

type II

type I

type IV

FAP3

FAP2

FAP1

Outgroup

MsCHI	
GmCHI4	
GmCHI11	
GmCHI10	
SmCHI3	
SmCHI5	
CrCHI7	
PaCHI5	
TaCHI16	
PaCHI2	
PaCHI1	
CqCHI5	
ZmCHI1	
ZmCHI6	
OsCHI3	
TaCHI11	
TaCHI9	
TaCHI7	
AtCHI6	
AtCHI7	
GmCHI12	
BoCHI7	
BoCHI5	
AtCHI3	
BoCHI6	
BoCHI4	
CqCHI2	
CqCHI3	
SlCHI2	
SlCHI3	
CsCHI4	
PtCHI3	
AtCHI5	
ZmCHI4	
ZmCHI9	
SmCHI7	
SmCHI1	
CrCHI2	
PpCHI2	
PpCHI7	
PaCHI4	
CqCHI7	
TaCHI6	
TaCHI10	
TaCHI8	
ZmCHI3	
OsCHI6	
OsCHI7	
BoCHI9	
GmCHI2	
GmCHI3	
CsCHI3	
PtCHI6	
SlCHI4	
PpCHI1	
PaCHI7	
AtCHI1	
CrCHI3	
SmCHI2	
SmCHI8	
PpCHI3	
CrCHI8	
TaCHI3	
TaCHI2	
TaCHI1	
ZmCHI7	
OsCHI1	
PaCHI8	
GmCHI5	
GmCHI7	
SlCHI6	
BoCHI3	
CqCHI4	
PtCHI4	
AtCHI2	
CrCHI4	
SmCHI6	
SmCHI4	
PpCHI6	
CrCHI6	
CrCHI1	
ZmCHI5	MLGVGTAAAVLLGAVALVLADAAARRAHWWYREAAEVVLVGGVALVVVDAAARRAHGWYREAAARLPPGEMGWPLVGGMWAFLRAFKFGRTRTG VYQGFMFSSLTVLMTTAEACKQVLMDEDAFVIG
ZmCHI8	MLGVGTAAAVLLGAVALVLADAAARRAHWWYREAAEVVLVGGVALVVVDAAARRAHGWYREAAARLPPGEMGWPLVGGMWAFLRAFKFGRTRTG VYQGFMFSSLTVLMTTAEACKQVLMDEDAFVIG
OsCHI2	
TaCHI2	
TaCHI14	
TaCHI13	
TaCHI15	
TaCHI17	
TaCHI18	
OsCHI4	
ZmCHI10	
CqCHI1	
BoCHI2	
GmCHI6	
GmCHI8	
SlCHI7	
CsCHI2	
PtCHI2	
PtCHI5	
AtCHI4	
PpCHI5	
CrCHI5	
CsCHI5	
SlCHI1	
CrCHI3	
BoCHI8	
BoCHI1	
CqCHI6	
PtCHI1	
ZmCHI2	
OsCHI5	
TaCHI4	
TaCHI5	
SlCHI5	
CsCHI1	
GmCHI1	
GmCHI9	
PpCHI4	
PaCHI3	
PaCHI6	
CrCHI1	
CrCHI2	

type II	MsCHI	
	GmCHI4	
	GmCHI11	
	GmCHI10	
	SmCHI3	
	SmCHI5	
	CriCHI7	
	PaCHI5	
	TaCHI16	
	PaCHI2	
type I	PaCHI1	MDVEGVAFSATVTVP
	CqCHI5	MDVEGVAFSATVTVP
	ZmCHI1	MDVEGVAFSATVTVP
	ZmCHI6	MDVEGVAFSATVTVP
	OsCHI3	MDVEGVAFSATVTVP
	TaCHI11	MDVEGVAFSATVTVP
	TaCHI7	MDVEGVAFSATVTVP
	TaCHI9	MDVEGVAFSATVTVP
	AtCHI6	MDVEGVAFSATVTVP
	AtCHI7	MDVEGVAFSATVTVP
	GmCHI12	
	BoCHI7	
	BoCHI5	
	AtCHI3	
	BoCHI6	
	BoCHI4	
	CqCHI2	
	CqCHI3	
	SlCHI2	
	SlCHI3	
	CsCHI4	
	PtCHI3	
	AtCHI5	
	ZmCHI4	
	ZmCHI9	
	SmCHI7	
	SmCHI1	
	CriCHI2	
	PpCHI2	
	PpCHI7	
type IV	PaCHI4	
	CqCHI7	
	TaCHI6	
	TaCHI10	
	TaCHI8	
	ZmCHI3	
	OsCHI6	
	OsCHI7	
	BoCHI9	
	GmCHI2	
	GmCHI3	
	CsCHI3	
	PtCHI6	
	SlCHI4	
	PpCHI1	
	PaCHI7	
	AtCHI1	
	CrCHI3	
	SmCHI2	
	SmCHI8	
FAP3	PpCHI3	
	CriCHI8	
	TaCHI3	
	TaCHI2	
	TaCHI1	
	ZmCHI7	
	OsCHI1	
	PaCHI8	
	GmCHI5	
	GmCHI7	
	SlCHI6	
	BoCHI3	
	CqCHI4	
	PtCHI4	
	AtCHI2	
	CriCHI4	
	SmCHI6	
	SmCHI4	
	PpCHI6	
	CriCHI6	
	CriCHI1	
	ZmCHI5	WPKATVALVGRS
	ZmCHI8	WPKATVALVGRS
	OsCHI2	WPKATVALVGRS
	TaCHI12	WPKATVALVGRS
	TaCHI14	WPKATVALVGRS
	TaCHI13	WPKATVALVGRS
	TaCHI15	WPKATVALVGRS
	TaCHI17	WPKATVALVGRS
	TaCHI18	WPKATVALVGRS
FAP2	OsCHI4	
	ZmCHI10	
	CqCHI1	
	BoCHI2	
	GmCHI6	
	GmCHI8	
	SlCHI7	
	CsCHI2	
	PtCHI2	
	PtCHI5	
	AtCHI4	
	PpCHI5	
	CriCHI5	
	CsCHI5	
	SlCHI1	
	CriCHI3	
	BoCHI8	
	BoCHI1	
	CqCHI6	
	PtCHI1	
FAP1	ZmCHI2	
	OsCHI5	
	TaCHI4	
	TaCHI5	
	SlCHI5	
	CsCHI1	
	GmCHI1	
	GmCHI9	
	PpCHI4	
	PaCHI3	
Outgroup	PaCHI6	
	CrCHI1	
	CrCHI2	MSEPEGVGMP

type II

type I

type IV

FAP3

FAP2

FAP1

Outgroup

MsCHI	.....
GmCHI4	.....
GmCHI11	.....
GmCHI10	.....
SmCHI3	.....
SmCHI5	.....
CriCHI7	.....MSFSFTMTWACGCK.....
PaCHI5	.....
TaCHI16	.....
PaCHI2	.....
PaCHI1	PHLALKWKDSTAEELGNRVDFYMDIITCPYEKFTRVTLILPLSGAQYSEKVSSEGCKAAWEAAAGIYGEEAEAKAIEQFKDIPQDQNFPPGSSIMFTTSPTRLVIAFSKDGSIPEKAAAVIENRIMAEGV
CqCHI5	.....
ZmCHI3	.....
ZmCHI6	.....
OsCHI3	.....
TaCHI11	.....
TaCHI7	.....
TaCHI9	.....
AtCHI6	.....
AtCHI7	.....
GmCHI12	.....
BoCHI7	.....
BoCHI5	.....
AtCHI3	.....
BoCHI6	.....MSSSNACAS.....
BoCHI4	.....
CqCHI2	.....
CqCHI3	.....
SlCHI2	.....
SlCHI3	.....
CsCHI4	.....
PtCHI3	.....
AtCHI5	.....
ZmCHI4	.....
ZmCHI9	.....
SmCHI7	.....
SmCHI1	.....
CriCHI2	.....
PpCHI2	.....
PpCHI7	.....
PaCHI4	.....MNKQNTDQPNNVWSKPCHPNRRGSSSTTTTYPFFNCYSVLSSALFNKSHSSSPLFIHIIRALPRIQ
CqCHI7	.....
TaCHI6	.....
TaCHI10	.....
TaCHI8	.....
ZmCHI3	.....
OsCHI6	.....
OsCHI7	.....
BoCHI9	.....
GmCHI2	.....
GmCHI3	.....
CsCHI3	.....
PtCHI6	.....
SlCHI4	.....
PpCHI1	.....
PaCHI7	.....
AtCHI1	.....MDGILAAVPSAVCVSLRISCRNLDNAESIYHFPFGKSLNRVSVLQTGNVY
CriCHI3	.....
SmCHI2	.....
SmCHI8	.....
PpCHI8	.....MHYCHYYLGLSIWVLIELHLELGFSVNDRSYLDDLHFSLAMALLSCLRAVCSQISISISLSSSVVAASK
CriCHI8	.....
TaCHI3	.....MSSSLQSVSIQGLTGG
TaCHI2	.....MVVRSPPSKRCAGAAAMMVASVVPSPLAGPALARPGRTRILL
TaCHI1	.....MMVPSVVPAPLAGPALARPVTRTLPPCDLPAGPSLQASAGCRVARGGARR
ZmCHI2	.....MMVASVVPSPALARPVTRTLPPCDLPAGPSLQASAGCRVARGGARR
OsCHI1	.....
PaCHI1	.....MSAVPVVSSALAGPAVAVAVARPASGGSVTRLRAPAPHGVAGSVPLASGLA
GmCHI5	.....
GmCHI7	.....MLGAVAAASTSLCFSPSTYSTRIVVLLRRISNSTLALNNGHSFLLLSAKPMHFFSSSHKSSRRQPHFL
SlCHI6	.....MLGAVAAASTSLYFSPSTNSTRIVVLLKRISNSTLPPSNDHSFLLSATPMHFFSSSHKSSRRQPHFL
BoCHI1	.....MAAGAGISVWLSTSTPTKITAFNSTIPRICYPLKLSRNGIYPL
CqCHI4	.....MDGVVLTSPVYVVICGLSLRSVCLNRVWAGSYHSPNVSVLRTVNCVSSLSHHPKQSSFL
PtCHI4	.....
AtCHI2	.....MAMSMCSTQAWNILHHFPLKSPNHPVSLPPYKTHSDFSPSLSTIPLHNNN
CriCHI4	.....LFSQLHIPGSLAFEPFSCISKFTGALLCWFSHGNLQKEVSKH.....QWGLTCKSRDLSLKHVFEHRNVSVFPFHVSKDISPGFFGNISKSTIQHFVNEAERLHSCSLLSLAAAMI
SmCHI4	.....
SlCHI4	.....MPPFEDMSPKVLPNLTESIEIDGL
PpCHI6	HLSDVSPLSILSSNSISPVPEKLVILGNGVAAVLHAAGAFLLRLLRSRDGDRGSRRRFIKSEKLTLDLKAVNYYTLIRDISPGIITISLCTRGVLSSSFPFSQISSVLEGGWSKLLCYDAAPIVLAAAL
CriCHI6	.....
CriCHI1	.....SKPIKGEFPGGAWKLALRSTIAVLPTTYIVKSSSRSETTIGKEDLNGTNSQRSPASAGLADSTGAYLSS.....SYSQHLRHLRLECLLMQATFLCSPAASALAAVVM
ZmCHI5	RHI..CATGSGTVQEAFCCLNKFABEAFYFWFSRASNPVKLFQRL.SA...AAGSSSRVCRSHIKOVASCLQHLPGLQFG...SOLRKDHAVQMLLARLASATTFGRLWT.EVEEHACNIMLMAA..AATVV
ZmCHI8	RHI..CATGSGAVQEAFCFNKFAAGAFYFWFSRASNPVKLFQRLSAA...AGSSSRACRSHIKOVTSCLQHLPGLQFG...SOLREDHAVQVLLARLASATTFGRLWTEVEERHACNIMLMAA..ATVI
OsCHI2	RHI..CSTGNGAVQEAFCFNKFAAGAFYFWFSRASNPVKILHRL.SA...AGSSSRACQSHIKOVTSCLQHLPGLQFG...SOLREDHAVQVLLARLASATTFGRLWTEVEERHACNIMLMAA..AATVV
TaCHI12	RHL..SSAGSGAVQEAFCSPFNKVAGAFYFCLSRASNPVKILHRL.SA...VAGSGSRACRAHIKOVTSQVQHLAGL.....QVREEHAIQMLLAKLANATLGRVNN.EVEERHACNIMLMAA..ASVI
TaCHI14	RHA..CSTGSGAVQEAFCFNKVAGAFYFCLSRASNPVKILHRL.SA...IAGSGSRACRAHIKOVTSQVQHLAGL.....QVREEHAIQMLLAKLANATLGRAWN.EVEERHACNIMLMAA..ASVI
TaCHI13	RHV..CSTGSGAVQEAFCFNKVAGAFYFCLSRATNPVKILHRL.....SATIAGSGSRACRAQIKOVTSQVQHLAGL.....QVREEHAIQMLLAKLANATLGRAWN.EVEERHACNIMLMAA..ASVI
TaCHI15	REI..CSSGNVKAQEAFCICLRKFARAFFFWFSRAYDPKSPHGF.....SHIKRVTSQVQNLVSGQFASLKEGHAVQVLLARLAQATVGRMWN.DIEQOHASNLLTMAGFAAIV
TaCHI11	REI..CFSGNVKAQEAFCICLRKFARAFFFWFSRAYDPKSPHGF.....SHIKRVTSQVQNLVSGQFASLKEGHAVQVLLARLAQATVGRMWN.DIEQOHASNLLTMAGFAAIV
TaCHI18	REI..CSSGNVKAQEAFCICLRKFARAFFFWFSRAYDPKSPHGF.....SHIKRVTSQVQNLVSGQFASLKEGHAVQVLLARLAQATVGRMWN.DIEQOHASNLLTMAGFAAIV
OsCHI4	RQI..CSSGNLIVQEAFDRLNKFARAFACYVLSRVSNPKNLRL.....MSMEGSPSSGACQSHINHLSRRMQNLAVLQFGYLVREEHAVQVLLANFASATTLGRLWN.DFOQOHACNVLLTAGAMAIV
ZmCHI10	.....MKPNOLITSHVDIHRFSFPMREEQAVQLILARLASATIGRLN...EQORACNLLTAGAVAIV
CqCHI1	KYL..LAPASVALTEAFTCFSKFAGSIVLFFS..GSSQIQTKF..NSDSNLPKPSN...SFGQSKHNAPSTKPYRRLPVTVSCFRFPFHESFAALFGHKFSAFSLRHLFLRAAADVVKFPVLSLA..AALI
BoCHI2	KRSLHLVPGSLALEAFSCITKFTGAMLCWNNNNNNLQ.....KMEISNYQLRSLSSGDDSSQQRVVKSCYHPNFSLFRIHYGSKDLIPALFBSKSTIQHFVNEAERLHSCSVLSLAVSLMSV
SlCHI5	.....TNSRSPALAEAFGHVSREFAGALLFWLSRASNNLARS.LRG.SPPLRFGS...VOVKA..YSTNVVFGPFPFG...SKWK..SSFSVRLGKISLAMRMWR.EAKRLSFPVLSLA..VAIV
GmCHI8	.....NNRSPALAEAFGHVSREFAGALLFWLSRASNNLARS.LRG.SPPLRFGS...VOVKA..YSTNVVFGPFPFG...LKKK..SPFASVRLGKISLAMRMWR.EAKRLSFPVLSLA..VAIV
CqCHI6	RNL..YVPGSQALQEAFCFKCFSKYAGALLVVFATVTNNSRGNNQI..SGGYRSSRNRTRSGMSIQTOETSSRHYPFMEFLWO...SRCKGKIIPVPIFRRISKFTVMQMYK.EAKHLQSPVLSLA..AALV
SlCHI7	SHLSSIPGSLAI..EGFNHHTAKLAGAILFVLVSSGSSVNI..REI..SGSPHGSKTRSCTSFSQVKHITSSRQNFKKFCFS...FRSQGDSRMPVPIFGKISSFPVSKLVPR.EAERLQSPVLSLA..AALV
CsCHI2	GFL..HVPETMAFQEAALNHVSKLAGGLIFWFTSASSSNLSRQI..SGNQSRSPRPGSCKSPAQVKNSTSTRHDLAGLQFG...SISKGESSHPVVFPSKIISNFVMRLLR.EAERLQSPVLSLA..AALI
PtCHI5	RFL..HVPETMAFQEAALNHVSKLAGGLIFWFTSASSSNLSRQI..SGNQISPTPGSCRSSAQVKNSTSTRCDLQAGLQFG...FVSKVSSPPVVSSTISSFVMRLLLG.EAERLQSPVLSLA..ASIV
AtCHI4	.....MVSFRFPFSPSQPPRATTSFSGFSISAVAVSVTVGAAAGAATAASRNPSHPILLEWAFSSHRSL
PpCHI5	.....MAMASRNMGILLAIL
CriCHI5	.....MAWRVUNGLATPLATLAAIQOQSYTVLLE
CsCHI5	.....MAT
SlCHI1	.....MPTTMDVTAKIDAVEIDSQSVVVALKEKAIIEGVKTTTETQEKITNEAKSN
CriCHI3	.....MAASFYSYFFGNVFANAPLWKKVSVGAGVAAASGMVAEEIYNRQNGFSAIASLSLDEFAFSGFMHNSL
BoCHI8	.....MVRRGGHVGNSSSSSTSSSLNHIKGVCLSVLMRECNERTKTKTNTSHLPNTRMLRSLASRFLSPLSPNHR
BoCHI1	.....MVSFRFPFSPSQPSLPKPPRATSSSSSFSVSAVAVTLTVGAAAVAAASRNPHITLDWVFSHRSSL
CqCHI6	.....MGSIRFPFSSFPFPFPNPKPSATSLRLLLAAGASIAAGACAGIAITQNSDKHIPILQNTDLFLLH
PtCHI1	.....MVSIRFPFPLFSQPKKHNGPISRTITSRSPFATTTTACALAGAAGAFAGIAATRNSKNPKQDNPFQ
ZmCHI2	.....MVSIRFPPTAAIPRLPPSQAPNGVAIAATAVAAAAAANAASLTLTGKSTGRPVPHPA
OsCHI5	.....MVSIRFPATFPRLPPPPPPPSRPAFAAALAAAAA
TaCHI4	.....MVSIRFPATFPRLPPPPPPPSRPAFAAALAAAAA
TaCHI5	.....MVSIRFPATFPRLPPPPPPPSRPAFAAALAAAAA
SlCHI5	.....MASIRFPFPLFPQPHKTPSSATSDAPSRSPSTVAVAVASGGSGALAAAGAITAITQSPKNPFLENANLILSNF
CsCHI1	.....MVSIRFPFSPSQSSTSTLPSPNSPFPFRASTLAVTVAAATAAVATIAATAAASASTKDTGATPNPKHPF
GmCHI1	.....MSSMLRFPFSPFLQOPRQOPRPFPTAFAAAAAVSSSDRSFLRNALNSFFSVNPSM
GmCHI9	.....MSSMLRFPFSPFPQRRKQFPFPPTAFAAAAVAGASAAVAVVSSSDRSFLRNALNSFFSDLSM
PpCHI4	.....MNAVPPSPSSSSSFPFTGVTSFVKNGGVPQRWRAAGAGAGVGLGALTTPV
PaCHI3	.....MASSILPLPLNPNSPQIPRHSSSTPTSSSTSSSIRCLAVTLGVGIGVGLVAPHLAKQRNWWAQSLRDV
PaCHI6	.....
CriCHI1	.....MVGFTETRDGFAIPTGNAGQSDSLKPFENKFWASARAAPM
CriCHI2	GQFTLGRRRRGPLKRFYKIALKTFTFGLAGRGGRGGAVGARRRRGRGARGPPLASLSAAILEPADVDLDDGYGPSTGQPLALTTTGVPGMSVTLTPAGVASFPFLATLPVPHDSEVPGLVEHSHIR

type II

type I

type IV

FAP3

FAP2

FAP1

Outgroup

		1	10	20	30
MsCH1	.....	..M...AASITAITVENL	EVFA.VV	..TSPVTGK	..SYFLGGA
GmCH14	.....	..MAT..PASITNVTVEFI	QFFA.VV	..TPPASTK	..SYFLGGA
GmCH111	.....	..MAT..PASITNVTVEFI	QFFA.LV	..TPPGSTK	..SYFLGGA
GmCH110	.....	..MAT..MATISAVQVEFI	EVFA.VV	..TSPASGK	..TYFLGGA
SmCH13	.....	..MAP..ELLKQGLVIEG	TFPP.GL	..TSPVSQK	..SLFLGGA
SmCH15	.....	..MAP..ELLKQGLVIEG	TFPP.GL	..TSPVSQK	..SLFLGGA
Cr1CH17	.....	..QIDFGSLGSL	TFFA.SI	..TLTGSTT	..ELILGGA
PaCH15	.....	..MFI..		..	..RPSLAIN
TaCH116	.....MED	..TTF..PAGITDMEVGRV	VVFGA.SA	..TPPHSSK	..ILFLGGA
PaCH12	AFSELVFCFCFKSSXS	NLSAVAAM	..SSA..VASVVSMEVEG	VVTFSP.TV	..TPRTSSK
PaCH11	LASIIGKSGSVSPPAK	ASIAIDRVSKLYPFELD	..HCF..ATVLNGVELEG	IAFFPP.TV	..RPPGGTK
CqCH15	.....	..MAVPEVVVDG	VVFFP.VA	..RPPGSAG	..SHFLGGA
ZmCH11	.....	..MAVPEVVVDG	VVFFP.VA	..RPPGSAG	..SHFLGGA
ZmCH16	.....	..MAVPEVVVDG	VVFFP.VA	..RPPGSAG	..SHFLGGA
OsCH13	.....	..MAVSEVVDG	VVFFP.VA	..RPPGSAGH	..AHFLGGA
TaCH111	.....	..MAVSEVVDG	VVFFP.VA	..RPPGSAGH	..AHFLGGA
TaCH17	.....	..MAVSEVVDG	VVFFP.VA	..RPPGSAGH	..AHFLGGA
TaCH19	.....	..MAVSEVVDG	VVFFP.VA	..RPPGSAGH	..AHFLGGA
AtCH16	.....	..MP..LPSTPLHVDAT	TFPP.AV	..ESFASHK	..RLFLGGA
AtCH17	.....	.....	.....	.....	.....
GmCH112	.....	..MAMA..FPSVTSVTIVEN	VTFPP.TV	..KPPCSFN	..TFFLAGA
BoCH17	..MFDQIIISSGV	..QSP..LPSVTNLQVDS	VNFPP.SV	..ISPASSN	..RLFLGGA
BoCH15	.....MFSSGS	..QLO..LPSVTNLQVDS	VNFPP.SV	..ISPASSN	..PLFLGGA
AtCH13	.....	..PSP..FPAVTKLHVD	TFPP.SV	..KSPASSN	..PLFLGGA
BoCH16	.....	..PSP..LPTVTKLQVDS	VTFPP.SV	..ISPASSN	..PLFLGGA
BoCH14	.....MSSSHC	..PTP..LPSVTKLQVDS	VTFPP.SV	..ISPASSN	..PLFLGGA
CqCH12	.....	..MGT..STGVSEVKVED	VVFFA.TV	..KAPGSDN	..SFFLAGAG
CqCH13	.....	..MAT..STPVTTEVKVED	VVFFP.TV	..KAPGSDK	..SFFLAGAG
SlCH12	.....	..MACVTKLQVENN	VVFFPSKV	..KPPSSNN	..TFFLAGA
SlCH13	.....	..MNLS..PLTSSGQIEA	AKFFP.AV	..KPPGLDK	..TLFLGGA
CsCH14	.....	..MSP..AVPLSEIQIEN	VTFPP.AV	..KPPASNN	..TLFLGGA
PtCH13	.....	..MGT..MGTEMVMVHE	VVFFP.OI	..I..T.SK	..PLSLLGQ
AtCH15	.....	..MSPLHPPPRDA	TFPPS.AI	..PPPSRRIPSS	..PPPLSAL
ZmCH14	.....	..MSPLHPPPRDA	TFPPS.AI	..PPPSRRIPSS	..PPPLSAL
ZmCH19	.....	..MEMD..TFQA..SI		..QSPSSSE	..TLILLGH
SmCH17	.....	..MGSECVVFE	GGSSFFM.AV	..SPPASSK	..TLVLLGN
Cr1CH12	.....	..MGLQVNVNEG	DDFAT.KF	..APPTSTT	..ELDILGH
PpCH12	.....	..MGSPQVVKVED	DDFAT.KF	..TPPTGST	..ELDLIGY
PaCH14	QYPPIRPISSVLT	YICSLASSSI	..DRP..KMASEVVMYDE	TFPPK.SI	..APTASK
CqCH17	.....	..GSEQE..KKAATAVE	EGTFPPR.EI	..A..G.AK	..ALSLVGH
TaCH16	.....	..GSEQE..KKAATAVE	EGTFPPR.EI	..A..G.AK	..ALSLVGH
TaCH110	.....	..GSEQE..KKAATAVE	EGTFPPR.EI	..A..G.AK	..ALSLVGH
TaCH18	.....	..GSEQE..KKAATAVE	EGTFPPR.EI	..A..G.AK	..ALSLVGH
ZmCH13	.....	..TETVNVNEG	TFPPA.EI	..T..V.GN	..TSLVLGT
OsCH16	.....	..GTEIATVE	VEGTFPP.OI	..TVSK	..PLSLLAN
OsCH17	.....	..MGTEIVMHE	VVFFP.OI	..I..T.SK	..PLSLLGH
BoCH19	.....	..MATEEVLD	VEITTFPS.KI	..TTTK	..PLSLLGH
GmCH12	.....	..MATEEVLD	VEITTFPS.KI	..TTTK	..PLSLLGH
GmCH13	.....	..MANNMVMVHE	VTFPP.TE	..KTTK	..PLSLLGY
PtCH16	.....	..MVNVDE	TFPPF.EI	..QIAIATK	..PLSLLGH
SlCH14	.....	..VKNSEVMYDE	TFPPF.OI	..M.VN.NK	..PLFMGH
PpCH11	.....	..MGSPQVNVNEG	DDFAT.KF	.....	.....
PaCH17	.....	..IAP..WKDSWSVPEKA	IAV.VI	..ENRILAE	..PLVLGT
AtCH11	SRKGNLSLLKNRHC	GEISRVIKSAASS	..VGN..AEDYAEETATS	VKKFRR.SV	..TLFGCSS
CrCH13	CPPAALRSRPA	AVSRGACQPV	..ASLTVRKDAQSG	VEYD.LA	..QKFWQGE
SmCH12	.....	.....	.....	.....	..FAGA
SmCH18	.....	..AVG..ADNVVTEPAT	SKFFAL.LL	..TVPDSN	..TLTFLGA
PpCH13	PASRTNATKCGS	ARLQSSLVAGSQL	.....GTSSILSVTAKSKVSVNKLGVRA	.....	..MLL
Cr1CH18	VQPLLGLLSSRP	QVQPCYRINTSVPHLSAYQVPSKQIV	..ITC..SEKVKVERTN	VSFT.SL	..EAPGGST
PtCH12	PPCDLPAGSS	LQASAGCRIA	RGGARRPQHSFAAGG	..GAE..GDAFVVEGATN	VKKFRR.EL
TaCH12	PQHISFAAGGG	AA	.....	..GDAFVVEGATN	VKKFRR.EL
TaCH11	PQHISFAAGGG	AA	.....	..GDAFVVEGATN	VKKFRR.EL
AtCH17	.....MLGW	.....	.....	..GTV..GDAFVIED	TNTNKKFPR.EI
OsCH11	NCYRRSAAAA	ARRLP	IPPSAAGG	.....	..AVPGYTE
PaCH18	.....	.....	.....	..MPYRATVSYKH	GLLLT.RI
GmCH15	AQAAAASSG	MLALSWKMMNNADWGINF	.....KAVV..NAEYVEEP	ATNKKFOT.SL	..SFPGCSN
GmCH17	AQAASSAA	.....	.....NAEYVEEP	ATNKKFOT.SL	..SFPGCSN
SlCH16	STFERNGQ	VEQNLTIKAAASS	.....SVG..SAEYTEPAT	NKKFOT.SL	..SFPGCSN
BoCH13	RKNRCVATS	RIVVKAAASSVGN	.....A..NAEYAE	EATNKKFOT.SL	..SFPGCSN
CqCH14	.....	.....	.....A..NAEYAE	EATNKKFOT.SL	..SFPGCSN
PtCH14	STPTHLSPK	ASSSSSSSSSSSF	.....SVG..SAEYTE	EATNKKFOT.SL	..SFPGCSN
AtCH12	PSLNVM	SANGALALPLGSDNDVKLR	ENIEHRTCPENTEHR	TCQVGC	EYSGSL
Cr1CH14	DEKEDLLE	QVSAMRVQDY	.....TFS..TESFVIE	PKTGKFFTYLE	PVGYKDRLDGGSL
SmCH16	.....	.....	.....	.....	..MOVLCGV
SmCH14	.....	.....	.....	.....	..MOVLCGV
PpCH16	PFSSSLAFQ	YGQDAPGV	DNC	DGALFGLP	.....SCN..SQAVV
Cr1CH16	.....	.....	.....	.....	..MDM..SENVSEPT
Cr1CH11	PSLENIP	SKMLSNQLDKAGNV	MGNK	.....EDFP	EEKVATVDIPHMSKHTFDK
ZmCH15	PFENN	.....	.....	.....	..RVL..LPEDTE
ZmCH18	PFENISPK	MLAASMAIRKDR	NIETP	.....	..RVL..LPEDTE
PpCH12	PFENISPK	MLADSM	TLGRDNGRTEP	.....	..RVL..LPEDTE
TaCH112	PFENISPK	MLADSM	TLGRDNGRTEP	.....	..RVL..LPEDTE
TaCH114	PFENISPK	MLADSM	TLGRDNGRTEP	.....	..RVL..LPEDTE
TaCH11	PFENISPK	MLADSM	TLGRDNGRTEP	.....	..RVL..LPEDTE
TaCH115	PFENISPK	MLAELITFG	NVDGYNMP	.....	..TTI..FQEDAVE
TaCH117	PFENISPK	MLAELMV	FNGVDGYNMP	.....	..TTI..FQEDAVE
AtCH18	PFENISPK	MLAELMA	FNGVDGYNMP	.....	..TTI..FQEDAVE
OsCH14	PLENISL	SKTLAESMALGN	IKRDYVSRPMDKPYLEDK	CIKRSRV	.....AVPSTI
PtCH110	PLENISS	MLAESITSRN	IDS	DIRRL	.....STI..FQEDPI
CqCH11	PLDHF	TPSM	LITIPPEDAD	TQVLASM	.....EFK..WLRD
BoCH12	NGLGLSLG	SDDDVQVSSNNV	EHRS	CQVGRNGL	.....SPFKLD
GmCH16	PPQNLS	SNVLASPL	LLNP	DVOIFGAM	.....ELS..QARPA
GmCH18	PPQNLS	SNVLASPL	LLNP	DVOIFGAM	.....ELS..QARPA
SlCH17	PPENFA	.....	.....	.....	..NLN..WSRHAVE
CsCH12	PLDNL	ISSKVLTA	PL	ENDVVMV	.....DLN..WRRHVE
PtCH12	PPFGN	LSKLLAIP	GENDDVP	VHAST	.....DLN..WRRHVE
PtCH15	PPFDNL	ASKVLAIP	LE	NDVQVHAST	.....DLN..WRRHVE
AtCH14	SWG	SITL	.....	.....	..SNA..YENK
PpCH15	PLLSN	SHDAVLSH	.....	.....	..SNA..YENK
Cr1CH15	P	.....	.....	.....	..SNA..YENK
CsCH15	SDGSS	NAAT	..K	.....	..SNA..YENK
SlCH11	PEKES	NGATFKEE	.....	.....	..SNA..YENK
Cr1CH13	PNRSV	IPFACLSPL	.....	.....	..SNA..YENK
BoCH18	PRRHL	SVSAVA	VT	VGGAAIVA	.....SRN..SVSP
BoCH11	LMWGS	ITL	.....	.....	..SRN..SVSP
CqCH16	LPFT	PNAPF	WGCL	SLSSDV	.....ADS..SSES
PtCH11	NALN	LLFSNHLLAP	WASLSLAD	.....	..ADS..SSES
ZmCH12	PLWAS	LSL	.....	.....	..ADS..SSES
OsCH15	AAAAS	LT	LAKS	AGRPPLP	.....HPA..PLWAS
TaCH15	SLWAS	LSL	..ADS	.....	..HPA..PLWAS
TaCH15	PLWAS	LSL	LAES	.....	..HPA..PLWAS
SlCH15	SPNKN	HSSPLWGS	SVS	.....	..LAD..NSAP
CsCH11	LQEA	NL	FFPANRSLPLWGS	LSL	.....LAN..SADP
GmCH11	PLLG	SL	SLAD	.....	..LAN..SADP
GmCH19	PLWGS	LSL	AD	.....	..LAN..SADP
PpCH14	APHKLA	AAREL	WRGLSS	WKCDVSRFASIA	.....WAE..PVE
PaCH13	CAQRK	RAPS	YFWG	PLIACLSLAT	.....EVSQ
PaCH16	.....	.....	.....	.....	..MO
CrCH11	TFPAS	LSAS	ILGGLG	.....	..KPG..SAGGR
CrCH12	SLHYHGHAEHL	AHNNQ	QNLSQLWNR	ARQPHHAHAQPHQTSHHQATQLCTCGGA	.....STG..MDCS

type II

type I

type IV

FAP3

FAP2

FAP1

Outgroup

		110	120		130	140
MsCHI	GPEYSRK	..VMEN	GAH	ILKSVGTG	..DAE	..AEAMOKFAEAKPV
GmCHI4	GREYVRK	..VSEN	CAH	MSVSGTYS	..EAE	..EKATEEERNNAFKDQ
GmCHI11	GREYVRK	..VSEN	CAH	MSVSGTYS	..DEE	..EKATEEERNNAFKDQ
GmCHI10	GAEYSKK	..VMEN	CAH	MSVSGTYS	..DAE	..AAATEEERNAFAKNV
SmCHI3	GTFDSKK	..VMEN	KQV	LAESNSLG	..EDE	..EKATEEERNNAFKDQ
SmCHI5	GTGFSKK	..VMEN	KQV	LAESNSLG	..EDE	..EKATEEERNNAFKDQ
CrCHI7	GPQYSEK	..VVER	IGL	IENSGVKE	..KVE	..ESKLELEIFKTE
PaCHI5	.....	..AEG	CAW	ETAGIYG	..KVE	..AVATEE...FKDQN
TaCHI16	GQEYSDK	..VTEN	VNI	WKSSEHY	..VDE	..GHGSAAATSEILKGIYPA
PaCHI2	GVEFCRK	..VSEN	CAH	ESAGIYS	..EAE	..EKATEEERNNAFKDQ
PaCHI1	GIOYTEK	..VTEG	CAW	EAGIYG	..KAE	..AAATEEERNAFAKNV
CqCHI5	GQYVSNK	..LTEN	CAW	KATGIYT	..DEE	..EKATEEERNNAFKDQ
ZmCHI1	GEQYAEK	..VTEN	CAW	KAAAGLYT	..DAE	..GVAVEKFRVFKPE
ZmCHI6	GEQYAGK	..VAEN	CAW	KAAAGLYT	..DAE	..GVAVEKFRVFKPE
OsCHI3	GEQYSDK	..VTEN	CAW	KAAAGLYT	..DAE	..GVAVEKFRVFKPE
TaCHI11	GAQYSDK	..VTEN	CAW	KATGIYT	..DAE	..AAATEEERNAFAKNV
TaCHI7	GAQYSDK	..VTEN	CAW	KAAAGLYT	..DAE	..AAATEEERNAFAKNV
TaCHI9	GAQYSDK	..VTEN	CAW	KATGIYT	..DAE	..AAATEEERNAFAKNV
AtCHI6	GIOYSEK	..VVEN	EEI	MKASGKYT	..RSE	..AKADDOFLMVFKNQ
AtCHI7	GIOYSEK	..VVEN	EEI	MKASGKYT	..RSE	..AKADDOFLMVFKNQ
GmCHI12	GQOYSEK	..VAEN	CAW	WKSIGIYT	..DSE	..AKADDOFLMVFKNQ
BoCHI7	GQOYSEK	..VTEN	CAW	WKSIGIYT	..DSE	..AKADDOFLMVFKNQ
BoCHI5	GQYVSNK	..LTEN	CAW	KATGIYT	..DEE	..EKATEEERNNAFKDQ
AtCHI3	GQOYSEK	..VTEN	CAW	KATGIYT	..DSE	..AKADDOFLMVFKNQ
BoCHI6	GQOYSEK	..VTEN	CAW	KATGIYT	..DSE	..AKADDOFLMVFKNQ
BoCHI4	GQOYSEK	..VTEN	CAW	KATGIYT	..DSE	..AKADDOFLMVFKNQ
CqCHI2	.....	..	CAW	KATGIYT	..DSE	..AKADDOFLMVFKNQ
CqCHI3	GQOYSEK	..VTEN	CAW	KATGIYT	..DSE	..AKADDOFLMVFKNQ
SlCHI2	GKQYSEK	..VAEN	CAW	KATGIYT	..DSE	..AKADDOFLMVFKNQ
SlCHI3	GKQYSEK	..VAEN	CAW	KATGIYT	..DSE	..AKADDOFLMVFKNQ
CsCHI4	GKQYSEK	..VAEN	CAW	KATGIYT	..DSE	..AKADDOFLMVFKNQ
PtCHI3	GLOYSEK	..VAEN	CAW	KATGIYT	..DSE	..AKADDOFLMVFKNQ
AtCHI5	GAQYGVQ	..LENT	RDR	LAEDDKYE	..EEE	..EATEEERNAFAKNV
ZmCHI4	GESLWNEKNLFTGCC	..VDP	ELTPKGV	EEAIEAGKRICNIPIDVIYTSSLIHAQMTAMLAMMOHRHKKVCFVFPFKFYGELGQNLNKOETVDRFRGKEQVHEWRRSYDIPPPNGESLEBKAKRAVAYFKDQV	..DAE	..EKATEEERNNAFKDQ
ZmCHI9	GESLWNEKNLFTGCC	..VDP	ELTPKGV	EEAIEAGKRICNIPIDVIYTSSLIHAQMTAMLAMMOHRHKKVCFVFPFKFYGELGQNLNKOETVDRFRGKEQVHEWRRSYDIPPPNGESLEBKAKRAVAYFKDQV	..DAE	..EKATEEERNNAFKDQ
SmCHI7	GSQYAST	..IETS	RDR	LAYDDKYE	..EDE	..EATEEERNAFAKNV
SmCHI1	GSQYAST	..IETS	RDR	LAYDDKYE	..EDE	..EATEEERNAFAKNV
CrCHI12	GSQFVTP	..LQST	RDR	LAYADLYE	..DEE	..EATEEERNAFAKNV
PpCHI2	GLPYGSA	..LQSS	RDR	LVNDDKFE	..DEE	..EATEEERNAFAKNV
PpCHI7	GLPYGSA	..LQSS	RDR	LVNDDKFE	..DEE	..EATEEERNAFAKNV
PaCHI4	GAALFSSA	..LNDEL	KPR	KSSPEGE	..DEE	..EATEEERNAFAKNV
CqCHI7	ASOLGTO	..LEGAV	RDR	LAADKYE	..DEE	..EATEEERNAFAKNV
TaCHI6	GSQYGVQ	..LESS	RDR	LVAADKYE	..DEE	..EATEEERNAFAKNV
TaCHI10	GSQYGVQ	..LESS	RDR	LVAADKYE	..DEE	..EATEEERNAFAKNV
TaCHI8	GSQYGVQ	..LESS	RDR	LVAADKYE	..DEE	..EATEEERNAFAKNV
ZmCHI3	GSQYGVQ	..LESS	RDR	LVAADKYE	..DEE	..EATEEERNAFAKNV
OsCHI6	GSQYGVQ	..LESS	RDR	LVAADKYE	..DEE	..EATEEERNAFAKNV
OsCHI7	GSQYGVQ	..LESS	RDR	LVAADKYE	..DEE	..EATEEERNAFAKNV
BoCHI9	GAQYGVQ	..LENS	RDR	LVAADKYE	..DEE	..EATEEERNAFAKNV
GmCHI2	GAQYGVQ	..IETA	RDR	LVAADKYE	..DEE	..EATEEERNAFAKNV
GmCHI3	GAQYGVQ	..IETA	RDR	LVAADKYE	..DEE	..EATEEERNAFAKNV
CsCHI3	GSQYGVQ	..LESS	RDR	LVAADKYE	..DEE	..EATEEERNAFAKNV
PtCHI6	GSQYGVQ	..LESS	RDR	LVAADKYE	..DEE	..EATEEERNAFAKNV
SlCHI4	GSQYGVQ	..LESS	RDR	LVAADKYE	..DEE	..EATEEERNAFAKNV
PpCHI1	GFAPT KH	..LSRS	KQD	WININLIE	..EEE	..EATEEERNAFAKNV
PaCHI7	.....	..VRRH	HATF	KLDL	..MVO	IFDIE...
AtCHI1	GKTFWDA	..LDEA	IPR	IKKSPSSD	..TTAL	STARGIFQNR
CrCHI3	GEQFTEA	..INKS	LPR	MLAGDTA	..SDD	KRFTYFNSK
SmCHI2	GAALFSSA	..LNDEL	KPR	KSSPEGE	..DEE	..EATEEERNAFAKNV
SmCHI8	GAALFSSA	..LNDEL	KPR	KSSPEGE	..DEE	..EATEEERNAFAKNV
PpCHI3	GATFWGA	..LDEA	VPR	LTAAGAGA	..DGD	..AAALAEFGNVFKNR
CrCHI18	GATFWSA	..LDEA	VPR	LEAANAGA	..AGK	..EALDAFGVEFKGR
TaCHI3	GKTFVKA	..LDGV	IAR	IKORT	..DEE	..ESSLSAFRNSFLGR
TaCHI2	GNTFVKA	..LDGV	IAR	IKORT	..DEE	..ESSLSAFRNSFLGR
SmCHI1	GNTFVKA	..LDGV	IAR	IKORT	..DEE	..ESSLSAFRNSFLGR
ZmCHI7	GKTFVNA	..LNDV	IAR	IKORT	..DEE	..ESSLSAFRNSFLGR
OsCHI1	GKTFVKA	..LDDI	IAR	IKORT	..DEE	..ESSLSAFRNSFLGR
PaCHI8	GETFWGA	..LDEA	IPR	IKKTGAAE	..EQS	..LSTQKTFLGR
GmCHI5	GKTFWDA	..LSDA	IPR	IKQTITTD	..ESA	..LSTQKTFLGR
GmCHI7	GKTFWDA	..LSDA	IPR	IKQTITTD	..ESA	..LSTQKTFLGR
SlCHI6	GKTFWDA	..LSDA	IPR	IKQTITTD	..ESA	..LSTQKTFLGR
BoCHI3	GKTFWDA	..LDEA	IPR	IKKSPSPD	..ESA	..LSTQKTFLGR
CqCHI4	GKTFWDA	..LDEA	IPR	IKKSPSPD	..ESA	..LSTQKTFLGR
PtCHI4	GKTFWDA	..LDDA	IPR	IKKTAIPVD	..ESA	..LSTQKTFLGR
AtCHI2	INTVRDV	..FEKS	LGR	LQKMNPN	..DYN	..CTTGGSGFTKDV
CrCHI4	IGLVKST	..FETA	KNR	LKKMKSN	..DYN	..CTTGGSGFTKDV
SmCHI6	VDLVRS	..FQVS	LNR	LKKMKSN	..DYN	..CTTGGSGFTKDV
SmCHI4	VDLVRS	..FQVS	LNR	LKKMKSN	..DYN	..CTTGGSGFTKDV
PpCHI6	MRMVRNA	..FHES	LNR	LKKMKSN	..DYN	..CTTGGSGFTKDV
CrCHI16	AGMVRSA	..FDTS	LNR	LKKMKSN	..DYN	..CTTGGSGFTKDV
CrCHI11	MGWVRKA	..FDTS	LNR	LKKMKSN	..DYN	..CTTGGSGFTKDV
ZmCHI5	IGTVRDA	..FEKS	LGR	LQKMNPN	..DYN	..CTTGGSGFTKDV
SmCHI9	IGTVRDA	..FEKS	LGR	LQKMNPN	..DYN	..CTTGGSGFTKDV
OsCHI2	IGTVRDA	..FEKS	LGR	LQKMNPN	..DYN	..CTTGGSGFTKDV
TaCHI12	ISAVRDA	..FEKS	LGR	LQKMNPN	..DYN	..CTTGGSGFTKDV
TaCHI14	ISAVRDA	..FEKS	LGR	LQKMNPN	..DYN	..CTTGGSGFTKDV
TaCHI13	ISAVRDA	..FEKS	LGR	LQKMNPN	..DYN	..CTTGGSGFTKDV
TaCHI15	IGAVRDA	..FEKS	LGR	LQKMNPN	..DYN	..CTTGGSGFTKDV
TaCHI17	IGAVRDA	..FEKS	LGR	LQKMNPN	..DYN	..CTTGGSGFTKDV
TaCHI18	IGAVRDA	..FEKS	LGR	LQKMNPN	..DYN	..CTTGGSGFTKDV
OsCHI4	IGAVRDA	..FEKS	LGR	LQKMNPN	..DYN	..CTTGGSGFTKDV
ZmCHI10	VGAVRDA	..FEKS	LGR	LQKMNPN	..DYN	..CTTGGSGFTKDV
CqCHI1	VYTVKDA	..IEKA	LAR	LAKTNPBT	..DYN	..CTTGGSGFTKDV
BoCHI2	INTVRDA	..FEKS	LGR	LQKMNPN	..DYN	..CTTGGSGFTKDV
GmCHI6	INSVKDA	..FEKS	LAR	LAKTNPBT	..DYN	..CTTGGSGFTKDV
GmCHI8	INSVKDA	..FEKS	LAR	LAKTNPBT	..DYN	..CTTGGSGFTKDV
SlCHI7	INTVRDA	..FEKS	LGR	LQKMNPN	..DYN	..CTTGGSGFTKDV
CsCHI2	INSVKDA	..FEKS	LAR	LAKTNPBT	..DYN	..CTTGGSGFTKDV
PtCHI2	INTVRDA	..FEKS	LGR	LQKMNPN	..DYN	..CTTGGSGFTKDV
PtCHI5	INTVRDA	..FEKS	LGR	LQKMNPN	..DYN	..CTTGGSGFTKDV
AtCHI4	IRSVRNA	..FQES	GSR	LKKFGGSD	..NDE	..LQSTTSIFKDEY
PpCHI5	GHHIAKG	..FDRS	LPR	IRKKAQGGG	..NDE	..LQSTTSIFKDEY
CrCHI5	GHHIAKG	..FDRS	LPR	IRKKAQGGG	..NDE	..LQSTTSIFKDEY
CsCHI5	LSMAKKG	..FTEA	MES	MLKLTGQK	..NDE	..LQSTTSIFKDEY
SlCHI1	MNMVRKN	..FDEG	LAR	LAKTNPBT	..NDE	..LQSTTSIFKDEY
CrCHI3	VGSVRSA	..FEES	VGR	LKKFGGSD	..NDE	..LQSTTSIFKDEY
BoCHI8	IRSVRSA	..FEES	VGR	LKKFGGSD	..NDE	..LQSTTSIFKDEY
BoCHI1	IRSVRSA	..FEES	VGR	LKKFGGSD	..NDE	..LQSTTSIFKDEY
CqCHI6	IRSVRSA	..FEES	VGR	LKKFGGSD	..NDE	..LQSTTSIFKDEY
PtCHI1	IRSVRSA	..FEES	VGR	LKKFGGSD	..NDE	..LQSTTSIFKDEY
ZmCHI2	IRSVRSA	..FEES	VGR	LKKFGGSD	..NDE	..LQSTTSIFKDEY
OsCHI5	IRSVRSA	..FEES	VGR	LKKFGGSD	..NDE	..LQSTTSIFKDEY
TaCHI4	IGSVRSA	..FEES	VGR	LKKFGGSD	..NDE	..LQSTTSIFKDEY
TaCHI5	IGSVRSA	..FEES	VGR	LKKFGGSD	..NDE	..LQSTTSIFKDEY
SlCHI5	INSVRSA	..FEES	VGR	LKKFGGSD	..NDE	..LQSTTSIFKDEY
CsCHI1	IRSVRNA	..FEES	VGR	LKKFGGSD	..NDE	..LQSTTSIFKDEY
GmCHI1	IRSVRSA	..FEES	VGR	LKKFGGSD	..NDE	..LQSTTSIFKDEY
GmCHI9	IRSVRSA	..FEES	VGR	LKKFGGSD	..NDE	..LQSTTSIFKDEY
PpCHI4	IGSVRSA	..FEES	VGR	LKKFGGSD	..NDE	..LQSTTSIFKDEY
PaCHI3	IGSVRSA	..FEES	VGR	LKKFGGSD	..NDE	..LQSTTSIFKDEY
PaCHI6	IGSVRSA	..FEES	VGR	LKKFGGSD	..NDE	..LQSTTSIFKDEY
CrCHI1	RKKFLDA	..LEDR	APR	LKKQAGPS	..NDE	..LQSTTSIFKDEY
CrCHI2	LPLLGAE	..FERI	LGR	HEKAGGRA	..DDP	..ALRELSYSRE

type II

type I

type IV

FAP3

FAP2

FAP1

Outgroup

			150		160			170		180										
MsCH1	NFP		P ⁶ ASV	..	FYRO	..	SPDG	IG	..	LS	..	FSPDT	SIPEK	..	EAAL	..	LENKAV	SSAV	LE	
GmCH14	NFP		P ⁶ STV	..	FYKO	..	SPTG	TI	G	..	LS	..	FSKDE	TIPEH	..	EHAV	..	IDNKPL	SEAV	LE
GmCH11	NFP		P ⁶ STV	..	FYKO	..	SPTG	TI	G	..	LS	..	FSKDE	TIPEH	..	EHAV	..	IDNKPL	SEAV	LE
SmCH10	NFA		P ⁶ SV	..	FYRO	..	SPDG	IG	..	YG	..	FSKDS	SWSPEK	..	ATAV	..	LENKAV	SSAV	LE	
SmCH13	ALK		P ⁶ MGF	..	FYVS	..	SSSG	IG	..	VG	..	FTDDP	..	EPSNLKISS	..	..	IGNVK	ANALLS	..	
SmCH15	ALK		P ⁶ MGF	..	FYVS	..	SSSG	IG	..	VG	..	FTDDP	..	EPSNLKISS	..	..	IGNVK	ANALLS	..	
Cr1CH17	NFP		P ⁶ TSV	..	VVVSF	..	TKSALK	..	..	..	..	FTKDN	EIPKE	..	PAAV	..	TEDEAF	ACG	FLA	
PaCH15	FLP		..	..	CFIHPLHDT	..	FTPL	..	..	..	..	AGMEDCKPM	..	..	..	..	VTSRMT	VEGV	LA	
TaCH116	SFP		T ⁶ STI	..	PFTH	..	SADG	..	..	..	..	FSDDT	KVPEQ	..	ESGR	..	VDSRAL	SEAV	LE	
PaCH12	NFP		P ⁶ STI	..	LYTI	..	SPAG	..	..	..	..	FSKDS	SWSPEK	..	ATAV	..	LENKAV	SSAV	LE	
PaCH11	NFP		P ⁶ STI	..	LLTI	..	SPTGLA	..	..	..	..	FSKDS	SIPEK	..	GRAV	..	IKSAVL	LAQ	GVLA	
CqCH15	KFP		P ⁶ HSI	..	LFTO	..	..	..	..	..	..	SLWDH	QRPIS	..	..	..	..	KTAF	RVNLK	..
ZmCH11	TFA		P ⁶ ASI	..	LFTH	..	SPAG	..	..	..	..	FSKDS	SVPAA	..	GGVA	..	LENKRL	CEAV	LE	
ZmCH16	TFP		P ⁶ ASI	..	HFTH	..	SPAG	..	..	..	..	FSRDS	SVPVA	..	GGVA	..	IDNKLL	CEAV	LE	
OsCH13	SFP		P ⁶ ASI	..	LFTH	..	SPPG	..	..	..	..	FSKDS	SVEGAVAAAA	..	..	..	IDNKAL	CEAV	LD	
TaCH111	SFA		P ⁶ STI	..	LFTH	..	SPAG	..	..	..	..	FSKDS	SVPES	..	GGVA	..	IDNKAL	CEAV	LE	
TaCH17	SFA		P ⁶ ASI	..	LFTH	..	SPAG	..	..	..	..	FSKDS	SVPES	..	GGVA	..	IDNKAL	CEAV	LE	
TaCH19	SFA		P ⁶ ASI	..	LFTH	..	SPAG	..	..	..	..	FSKDS	SVPES	..	GGVA	..	IDNKAL	CEAV	LE	
AtCH16	DFF		P ⁶ STI	..	IFAI	..	CPKG	..	..	..	..	FSKEE	RVPKT	..	..	..	IKNKLL	CEAV	LE	
AtCH17	DFF		P ⁶ STI	..	IFAI	..	CPKG	..	..	..	..	FSKEE	RVPKT	..	..	..	IKNKLL	CEAV	LE	
GmCH112	TFF		P ⁶ STI	..	LFTH	..	SPNG	..	..	..	..	FSGDE	TIPEV	..	TSAV	..	IKNKLL	CEAV	LE	
BoCH17	KFP		P ⁶ STI	..	LFAL	..	SPKG	..	..	..	..	FSDD	GIPKR	..	GNTA	..	IDNKFL	CEAV	LE	
BoCH15	KFP		P ⁶ STI	..	LFAL	..	SPEG	..	..	..	..	FSKDD	SIPVT	..	..	..	IKNKLL	CEAV	LE	
AtCH13	TFF		P ⁶ STI	..	LFAL	..	SPTG	..	..	..	..	FSKDD	SIPET	..	..	..	IKNKLL	CEAV	LE	
BoCH16	KFP		P ⁶ STI	..	LFAL	..	ASKG	..	..	..	..	FSKDD	SIPET	..	..	..	IKNKLL	CEAV	LE	
BoCH14	TFF		P ⁶ STI	..	LFAL	..	SPNG	..	..	..	..	FSKDD	SIPKT	..	..	..	IKNKLL	CEAV	LE	
CqCH12	..		..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
CqCH13	..		..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
SlCH12	TFS		P ⁶ STI	..	LFTO	..	SVVG	..	..	..	..	FSDDD	SVPGT	..	GNVV	..	IDNKPL	SEAV	LE	
SlCH13	TFF		P ⁶ STI	..	LFTO	..	SPLG	..	..	..	..	FSDDD	SVPV	..	GNV	..	IDNKQL	SEAV	LD	
CsCH14	NFL		P ⁶ STI	..	LFTO	..	SPNG	..	..	..	..	FSKDE	SIPET	..	..	..	IESKLL	SEAV	LE	
PtCH13	TFF		P ⁶ STI	..	LFTH	..	SPHG	..	..	..	..	..	..	..	..	..	..	..	..	..
AtCH15	YFK		P ⁶ STI	..	TYHFS	..	AKDG	..	..	..	..	..	..	..	..	..	..	..	..	..
ZmCH14	HLA		P ⁶ STI	..	NWKH	..	PLG	..	..	..	..	..	..	..	..	..	..	..	..	..
ZmCH19	LPRYTSHISA		H ⁶ SL	..	IRSLERLMRW	..	LTTR	..	..	..	..	FLPSRSVSHHP	..	..	..	..	..	..	..	..
SmCH17	KLE		P ⁶ STI	..	VYSW	..	PSSSSH	..	..	..	..	ARSQKFLSGKIP	..	..	..	..	..	..	..	..
SmCH11	KLE		P ⁶ STI	..	VYSW	..	PSSSSH	..	..	..	..	..	..	..	..	..	..	..	..	..
Cr1CH12	WLA		Q ⁶ CTI	..	YLHWP	..	SPTCLO	..	..	..	..	..	..	..	..	..	..	..	..	..
PpCH12	NLP		P ⁶ STI	..	TYHW	..	ATPD	..	..	..	..	..	..	..	..	..	..	..	..	..
PpCH17	NLP		P ⁶ STI	..	TYHW	..	ATPD	..	..	..	..	..	..	..	..	..	..	..	..	..
PaCH14	YLK		P ⁶ STI	..	TYNP	..	SASTKT	..	..	..	..	..	..	..	..	..	..	..	..	..
CqCH17	YLK		P ⁶ STI	..	TFSP	..	FASG	..	..	..	..	..	..	..	..	..	..	..	..	..
TaCH16	YFR		P ⁶ STI	..	TFHFP	..	ATPTAA	..	..	..	..	..	..	..	..	..	..	..	..	..
TaCH110	YFR		P ⁶ STI	..	TFHFP	..	ATPTAA	..	..	..	..	..	..	..	..	..	..	..	..	..
TaCH18	YFR		P ⁶ STI	..	TFHFP	..	ATPTAA	..	..	..	..	..	..	..	..	..	..	..	..	..
OsCH13	YFK		P ⁶ STI	..	TFHFP	..	ATPTAA	..	..	..	..	..	..	..	..	..	..	..	..	..
OsCH17	YFK		P ⁶ STI	..	TFHFP	..	ATPTAA	..	..	..	..	..	..	..	..	..	..	..	..	..
BoCH19	YFK		P ⁶ STI	..	TYRFS	..	AKDG	..	..	..	..	..	..	..	..	..	..	..	..	..
GmCH12	YFK		P ⁶ STI	..	TYHFS	..	PTNSAT	..	..	..	..	..	..	..	..	..	..	..	..	..
GmCH13	YFK		P ⁶ STI	..	TYHFS	..	PTNSAT	..	..	..	..	..	..	..	..	..	..	..	..	..
CsCH13	YFK		P ⁶ STI	..	TYHFS	..	PTNSAT	..	..	..	..	..	..	..	..	..	..	..	..	..
PtCH16	YMK		P ⁶ STI	..	TYHFS	..	PTNSAT	..	..	..	..	..	..	..	..	..	..	..	..	..
SlCH14	YFK		P ⁶ STI	..	TYHFS	..	PTNSAT	..	..	..	..	..	..	..	..	..	..	..	..	..
PpCH11	CF		..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
PaCH17	..		..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
AtCH11	NLN		P ⁶ STI	..	LLTW	..	INTS	..	..	..	..	..	..	..	..	..	..	..	..	..
TaCH12	KLK		P ⁶ STI	..	YFTW	..	IQPD	..	..	..	..	..	..	..	..	..	..	..	..	..
SmCH12	KLK		P ⁶ STI	..	YFTW	..	IQPD	..	..	..	..	..	..	..	..	..	..	..	..	..
SmCH18	KLK		P ⁶ STI	..	YFTW	..	IQPD	..	..	..	..	..	..	..	..	..	..	..	..	..
PpCH13	SLQ		P ⁶ STI	..	TLTW	..	VQPS	..	..	..	..	..	..	..	..	..	..	..	..	..
Cr1CH18	SLK		P ⁶ STI	..	YLNW	..	VQPP	..	..	..	..	..	..	..	..	..	..	..	..	..
TaCH13	NLK		P ⁶ STI	..	YLTW	..	LEPS	..	..	..	..	..	..	..	..	..	..	..	..	..
NtCH12	NLK		P ⁶ STI	..	YLTW	..	LEPS	..	..	..	..	..	..	..	..	..	..	..	..	..
TaCH11	NLQ		P ⁶ STI	..	YLTW	..	LEPS	..	..	..	..	..	..	..	..	..	..	..	..	..
ZmCH17	NLK		P ⁶ STI	..	YLTW	..	LEPS	..	..	..	..	..	..	..	..	..	..	..	..	..
OsCH11	SLK		P ⁶ STI	..	YLTW	..	LEPS	..	..	..	..	..	..	..	..	..	..	..	..	..
PaCH18	SLK		P ⁶ STI	..	YLNW	..	LEPS	..	..	..	..	..	..	..	..	..	..	..	..	..
GmCH15	P ⁶ STI		P ⁶ STI	..	YLTW	..	LEPS	..	..	..	..	..	..	..	..	..	..	..	..	..
GmCH17	P ⁶ STI		P ⁶ STI	..	YLTW	..	LEPS	..	..	..	..	..	..	..	..	..	..	..	..	..
SlCH16	P ⁶ STI		P ⁶ STI	..	YLTW	..	LEPS	..	..	..	..	..	..	..	..	..	..	..	..	..
SlCH13	P ⁶ STI		P ⁶ STI	..	YLTW	..	LEPS	..	..	..	..	..	..	..	..	..	..	..	..	..
PaCH14	P ⁶ STI		P ⁶ STI	..	YLTW	..	LEPS	..	..	..	..	..	..	..	..	..	..	..	..	..
CqCH14	SLK		P ⁶ STI	..	YLTW	..	LEPS	..	..	..	..	..	..	..	..	..	..	..	..	..
PtCH14	SLK		P ⁶ STI	..	YLTW	..	LEPS	..	..	..	..	..	..	..	..	..	..	..	..	..
AtCH12	P ⁶ STI		P ⁶ STI	..	YLTW	..	LEPS	..	..	..	..	..	..	..	..	..	..	..	..	..
Cr1CH14	..		..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
SmCH16	KIH		P ⁶ STI	..	DIHW	..	OPGG	..	..	..	..	..	..	..	..	..	..	..	..	..
SmCH14	KIH		P ⁶ STI	..	DIHW	..	OPGG	..	..	..	..	..	..	..	..	..	..	..	..	..
PpCH16	R ⁶ STI		P ⁶ STI	..	DVRW	..	OVGG	..	..	..	..	..	..	..	..	..	..	..	..	..
Cr1CH16	P ⁶ STI		P ⁶ STI	..	DFQW	..	MOGG	..	..	..	..	..	..	..	..	..	..	..	..	..
Cr1CH11	R ⁶ STI		P ⁶ STI	..	DFQW	..	MOGG	..	..	..	..	..	..	..	..	..	..	..	..	..
ZmCH15	R ⁶ STI		P ⁶ STI	..	DFQW	..	MOGG	..	..	..	..	..	..	..	..	..	..	..	..	..
ZmCH18	R ⁶ STI		P ⁶ STI	..	DFQW	..	MOGG
OsCH12	C ⁶ STI		P ⁶ STI	..	DFQW	..	MOGG
TaCH112	R ⁶ STI		P ⁶ STI	..																

220

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LLN..EGAFKIGN.....
FFLELANPNNN.....
FLELANPNNIEN.....
VLHGIIIV.....
LL.....
LL.....
LK.....
LCSNRRLMYEIIWLKLKNVKKLIGLSLTKSNSQ.
LINHH.....
LVKEY.....
VVATDT.....

```

LLAKETAAPADAPQAEPPVSITA.
 LLTKGTAAAAALAREPPVSVA.
 LLKAESTGDDVAAAAPAPVSA.
 LLEGAALAGGEPAAEAAVSVV.
 LLKGAAGGEPFAVEPPVSVSV.
 LLKGASHAGEPAAEPPVSVSV.
 LLNKKDIPYAAVNTPSSTRVRVTSQTRCAINLLSSCKADDWSDKCSQSKSVQR
 LLNKKDPPYNEANNVYVATKN.
 LLKEPQGCDQPSHK.
 LLKNNEVKEDATKAKTQDEEANDLSLGDKLAENKKTDLPGDPSFWFVRLALCFYA.
 LLNNSDKVEEDATKT.
 LLMKNKDEKEYSVDSHVEEKLAN.
 LLNNSDKVEEDATKTQDEEANNPLGDKKAKK.
 LLMKENKVEKDATKTQDEEANDVSLGDKKLAKEN.
 LLNPNENAEANSTNGVESEKSAKVVDTEKLSGQEDIKS.
 LLMKXSNAAEST.
 LLVCERKSGDVSQV.
 LLKENNGSTNDHKAAGEIDGDINLKATKAYKDKDVISIPIENGNGKHKHVTNE

```

VLT.....
LAE.....
FF.....
  _EC.....
  _EC.....
OL.....
OVA.....
LLKQ.....
ELSK.....
MLSSP.....
MLSSP.....
MLTSP.....
LLAVAA.....
LLSA.....
LLSA.....
VLT.....
ELSK.....
ELSK.....
ELSK.....
ELAR.....
ELSK.....
NIOPPKFDNIFYRILFLV.....

```

```

      .C
      LV.....
      LLDENVKRSTRA.....
      LP.....
      SL.....
      TL.....
      ILTK.....
      LLTK.....
      LLLAK.....
      ILTK.....
      LI.....
      VLK.....
      VIK.....
      VK.....
      VLK.....
      L.....
      ILK.....
      IIRKC.....

```

```

ILHGSG...
ILNN...
ILNN...
ILKRR...
ILKS...
ILQTS...
LMRRC...
LIRRC...
LIRRCY...
LIRRC...
LIRRC...
LIRRC...
LMGRCGG...
LMGRCGG...
LMGRCGG...
LIGRC...
LIGRR...
LMRRC...
ILKSC...
ILNRK...
ILRRC...
ILRGC...
ILRRC...
LIGKC...

```

```

L1GRU.....
LAFDN.....
LFHGGASET...
LFHKP.....
LF.....
LF.....
FLSKE.....
IAVDDKAAHEIQK..
IADVDK.....
VLKEN.....
LLQS.....
LLKS.....
ILLKN.....
ILKA.....
ILKA.....
LLHK.....
LLQE.....
LL.....
LLC.....
LLSQ.....
LLTO.....
ALKE.....

```

. **LA**EGGDSPYRLQFGERLLCAPGASPTSQPNACVLASS.....

type II

type I

type IV

FAP3

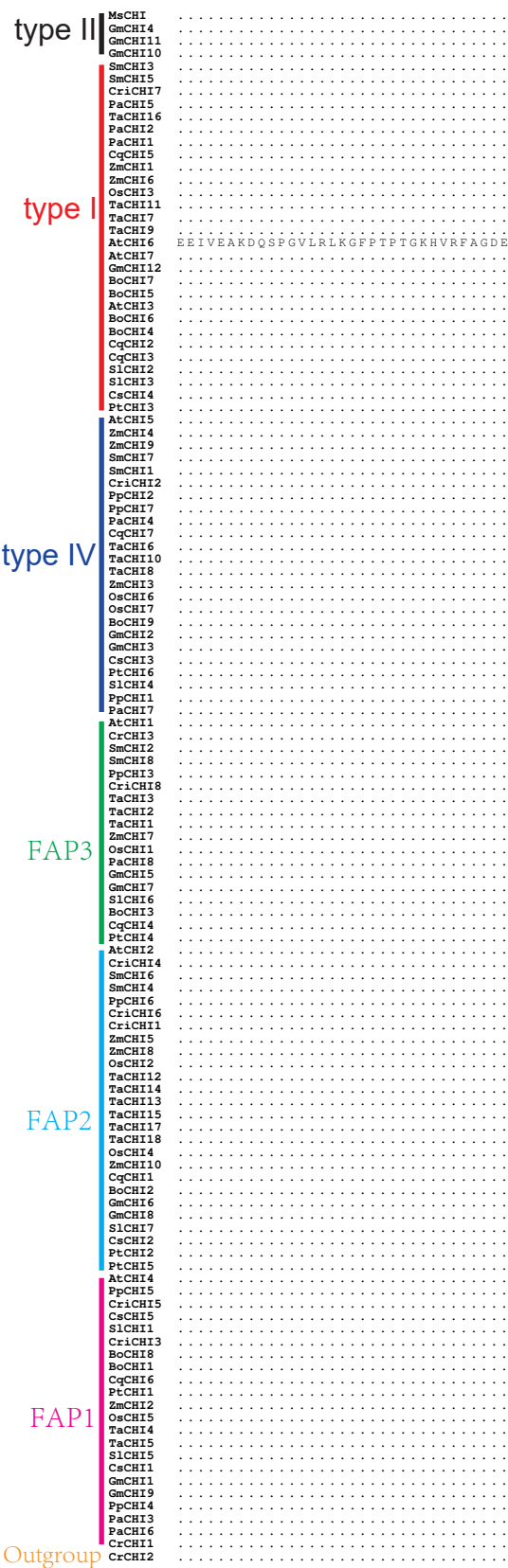
FAP2

FAP1

Outgroup

MsCHI	
GmCHI4	
GmCHI11	
GmCHI10	
SmCHI3	
SmCHI5	
CriCHI7	
PaCHI5	
TaCHI16	
PaCHI2	
PaCHI1	
CqCHI5	
ZmCHI1	
ZmCHI6	
OsCHI3	
TaCHI11	
TaCHI7	
TaCHI9	
AtCHI6	NGAKDRSALFDITNDSPiVGLAMQTPSSGGVVGKRNMsrINNTPGSGEALLRGQVKTL LQKV EEEADLTkISLESrPFiHLVTSPMGLLAPTPANTPQVLGFSDEVQVVITSPVVAGQFRAPSQVVES
AtCHI7	
GmCHI12	
BoCHI7	
BoCHI5	
AtCHI3	
BoCHI6	
BoCHI4	
CqCHI2	
CqCHI3	
SlCHI2	
SlCHI3	
CsCHI4	
PtCHI3	
AtCHI5	
ZmCHI4	
ZmCHI9	
SmCHI7	
SmCHI1	
CriCHI2	
PpCHI2	
PpCHI7	
PaCHI4	
CqCHI7	
TaCHI6	
TaCHI10	
TaCHI8	
TaCHI3	
OsCHI6	
OsCHI7	
BoCHI9	
GmCHI2	
GmCHI3	
CsCHI3	
PtCHI6	
SlCHI4	
PpCHI1	
PaCHI7	
AtCHI1	
CrCHI3	
SmCHI2	
SmCHI8	
PpCHI3	
CriCHI8	
TaCHI3	
TaCHI2	
TaCHI1	
ZmCHI7	
OsCHI1	
PaCHI8	
GmCHI5	
GmCHI7	
SlCHI6	
BoCHI3	
CqCHI4	
PtCHI4	
AtCHI2	
CriCHI4	
SmCHI6	
SmCHI4	
PpCHI6	
CriCHI6	
CriCHI1	
ZmCHI5	
ZmCHI8	
OsCHI2	
TaCHI12	
TaCHI14	
TaCHI13	
TaCHI15	
TaCHI17	
TaCHI18	
OsCHI4	
ZmCHI10	
CqCHI1	
BoCHI2	
GmCHI6	
GmCHI8	
SlCHI7	
CsCHI2	
PtCHI2	
PtCHI5	
AtCHI4	
PpCHI5	
CriCHI5	
CsCHI5	
SlCHI1	
CriCHI3	
BoCHI8	
BoCHI1	
CqCHI6	
PtCHI1	
ZmCHI2	
OsCHI5	
TaCHI4	
TaCHI5	
SlCHI5	
CsCHI1	
GmCHI1	
GmCHI9	
PpCHI4	
PaCHI3	
PaCHI6	
CrCHI1	
CrCHI2	

type II	MsCHI	
	GmCHI4	
	GmCHI11	
	GmCHI10	
	SmCHI3	
	SmCHI5	
	CrCHI7	
	PaCHI5	
	TaCHI16	
	PaCHI2	
type I	PaCHI1	
	CqCHI5	
	ZmCHI1	
	ZmCHI6	
	OsCHI3	
	TaCHI11	
	TaCHI7	
	TaCHI9	
	AtCHI6	NMFDKEESLELEKSPSITRSLLLDFSDKSELWESSDCSSVVTQNPEDDNSSVWSMQANASAKDEEYDDEEEEAYSYGEEYDEEYDDEEEEEE
	AtCHI7	GGIVDGLCEGIRKMSVETDFAGKHTRFVYDSED
	GmCHI12	
	BoCHI7	
	BoCHI5	
	AtCHI3	
	BoCHI6	
	BoCHI4	
	CqCHI2	
	CqCHI3	
	SlCHI2	
	SlCHI3	
	CsCHI4	
	PtCHI3	
	AtCHI5	
	ZmCHI4	
	ZmCHI9	
	SmCHI7	
	SmCHI1	
	CriCHI2	
	PpCHI2	
	PpCHI7	
type IV	PaCHI4	
	CqCHI7	
	TaCHI6	
	TaCHI10	
	TaCHI8	
	ZmCHI3	
	OsCHI6	
	OsCHI7	
	BoCHI9	
	GmCHI2	
	GmCHI3	
	CsCHI3	
	PtCHI6	
	SlCHI4	
	PpCHI1	
	PaCHI7	
	AtCHI1	
	CrCHI3	
	SmCHI2	
	SmCHI8	
FAP3	PpCHI3	
	CriCHI8	
	TaCHI3	
	TaCHI2	
	TaCHI1	
	ZmCHI7	
	PaCHI1	
	PaCHI8	
	GmCHI5	
	GmCHI7	
	SlCHI6	
	BoCHI3	
	CqCHI4	
	PtCHI4	
	AtCHI2	
	CriCHI4	
	SmCHI6	
	SmCHI4	
	PpCHI6	
	CriCHI6	
FAP2	CriCHI1	
	ZmCHI5	
	ZmCHI8	
	OsCHI2	
	TaCHI12	
	TaCHI14	
	TaCHI13	
	TaCHI15	
	TaCHI17	
	TaCHI18	
	OsCHI4	
	ZmCHI10	
	CqCHI1	
	BoCHI2	
	GmCHI6	
	GmCHI8	
	SlCHI7	
	CsCHI2	
	PtCHI2	
	PtCHI5	
FAP1	AtCHI4	
	PpCHI5	
	CriCHI5	
	CsCHI5	
	SlCHI1	
	CriCHI3	
	BoCHI8	
	BoCHI1	
	CqCHI6	
	PtCHI1	
	ZmCHI2	
	OsCHI5	
	TaCHI4	
	TaCHI5	
	SlCHI5	
	CsCHI1	
	GmCHI1	
	GmCHI9	
	PpCHI4	
	PaCHI3	
Outgroup	PaCHI6	
	CrCHI1	
	CrCHI2	



Supplementary Figure S3. Protein sequence alignment of CHIs among 15 green plants. The first line indicated the model protein sequence of MsCHI. The critical catalytic residues essential for *bona fide* CHI active sites are shown with red asterisks. Residues for the hydrogen bond network are marked with green asterisks. The blue boxes indicated the residues responsible for substrate preference.