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Comparative analysis of plant lycopene cyclases

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ABSTRACT

Carotenoids are essential isoprenoid pigments produced by plants, algae, fungi and bacteria. Lycopene cyclase (LYC) commonly cyclize carotenoids, which is an important branching step in the carotenogenesis, at one or both end of the backbone. Plants have two types of LYC (β -LCY and ϵ -LCY). In this study, plant LYCs were analyzed. Based on domain analysis, all LYCs accommodate lycopene cyclase domain (Pf05834), Furthermore, motif analysis indicated that motifs were conserved among the plants. On the basis of phylogenetic analysis, β -LCYs and ϵ -LCYs were classified in β and ϵ groups. Monocot and dicot plants separated from each other in the phylogenetic tree. Subsequently, Oryza sativa Japonica Group and Zea mays of LYCs as monocot plants and Vitis vinifera and Solanum lycopersicum of LYCs as dicot plants were analyzed. According to nucleotide diversity analysis of β -LCY and ε -LCY genes, nucleotide diversities were found to be π : 0.30 and π : 0.25, respectively. The result highlighted β -LCY genes showed higher nucleotide diversity than &-LCY genes. LYCs interacting genes and their co-expression partners were also predicted using String server. The obtained data suggested the importance of LYCs in carotenoid metabolism. 3D modeling revealed that depicted structures were similar in O. sativa, Z mays, S. lycopersicum, and V. vinifera β -LCYs and ϵ -LCYs. Likewise, the predicted binding sites were highly similar between O. sativa, Z mays, S. lycopersicum, and V. vinifera LCYs. Most importantly, analysis elucidated the V/IXGXGXXGXXXA motif for both type of LYC (β -LCY and ϵ -LCY). This motif related to Rossmann fold domain and probably provides a flat platform for binding of FAD in O. sativa, Z mays, S. lycopersicum, and V. vinifera β -LCYs and ϵ -LCYs with conserved structure. In addition to lycopene cyclase domain, the V/ IXGXGXXGXXXA motif can be used for exploring LYCs proteins and to annotate the function of unknown proteins containing lycopene cyclase domain. Overall results indicated that a high degree of conserved signature were observed in plant LYCs.

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1. Introduction

With more than 600 different structures, carotenoids are common isoprenoid pigments synthesized by various organisms including plants, certain algae, fungi and bacteria (Alquezar et al., 2009). These are structurally localized in the thylakoid membrane and play a key role as accessory molecules for harvesting light, prevention from photo damage, and as antioxidants under stress conditions (Gao et al., 2010; Demmig-Adams et al., 1996; Cui et al., 2011). Carotenoids also provide the yellow, orange or red coloration characteristic of many flowers and fruits to attract animals and insects for pollination or for the dispersal of seeds

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(Bartley and Scolnik, 1995). The attractive colors and beneficial health effects of caretonoids, especially β -carotene, have received attention (Alquezar et al., 2009). In addition, β -carotene is a substrate for the biosynthesis of other carotenoids such as zeaxanthin, xanthphylls, neoxanthin, violaxanthin (Hugueney et al., 1995). Vitamin A is also synthesized from β -caroten (Rock and Zeevaart, 1991). Thus, vitamin A is not only fundamental for plants but also beneficial for human and animal nutrition.

Toward the end of metabolic processes of carotenoids, they are commonly cyclized at one or both ends of backbones by lycopene cyclase (Mohamed and Vermaas, 2006). Lycopene cyclization is a crucial branching point in the carotenogenesis (Alquezar et al., 2009). Lycopene cyclization is caused by β -LCY (EC:5.5.1.19) using NADP(H) or FAD as a co-factor (Hornero-Méndez and Britton, 2002; Yu et al., 2010). β -LCY alone produces β -carotene whereas two enzymes, β -LCY and ϵ -LCY (EC: 5.5.1.18), together form α -carotene (Beyer et al., 1991; Hornero-Méndez and Britton, 2002; Moreno et al., 2013).

 $\beta\text{-LCYs}$ of plants and bacteria have a conserved dinucleotide binding motif. Furthermore, several conserved domains such as

conserved region β -LCY's, β -LCY specific motif, cylase motif I and II (CMI and CMII), β -LCY CAD (catalytic activity domain) and a charged region are highly conserved in plants (Moreno et al., 2013; Hugueney et al., 1995). β -LCY CAD is essential for β -LCY activity

On Data	Plant β-Lvc conserved region MATTALLLRAHPSCKPPPPSPSPRPTRALVCRAAAAGEATRSLAEPSRPELLSLDLERVDP	60
Os-Beta Vv-Beta2		82
Vv-Betal		75
Sl-Betal	FGSRKFCETLCRSVCVKCSSSALLELVFETKKENLDFELFMXDF FGSRKFCETLCRSVCVKCSSSALLELVFETKKENLDFELFMXDF MEALIKFFSLLSSPTPHRSIFQQNPSFLSPTKKKSRKCLLRNKSSKLECSFLDLAFTSKFESLDVNISWVDFN	78
Sl-Beta2	MEALIKPFESLILSSPTPHRSIFQQNPSFLSPTTKKKSRKCLIRNKSSKLDCSFLDLAFTSKPESLOVNISWVDPN	76
Zm-Beta		62 100
Vv-Epsilor	1MECI <mark>CAPNFAAMAMAAAAAABERKSNAWWFRAWEFRANGAMEWKCWAFBARKDAAFARGGWEMERADEEDWKGGGGEDDWWGGGGEDDWWGGGGGEDDWWGGG 1MECI<mark>CAPNFAAWAWSTSAPWR</mark>SRRR<mark>R</mark>MRPENACFNHRDSCYLPS<mark>WRWRASAGS</mark>ES-CVV<mark>W</mark>EGFADEEDYIKAGGSELLFVOMCONKAMDE</mark>	
Sl-Epsilor	nmecvgaqnvgamavftrprikelvgrrimprkkosfwp-mssmovkonsssgses-cvvdkedfadeedytkaggsoltfvomookkdmdo	89
Zm-Epsilor	-MGLSGATISAPLCCVLRCCAVGGCKALKADAERWR-RAGWSRRVGGPKVRCVATERHDETAAVCAAVGVDFADEEDYRKGGGGELLYVOMCSTKPMES Dinucleotid binding signature	98
Os-Beta		150
Vv-Beta2	SKGLVVDLAVVGGGPAGLAVAQQVSEAGLSVC <mark>S</mark> IDPSPKLIWPNNYGVWVDEFEAMDLLDCLDTTMSCAVVFIDDH-SKKLLGRPYAR	169
Vv-Betal	SCKSCLDVIIIGAGPAGLRLAEQVSRYGIHVCCIDPSPLSMWPNNYGVWVDEFEGLGLEDCLDKTWEMTCVRIDDH-RTKYLDRAYGR	162
Sl-Betal	SKGLVVDLAVVGGGPAGLAVAQUVSEAGLSVCSIDPSPKLIWPNNYGVWVDEFEAMDLHDCLDTTMSGAVVFIDDH-SKKLLGRPYAR SCKSCLDVIIIGAGPAGLRLAEQVSRYGIHVCCIDPSPLSMWPNNYGVWVDEFEGLGLEDCLDKTWPMTCVRIDDH-RTKYLDRAYGR SKGVVVDLAVVGGGPAGLAVAQQVSEAGLSVCSIDPNPKLIWPNNYGVWVDEFEAMDLHDCLDATMSGAAVYIDDN-TAKDLHRPYGR SNRAQEDVIIIGAGPAGLRLAEQVSKYGIKVCCVDPSPLSMWPNNYGVWVDEFENLGLENCLDHKWPMTCVHINDN-KTKYLGRPYGR	165
Sl-Beta2 Zm-Beta	SNRAOFDVIIIGAGPAGIRIAEOVSKYGIRVCCVDPSPISMWPNNYGVWVDEFENIGLENCLDHRWBMCVHINDN-RIKYIGRPYGR APARPVDIAVVGGGPAGIAVAC <mark>R</mark> VAEAGISVCAIDPSPAVVWPNNYGVWVDEFEAMGI <mark>SH</mark> CLDTVWP <mark>S</mark> ASVFIDDG-GAK <mark>SID</mark> RPYAR	163 149
Os-Epsilor		
Vv-Epsilor	1 OSKLADKLPOISIEDGTLDLVVIGCGPAGLALAAESAKLGLSVGLIGPDLPFTNNYGVWEDEFKDLGLGRCIEHVWRDTIVYLDDG-DPILIGRAYGR	187
Sl-Epsilor		
Zm-Epsilor	n <mark>oski</mark> ask <mark>u</mark> spi <mark>sdentvldlviigcgpagl</mark> sla <mark>sesak</mark> kgltvgligpdlpftnnygvwedefkdlgle <mark>sciehvwkdtivyldnn-kpi</mark> ligrsygr CMI	195
Os-Beta	VARRKLKSTMMDRCVAHGVUPHKARVVKAVHG-PASSILLCDDGVAVPAVVLDATGFSR-CLVQYDKPYDPGYQVAYGLLABVDCHPFDLDKM FMD	246
Vv-Beta2	VNRK <mark>OLKSKMMOKCILNGVK</mark> FHOAKVIKVIHE-E <mark>S</mark> KSLLICNDGVTICAAVVLDATGFSR-CLVQYDKPYNPGYQVAYGILAEVEEHPFDVDKMVFMD	265
Vv-Betal	VSRKRLK <mark>W</mark> KLLE <mark>ICAAY</mark> GV <mark>CFHKAKVWKVE</mark> HQ-EFESLVECDDG <mark>SKLRAN</mark> LVVDASGFAS-TFIEYDKPRNHGYQIAHGILAEVD <mark>S</mark> HPFDLDKMLLMD	258
Sl-Beta1 Sl-Beta2	VSKKLKKKLLDICHISVEHARVMVEHCEPESIVECDGSTARAMVDASSFAS-IIIEIDK-FKNHGIGIALSUNGILAEVDSHPFDDDKHLDD VNRKCLKSKMCKCIMGGVEHCAKVKUVHE-BESSJVCCDGKIIGAGVVDASGFAS-BIGIGIAC-PXNPGGQVAYGILAEVDEHPFDDVKKVFMD VSRKKLKIKLINSCVENRVKHYKAKVMKVEHE-BESSIVCCDGKKIRGSLVVDASGFAS-DEIEYDRPXNPGQVAYGILAEVDHPFDLDKMVIMD VARRKLKSIMMDRCVANGVFHOAKVAKAVHY-DASSILICDDGVAVPASVVLDATGFSR-CLVQYDKPYNPGYQVAYGILAEVDHPFDLDKMVIMD 1 VHRDLLHEELLRRCYDAGVTYLSSKVDKIMESEDGHRVVCCEGDREVLCRLAIVASGAASGRLLEYEVGGPR-VCVQTAYGVEVEVNNPYDPSLMVFMD	261 259
Zm-Beta	VARRKLKSTMMDRCVANGVFHQAKVAKAVHY-DASSLLICDDGVAVPASVVLDATGFSR-CLVQYDKPYNPGYQVAYGILAEVDAHPFDIDKMLFMD	245
Os-Epsilor	1 VHRDLLHEELLRRC <mark>Y</mark> DAGVTYLSSKVDKI <mark>ME</mark> SPDGH <mark>RVVCCEGDREVLCRLAIVASGAASGRLLEYEVG</mark> GPR-VCV <mark>OTAYGVEVEVENNPYDPSLMVFMD</mark>	296
Vv-Epsilor	WNRHT HEETTKROVESCVSVCSSKVERTTEASNCHSTVVCERDINTDORTATVASCAASCKITOVECONSCCECONSING WKEEVENNDVDDSTMVEMD	287
Sl-Epsilor Zm-Epsilor		285 294
Dia Epsilion		251
	CMI	
Os-Beta	CM I WRDAHLPEGSETRERNRRIPTFLYAMPFSPTRIFLEETSLWARPGLAMDDIOERMAARLRHLGIRVRAVEEDERCVIPMGGPLPVLPORVVGIGGTAGMV	346
Os-Beta Vv-Beta2	WRD <mark>R</mark> HLPEGSEIRERNRRIPTFLYAMPFSPTRIFLEETSLVARPGLAMDDIQERMAARLRHLGIRVRAVEEDERCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLNNNMELKNRN <mark>GRIPTFLYAMPFSSNRIFLEETSLVARPGVPMEDIQERMVARLRHLGIKVKSIEEDERCIIPMGGPLPVLPQRVVGIGGTAGMV</mark>	346 365
Vv-Beta2 Vv-Beta1	WRD <mark>R</mark> HLPEGSEIRERNRRIPTFLYAMPFSPTRIFLEETSLVARPGLAMDDIQERMAARLRHLGIRVRAVEEDERCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLNNNMELKNRNGRIPTFLYAMPFSSNRIFLEETSLVARPGVPMEDIQERMVARLRHLGIKVKSIEEDERCIIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLCNEPYIRAGNSSLPTFLYAMPFNSNLIFLEETSLVSRPMLSMKEVKRRMVARLRHLGIRVRVIEDEKCLIPMGGPXPOIPQSVMAIGGTAGL	365 358
Vv-Beta2 Vv-Beta1 Sl-Beta1	WRD <mark>R</mark> HLPEGSEIRERNRRIPTFLYAMPFSPTRIFLEETSLVARPGLAMDDIQERMAARLRHLGIRVRAVEEDERCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLNNNMELKNRNGRIPTFLYAMPFSSNRIFLEETSLVARPGVPMEDIQERMVARLRHLGIKVKSIEEDERCIIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLCNEPYIRAGNSSLPTFLYAMPFNSNLIFLEETSLVSRPMLSMEVKRRMVARLRHLGIRVRVIEDEKCLIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLKNNTDLKERNSRIPTFLYAMPFSSNRIFLEETSLVARPGL <mark>RI</mark> DDIQERMVARLNHLGIKVKSIEEDEHCLIPMGGPLPVLPQRVVGIGGTAGMV	365 358 361
Vv-Beta2 Vv-Beta1 Sl-Beta1 Sl-Beta2	WRD <mark>a</mark> HLPEGSEIRERNRRIPTFLYAMPFSPTRIFLEETSLVARPGLAMDDIQERMAARLRHLGIRVRAVEEDERCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLNNMELKNRNGRIPTFLYAMPFSSNRIFLEETSLVARPGVPMEDIQERMVARLRHLGIRVRSIEEDERCIIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLGNEPYIRAGNSSLPTFLYAMPFNSNLIFLEETSLVSRPMLSYREVKRRMVARLRHLGIRVRRVIEDEKCLIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLKNNTDLKERNSRIPTFLYAMPFSSNRIFLEETSLVSRPMLSYREVKRRMVARLRHLGIRVRSIEEDEHCLIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLGNEPYLRVNNAKEPTFLYAMPFDRDIVFLEETSLVSRPVLSYMEVKRRMVARLRHLGIRVKSIEEDEHCLIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLGNEPYLRVNNAKEPTFLYAMPFDRDIVFLEETSLVSRPVLSYMEVKRRMVARLRHLGIRVKSVIEEDEKCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLGREPYLRVNNAKEPTFLYAMPFDRDIVFLEETSLVSRPVLSYMEVKRRMVARLRHLGIRVRSVEEDERCVIPMGGPLPVLPQRVVGIGGTAGMV	365 358 361 359
Vv-Beta2 Vv-Beta1 Sl-Beta1	WRDAHLPEGSEIRERNRRIPTFLYAMPFSPTRIFLEETSLVARPGLAMDDIQERMAARLRHLGIRVRAVEEDERCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLNNMELKNRNGRIPTFLYAMPFSSNRIFLEETSLVARPGVPMEDIQERMVARLRHLGIKVKSIEEDERCIIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLCNEPYIRAGNSSLPTFLYAMPFNSNIFLEETSLVARPGRIDDIQERMVARLRHLGIKVKSIEEDEHCLIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLKNNTDLKERNSRIPTFLYAMPFSSNRIFLEETSLVARPGIRIDDIQERMVARLRHLGIKVKSIEEDEHCLIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLKNNTDLKERNSRIPTFLYAMPFDRDLVFLEETSLVARPGIRIDDIQERMVARLRHLGIKVKSIEEDEHCLIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLGNEPYLRVNNARDPTFLYAMPFDRDLVFLEETSLVARPGIRIDDIQERMVARLRHLGIKVKSIEEDEHCLIPMGGPLPRIPQNVAAIGGTAGMV WRDSHLGNEPYLRVNNARDPTFLYAMPFDRDLVFLEETSLVARPGIRIDDIQERMAARLRHLGIKVKSVIEEEKCVIPMGGPLPRIPQNVAAIGGTAGMV WRDSHLGNEPYLRVNNARDPTFLYAMPFDRDLVFLEETSLVARPGLAMDDIQERMAARLRHLGIKVFSVEEDERCVIPMGGPLPRIPQNVAAIGGTAGMV WRDSHLGNEPYLRVNNARDPTFLYAMPFDRIFTEETSLVARPGLAMDDIQERMAARLRHLGIKVFSVEEDERCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLGNEPYLRVNNARDPTFLYAMPFSTRIFLEETSLVARPGLAMDDIQERMAARLRHLGIKVFSVEEDERCVIPMGGPLPVLPQRVVGIGGTAGMV	365 358 361
Vv-Beta2 Vv-Beta1 Sl-Beta1 Sl-Beta2 Zm-Beta Os-Epsilon Vv-Epsilon	WRDAHLPEGSEIRERNRRIPTFLYAMPFSPTRIFLEETSLVARPGLAMDDIQERMAARLRHLGIRVRAVEEDERCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLNNMELKNRNGRIPTFLYAMPFSSNRIFLEETSLVARPGVPMEDIQERMVARLRHLGIKVKSIEEDERCIIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLCNEPYIRAGNSSLPTFLYAMPFNSNIFLEETSLVARPGRIDDIQERMVARLRHLGIKVKSIEEDEHCLIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLKNNTDLKERNSRIPTFLYAMPFSSNRIFLEETSLVARPGIRIDDIQERMVARLRHLGIKVKSIEEDEHCLIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLKNNTDLKERNSRIPTFLYAMPFDRDLVFLEETSLVARPGIRIDDIQERMVARLRHLGIKVKSIEEDEHCLIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLGNEPYLRVNNARDPTFLYAMPFDRDLVFLEETSLVARPGIRIDDIQERMVARLRHLGIKVKSIEEDEHCLIPMGGPLPRIPQNVAAIGGTAGMV WRDSHLGNEPYLRVNNARDPTFLYAMPFDRDLVFLEETSLVARPGIRIDDIQERMAARLRHLGIKVKSVIEEEKCVIPMGGPLPRIPQNVAAIGGTAGMV WRDSHLGNEPYLRVNNARDPTFLYAMPFDRDLVFLEETSLVARPGLAMDDIQERMAARLRHLGIKVFSVEEDERCVIPMGGPLPRIPQNVAAIGGTAGMV WRDSHLGNEPYLRVNNARDPTFLYAMPFDRIFTEETSLVARPGLAMDDIQERMAARLRHLGIKVFSVEEDERCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLGNEPYLRVNNARDPTFLYAMPFSTRIFLEETSLVARPGLAMDDIQERMAARLRHLGIKVFSVEEDERCVIPMGGPLPVLPQRVVGIGGTAGMV	365 358 361 359 345 393 384
Vv-Beta2 Vv-Beta1 Sl-Beta1 Sl-Beta2 Zm-Beta Os-Epsilon Vv-Epsilon Sl-Epsilon	WRDAHLPEGSEIRERNRRIPTFLYAMPFSPTRIFLEETSLVARPGLAMDDIQERMAARLRHLGIRVRAVEEDERCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLNNMELKNRNGRIPTFLYAMPFSSNRIFLEETSLVARPGVPMEDIQERMVARLRHLGIRVRSIEEDERCIIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLCNEPYIRAGNSSLPTFLYAMPFNSNIFLEETSLVARPGRIDDIQERMVARLRHLGIRVRSIEEDEHCLIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLKNNTDLKERNSRIPTFLYAMPFSSNRIFLEETSLVARPGIRIDDIQERMVARLRHLGIKVKSIEEDEHCLIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLKNNTDLKERNSRIPTFLYAMPFDRDLVFLEETSLVARPGIRIDDIQERMVARLRHLGIKVKSIEEDEHCLIPMGGPLPRIPQNVMAIGGNSGIV WRDSHLGNEPYLRVNNARDPTFLYAMPFDRDLVFLEETSLVARPGIRIDDIQERMVARLRHLGIKVKSIEEDEHCLIPMGGPLPRIPQNVMAIGGGNSGIV WRDSHLGNEFYLRVNNARDPTFLYAMPFSPRIFLEETSLVARPGIRAMDDIQERMAARLRHLGIKVKSVIEEEKCVIPMGGPLPRIPQNVMAIGGGNSGIV WRDSHLGNEFYLRVNNARDPTFLYAMPFSPRIFLEETSLVARPGLAMDDIQERMAARLRHLGIKVKSVIEEEKCVIPMGGPLPRIPQNVMAIGGGAGMV YRDSHLGKESIRERNRIPTFLYAMPFSPRIFLEETSLVARPGLAMDDIQERMAARLRHLGIKVKSVIEEEKCVIPMGGPLPUTPQRVVGIGGTAGMV YRDGFKDKFSHPEOGNPTFLYMPMSSTRIFFEETCLASKEAMPFDLLKKKLMSRLEMMGIRIIRTYEEEWSYIPVGGSLPNTPQKNLAFGAAASMV YRDIKKVQCLFVQYPTFLYMPMSSTRIFFEETCLASKEAMPFDLLKKKLMSRLEMGIRIIRTYEEEWSYIPVGGSLPNTPQKNLAFGAAASMV	365 358 361 359 345 393 384 384
Vv-Beta2 Vv-Beta1 Sl-Beta1 Sl-Beta2 Zm-Beta Os-Epsilon Vv-Epsilon Sl-Epsilon	WRD <mark>A</mark> HLPEGSEIRERNRRIPTFLYAMPFSPTRIFLEETSLVARPGLAMDDIQERMAARLRHLGIRVRAVEEDERCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLNNMELKNRNGRIPTFLYAMPFSPTRIFLEETSLVARPGVPMEDIQERMVARLRHLGIRVRSIEEDERCIIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLCNEPYIRAGNSSLPTFLYAMPFSSNRIFLEETSLVARPGRIDDIQERMVARLRHLGIRVRSIEEDEHCLIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLKNNTDLKERNSRIPTFLYAMPFSSNRIFLEETSLVARPGIRIDDIQERMVARLRHLGIKVKSIEEDEHCLIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLKNNTDLKERNSRIPTFLYAMPFSSNRIFLEETSLVARPGIRIDDIQERMVARLRHLGIKVKSIEEDEHCLIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLKNNTDLKERNSRIPTFLYAMPFSSNRIFLEETSLVARPGIRIDDIQERMVARLRHLGIKVKSIEEDEHCLIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLKNSTDLKERNSRIPTFLYAMPFSPRIFLEETSLVARPGIRIDDIQERMARLRHLGIKVKSIEEDEHCLIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLKNSTDLKERNSRIPTFLYAMPFSPRIFLEETSLVARPGIAMDDIQERMAARLRHLGIKVKSVEEDERCVIPMGGPLPRIPQRVVGIGGTAGMV WRDSHLKNSTDLKERNSRIPTFLYAMPFSPRIFIEETSLVARPGIAMDDIQERMAARLRHLGIKVKSVEEDERCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLGNEPYLRVNMAREPTFLYAMPFSPRIFIFEETSLVARPGIAMDDIQERMAARLRHLGIKVSSVEEDERCVIPMGGPLPUPQRVVGIGGTAGMV WRDSHLGNEPYLRVNMAREPTFLYAMPSSTRIFFEETCLASKEAMPFDLLKKRLMSRLDAMGVHIRKVEEEWSVIPVGGSLPNTPQKNLAFGAAASMV YRHHKQKVQCLEVQYPTFLYMPMSSTRIFFEETCLASKDAMPFDLLKKKLMSRLTMGIRIIRTYEEEWSVIPVGGSLPNTEQKNLAFGAAASMV YRDYRHDAQSLEAKYPTFLYAMPMSPTRVFFEETCLASKDAMPFDLLKKKLMSRLTMGIRIIKTVEEEWSVIPVGGSLPNTEQKNLAFGAAASMV	365 358 361 359 345 393 384
Vv-Beta2 Vv-Beta1 Sl-Beta1 Sl-Beta2 Zm-Beta Os-Epsilon Vv-Epsilon Sl-Epsilon	WRDAHLPEGSEIRERNRRIPTFLYAMPFSPTRIFLEETSLVARPGIAMDDIQERMAARLRHLGIRVRAVEEDERCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLNNMELKNRNGRIPTFLYAMPFSSNRIFLEETSLVARPGVPMEDIQERMVARLRHLGIKVKSIEEDERCIIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLGNEPYIRACNSSLPTFLYAMPFNSNLIFLEETSLVARPGVPMEDIQERMVARLRHLGIKVKSIEEDERCIIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLGNEPYIRACNSSLPTFLYAMPFSSNRIFLEETSLVARPGIRIDDIQERMVARLRHLGIKVKSIEEDEHCLIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLGNEPYLRVNNAKEPTFLYAMPFDRDLVFLEETSLVARPGIRIDDIQERMVARLRHLGIKVKSIEEDEHCLIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLGNEPYLRVNNAKEPTFLYAMPFSSNRIFLEETSLVARPGIRIDDIQERMAARLRHLGIKVKSIEEDEHCLIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLGNEPYLRVNNAKEPTFLYAMPFSSTRIFLEETSLVARPGIAMDDIQERMAARLRHLGIKVKSVIEEEKCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLPEGSEIRERNRRIPTLYAMPFSSTRIFLEETSLVARPGIAMDDIQERMAARLRHLGIRVRSVEEDERCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLPEGSEIRERNRIPTLYAMPFSSTRIFFEETCLASKEAMPFDLLKKRLMSRLAMGVHIRKVYEEEWSYIPVGGSLPNTOCKNLAFGAAASMV YRDCFKDKSGEQGNPTFLYAMPMSSTRIFFEETCLASKEAMPFDLLKKKLMSRLAMGVHIRKVYEEEWSYIPVGGSLPNTOCKNLAFGAAASMV YRDCFKDEFSHTECENPTFLYAMPMSPTRVFFEETCLASKDAMPFDLLKKKLMSRLAMGVRIKEITEEWSYIPVGGSLPNTOCKNLAFGAAASMV YRDCFKEEFSHTECENPTFLYAMPMSPTRVFFEETCLASKDAMPFDLLKKKLMSRLAMGIRIIKTUGVRISTIEVGGSLPNTOCKNLAFGAAASMV YRDCFKEEFSHTECENPTFLYAMPMSPTRVFFEETCLASKDAMPFDLLKKKLMSRLAMGIRILGVEWSYIPVGGSLPNTOCKNLAFGAAASMV CMII Charged Region B-Lvc motif HPSTCYMVARTLATAFIVADAIVRTLDICSGDSAFACDALSAEVWRELWPAQRRRQREFFCFGMDILLKLLDICTRRFFDAFFDLEPRYWHGFLS	365 358 361 359 345 393 384 384
Vv-Beta2 Vv-Beta1 Sl-Beta2 Zm-Beta Os-Epsilon Vv-Epsilon Zm-Epsilon Os-Beta Vv-Beta2	WRDAHLPEGSEIRERNRRIPTFLYAMPFSPTRIFLEETSLVARPGIAMDDIQERMAARLRHLGIRVRAVEEDERCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLNNMELKNRNGRIPTFLYAMPFSSRRIFLEETSLVARPGVPMEDIQERMVARLRHLGIRVRSIEDERCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLGNEPYIRACNSSLPTFLYAMPFSSRRIFLEETSLVARPGVPMEDIQERMVARLRHLGIRVRSIEDERCLIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLGNEPYIRACNSSLPTFLYAMPFSSRRIFLEETSLVARPGIRIDDIQERMVARLRHLGIRVRSIEDERCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLGNEPYLRVNNAKEPTFLYAMPFSSRRIFLEETSLVARPGIRIDDIQERMVARLRHLGIKVKSIEEDERCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLGNEPYLRVNNAKEPTFLYAMPFSSRRIFLEETSLVARPGIAMDDIQERMAARLRHLGIKVKSVIEEEKCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLPEGSEIRERNRRIPTFLYAMPFSSTRIFLEETSLVARPGIAMDDIQERMAARLRHLGIKVKSVIEEEKCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLPEGSEIRERNRIPTFLYAMPFSSTRIFLEETSLVARPGIAMDDIQERMAARLRHLGIRVRSVEEDERCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLPEGSEIRERNRIPTFLYAMPFSSTRIFFEETCLASKEAMPFDLLKKRIMSRLDAMGVHIRKVYEEEWSYIPVGGSLPNTOCKNLAFGAAASMV YRDCFKDKFSHPEGGNPTFLYAMPMSSTRIFFEETCLASKDAMPFDLLKKKINSRLDAMGVHIRKVYEEEWSYIPVGGSLPNTOCKNLAFGAAASMV YRDUVRHDAQSLEAKYPTFLYAMPMSPTRVFFEETCLASKDAMPFDLLKKKINSRLDAMGVHIKVYEEEWSYIPVGGSLPNTOCKNLAFGAAASMV YRDUVRHDAQSLEAKYPTFLYAMPMSPTRVFFEETCLASKDAMPFDLLKKKINSRLMINTLGVRIKETVEEWSYIPVGGSLPNTOCKNLAFGAAASMV YRDCFKEFSHTECENPTFLYAMPMSPTRVFFEETCLASKDAMPFDLLKKKINSRLMINTLGVRIKETVEEWSYIPVGGSLPNTOCKNLAFGAAASMV YRDCFKEFSHTECENPTFLYAMPMSPTRVFFEETCLASKDAMPFDLLKKKINGRINILGVRIKETSEWSIPVGGSLPNTOCKNLAFGAAASMV CMII Charged Region B-Lvc motif HPSTGYTVARTLAAAPTVANSIVQIGSSAFACDALSASVWREWPAQRRRQREFFCFGMDILLKLDLOTRRFFDAFFDLFPLEPRYWHGFLS HPSTGYTVARTLAAAPTVANSIVQIGSDRSFFGNELSSEVWRDLWPIERRRQREFFCFGMDILLKLDLOTRRFFDAFFDLEPRYWHGFLS	365 358 361 359 345 393 384 382 391 441 457
Vv-Beta2 Vv-Beta1 Sl-Beta2 Zm-Beta Os-Epsilon Vv-Epsilon Zm-Epsilon Os-Beta Vv-Beta2 Vv-Beta1	WRDAHLPEGSEIRERNRRIPTFLYAMPFSPTRIFLEETSLVARPGIAMDDIQERMAARLRHLGIRVRAVEEDERCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLNNMELKNRNGRIPTFLYAMPFSPRIFLEETSLVARPGVPMEDIQERMVARLRHLGIRVRSIEEDERCIIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLGNEPYIRAGNSSLPTFLYAMPFSSNRIFLEETSLVARPGIRIDDIQERMVARLRHLGIRVRSIEEDEHCLIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLKNNTDLKERNSRIPTFLYAMPFSSNRIFLEETSLVARPGIRIDDIQERMVARLRHLGIRVRSVEEDEHCLIPMGGPLPRIPQNVAIGGTAGMV WRDSHLKNNTDLKERNSRIPTFLYAMPFSSNRIFLEETSLVARPGIRIDDIQERMVARLRHLGIKVKSIEEDEHCLIPMGGPLPRIPQNVAIGGTAGMV WRDSHLKNNTDLKERNSRIPTFLYAMPFSSTRIFLEETSLVARPGIRIDDIQERMVARLRHLGIKVKSIEEDEHCLIPMGGPLPRIPQNVAIGGTAGMV WRDSHLKNNTDLKERNSRIPTFLYAMPFSSTRIFLEETSLVARPGIAMDDIQERMAARLRHLGIKVKSVEEDERCVIPMGGPLPRIPQNVAIGGTAGMV WRDSHLKNNTDLKERNRRIPTFLYAMPFSSTRIFLEETSLVARPGIAMDDIQERMAARLRHLGIKVKSVEEDERCVIPMGGPLPRIPQNVAIGGTAGMV WRDSHLVANKINGINFINAKEPTFLYAMPFSSTRIFEETCLASKEAMPFDLLKKRLMSRLDAMGVHIRVYEEEWSYIPVGGSLPNTDQKNLAFGAASSMV YRLHIKQKVQCLEVQYPTFLYMPMSSTRIFFEETCLASKEAMPFDLLKKRLMSRLDAMGVHIRVYEEEWSYIPVGGSLPNTDQKNLAFGAAASSMV YRLHIKQKVQCLEVQYPTFLYMPMSPTRVFFEETCLASKEAMPFDLLKKKLMSRLETMGIRIIRTYEEEWSYIPVGGSLPNTDQKNLAFGAAASSMV YRLGFKEEFSHTEQENPTFLYMPMSPTRVFFEETCLASKEAMPFDLLKKKLMSRLETMGIRIIRTYEEEWSYIPVGGSLPNTOQKNLAFGAAASSMV CMII Charged Region B-Lycemotif HSTGYMVARTLAAPIVANSIVGIGSSAFAGDALSAEVWRELWPAQRRRQREFFCFGMDILLKLDLDGTRRFFDAFFDLEPRYWHGFLS HPSTGYMVAKTMALAPIVANSIVGIGSSAFAGDALSAEVWRELWPAQRRRQREFFCFGMDILLKLDLQGTRRFFDAFFDLEPRYWHGFLS HPSTGYMVAKTMALAPIVANSIVANSIVANGKPLEFFAFFDLEPRYWHGFLS	365 358 361 359 345 393 384 382 391 441 457 450
Vv-Beta2 Vv-Beta1 Sl-Beta2 Zm-Beta Os-Epsilon Vv-Epsilon Zm-Epsilon Os-Beta Vv-Beta2 Vv-Beta1 Sl-Beta1	WRDALIPEGSEIRERNRRIPTFLYAMPFSPTRIFLEETSLVARPGIAMDDIQERMAARLRHLGIRVRAVEEDERCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLNNMELKNRNGRIPTFLYAMPFSSRRIFLEETSLVARPGVPMEDIQERMVARLRHLGIRVRSIEDERCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLGNEPYIRACNSSLPTFLYAMPFSSRRIFLEETSLVARPGVPMEDIQERMVARLRHLGIRVRSIEDERCLIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLGNEPYIRACNSSLPTFLYAMPFSSRRIFLEETSLVARPGIRIDDIQERMVARLRHLGIRVRSIEDERCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLGNEPYLRVNNAKEPTFLYAMPFSSRRIFLEETSLVARPGIRIDDIQERMVARLRHLGIRVRSVEEDERCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLGNEPYLRVNNAKEPTFLYAMPFSSRRIFLEETSLVARPGIAMDDIQERMAARLRHLGIRVRSVEEDERCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLPEGSEIRERNRRIPTFLYAMPFSSTRIFLEETSLVARPGIAMDDIQERMAARLRHLGIRVRSVEEDERCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLPEGSEIRERNRIPTFLYAMPFSSTRIFFEETCLASKEAMPFDLLKKRLMSRLDAMGVHIRVYEEEWSYIPVGGSLPNTDQKNLAFGAAASMV YRDCFKDKFSHPEQGNPTFLYAMPMSSTRIFFEETCLASKEAMPFDLLKKKLMSRLDAMGVHIRVYEEEWSYIPVGGSLPNTDQKNLAFGAAASMV YRDCFKDEFSHTEQENPTFLYAMPMSPTRVFFEETCLASKDAMPFDLLKKKLMSRLDAMGVHIRVYEEEWSYIPVGGSLPNTQKNLAFGAAASMV YRDVRHDAQSLEAKYPTFLYAMPMSPTRVFFEETCLASKDAMPFDLLKKKLMSRLDAMGVHIRVYEEEWSYIPVGGSLPNTQKNLAFGAAASMV YRDCFKEFSHTEQENPTFLYAMPMSPTRVFFEETCLASKDAMPFDLLKKKLMSRLDAMGVHIRVYEEEWSYIPVGGSLPNTQKNLAFGAAASMV YRDCYWRHDAQSLEAKYPTFLYAMPMSPTRVFFEETCLASKDAMPFDLLKKKLMSRLDAMGVHILGVRIKETVEEWSYIPVGGSLPNTQKNLAFGAAASMV YRDCYWRHDAQSLEAKYPTFLYAMPMSPTRVFFEETCLASKDAMPFDLLKKKLMSRLDAMGVHILGVRIKETSUPVGGSLPNTQKNLAFGAAASMV YRDYWRHDAQSLEAKYPTFLYAMPMSPTRVFFEETCLASKDAMPFDLKKKLMSRLDAMGINLLGVRIKETSUPVGGSLPNTQKNLAFGAAASMV CMII HPSTGYMVARTLAAAPTVANSIVQUGGSSAFACDALSAEVWRELWPAQRRRQREFFCFGMDILLKLDLDGTRRFFDAFFDLEPRYWHGFLS HPSTGYMVARTLAAAPTVANSIVQUGGSSRMIRGKPLHHRVWNCLWPSERRFTREFYSFGMETLLKLDLNGTRGFFDAFFDLEPRYWHGFLS HPSTGYMVARTLAAAPTVANSIVQUGGS	365 358 361 359 345 393 384 382 391 441 457 450 453
Vv-Beta2 Vv-Beta1 Sl-Beta2 Zm-Beta Os-Epsilon Vv-Epsilon Zm-Epsilon Os-Beta Vv-Beta2 Vv-Beta1 Sl-Beta1 Sl-Beta2 Zm-Beta	WRDAHLPEGSEIRERNRRITTFLYAMPFSPTRIFLEETSLVARPGIAMDDIQERMAARLRHLGIRVRAVEEDERCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLNNMELKNRNGRIPTFLYAMPFSPRRIFLEETSLVARPGVPMEDIQERMVARLRHLGIKVKSTEEDERCIIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLGNEPYIRACNSSLPTFLYAMPFSSNRIFLEETSLVARPGVPMEDIQERMVARLRHLGIKVKSTEEDERCIIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLGNEPYIRACNSSLPTFLYAMPFSSNRIFLEETSLVARPGIRIDDIQERMVARLRHLGIKVKSTEEDEHCLIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLGNEPYLRVNNAREPTFLYAMPFSSNRIFLEETSLVARPGIRIDDIQERMVARLRHLGIKVKSTEEDEHCLIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLGNEPYLRVNNAREPTFLYAMPFSSNRIFLEETSLVARPGIRIDDIQERMAARLRHLGIKVKSVIEEDERCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLPEGSEIRERNRRIPTFLYAMPFSSTRIFLEETSLVARPGIAMDDIQERMAARLRHLGIKVKSVIEEDERCVIPMGGSLPNTDQKNLAFGAAASMV WRDSHLPEGSEIRERNRRIPTFLYAMPFSSTRIFLEETSLVARPGIAMDDIQERMAARLRHLGIKVKSVIEEDERCVIPMGGSLPNTDQKNLAFGAAASMV YRDCFKDKSBEGGNPTFLYAMPMSSTRIFFEETCLASKDAMPFDLLKKRLMSRLDAMGVHIKVYEEEWSYIPVGGSLPNTDQKNLAFGAAASMV YRDYRHDAQSLFAKYPTFLYAMPMSSTRVFFEETCLASKDAMPFDLLKKKLMSRLDAMGVHIKVYEEEWSYIPVGGSLPNTDQKNLAFGAAASMV YRDYRHDAQSLFAKYPTFLYAMPMSSTRVFFEETCLASKDAMPFDLLKKKLMSRLDAMGGRILKVYEEEWSYIPVGGSLPNTDQKNLAFGAAASMV YRDYRHDAQSLFAKYPTFLYAMPMSSTRVFFEETCLASKDAMPFDLLKKKLMSRLDAMGGRILLKVYEEEWSYIPVGGSLPNTDQKNLAFGAAASMV YRDYRHDAQSLFAKYPTFLYAMPMSSTRVFFEETCLASKDAMFFDLKKKLMSRLDAMGGRILLKVYEEEWSYIPVGGSLPNTDQKNLAFGAAASMV YRDYRHDAQSLFAKYPTFLYAMPMSSTRVFFEETCLASKDAMFFDLKKKLMSRLDAGGRRQEFFCFGMDILLKLDLGTRRFFDAFFDLEPRYWHGFLS HPSTGYMVARTLAAPIVANSIVQUGGSSAFAGDALSAEVWRELWPAQRRRQEFFCFGMDILLKLDLGTRRFFDAFFDLEPRYWHGFLS HPSTGYMVARTLAAPIVANSIVQUGGSSRMIRGKPLHRVWNGLWPSSRFTREFYSFGMETLLKLDLNGTRGFFDAFFDLDPYWQGFLS HPSTGYMVARTLAAPVANAIIVQLGS	365 358 361 359 345 393 384 382 391 441 457 450 453 451 442
Vv-Beta2 Vv-Beta1 Sl-Beta2 Zm-Beta Os-Epsilon Vv-Epsilon Zm-Epsilon Os-Beta Vv-Beta2 Vv-Beta1 Sl-Beta1 Sl-Beta2 Zm-Beta	WRDAHLPEGSEIRERNRRITTFLYAMPFSPTRIFLEETSLVARPGIAMDDIQERMAARLRHLGIRVRAVEEDERCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLNNMELKNRNGRIPTFLYAMPFSPRRIFLEETSLVARPGVPMEDIQERMVARLRHLGIKVKSTEEDERCIIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLGNEPYIRACNSSLPTFLYAMPFSSNRIFLEETSLVARPGVPMEDIQERMVARLRHLGIKVKSTEEDERCIIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLGNEPYIRACNSSLPTFLYAMPFSSNRIFLEETSLVARPGIRIDDIQERMVARLRHLGIKVKSTEEDEHCLIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLGNEPYLRVNNAREPTFLYAMPFSSNRIFLEETSLVARPGIRIDDIQERMVARLRHLGIKVKSTEEDEHCLIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLGNEPYLRVNNAREPTFLYAMPFSSNRIFLEETSLVARPGIRIDDIQERMAARLRHLGIKVKSVIEEDERCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLPEGSEIRERNRRIPTFLYAMPFSSTRIFLEETSLVARPGIAMDDIQERMAARLRHLGIKVKSVIEEDERCVIPMGGSLPNTDQKNLAFGAAASMV WRDSHLPEGSEIRERNRRIPTFLYAMPFSSTRIFLEETSLVARPGIAMDDIQERMAARLRHLGIKVKSVIEEDERCVIPMGGSLPNTDQKNLAFGAAASMV YRDCFKDKSBEGGNPTFLYAMPMSSTRIFFEETCLASKDAMPFDLLKKRLMSRLDAMGVHIKVYEEEWSYIPVGGSLPNTDQKNLAFGAAASMV YRDYRHDAQSLFAKYPTFLYAMPMSSTRVFFEETCLASKDAMPFDLLKKKLMSRLDAMGVHIKVYEEEWSYIPVGGSLPNTDQKNLAFGAAASMV YRDYRHDAQSLFAKYPTFLYAMPMSSTRVFFEETCLASKDAMPFDLLKKKLMSRLDAMGGRILKVYEEEWSYIPVGGSLPNTDQKNLAFGAAASMV YRDYRHDAQSLFAKYPTFLYAMPMSSTRVFFEETCLASKDAMPFDLLKKKLMSRLDAMGGRILLKVYEEEWSYIPVGGSLPNTDQKNLAFGAAASMV YRDYRHDAQSLFAKYPTFLYAMPMSSTRVFFEETCLASKDAMFFDLKKKLMSRLDAMGGRILLKVYEEEWSYIPVGGSLPNTDQKNLAFGAAASMV YRDYRHDAQSLFAKYPTFLYAMPMSSTRVFFEETCLASKDAMFFDLKKKLMSRLDAGGRRQEFFCFGMDILLKLDLGTRRFFDAFFDLEPRYWHGFLS HPSTGYMVARTLAAPIVANSIVQUGGSSAFAGDALSAEVWRELWPAQRRRQEFFCFGMDILLKLDLGTRRFFDAFFDLEPRYWHGFLS HPSTGYMVARTLAAPIVANSIVQUGGSSRMIRGKPLHRVWNGLWPSSRFTREFYSFGMETLLKLDLNGTRGFFDAFFDLDPYWQGFLS HPSTGYMVARTLAAPVANAIIVQLGS	365 358 361 359 345 393 384 382 391 441 457 450 453 451 442
Vv-Beta2 Vv-Beta1 Sl-Beta2 Zm-Beta Os-Epsilon Vv-Epsilon Zm-Epsilon Os-Beta Vv-Beta2 Vv-Beta1 Sl-Beta1 Sl-Beta2 Zm-Beta	WRDAHLPEGSEIRERNRRITTFLYAMPFSPTRIFLEETSLVARPGIAMDDIQERMAARLRHLGIRVRAVEEDERCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLNNMELKNRNGRIPTFLYAMPFSPRRIFLEETSLVARPGVPMEDIQERMVARLRHLGIKVKSTEEDERCIIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLGNEPYIRACNSSLPTFLYAMPFSSNRIFLEETSLVARPGVPMEDIQERMVARLRHLGIKVKSTEEDERCIIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLGNEPYIRACNSSLPTFLYAMPFSSNRIFLEETSLVARPGIRIDDIQERMVARLRHLGIKVKSTEEDEHCLIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLGNEPYLRVNNAREPTFLYAMPFSSNRIFLEETSLVARPGIRIDDIQERMVARLRHLGIKVKSTEEDEHCLIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLGNEPYLRVNNAREPTFLYAMPFSSNRIFLEETSLVARPGIRIDDIQERMAARLRHLGIKVKSVIEEDERCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLPEGSEIRERNRRIPTFLYAMPFSSTRIFLEETSLVARPGIAMDDIQERMAARLRHLGIKVKSVIEEDERCVIPMGGSLPNTDQKNLAFGAAASMV WRDSHLPEGSEIRERNRRIPTFLYAMPFSSTRIFLEETSLVARPGIAMDDIQERMAARLRHLGIKVKSVIEEDERCVIPMGGSLPNTDQKNLAFGAAASMV YRDCFKDKSBEGGNPTFLYAMPMSSTRIFFEETCLASKDAMPFDLLKKRLMSRLDAMGVHIKVYEEEWSYIPVGGSLPNTDQKNLAFGAAASMV YRDYRHDAQSLFAKYPTFLYAMPMSSTRVFFEETCLASKDAMPFDLLKKKLMSRLDAMGVHIKVYEEEWSYIPVGGSLPNTDQKNLAFGAAASMV YRDYRHDAQSLFAKYPTFLYAMPMSSTRVFFEETCLASKDAMPFDLLKKKLMSRLDAMGGRILKVYEEEWSYIPVGGSLPNTDQKNLAFGAAASMV YRDYRHDAQSLFAKYPTFLYAMPMSSTRVFFEETCLASKDAMPFDLLKKKLMSRLDAMGGRILLKVYEEEWSYIPVGGSLPNTDQKNLAFGAAASMV YRDYRHDAQSLFAKYPTFLYAMPMSSTRVFFEETCLASKDAMFFDLKKKLMSRLDAMGGRILLKVYEEEWSYIPVGGSLPNTDQKNLAFGAAASMV YRDYRHDAQSLFAKYPTFLYAMPMSSTRVFFEETCLASKDAMFFDLKKKLMSRLDAGGRRQEFFCFGMDILLKLDLGTRRFFDAFFDLEPRYWHGFLS HPSTGYMVARTLAAPIVANSIVQUGGSSAFAGDALSAEVWRELWPAQRRRQEFFCFGMDILLKLDLGTRRFFDAFFDLEPRYWHGFLS HPSTGYMVARTLAAPIVANSIVQUGGSSRMIRGKPLHRVWNGLWPSSRFTREFYSFGMETLLKLDLNGTRGFFDAFFDLDPYWQGFLS HPSTGYMVARTLAAPVANAIIVQLGS	365 358 361 359 345 393 384 382 391 441 457 450 453 451 442
Vv-Beta2 Vv-Beta1 Sl-Beta2 Zm-Beta Os-Epsilon Vv-Epsilon Zm-Epsilon Os-Beta Vv-Beta2 Vv-Beta1 Sl-Beta1 Sl-Beta1 Sl-Beta2 Zm-Beta Os-Epsilon Vv-Epsilon Sl-Epsilon	WRDAHLPEGSEIRERNRRIDTFLYAMPFSPTRIFLETSLVARPGLAMDDIQERMAARLRHLGIRVRAVEEDERCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLNNMELKNRDGRIPTFLYAMPFSPTRIFLEETSLVARPGVPMEDIQERMVARLRHLGIRVRRVIEDERCTIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLKNNTDLKERNSRIPTFLYAMPFSPTRIFLEETSLVARPGVPMEDIQERMVARLRHLGIRVRRVIEDERCLIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLKNNTDLKERNSRIPTFLYAMPFSPTRIFLEETSLVARPGVPMEDIQERMVARLRHLGIRVRSVIEDERCVIPMGGPLPRIPONVAIGGTAGMV WRDSHLGNEPYLRVNNREPTFLYAMPFSPTRIFLEETSLVARPGVPMENIZ WRDSHLENESIRERNRIPTFLYAMPFSPTRIFLEETSLVARPGVPMENIZ WRDSHLPEGSEIRERNRIPTLYAMPFSPTRIFLEETSLVARPGVPMENIZ WRDSHLENESEIRERNRIPTLYAMPFSPTRIFLEETSLVARPGVAN WRDSHLENESEIRERNRIPTLYAMPFSPTRIFLEETSLVARPGVAN WRDSHLPEGSEIRERNRIPTLYAMPFSPTRIFLEETSLVARPGVAN WRDSHLPEGSEIRERNRIPTLYAMPFSPTRIFLEETSLVARPGVAN WRDSHLPEGSEIRERNRIPTLYAMPFSPTRIFLEETSLVARPGVAN WRDSHLPEGSEIRERNRIPTLYAMPFSPTRIFLEETSLVARPGVAN WRDSHLPEGSEIRERNRIPTLYAMPFSPTRIFLETSLVARPGVAN WRDSHLPEGSEIRERNRIPTLYAMPFSPTRIFLETSLVARPGVAN WRDSHLPEGSEIRERNRIPTLYAMPFSPTRIFLETSLVARPGVAN WRDSHLPEGSEIRERNRIPTLYAMPFSPTRIFLETSLVARPGVAN WRDSHLPEGSEIRERNRIPTLYAMPFSPTRIFLETSLVARPGVAN WRDSHLPEGSEIRERNRIPTLYAMPFSPTRIFLETSLVARPGVAN WRDSHLPEGSEIRERNRIPTLYAMPFSPTRIFLETSLVARPGVAN WRDSHLPEGSEIRERNRIPTLYAMPFSPTRIFLETSLVARPGVAN WRDSHLPEGSEIRERNRIPTLYAMPFSPTRIFLETSLVARPGVAN WRDSHLPEGSEIRERNRIPTLYAMPFSPTRIFLETSLVARPGVAN WRDSHLPEGSEIRERNRIPTLYAMPFSPTRIFLETSLVARPGVAN WRDSHLPEGSEIRERNRIPTLYAMPFSPTRIFLETSLVARPGVAN WRDSHLPEGSEIRERNRIPTLYAMPFSPTRIFLETSLVARPGVAN WRDSHLPEGSEIRERNRIPTLYAMPFSPTRIFLETSLVARPGVAN WRDSHLPEGSEIRERNRIPTLYAMPFSPTRIFLY WRDSHLFT WRDSHLPEGSEIRERNRIPTLYAMPFSPTRIFLETSLVARPGVAN WRDSHLFT WRDSHLF	365 358 361 359 345 393 384 382 391 441 457 450 453 451 4453 483 480
Vv-Beta2 Vv-Beta1 Sl-Beta1 Sl-Beta2 Zm-Beta Os-Epsilon Zm-Epsilon Zm-Epsilon Os-Beta Vv-Beta2 Vv-Beta1 Sl-Beta1 Sl-Beta2 Zm-Beta Os-Epsilon Vv-Epsilon Zm-Epsilon	WRDAHL DEGSEIRERNRRIPTFLYAMPFSPTRIFIEETSLVARPGLAMDDIOERMAARLRHLGIRVRA WRDSHLNNNMELKNRNGRIPTFLYAMPFSPTRIFIEETSLVARPGVPMEDIOERMVARLRHLGIRVRA WRDSHLGNEPYIRAGNSSIPTFLYAMPFSPTRIFIEETSLVARPGVPMEDIOERMVARLRHLGIRVRAVIEDERCIPMGGPLPVLPORVVGIGGTAGMV WRDSHLGNEPYIRAGNSSIPTFLYAMPFSPTRIFIEETSLVARPGLRIDDIOERMVARLRHLGIRVRAVIEDERCIPMGGPLPVLPORVVGIGGTAGMV WRDSHLGNEPYIRVNNAKEPTFLYAMPFSPTRIFIEETSLVARPGLRIDDIOERMVARLRHLGIRVRAVIEDERCVIPMGGPLPVLPORVVGIGGTAGMV WRDSHLGNEPYIRVNNAKEPTFLYAMPFSPTRIFIEETSLVARPGLAMDDIOERMVARLRHLGIRVRAVIEDERCVIPMGGPLPVLPORVVGIGGTAGMV WRDSHLGNEPYIRVNNAKEPTFLYAMPFSPTRIFIEETSLVARPGLAMDDIOERMVARLRHLGIRVRAVIEENSVIPMGGPLPVLPORVVGIGGTAGMV WRDSHLGNEPYIRVNNAKEPTFLYAMPFSPTRIFIEETSLVARPGLAMDDIOERMAARLRHLGIRVRAVIEENSVIPMGGPLPVLPORVVGIGGTAGMV WRDSHLGREPYIRVNNAKEPTFLYAMPFSPTRIFIEETCLASKEAMPFDLLKKRLMSRLDAMGVHIRKVYEEEWSYIPVGGSLPNTOORNLAFGAAASMV VRDCFKREFSHEDOGNPTFLYAMPMSPTRVFFEETCLASKEAMPFDLLKKRLMSRLDAMGVHIRKVYEEEWSYIPVGGSLPNTOORNLAFGAAASMV VRDVREDAOSLEAKYPTFLYAMPMSPTRVFFEETCLASKEAMPFDLLKKRLMSRLDAMGVHIRKVYEEEWSYIPVGGSLPNTOORNLAFGAAASMV VRDVREDAOSLEAKYPTFLYAMPMSPTRVFFEETCLASKEAMPFDLLKKRLMSRLTMGIRIERTYEEWSYIPVGGSLPNTOORNLAFGAAASMV CMII BESTGYNVARTLATAFIVADAIVRED DIGSGDSAFAGDALSAEVWRELWPAORRROREFFCFGMDILLKLDLOGTRRFFDAFFDLEPRYWHGFLS HPSTGYNVARTLATAFIVADAIVRED HSTGYNVARTLATAFIVADAIVRED HSTGYNVARTLATAFIVADAIVRED HSTGYNVARTLATAFIVADAIVRED HSTGYNVARTLATAFIVADAIVFED HSTGYNVARTLATAFINAN HTTON HANGGYNVARTLATAFIVADAIVFEN HSTGYNVARTLATAFINAN HTTON HANGGYNVARTLATAFINAN	365 358 361 359 345 393 384 382 391 441 457 450 453 451 4453 483 480
Vv-Beta2 Vv-Beta1 Sl-Beta1 Sl-Beta2 Zm-Beta Os-Epsilon Zm-Epsilon Zm-Epsilon Os-Beta Vv-Beta2 Vv-Beta1 Sl-Beta1 Sl-Beta2 Zm-Beta Os-Epsilon Sl-Epsilon Zm-Epsilon Zm-Epsilon	WRDAHL DEGSEIRERNRRIPTFLYAMPFSPTRIFIEETSLVARPGLAMDDIOERMAARLRHLGIRVRA WRDSHLNNNMELKNRNGRIPTFLYAMPFSPTRIFIEETSLVARPGVPMEDIOERMVARLRHLGIRVRA WRDSHLGNEPYIRAGNSSIPTFLYAMPFSPTRIFIEETSLVARPGVPMEDIOERMVARLRHLGIRVRAVIEDERCIPMGGPLPVLPORVVGIGGTAGMV WRDSHLGNEPYIRAGNSSIPTFLYAMPFSPTRIFIEETSLVARPGLRIDDIOERMVARLRHLGIRVRAVIEDERCIPMGGPLPVLPORVVGIGGTAGMV WRDSHLGNEPYIRVNNAKEPTFLYAMPFSPTRIFIEETSLVARPGLRIDDIOERMVARLRHLGIRVRAVIEDERCVIPMGGPLPVLPORVVGIGGTAGMV WRDSHLGNEPYIRVNNAKEPTFLYAMPFSPTRIFIEETSLVARPGLAMDDIOERMVARLRHLGIRVRAVIEDERCVIPMGGPLPVLPORVVGIGGTAGMV WRDSHLGNEPYIRVNNAKEPTFLYAMPFSPTRIFIEETSLVARPGLAMDDIOERMVARLRHLGIRVRAVIEENSVIPMGGPLPVLPORVVGIGGTAGMV WRDSHLGNEPYIRVNNAKEPTFLYAMPFSPTRIFIEETSLVARPGLAMDDIOERMAARLRHLGIRVRAVIEENSVIPMGGPLPVLPORVVGIGGTAGMV WRDSHLGREPYIRVNNAKEPTFLYAMPFSPTRIFIEETCLASKEAMPFDLLKKRLMSRLDAMGVHIRKVYEEEWSYIPVGGSLPNTOORNLAFGAAASMV VRDCFKREFSHEDOGNPTFLYAMPMSPTRVFFEETCLASKEAMPFDLLKKRLMSRLDAMGVHIRKVYEEEWSYIPVGGSLPNTOORNLAFGAAASMV VRDVREDAOSLEAKYPTFLYAMPMSPTRVFFEETCLASKEAMPFDLLKKRLMSRLDAMGVHIRKVYEEEWSYIPVGGSLPNTOORNLAFGAAASMV VRDVREDAOSLEAKYPTFLYAMPMSPTRVFFEETCLASKEAMPFDLLKKRLMSRLTMGIRIERTYEEWSYIPVGGSLPNTOORNLAFGAAASMV CMII BESTGYNVARTLATAFIVADAIVRED DIGSGDSAFAGDALSAEVWRELWPAORRROREFFCFGMDILLKLDLOGTRRFFDAFFDLEPRYWHGFLS HPSTGYNVARTLATAFIVADAIVRED HSTGYNVARTLATAFIVADAIVRED HSTGYNVARTLATAFIVADAIVRED HSTGYNVARTLATAFIVADAIVRED HSTGYNVARTLATAFIVADAIVFED HSTGYNVARTLATAFINAN HTTON HANGGYNVARTLATAFIVADAIVFEN HSTGYNVARTLATAFINAN HTTON HANGGYNVARTLATAFINAN	365 358 361 359 345 393 384 382 391 441 457 450 453 451 4453 483 480
Vv-Beta2 Vv-Beta1 Sl-Beta1 Sl-Beta2 Zm-Beta Os-Epsilon Sl-Epsilon Zm-Epsilon Os-Beta Vv-Beta2 Vv-Beta1 Sl-Beta1 Sl-Beta2 Zm-Beta1 Os-Epsilon Sl-Epsilon Zm-Epsilon Os-Beta Vv-Beta2	WRDAHL DEGSEIRERNRRIPTFLYAMPFSPTRIFIEETSLVARPGLAMDDIOERMAARLRHLGIRVRA WRDSHLNNNMELKNRNGRIPTFLYAMPFSPTRIFIEETSLVARPGVPMEDIOERMVARLRHLGIRVRA WRDSHLGNEPYIRAGNSSIPTFLYAMPFSPTRIFIEETSLVARPGVPMEDIOERMVARLRHLGIRVRAVIEDERCIPMGGPLPVLPORVVGIGGTAGMV WRDSHLGNEPYIRAGNSSIPTFLYAMPFSPTRIFIEETSLVARPGLRIDDIOERMVARLRHLGIRVRAVIEDERCIPMGGPLPVLPORVVGIGGTAGMV WRDSHLGNEPYIRVNNAKEPTFLYAMPFSPTRIFIEETSLVARPGLRIDDIOERMVARLRHLGIRVRAVIEDERCVIPMGGPLPVLPORVVGIGGTAGMV WRDSHLGNEPYIRVNNAKEPTFLYAMPFSPTRIFIEETSLVARPGLAMDDIOERMVARLRHLGIRVRAVIEDERCVIPMGGPLPVLPORVVGIGGTAGMV WRDSHLGNEPYIRVNNAKEPTFLYAMPFSPTRIFIEETSLVARPGLAMDDIOERMVARLRHLGIRVRAVIEENSVIPMGGPLPVLPORVVGIGGTAGMV WRDSHLGNEPYIRVNNAKEPTFLYAMPFSPTRIFIEETSLVARPGLAMDDIOERMAARLRHLGIRVRAVIEENSVIPMGGPLPVLPORVVGIGGTAGMV WRDSHLGREPYIRVNNAKEPTFLYAMPFSPTRIFIEETCLASKEAMPFDLLKKRLMSRLDAMGVHIRKVYEEEWSYIPVGGSLPNTOORNLAFGAAASMV VRDCFKREFSHEDOGNPTFLYAMPMSPTRVFFEETCLASKEAMPFDLLKKRLMSRLDAMGVHIRKVYEEEWSYIPVGGSLPNTOORNLAFGAAASMV VRDVREDAOSLEAKYPTFLYAMPMSPTRVFFEETCLASKEAMPFDLLKKRLMSRLDAMGVHIRKVYEEEWSYIPVGGSLPNTOORNLAFGAAASMV VRDVREDAOSLEAKYPTFLYAMPMSPTRVFFEETCLASKEAMPFDLLKKRLMSRLTMGIRIERTYEEWSYIPVGGSLPNTOORNLAFGAAASMV CMII BESTGYNVARTLATAFIVADAIVRED DIGSGDSAFAGDALSAEVWRELWPAORRROREFFCFGMDILLKLDLOGTRRFFDAFFDLEPRYWHGFLS HPSTGYNVARTLATAFIVADAIVRED HSTGYNVARTLATAFIVADAIVRED HSTGYNVARTLATAFIVADAIVRED HSTGYNVARTLATAFIVADAIVRED HSTGYNVARTLATAFIVADAIVFED HSTGYNVARTLATAFINAN HTTON HANGGYNVARTLATAFIVADAIVFEN HSTGYNVARTLATAFINAN HTTON HANGGYNVARTLATAFINAN	365 358 361 359 345 393 384 382 391 441 457 450 453 451 4453 483 480
Vv-Beta2 Vv-Beta1 Sl-Beta1 Sl-Beta2 Zm-Beta Os-Epsilon Zm-Epsilon Zm-Epsilon Os-Beta Vv-Beta2 Vv-Beta1 Sl-Beta1 Sl-Beta2 Zm-Beta Os-Epsilon Zm-Epsilon Zm-Epsilon Sn-Epsilon	WRDAHL DEGSEIRERNRRIPTFLYAMPFSPTRIFIEETSLVARPGLAMDDIOERMAARLRHLGIRVRA WRDSHLNNNMELKNRNGRIPTFLYAMPFSPTRIFIEETSLVARPGVPMEDIOERMVARLRHLGIRVRA WRDSHLGNEPYIRAGNSSIPTFLYAMPFSPTRIFIEETSLVARPGVPMEDIOERMVARLRHLGIRVRAVIEDERCIIPMGGPLPVLPORVVGIGGTAGMV WRDSHLGNEPYIRAGNSSIPTFLYAMPFSPTRIFIEETSLVARPGLRIDDIOERMVARLRHLGIRVRAVIEDERCIIPMGGPLPVLPORVVGIGGTAGMV WRDSHLGNEPYIRVNNAKEPTFLYAMPFSPTRIFIEETSLVARPGLRIDDIOERMVARLRHLGIRVRAVIEDERCVIPMGGPLPVLPORVVGIGGTAGMV WRDSHLGNEPYIRVNNAKEPTFLYAMPFSPTRIFIEETSLVARPGLAMDDIOERMVARLRHLGIRVRAVIEDERCVIPMGGPLPVLPORVVGIGGTAGMV WRDSHLESTIGNEN WRDSHLES	365 358 361 359 345 393 384 382 391 441 457 450 453 451 4453 483 480
Vv-Beta2 Vv-Beta1 Sl-Beta1 Sl-Beta2 Zm-Beta Os-Epsilon Vv-Epsilon Zm-Epsilon Os-Beta Vv-Beta2 Vv-Beta1 Sl-Beta2 Zm-Beta Os-Epsilon Zm-Epsilon Zm-Epsilon Sl-Epsilon Zm-Epsilon Sl-Epsilon Sl-Epsilon Sl-Epsilon Zm-Epsilon Sl-Epsilon Sl-Epsilon Sl-Epsilon Sl-Epsilon Sl-Epsilon Sl-Epsilon Sl-Epsilon Sl-Epsilon Sl-Epsilon Sl-Epsilon	WRDAHL DEGSEIRERNRRIPTFLYAMPFSPTRIFIEETSLVARPGLAMDDIOERMAARLRHLGIRVRA WRDSHLNNNMELKNRNGRIPTFLYAMPFSPTRIFIEETSLVARPGVPMEDIOERMVARLRHLGIRVRA WRDSHLGNEPYIRAGNSSIPTFLYAMPFSPTRIFIEETSLVARPGVPMEDIOERMVARLRHLGIRVRAVIEDERCIIPMGGPLPVLPORVVGIGGTAGMV WRDSHLGNEPYIRAGNSSIPTFLYAMPFSPTRIFIEETSLVARPGLRIDDIOERMVARLRHLGIRVRAVIEDERCIIPMGGPLPVLPORVVGIGGTAGMV WRDSHLGNEPYIRVNNAKEPTFLYAMPFSPTRIFIEETSLVARPGLRIDDIOERMVARLRHLGIRVRAVIEDERCVIPMGGPLPVLPORVVGIGGTAGMV WRDSHLGNEPYIRVNNAKEPTFLYAMPFSPTRIFIEETSLVARPGLAMDDIOERMVARLRHLGIRVRAVIEDERCVIPMGGPLPVLPORVVGIGGTAGMV WRDSHLESTIGNEN WRDSHLES	365 358 361 359 345 393 384 382 391 441 457 450 453 451 4453 483 480
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Vv-Beta2 Vv-Beta1 Sl-Beta1 Sl-Beta2 Zm-Beta Os-Epsilon Zm-Epsilon Zm-Epsilon Zm-Epsilon Sl-Beta2 Vv-Beta1 Sl-Beta2 Zm-Beta Os-Epsilon Zm-Epsilon Zm-Epsilon Sl-Epsilon Sl-Epsilon Sl-Epsilon Sl-Beta2 Vv-Beta1 Sl-Beta2 Zm-Beta1 Sl-Beta2 Zm-Beta1 Sl-Beta2	NRIAHLEGS EIRENNRET PTELYAMPFSPTRIFLEETSLVARPGI AMDDIQERMAARLRHLGIRVREVEDERCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLENNER KNRNGRIPTELYAMPFSSNRIFLEETSLVARPGIPMEDIQERMVARLRHLGIRVRSTEDDERCIIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLENEPYIRAGNSTPTELYAMPFSSNRIFLEETSLVARPGIPSIDIQERMVARLRHLGIRVRSVIEDDERCIIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLENEPYIRAGNSTPTELYAMPFSSRIFLEETSLVARPGIPSIDIQERMVARLRHLGIRVRSVIEDDERCIIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLENEPYIRVNAREPTFLYAMPFSSRIFLEETSLVARPGIPSIDIQERMVARLRHLGIRVRSVIEDDERCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLENEPYIRVNAREPTFLYAMPFSSRIFLEETSLVARPGIAMDIQERMARLRHLGIRVRSVEEDDERCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLENEPYIRVNAREPTFLYAMPFSSRIFIEDETSLVARPGIAMDIQERMARLRHLGIRVRSVEEDDERCVIPMGGPLPVLPQRVVGIGGTAGMV YRDCFDRSHBDCSGIPTFLYAMPHSSTRIFLEETSLVARPGIAMDIQERMARLRHLGIRVRSVEEDERCVIPMGGPLPVLPQRVVGIGGTAGMV YRDCFDRSHBDCSGIPTFLYAMPHSSTRIFLEETSLVARPGIAMDIQERMARLRHLGIRVRSVEEDERCVIPMGGSLENTOKNLAFGAASMV YRDTVREDAOSLEARYPTFLYAMPHSSTRIFFEETCLASKDAMPFDLLKKRLMGRLETMGIRIETTGIRIETYEEWSYIPVGGSLENTOKNLAFGAASMV YRDTVREDAOSLEARYPTFLYAMPHSSTRIFFEETCLASKDAMPFDLLKKRLMGRLETMGIRIETTGIRIETYEEWSYIPVGGSLENTOKTLAFGAASMV YRDTVREDAOSLEARYPTFLYAMPHSSTRIFFEETCLASKDAMPFDLLKKRLMGRLETMGIRIETTGIRIETYEEWSYIPVGGSLENTOKTLAFGAASMV YRDTVREDAOSLEARYPTFLYAMPHSSTRIFFEETCLASKDAMPFDLLKKRLMGRLETMGIRIETTGIRIETYEEWSYIPVGGSLENTOKTLAFGAAASMV YRDTVREDAOSLEARYPTFLYAMPHSSTRIFFEETCLASKDAMPFDLLKKRLMGRLETMGIRIETTGIRIETYEEWSYIPVGGSLENTOKTLAFGAAASMV YRDTVREDAOSLEARY	365 358 361 359 345 393 384 382 391 441 457 450 453 451 4453 483 480
Vv-Beta2 Vv-Beta1 Sl-Beta1 Sl-Beta2 Zm-Beta Os-Epsilon Zm-Epsilon Zm-Epsilon Zm-Epsilon Sl-Beta2 Vv-Beta1 Sl-Beta2 Zm-Beta Os-Epsilon Zm-Epsilon Zm-Epsilon Sl-Epsilon Sl-Epsilon Sl-Epsilon Sl-Beta2 Vv-Beta1 Sl-Beta2 Zm-Beta1 Sl-Beta2 Zm-Beta1 Sl-Beta2	NRIAHLEGS EIRENNRET PTELYAMPFSPTRIFLEETSLVARPGI AMDDIQERMAARLRHLGIRVREVEDERCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLENNER KNRNGRIPTELYAMPFSSNRIFLEETSLVARPGIPMEDIQERMVARLRHLGIRVRSTEDDERCIIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLENEPYIRAGNSTPTELYAMPFSSNRIFLEETSLVARPGIPSIDIQERMVARLRHLGIRVRSVIEDDERCIIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLENEPYIRAGNSTPTELYAMPFSSRIFLEETSLVARPGIPSIDIQERMVARLRHLGIRVRSVIEDDERCIIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLENEPYIRVNAREPTFLYAMPFSSRIFLEETSLVARPGIPSIDIQERMVARLRHLGIRVRSVIEDDERCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLENEPYIRVNAREPTFLYAMPFSSRIFLEETSLVARPGIAMDIQERMARLRHLGIRVRSVEEDDERCVIPMGGPLPVLPQRVVGIGGTAGMV WRDSHLENEPYIRVNAREPTFLYAMPFSSRIFIEDETSLVARPGIAMDIQERMARLRHLGIRVRSVEEDDERCVIPMGGPLPVLPQRVVGIGGTAGMV YRDCFDRSHBDCSGIPTFLYAMPHSSTRIFLEETSLVARPGIAMDIQERMARLRHLGIRVRSVEEDERCVIPMGGPLPVLPQRVVGIGGTAGMV YRDCFDRSHBDCSGIPTFLYAMPHSSTRIFLEETSLVARPGIAMDIQERMARLRHLGIRVRSVEEDERCVIPMGGSLENTOKNLAFGAASMV YRDTVREDAOSLEARYPTFLYAMPHSSTRIFFEETCLASKDAMPFDLLKKRLMGRLETMGIRIETTGIRIETYEEWSYIPVGGSLENTOKNLAFGAASMV YRDTVREDAOSLEARYPTFLYAMPHSSTRIFFEETCLASKDAMPFDLLKKRLMGRLETMGIRIETTGIRIETYEEWSYIPVGGSLENTOKTLAFGAASMV YRDTVREDAOSLEARYPTFLYAMPHSSTRIFFEETCLASKDAMPFDLLKKRLMGRLETMGIRIETTGIRIETYEEWSYIPVGGSLENTOKTLAFGAASMV YRDTVREDAOSLEARYPTFLYAMPHSSTRIFFEETCLASKDAMPFDLLKKRLMGRLETMGIRIETTGIRIETYEEWSYIPVGGSLENTOKTLAFGAAASMV YRDTVREDAOSLEARYPTFLYAMPHSSTRIFFEETCLASKDAMPFDLLKKRLMGRLETMGIRIETTGIRIETYEEWSYIPVGGSLENTOKTLAFGAAASMV YRDTVREDAOSLEARY	365 358 361 359 345 393 384 382 391 441 457 450 453 451 4453 483 480
Vv-Beta2 Vv-Beta1 Sl-Beta1 Sl-Beta2 Zm-Beta Os-Epsilon Zm-Epsilon Zm-Epsilon Zm-Epsilon Sl-Beta2 Vv-Beta1 Sl-Beta2 Zm-Beta Os-Epsilon Zm-Epsilon Zm-Epsilon Sl-Epsilon Sl-Epsilon Sl-Epsilon Sl-Beta2 Vv-Beta1 Sl-Beta2 Zm-Beta1 Sl-Beta2 Zm-Beta1 Sl-Beta2	WRDAHL DEGSEIRERNRRIPTFLYAMPFSPTRIFIEETSLVARPGLAMDDIOERMAARLRHLGIRVRA WRDSHLNNNMELKNRNGRIPTFLYAMPFSPTRIFIEETSLVARPGVPMEDIOERMVARLRHLGIRVRA WRDSHLGNEPYIRAGNSSIPTFLYAMPFSPTRIFIEETSLVARPGVPMEDIOERMVARLRHLGIRVRAVIEDERCIIPMGGPLPVLPORVVGIGGTAGMV WRDSHLGNEPYIRAGNSSIPTFLYAMPFSPTRIFIEETSLVARPGLRIDDIOERMVARLRHLGIRVRAVIEDERCIIPMGGPLPVLPORVVGIGGTAGMV WRDSHLGNEPYIRVNNAKEPTFLYAMPFSPTRIFIEETSLVARPGLRIDDIOERMVARLRHLGIRVRAVIEDERCVIPMGGPLPVLPORVVGIGGTAGMV WRDSHLGNEPYIRVNNAKEPTFLYAMPFSPTRIFIEETSLVARPGLAMDDIOERMVARLRHLGIRVRAVIEDERCVIPMGGPLPVLPORVVGIGGTAGMV WRDSHLESTIGNEN WRDSHLES	365 358 361 359 345 393 384 382 391 441 457 450 453 451 4453 483 480

Fig. 1. Aligment of the amino acid sequences of β-LCY and ε-LCY proteins in *O. Sativa*, *V. Vinifera*, *S. Lycopersicum*, and *Z. mays* via ClustalW. The numbers on the left indicate the number of amino acids. Residues identical for all sequences in a given position are indicated with white text on a black background. Illustration was made by using BoxShade server. Characteristic regions of LCYs indicated on the sequences; Plant β-LCY conserved region, dinucleotide binding signature, cyclase motif (CM I and CM II), charged region, and β-LCY motif.

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