CTT TTT GAA TGG TTC CAT CCG CTC TTT CTG GAG GAT CAG TCC AGC TCA TTC CAA
sp Q9BTY2 FUCO2_HUMAN	K R Q F P V S K T L P E L Y E L V N N Y
	AAG CGG CAA TTT CCA GTT TCT AAG ACA TTG CCA GAG CTC TAT GAG TTA GTG AAC AAC TAT
sp Q99KR8 FUCO2_MOUSE	K Q R F P V S K T L P E L Y E L V N R Y
	AAG CAG CGA TTT CCC GTT TCT AAG ACA TTG CCI GAG CTC TAT GAG TTG GIG AAC AGA TAC
sp Q9BTY2 FUCO2_HUMAN	Q P E V L W S D G D G G A P D Q Y W N S
	CAG CCT GAG GTT CTG TGG TCG GAT GGT GAC GGA GGA GCA CCG GAT CAA TAC TGG AAC AGC
sp Q99KR8 FUCO2_MOUSE	Q P E V I W S D G D G G A P D H Y W N S
	CAG CCT GAA GTC CTG TGG TCA GAC GGA GAT GGG GGC GCG CCA GAT CAC TAC TGG AAC AGC

# B

A0A146FBG2 ACA CTG GAG CCC GGA AAC ATC AAG CGA CTC TGC CCC GGC GAC CAA AAA CGC GTC AAC ATT  
T L E P G N I K R L C P G D Q K R V N I  
A0A146FA45 ACA CTG GAG CCC GGA AAC ATC AAG CGA CTC TGC CCC GGC GAC CAA AAA CGC GTC AAC ATT

G I N G T A N G T A T V V L N Y T H S I  
A0A146FBG2 GGC ATC AAT GGT ACA GCC AAC GGA ACA GCA ACC GTC GTC CTG AAC TAC ACC CAC TCC ATC  
G I N G T A N G T A T V V L N Y T H S I  
A0A146FA45 GGC ATC AAT GGT ACA GCC AAC GGA ACA GCA ACC GTC GTC CTG AAC TAC ACC CAC TCC ATC

Q H Q T Y P H T L S L G L T E W T S E L  
A0A146FBG2 CAG CAT CAA ACC TAC CCT CAC ACC CTC TCC CTC GGC CTA ACA GAA TGG ACC TCG GAG CTA  
Q H Q T Y P H T L S L G L T E W T S E L  
A0A146FA45 CAG CAT CAA ACC TAC CCT CAC ACC CTC TCC CTC GGC CTA ACA GAA TGG ACC TCG GAG CTA

S S L S Q H E S P E W F D D A K F G I M  
A0A146FBG2 TCC AGC CTC TCG CAA CAC GAA AGC CCC GAA TGG TTC GAC GAC GCC AAA TTC GGC ATC ATG  
S S L S Q H E S P E W F D D A K F G I M  
A0A146FA45 TCC AGC CTC TCG CAA CAC GAA AGC CCC GAA TGG TTC GAC GAC GCC AAA TTC GGC ATC ATG

I H W G P Y S V P G W G N S T P Y E S Y  
A0A146FBG2 ATC CAC TGG GGT CCT TAC TCC GTC CCC GGC TGG GGC AAC TCG ACA CCC TAT GAA AGC TAC  
I H W G P Y S V P G W G N S T P Y E S Y  
A0A146FA45 ATC CAC TGG GGT CCT TAC TCC GTC CCC GGC TGG GGC AAC TCG ACA CCC TAT GAA AGC TAC

A E W F W W Y T T H R A A D K S D T Y D  
A0A146FBG2 GCC GAG TGG TTC TGG TGG TAC ACC ACG CAC CGC GCC GCC GAC AAA TCC GAC ACC TAC GAC  
A E W F W W Y T T H R A A D K S D T Y D  
A0A146FA45 GCC GAG TGG TTC TGG TGG TAC ACC ACG CAC CGC GCC GCC GAC AAA TCC GAC ACC TAC GAC

Y R L R T F G P D W N Y D D S F P S F T  
A0A146FBG2 TAC CGA CTC CGC ACC TTC GGC CCT GAC TGG AAC TAC GAC GAC TCG TTC CCC TCC TTC ACG  
Y R L R T F G P D W N Y D D S F P S F T  
A0A146FA45 TAC CGA CTC CGC ACC TTC GGC CCT GAC TGG AAC TAC GAC GAC TCG TTC CCC TCC TTC ACG

A S N F S P K A W V D L I A A S G A K Y  
A0A146FBG2 GCC TCC AAT TTC TCC CCC AAA GCC TGG GTG GAC CTA ATC GCG GCC TCC GGC GCC AAA TAC  
A S N F S P K A W V D L I A A S G A K Y  
A0A146FA45 GCC TCC AAT TTC TCC CCC AAA GCC TGG GTG GAC CTA ATC GCG GCC TCC GGC GCC AAA TAC

F V L T T K H H D G F A L F D T K N T T  
A0A146FBG2 TTC GTA CTA ACA ACA AAA CAC CAC GAC GGC TTC GCG CTC TTC GAC ACC AAA AAC ACC ACG  
F V L T T K H H D G F A L F D T K N T T  
A0A146FA45 TTC GTA CTA ACA ACA AAA CAC CAC GAC GGC TTC GCG CTC TTC GAC ACC AAA AAC ACC ACG

N R S S L H Y G P R R D L V S E L F T A  
A0A146FBG2 AAC CGC TCC TCC CTC CAC TAC GGC CCC CGC CGA GAC CTC GTG TCG GAA CTC TTC ACC GCA  
N R S S L H Y G P R R D L V S E L F T A  
A0A146FA45 AAC CGC TCC TCC CTC CAC TAC GGC CCC CGC CGA GAC CTC GTG TCG GAA CTC TTC ACC GCA

S S L H H P F L K R G T Y F S L P E W F  
A0A146FBG2 TCC TCC CTC CAC CAC CCC TTC CTA AAA CGC GGC ACC TAC TTC TCC CTC CCC GAA TGG TTC  
S S L H H P F L K R G T Y F S L P E W F  
A0A146FA45 TCC TCC CTC CAC CAC CCC TTC CTA AAA CGC GGC ACC TAC TTC TCC CTC CCC GAA TGG TTC

N P D F G P Y G F A E L P G N T S T S W  
A0A146FBG2 AAT CCA GAC TTC GGG CCC TAC GGG TTC GCC GAA CTA CCC GGT AAC ACC TCA ACG AGC TGG  
N P D F G P Y G F A E L P G N T S T S W  
A0A146FA45 AAT CCA GAC TTC GGG CCC TAC GGG TTC GCC GAA CTA CCC GGT AAC ACC TCA ACG AGC TGG

P G I I A R N P Y T G L N E P Y T G R I  
A0A146FBG2 CCG GGC ATC ATC GCG CGC AAC CCC TAC ACG GGC CTC AAC GAG CCC TAC ACG GGC CGC ATC  
P G I I A R N P Y T G L N E P Y T G R I  
A0A146FA45 CCG GGC ATC ATC GCG CGC AAC CCC TAC ACG GGC CTC AAC GAG CCC TAC ACG GGC CGC ATC

P V T D F I T D V M V P Q M S I L A H K  
A0A146FBG2 CCG GTC ACC GAC TTC ATC ACC GAC GTA ATG GTG CCC CAA ATG AGC ATC CTC GCA CAC AAG  
P V T D F I T D V M V P Q M S I L A H K  
A0A146FA45 CCG GTC ACC GAC TTC ATC ACC GAC GTA ATG GTG CCC CAA ATG AGC ATC CTC GCA CAC AAG

# C

Q7XUR3 M A T I L L L L L G L L V G L P L L R A  
 ATG GCG ACC ATT CTT CTT CTT CTT GGG TTG CTT GTC GGC CTC CCC CTC CTC CGC GCC  
 Q8GW72 M N S Q I T L F F F F F S I L S L S Q I  
 ATG AAC TCT CAA ATC ACT CTT TTC TTC TTC TTC TCA ATC CTC TCC CTC TCC CAA ATC  
  
 Q7XUR3 H G V T G S A A P T P P P L P V L P V P  
 CAT GGC GTC ACC GGC TCC GCG GCC CCG ACG CCG CCT CTG CCG GTC CTC CCC GTC CCC  
 Q8GW72 S - - N S S S L L K P H P C P I L P L P  
 TCA --- --- AAT TCA TCA TCA CTA CTA AAA CCA CAC CCA TGT CCA ATT TTA CCC CTC CCA  
  
 Q7XUR3 S Y A Q L Q W Q L S E M A I F L H F G P  
 TCC TAC GCG CAG CTC CAG TGG CAG CTC TCC GAG ATG GCC CTC TTC CTC CAC TTC GGC CCC  
 Q8GW72 S S Q Q L Q W Q L G S M A M F L H F G P  
 TCC TCC CAA CAG CTC CAA TGG CAA CTC GGA TCC ATG GCC ATG TTC CTC CAT TTT GGA CCC  
  
 Q7XUR3 N T F T D S E W G S V R A D P A V F A P  
 AAC ACC TTC ACG GAT TCC GAG TGG GGC TCC GTC CGC GCC GAC CCG GCC GTG TTC GCG CCC  
 Q8GW72 N T F T D S E W G T G K A N P S I F N P  
 AAC ACT TTC ACC GAC TCC GAA TGG GGC ACC GGA AAA GCT AAC CCA TCC ATT TTC AAC CCG  
  
 Q7XUR3 S A L D A G Q W A R A A A A G G F G R V  
 TCC GCG CTC GAC GCG GGC CAG TGG GCG CGC GCG GCG GCG GGA GGG TTC GGG CGC GTC  
 Q8GW72 T H L N A S Q W V Q I A K D S G F S R V  
 ACC CAT CTC AAC GCA AGT CAA TGG GTC CAA ATC GCT AAA GAC TCA GCG TTT TCC CGC GTT  
  
 Q7XUR3 V L T A K H H D G F C L W P S A L T N Y  
 GTG CTC ACG GCC AAG CAC CAC GAC GGC TTC TGC CTC TGG CCC TCG GCC CTG ACG AAC TAC  
 Q8GW72 I L T A K H H D G F C L W P S E Y T D Y  
 ATC CTC ACA GCT AAG CAC CAT GAT GGA TTC TGT CTC TGG CCT AGC GAA TAC ACT GAT TAC  
  
 Q7XUR3 S V A A S P W K G G A G D V V G E L A A  
 TCG GTG GCC GCC TCT CCG TGG AAG GGC GGC GCC GGC GAC GTC GTC GGC GAG CTC GCC GCC  
 Q8GW72 S V K S S Q W R N G A G D V V A E L A S  
 TCC GTC AAA TCT AGC CAA TGG AGA AAC GGA GCC GGC GAT GTA GTG GCT GAA CTA GCT TCT  
  
 Q7XUR3 A A R A E G I G L G L Y L S P W D R H E  
 GCC GCG CGC GCC GAA GGT ATC GGG CTG GGG CTG TAC CTC TCG CCG TGG GAC CGG CAC GAG  
 Q8GW72 A A K E A G I G L G L Y L S P W D R H E  
 GCG GCA AAG GAA GCT GGA ATT GGA CTT GGT CTT TAC CTT TCT CCA TGG GAT CGA CAT GAA  
  
 Q7XUR3 P V Y G D T V A Y N E H Y L G Q M T E L  
 CCG GTG TAC GGC GAC ACC GTC GCG TAC AAC GAG CAC TAC TTG GGC CAG ATG ACG GAA TTG  
 Q8GW72 Q C Y G K T L E Y N E F Y L S Q M T E L  
 CAG TGT TAT GGC AAG ACA TTG GAG TAT AAC GAG TTC TAT CTG AGT CAA ATG ACC GAG TTA  
  
 Q7XUR3 L T R Y G D V E E V W L D G A K G E G -  
 CTC ACC AGG TAT GGA GAT GTG GAC GAA GTT TGG CTT GAT GGT GCA AAG GGA GAG GGC ---  
 Q8GW72 L T K Y G E I K E V W L D G A K G D G E  
 CTA ACA AAG TAT GGA GAG ATT AAG GAA GTT TGG TTA GAT GGA GCT AAA GGA GAC GGA GAG  
  
 Q7XUR3 K D M D Y M F D A W F A L I H Q I Q Q R  
 AAG GAC ATG GAT TAC ATG TTT GAT GCC TGG TTT GCA CTT ATC CAT CAG CTC CAG CAA AGG  
 Q8GW72 K D M E Y F F D T W F S I I H Q I Q P K  
 AAA GAT ATG GAA TAT TTC TTT GAT ACT TGG TTT AGT TTG ATC CAT CAG CTT CAG CCT AAA  
  
 Q7XUR3 V V I F S D A G P D T R W V G D E A G V  
 GTT GTC ATC TTC TCA GAT GCT GGA CCA GAT ACA AGA TGG GTA GGA GAT GAG GCA GGG GTC  
 Q8GW72 A V I F S D A G P D V R W I G D E A G L  
 GCT GTT ATA TTC TCT GAC GCT GGT CCT GAT GTC AGG TGG ATT GGT GAT GAA GCT GGT CTA  
  
 Q7XUR3 A G Y T C W S P F N K S T V T I G H I I  
 GCA GGT TAT ACT TGC TGG TCT CCT TTC AAT AAG AGC ACG GTG ACG ATT GGG CAC ATC ATT  
 Q8GW72 A G S T C W S L F N R T N A K I G D T E  
 GCT GGC TCT ACT TGC TGG TCA CTC TTT AAC AGA ACC AAT GCA AAG ATT GGT GAC ACT GAG  
  
 P E Y S R C G D P F G Q D W V P A E C D

**Supplementary Figure 2. codon alignment used for estimating selection pressure.**  
 The sequences are from metazoans (A), fungi (B), and plants (C).