**Title: Comprehensive *in silico* characterization of *Arabidopsis thaliana* RecQl helicases through structure prediction and molecular dynamics simulations**

**Supplementary Figure S1**. Domain structure, chromosomal location, and exon-intron arrangement of AtRecQl : (a) SMART (http://smart.embl-heidelberg.de/smart/) was used to forecast domain structures and MyDomains (http://prosite.expasy.org/mydomains/) was used to design them. The domains are projected by blue pentagon for DEXDc- N-terminal DEAD-like helicase superfamily domain; green horizontal hexagon for HELICc- Helicase Superfamily c-terminal domain; gray rectangle for RecQ\_Zn\_Bind- zinc-binding domain; orange vertical hexagon for RQC- RecQ C-terminal domain; and gray oval for HRDC- hypothetical role in nucleic acid binding domain. (b) Chromosome mapping of the AtRecQl genes f in A. thaliana. The length of each chromosome is indicated by its relative length. (c) The exon-intron structure of five AtRecQls genes is depicted, with the scale below the figure comparing the length of the gene in base pairs (bp). Exons are represented by the violet round-cornered rectangle, UTRs by the orange rectangle, and introns by the black line.

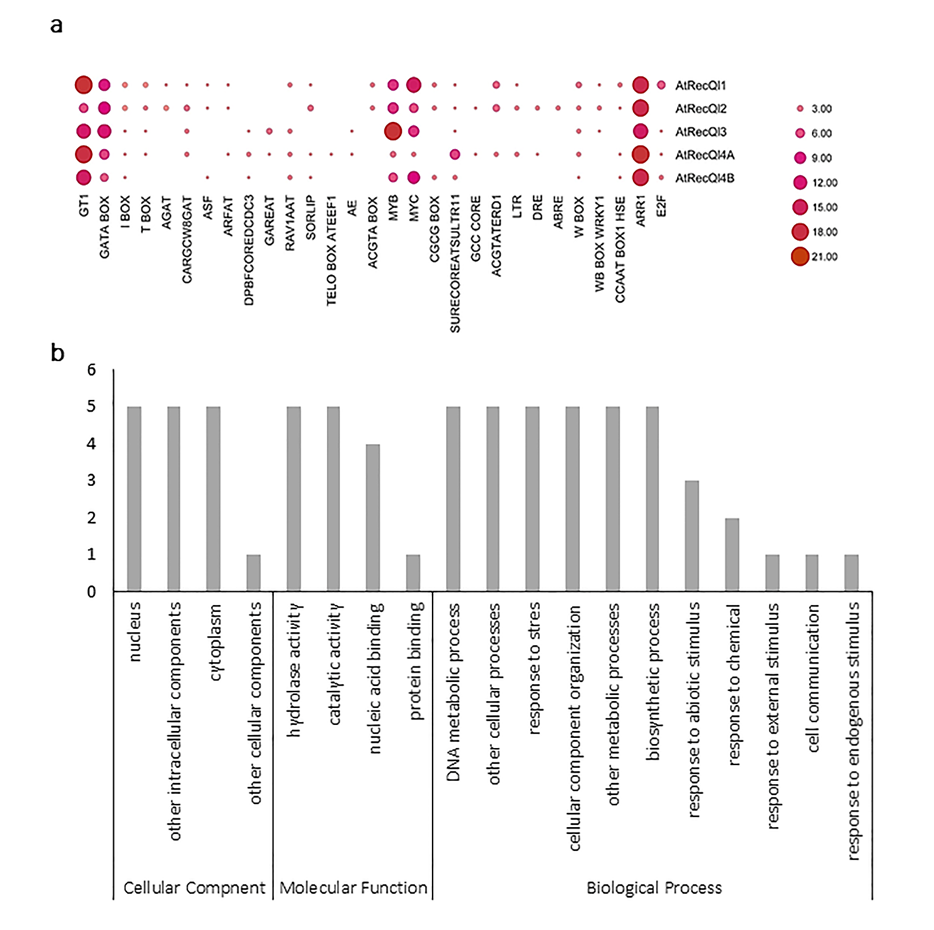
****

*(AtRecQl* genomic sequences were plotted using the Gene Structure Display Server (GSDS) 2.0 program (<http://gsds.cbi.pku.edu.cn/>) to visualize the intron/exon organization of the genes. Domains were analyzed using SMART online database (http://smart.embl-heidelberg.de/smart/) with default parameter HMMER searches. The Domains were drawn by Mydomains (https://prosite.expasy.org/mydomains/). )

**Supplementary Figure S2. Phylogenetic analysis of RecQl proteins from ten different plants.**The tree was constructed with four groups. Groups I, II, III, and IV are represented by light blue, pink, violet, and black, respectively, while RecQls from A. thaliana are indicated in red.

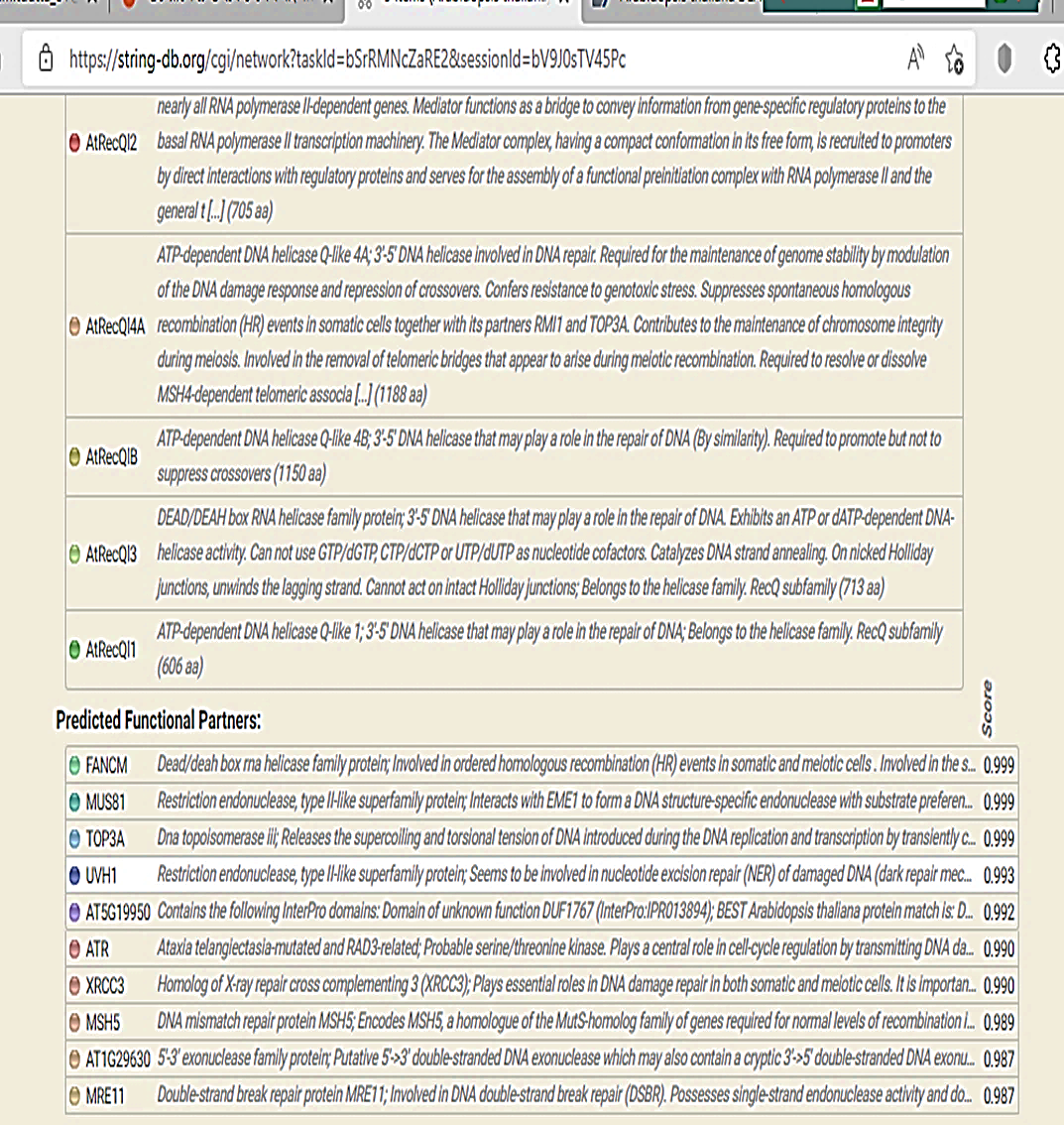
**E:\AtRecQ paper 1\king saoud\review\RecQ-TREE-edited-FH-20240902.tif**

**Supplementary Figure S3. Predicted cis-elements in the promoter regions of AtRecQl genes.**(a**)** Predicted cis-elements was presented as heat map using TBTools. Scale red to pink and circle size by area indicating the highest to lowest number of cis-elements. (b) The three Gene Ontology (GO) terms are presented by column chart.

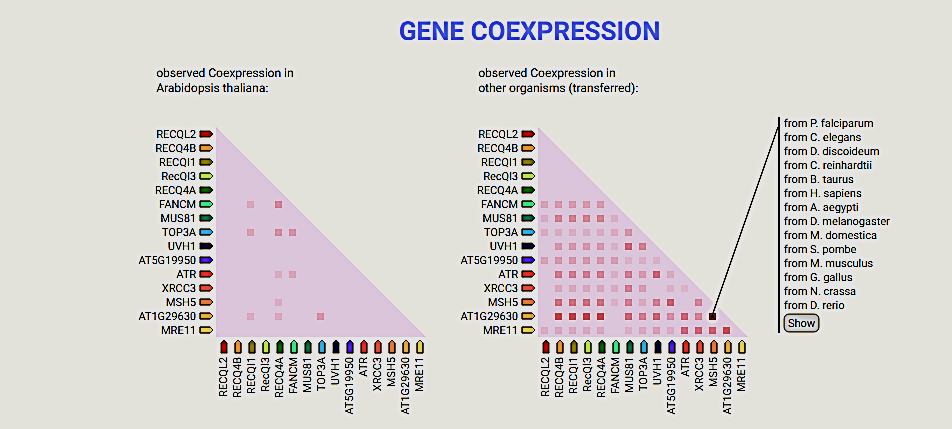
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**Supplementary Figure S4.** KEGG pathways proteins from AtrecQls Protein–Protein Interaction network.

**Supplementary Figure S5.** Top ten predicted functional partners of AtRecQls.

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**Supplementary Figure S6.** Co-expression networks were generated by STRING from Protein–Protein Interaction networks of AtRecQls as query genes. Dark red indicate the higher co-expression.

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**Supplementary Figure S7.** Cellular component of AtRecQls Protein–Protein Interaction network.

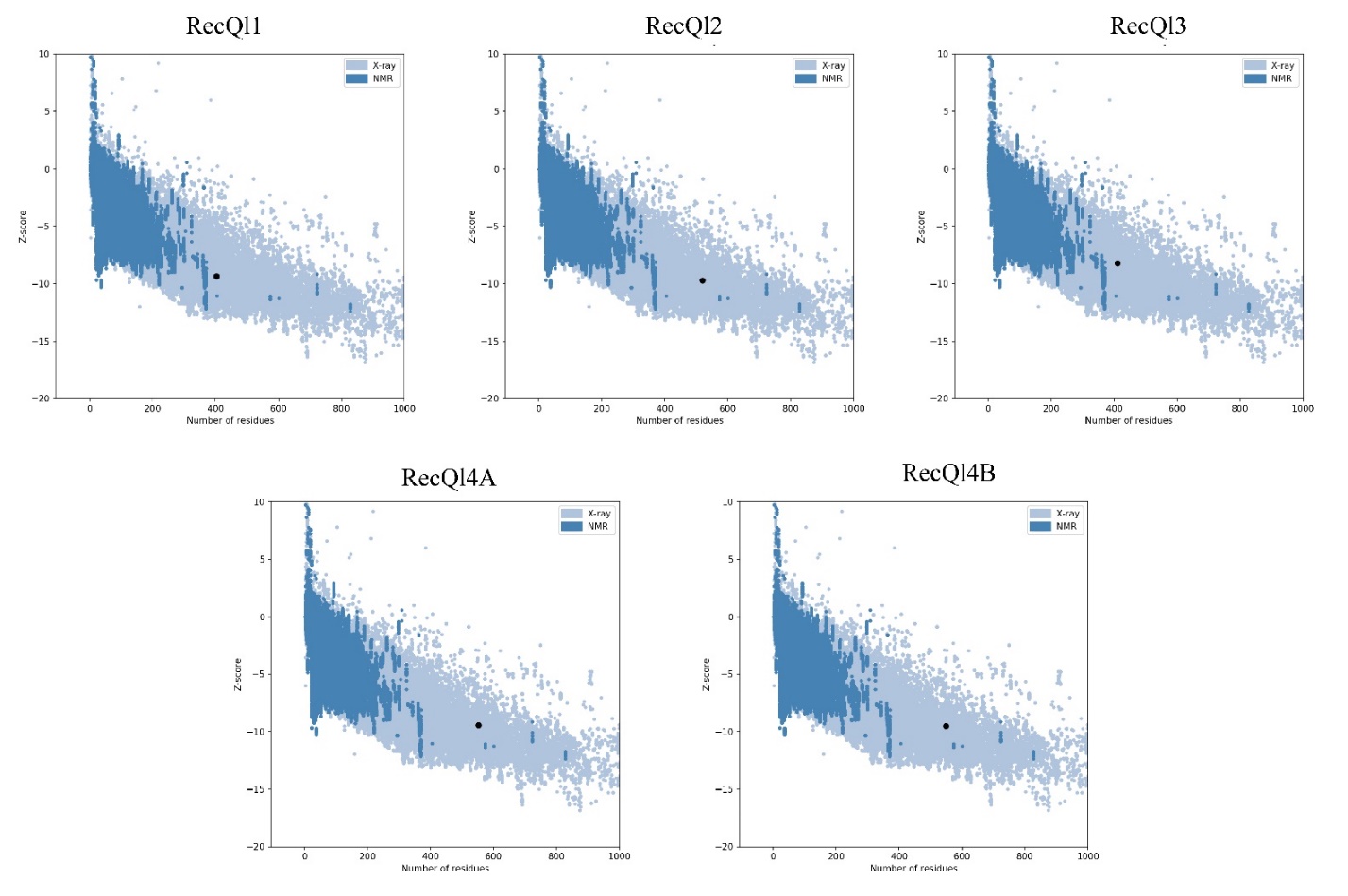
**Supplementary Figure S8.** Molecular function terms of AtRecQls Protein–Protein Interaction network.

**Supplementary Figure S9.** Biological process of AtRecQls Protein–Protein Interaction network.

**Supplementary Figure S10.** The 3D structure and the contrast between the Ramachandran plots of AtRecQl proteins constraints applied in MolProbity. The 3D structure of AtRecQl proteins and the ψ and φ plot delineates validation regions for protein structures, blue (favored) and purple (allowed) outlines. Black circles represent the amino acids of corresponding proteins.

E:\AtRecQ paper 1\new submission 100624\Fig. 5.tif

**Supplementary Figure S11**. The ProSA-web generated a z-score plot depicting the 3D structure of AtRecQl proteins. The z-score falls nearly within the range typically observed for native protein conformations. A black dot on the plot represents the z-score for the protein vaccine. The analysis integrates data from various experimental chains of proteins in the Protein Data Bank (PDB), acquired through both nuclear magnetic resonance (NMR) and x-ray crystallography techniques. NMR-derived chains are indicated in dark blue, while X-ray crystallography-derived chains are represented in light blue.

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**Table S1:** Amino acid sequence used for construction of phylogenetic tree.

|  |  |  |  |
| --- | --- | --- | --- |
| Name | NCBI Reference | Gene name | **Amino acid sequence, signal peptide, LRR** |
| AtRecQl1 | NP\_187225.2 RECQ helicase l1 [Arabidopsis thaliana] | *A. thaliana* | MKDQDLELEKVRLISLATKLGFDEDSAKKCLDRFVDLYGDDGRDFITVELCGDDFLAALADFEEGTEEWDDIQAIESEAQGNLAEMFDKSTNPSDNGFDTDDDDDDSRVEVHVIEDSPEPKKKPEIVELDSSSDLEDVETRFKVPRRSQTCSRSMDYSMEDSVSTISGRKPSVQISNKDHETPSYEELQALDDLEFANLVIFGNKVFRPLQHQACRASMERKDCFVLMPTGGGKSLCYQLPATLKAGVTIVISPLLSLIQDQIVALNLKFGIPATFLNSQQTSSQAAAVLQELRRDNPSCKLLYVTPEKIAGSSSFLETLRCLDRKGLLAGFVVDEAHCVSQWGHDFRPDYRELGCLKQNFPRVPVMALTATATESVCQDVLKSLRIPRAPVLKMSFDRINLKYEVIVKTKEPLKQLQELLRDRFKDQSGIVYCLSKSECVDVAKFLNEKCKVKTVYYHAGVPAKQRVDVQRKWQTGEVRIVCATIAFGMGIDKADVRFVIHNTLSKAVESYYQESGRAGRDGLQAQCICLYQKKDFSRVVCMLRNGQGRNMDRFKSAMAQAKKMQQYCELKTECRRQMLLEYFGESFDRMICKSSLNPCDNCERS |
| CsRecQl1 | XP\_010486049.1 | *Camelina sativa* | MKDQDLELEKARLISLATQLGFDEDSAKKCLDRFVSLYGDDGRDFITVELCGDDFLAALADFDEGTEEWDDIQAIESEAQGTLAEMFDKANPSDNGFNTDDDDDDDSRVQVHVIEDSPEPKKHPEVMDLDSSSDLEDVETRFKVPRRPQTSSINHSLRSMDCSMEDSVSTISGRKPSVHISQKDLEETPSYEELQALDDLEFANLVIFGNKVFRPLQHQACRASMEKKDCFVLMPTGGGKSLCYQLPATLKAGVTIVISPLLSLIQDQIVALNLKYGIPATFLNSQQTASQAAAVLQELRRDNPSCKLLYVTPEKIAGSSSFLETLRCLDRKGLLAGFVVDEAHCVSQWGHDFRPDYRELGCLKQNFPRVPVMALTATATESVCQDVLKSLRIPRAPVLKMSFDRTNLKYEVIVKTKEPLKQLQELLKDRFKDQSGIVYCLSKSECVDVAKFLNEKCKVKTVYYHAGIPAKQRVDVQRKWQTGEVRIVCATIAFGMGIDKADVRFVIHNTLSKAVESYYQESGRAGRDGLQAQCICLYQKKDFSRVVCMLRNGQGRNMDRFKSAMAQAKKMQQYCELKTECRRQTLLEYFGESFDRRICKSSLNPCDNCEKS |
| BnRecQl1 | XP\_013693734.1 | *Brassica napus* | MKGQDLELEKARLLILATRLGFDEESAKKCLDRFVDLYGDDGRDFITVELCGDDFLAALADFEEGTEEWDDVQALETEAQGTLAEMFNRANTSDNGFETDDGESSVQVHVIEDSLESKNKPDVMELDSSSDFEDDEDTQTGSRSHSLRSMEYSMEDSVSTISGRKPSVLTSGKDHETPSYEELQALDDLEFANLVIFGNKVFRPLQHQACRASMEKKDCFVLMPTGGGKSLCYQLPAALKTGVTIVISPLLSLIQDQIVALNLKFGVPATFLNSQQTSSQAAIVLQELRRDNPSCKLLYVTPEKIAGSSSFLETLRCLDRKGLLAGFVVDEAHCVSQWGHDFRPDYRELGCLKQNFPRVPVMALTATATESVCQDVLKSLRIPRAPVLKMSFDRTNLKYEVINKTKEPLKQLQELLKDRFKDQSGIVYCLSKSECVDVAKFLNEKCKVKTVYYHAGMPAKQRVDVQRKWQTGEVRIVCATIAFGMGIDKADVRFVIHNTLSKAIESYYQESGRAGRDGLQAQCICLYQKKDFSRVVCMLRNGQGRNMDRFKSAMAQAKKMQQYCELKTECRRQMLLDYFGESFDRRICKSSLHPCDNCEKS |
| RsRecQl1 | XP\_018490404.1 | *Raphanus sativus* | MKGQDLELEKARLLSLATKLGFDEESARKCLDRFVDLYGDDGRDFITVALCGDDFIAALADFEEGTEEWDDVQALETEAQGTLAEMFCKAKTSDDNGFETDDDGESRSAAQVHVIEDSPPPDSKNNNPDVMELDSSSDFEDDDDDGTQFKAPMTGSRNHFSRSMEYSMQDSVSTISGKKPSVQTSDKDHETPSYEELQALDDLEFANLVVFGNKVFRPLQHQACRASMEKKDCFVLMPTGGGKSLCYQLPATLKAGVTIVISPLLSLIQDQIVALNLKFGVPATFLNSQQTSSQAAIVLQELRRDNPSCKLLYVTPEKIAGSSSFLETLRCLDRKGLLAGFVVDEAHCVSQWGHDFRPDYRELGCLKQNFPRVPVMALTATATESVCQDVLKSLRIPRALVLKMSFDRTNLKYEVINKTKEPLKQLQELLKDRFKDQFGIVYCLSKSECVDVAKFLNEKCKVKTVYYHAGMPAKQRVDVQRKWQTGEVRIVCATIAFGMGIDKADVRFVIHNTLSKAIESYYQESGRAGRDGLQAQCICLYQKKDFSRVVCMLRNGQGRNMDRFKSAMAQAKKMQQYCELKTECRRQMLLEHFGESFDRRICKSSLHPCDNCEKSSNPCDNCLKSSS |
| StRecQl1 | XP\_006344742.1 | *Solanum tuberosum* | MKARENQRRPPLRRPRKAEIEDAEEMQDEDLELEKVRLLSLALEFGFDEDSAKTCLNRLVELYGDDGRDFISVELCGDEFLALLAESMQDTEDWDDLQAIESEACGALADMLGKGAREDCEVDCDEDSGAYVHVIEDSPQQQRRAKAVLLDSSSDSEEMGIRFARKEDLPSTSKIRRDRIHQGMNPQSGCRASTSMDYTSVVTEGSYSSVSPEMECPLESNHGDKTLSYEELQRLDDIELANVVVFGNRSFRPLQHQACQACLQKRDCFVLMPTGGGKSLCYQLSAIVQPGVMIVVSPLLSLIQDQIITLNLKFGIPATFLNSQQTQSQTAAVLRELRKDVPSCKLLYVTPERIAGNLSFQETLQCMHRKGQLAGFVIDEAHCVSQWGHDFRPDYRVLGCLKQNFPDVPVMALTATATHAVREDILSALRIPRALVLETSFDRSNLKYEVTGKSKEPLKQLGNLLLDRFKNLSGIVYCLSKSECVDVSKFLNEKCKIKTVYYHAGLASRQRVAVQKRWRSGEVDIVCATIAFGMGIDKPDVRFVVHNTMSKSIESYYQEAGRAGRDGLPATCVILYQKKDFSRVVCMLRSGQGYKKESLKRAMEQARKMQKYCELKTECRRKLLLEHFGESFDQYSCKNG |
| CtsRecQl1 | XP\_024951762.1 | *Citrus sinensis* | MDCHDFEFEKARLLSLALEFGFDQESANKSLNRLISLYGDDGQDFISVEHCGDDFIATLAETMQDSEEWDDLQAMESEACGALNNMFDKRVIDNNQANDNDNSRKYIDILDDSPEPKRRPTLMELDSLSDTEDLDFTIPKQKDAILNLSSCPDGRSQIFTPSSVKHSSKSVDCKSGVSTSSASSVSNKKRSSLISDNEHGTLSFEELQALDDMEFANVVIFGNRAFRPLQHQACKASVAKQDCFVLLPTGGGKSLCYQLPATLKSGVTVVISPLLSLIQDQIITLNLKFGIPATFLNSQQTVSQAAAVLQELRKDKPSCKLLYVTPERIVGNQSFSEVLKCLHRKRQLAGFVVDEAHCVSQWGHDFRPDYRGLGLLKQNFPDVPVMALTATATQSVRLDILKALRIPHALVLETSFDRPNLKYEVIGKSKEALKQIGQLIKDRFKDQCGIIYCLSKNECVEVSNFLNQKCKIKTVYYHAGLAARQRVVVQKKWHTGDVQIVCATIAFGMGIDKPDVRFVIHNTLSKSIESYYQESGRAGRDNLPSVCIVLYQKKDFSRVVCMLRNGQGFKSEAFKTAMAQAKKMQQYCEQKAECRRQTLLEHFGESFDRKACKNGSNPCDNCLKTSL |
| GhRecQl1 | XP\_016666706.1 | *Gossypium hirsutum* | MEDHDFKLEKARLLSLALEFGFDERLAKKSLDRLISLYGDDGRDFITVEHCGDDFLVALAETMEDSEDWDDDLQVVESEACGALNNMLDKNALPNTRSNSNTNVRNCINVIDDSPKRKKQTNLMELDSSSDEESLDAWISKKKGNFSTLSSRQDQSSRVDCRSSVTGGSISGQKQFFSTSMGGNGTLSYDELQALDDVELANVVIFGNRSFRALQRQACKASLAKRDCFILMPTGGGKSLCYQLPATLKPGVTLVISPLLSLIQDQIVTLNLKFGIPATFLNSQQTASQAAAVLHELRKDNPSCKLLYVTPERVAGNQSFLEVLKCLHRKGQLAGFAVDEAHCVSQWGHDFRPDYRGLGCLKQHFPNVPVTALTATATHSVREDILKALRIPNALVLKTSFDRSNLKYEVIGKAKDSLKQLGQLLQDRFKNQCGIVYCLSKNECAEVSNFLNEKCKIKTVYYHAGLASQQRVTVQKKWFDGEVQIVCATIAFGMGIDKPDVRFVVHNTMSKSIESYYQESGRAGRDNCSAVCIALYQKKDFSRVVCMLRNGQGCKSQSFKTAMAQAQKMRQYCELKDECRRKILLEHFGESFDRKACKNGSNPCDNCLRTS |
| GmRecQl1 | XP\_006589123.1 | *Glycine max* | MGSSSRKKNQDLELEKVRLISLALEFGFDESSANKCLDRLIALYGEDGRDFITVEHCGDDFLAALAESMQTEDWDDQQEMESQACGTLTHVLDKTVDTCADADNDDASRSFFVDIVDDSPQPQRRKGKSHTNVVELDSSDDEDMHCSVSREKPTDYRSGITQGSVSSTSSKMQSSFASRDTSSSPTYEELQALDDIELANVVIFGNRTFRPLQHQACKAALAKQDSFILMPTGGGKSLCYQLPATLQPGVTVVVSPLLSLIQDQIITLNLKFGIPSTFLNSQQTASQVTAVLQELRKDKPSCKLLYVTPERIAGNQSFLEILKFMHQKGQLAGFVVDEAHCVSQWGHDFRPDYRGLGSLKLHFPDVPVMALTATATHAVREDILKALRIPHALVLERSFDRPNLKYEVIAKTKEPLKQLGQLLIDRFRNQCGIVYCLSKSECVEVSKFLNEKCKIKTVYYHAGLAARQRVAVQKKWYDGEVHIVCATIAFGMGIDKPDVRFVIHNTMSKSIESYYQESGRAGRDNFPSVCIALYQKKDFSRVVCMIRNGQGYKKESFKTAMAQAKKMQEYCEIKAECRRQTLLKHFGESFDRKDCKYGSSPCDNCLKNVL |
| McRecQl1 | XP\_022156332.1 | *Momordica charantia* | MGGHDLELERVRLLSLAAEFGFDEESAKACLDRIINLYGDDGQEFVSVEHCGDDFLVALAESAQDNEEWDDLQAMESEACGALDIIFDENIQKKDGVHNFHDRKGTINIIEDTSETEGKPNLVNIDSSSESDDVDFIASKKRNLDSAISYCSDQAISILTSSKYSSRSRDCKSSTGRGSVSSGSVERQSSGTSKDGHKTLSYEELQTLDDFELANVVIFGNKRFRPLQHEACKAAVSRQDCFVLMPTGGGKSLCYQLPATIQPGVTVVVSPLLSLIQDQIITLNLKFGIPSTFLNSQQTTSQAAAVLQELRKDKPSCKLLYVTPERIANQSFLEILRFLYLKRQLAGFVVDEAHCVSQWGHDFRPDYRSLGCLKQNFPDVPVMALTATATQSVREDVLKALRIPHALILERSFDRPNLKYEVVCKTKEPLMQLGQLITDRFKNYCGIVYCLSKSECVEVSDSLDKKFKIKTAYYHAGLAARQRVMVQKKWHVGDIQIVCATIAFGMGIDKPDVRFVIHNTMSKSIESYYQESGRAGRDDCPASCIVLYQKKDFSRVVCMLRNGKGFKSENFKLSMSQAKKMQQFCELKDECRRQMLLQHFGESFDRKACKYGSNPCDNCLKKSS |
| OsRecQl1 | XP\_015616587.1 | *Oryza sativa* Japonica Group] | MAGYEREKKRLLDLAADSGFERDLAADCLDRIVRLYGEGGQGFITVENCGDDFLGALADATNNNDDWDDLNAIENEACGNLNGMMKHGVIDDKEVEVRTPLFRQAESSARQTRINLDSFGFSSDDDFETLESHCDRSVSTQKKVNRGNNRCESSTSTSNRETLSYQQLYSLDDINFANVVIFGNKSFRPLQYEACRAAVSNMDTFVLMPTGGGKSLCYQLPATLHPGVTVVVCPLLSLIEDQIVALNFKFAIPAAFLNSQQTPSQSSAVIQELRSGKPSFKLLYVTPERMAGNSSFIGILIGLHQRGLLARFVIDEAHCVSQWGHDFRPDYRGLGCLKQNFPRVPIMALTATATASVCKDILSTLRIPNATVLKRSFDRTNLNYEVIGKTKTPQKQLGDLLKERFMNMSGIVYCLSKNECADTAKFLREKYKIKCAHYHAGLAARQRSNVQGKWHSGEVKVICATIAFGMGIDKPDVRFVIHNTMSKSIESYYQESGRAGRDNLPAHCIVLYQKKDLGRIVCMLRNSGNFKSESFKVAMEQAKKMQTYCELKTECRRQTLLGHFGEQYDRQRCKHGCSPCDNCIKIPS |
| AtrecQl2 | NP\_174421.3 | *Arabidopsis thaliana* | MFCFTSCLGAVADFWERRRRRKGKHAAVDSAGESMESEAIQEDLQNLDVELKDVQGQISALIEHQDRLYERKSELKTLLKALAASGSPVASSGGSSAIENWSETFEWDSRADDVRFNVFGISKYRANQKEIINAIMTGRDVLVIMAAGGGKSLCYQLPAMLRGGTTLVVSPLLSLIQDQVMGLAALGISAYMLTSTSGKENEKFVYKALEKGEDDLKILYVTPEKVSKSKRFMSKLEKCHNAGRLSLISIDEAHCCSQWGHDFRPDYKNLSILKTQFPKVPMVALTATATQKVQNDLIEMLHIPKCVKFVSSVNRPNLFYSVREKSAVGKLVVDEIAEFIRESYSNNESGIVYCFSRKECEQIAGDLRERGISADYYHADMDANMREKVHMRWSKNKLQVIVGTVAFGMGINKPDVRFVIHHSLSKSMETYYQESGRAGRDGLPSECILFFRSADVPRQSSMVFYEYSGLQNLYDIVRYCQSKTKCRRSAFFRHFGEPSQDCNGMCDNCALSSEVKEVDVSDLSKLVVSMVQETQAKDQRVTMLQLGDKLRNKHKDLIAELKRDEVEHLVIKLIVDSVLKEEFQHTPYSTNAYVTMGPLANQLLQGRKTIKMETSSRQTKKLKRSITFSGLELKLDELRKEISAADGSILPHTVLSTQQIGSISSQKPVSLQELESIIGKLKTEKYGDRILEEVMRHEAVSEQLVEDPTKEETCKSRLRKRAKTQKDVVLVESSGEEEA |
| CsRecQl2 | XP\_010478887.1 | *Camelina sativa* | MESEAIQEELQNLDVELKDVQGQISALIEHQDRLYERKSELKTLLKALAASESPVASSSGGSTVIENWSEAFEWDSRADDVRFNTFGISEYRANQKEIINAIMLGRDVLVIMAAGGGKSLCYQLPAILRGGTTLVVSPLLSLIQDQVMGLAALGISAYMLTSTSGKENEKFVYKALEKGEDDLKILYVTPEKVSKSKRFMSKLEKCHNAGRLSLISIDEAHCCSQWGHDFRPDYKNLSILKTQFPKVPMVALTATATQKIQNDLIEMLHIPKCVKFVSSVNRPNLFYSVREKSAVGKVVVDEIADFIRESYSNNESGIVYCFSRKECEQIASDLRERGISADYYHADMDVNMREKVHMRWSKNKLQVIVGTVAFGMGINKPDVRFVIHHSLSKSMETYYQESGRAGRDGLPSECILFFRSADVPRQSSMVFYEYSGLKNLYDIVRYCQSKTKCRRSAFFRHFGEPSQDCDGMCDNCALSSELKEVDVSDLAKLVVSMVQETQAKDQRVTMLQLGDKLRNKHKDLSAELKRDEIEHLVIKLIVDSVLKEEFQHTPYSTNAYVTMGPLANQLLQGRKTIKMETSSKQIKKSKRSISFSGLELKLDELRKEISAADGNILPHTVLSTQQIGSISSQKPDSLQELEKIIGKFKTEKYGDRILEEVMRHDAASEHIVKDPTKEGTCESRSRKRAKTQKDVVLVESSNEEEA |
| BnRecQl2 | XP\_013693262.1 | *Brassica napus* | MESEAIQDELQSLELEINDVQGQISALIEHQDRLYERKSELKTLLKAVSASVTPVAPSCPDGSSAVENWSESFEWDSRADDIRFNIFGISKYRANQREIVNAIMAGRDVLVIMAAGGGKSLCYQLPAILRGGTTLVVSPLLSLIQDQVMGLAALGISAYMLTSTSGKENEKFVYKALEKGEDDLKILYVTPEKVSKSKRFMSKLEKCHNAGRLSLISIDEAHCCSQWGHDFRPDYKNLSILKTQFPKVPMVALTATATQKVQNDLIEMLHIPKCVKFVSSVNRPNLFYSVREKSLVGKAVVDEIAEFIRESYSNNESGIVYCFSRKECEQIAGELRERGISADYYHAEMDVNMREKVHMRWSKNKLQVIVGTVAFGMGINKPDVRFVIHHSLSKSMETYYQESGRAGRDGLPSECVLFFRSGDVPRQSSMVFYEYSGLQNLYDIVRYCQSKTKCRRSAFFRHFGEPSQDCNGMCDNCALSSEVKEVDVSDLAKLVVSMVQEMQAKDQRVTMLQLGDKLRTKHKDLSAELKREEIEHLVIKLIVDSVLKEEFQHTPYSTNAYVTTGPLANQLLQGRKTIKTETSSRQINKKSKRSSSFSGLESKLDELRKEISAAHGSMLPHTVLSTQQIGLISSQKPDSLQELESIIGKLKTDKYGDKILEVMRHDTVSEQLVEDGTKEDTCKSRSSKRAKTQKNVVLLESSEEEEA |
| RsRecQl2 | XP\_018451754.1 34 | *Raphanus sativus* | MESEAIQDELQSLELEINDVQGQISALIEHQDRLYERKSELKTLLKAVTAGTPVASSCPAVENWSEPFEWDSRADDIRFNMFGISKYRANQREIINAVMAGRDVLVIMAAGGGKSLCYQLPAILRGGTTLVVSPLLSLIQDQVMGLAALGISAYMLTSTSGKENEKFVYKALEKGEDDLKILYVTPEKVSKSKRFMSKLEKCHNAGRLSLISIDEAHCCSQWGHDFRPDYKNLSILKTQFPKVPMVALTATATQKVQNDLIEMLHIPKCVKFVSSVNRPNLFYSVREKSLVGKAVVDEIAEFIRESYSNNESGIVYCFSRKECEQIAGELRERGISADYYHAEMDVNLREKVHMRWSKNKLQVIVGTVAFGMGINKPDVRFVIHHSLSKSMETYYQESGRAGRDGLPSECVLFFRSGDVPRQSSMVFYEYSGLQNLYDIVRYCQSKTKCRRSAFFRHFGEPSQDCNGMCDNCALSSEVKEVDVSDLAKLVVSMVQEMQAKDQRVTMLQLGDKLRTKHKDLSAELKREEIEHLVIKLIVDSVLKEEFQHTPYSTNAYVTMGPLANQLLQGRKTIKTETSSRQMNKKSKRSSSLSGLESKLDELRKEISAAHGSMLPHTVLSTQQIGLISSQKPDSLQELESIIGKLKTDKYGDKILKVMRHDAVSEQHVEDATKDETCKRRSSKRAKTQKDVVLLESSEEEEEA |
| StRecQl2 | XP\_006355238.1 | *Solanum tuberosum* | MGRTEELLEELVNVEVELQDVQDQIKYLLDRQEKLHERQFELKALVESCESSSGPGSDNAAVPVDDWSRPFEWDSQADDIRFNVFGISKYRANQREIINTIMSGRDVLVIMAAGGGKSLCYQLPAVLRDGVALVVSPLLSLIQDQVMGLAALGIPAFMLTSTTTKENEKFIYKALEKGGDELKILYVTPEKISKSKRFMSKLEKCHHAGRLSLISIDEAHCCSQWGHDFRPDYKNLGILKTQFPNVPMVALTATATKKVQDDLMEMLHIPRCVKFVSSVNRPNLYYMVREKSSIAKTVVDEIAEYIRTSYPNNESGIVYCFSRKECEQVAQELRERGISADHYHADMDVNARERVHLRWSNGKLQVIVGTVAFGMGINKPDVRFVVHHSLSKSMETYYQESGRAGRDGLPSECVLFFRPADAPRQSSMVFYENSGLKNLYDIVRYCQSKRECRRSAFFRHFAEPLQECNGMCDNCAFSNEVEELDVSSHAKLIVSMLKDIQENDQRVTMLQLVEKLKVKQKNLGPDLKKDELEQLVIKLVLDHVLKEEFQHTAYATNAYVTVGPLAKQVLQGNKIIKVEMSTRQSRTSSSMKSSKRERSTGLDDKLDELRKELASIHGGIFPHSVLSTQQISTLSGQKPKSIEELEKIIGKLKTEKYGDRILEEIVSYESDPQKDADGSKETKGNTVKKLKTKKALVVLESSEDET |
| GmRecQl2 | XP\_003534325.1 | Glycine max | MENNEILEELLNIEVEIQDVQEQIRALIERQESLYERKSELSAILEACKESGNEANNAASSAAENWSGEFEWDSEADDVRLNVFGISSYRANQREIINAIMSGRDVLVIMAAGGGKSLCYQLPAVLRDGIALVVSPLLSLIQDQVMGLTALGIPAYMLTSTNKGDEKFIYKTLEKGEGELKILYVTPEKISKSKRFMSKLEKCHHAGRLSLISIDEAHCCSQWGHDFRPDYKSLSILKTQFPRVPIVALTATATQRVQNDLIEMLHIPRCVKFVSTVNRPNLFYMVKEKSSVGKVVIDEIAEFIQESYPNNESGIVYCFSRKECEQVAKELRERGISADYYHADMDVNAREKVHMRWSNNKLQVIVGTVAFGMGINKPDVRFVIHHSLSKSMETYYQESGRAGRDGLPSECLLYFRPGDAPRQSSMVFYENSGLQNLYDIVRYCLSKRQCRRSAFFHHFAEPLQECNGMCDICAFSSEVKEVDVSGHAKLMVSLLQDMQANDQRSTMLQLVDKMKIKQKELGSELKREEIEQLILHLLLARFLKEEFQHTPYATNAYIAVGSLAKQILQGKKSVKLEIYTEQRTKDGVRSAKQCLGSSGLELKLDELRKELSSAHGGILPHSVLSTEQIIQLASQKPNSLEQLEKLIGKLRTEKYGNRILKQIEKYYDFEPTDKQEIDARAAKRLKSKKNLVIIE |
| CtsRecQl2 | XP\_006471562.1 | *Citrus sinensis* | METEEILQELENVEAEVRLVQEQIKQLVDRQDQLYERQSELKSLLEAFEASRGSPIQYGGSSSTAVENWSGTFEWDSRADDVRLNVFGIPAYRANQQEIINAVLSGRDVLVIMAAGGGKSLCYQLPAVLREGIALVVSPLLSLIQDQVMCLAALGIPAHMLTSTTSKEDEKFIYKALEKGEGELKMLYVTPEKISKSKRFMSKLEKCHHAGRLSLISIDEAHCCSQWGHDFRPDYKNLGILKTQFPDVPMMALTATATQKVQNDLMEMLHIRKCIKFVSTINRPNLFYMVREKSSVGKVVIDEIAKYIQESYPNSESGIVYCFSRKECEQVAQELRQRGISADYYHADMDINAREKVHMRWSKNKLQVIVGTVAFGMGINKPDVRFVIHHSLSKSVETYYQESGRAGRDGLPSECLLFFRPADVPRQSSMVFYENSGLQNLYDIVRYSQSKKQCRRSTFFRHFAEPLQDCNGMCDICAFSYEVNEVDVTRHAQCIISLLQDIQDNNQRLTMLQLVDKMKIKLKEIDSDLKREEIEQLVLQLIIDRVLSEEFQHTAYSTNAYVTIGPLAKLVLQGKKIIKLEISSVQKNTADNKKSTKRSLTSSALEFELDELRKELASISGGILPHSVLSSQLIRLISARKPSTMEELEKIIGKLKTGKYGSRILEVISKCGNSEQQHDNNAVSKEEQGRGARASKRTKKEKAVVVVDSSDDSEV |
| GhRecQl2 | XP\_016692027.1 | *Gossypium hirsutum* | MEADEIAEELQNIEFEIHDVEEQIRELIEKQEKLYERRSELQVLLETCPIDVKDGSAPTNVQAEDWSRSFDWDSQAEDIRFNVFGISSYRPNQREIINAVMSGRDVLVIMAAGGGKSLCYHPPAILRQGIALVVSPLLSLIQDQVMGLVASGIPARMLTSTTSKEDEKFIYKALEKGEEDLKLLYVTPEKVSKSKRFMSKLEKCHHAGRLSLISIDEAHCCSQWGHDFRPDYKNLGILKTQFPNVPVVALTATATMKVQNDLIEMLHIPKCVKFVSTVNRPNLFYMVREKSSVGKIVVDEIAKYIKESYPNKESGIVYCFSRKECEQVASELCERGISADYYHADMDENAREKVHMRWSKNKLQVIVGTVAFGMGINKPDVRFVIHHSLSKSMETYYQESGRAGRDGLPSECLLFFRSADMPRQSTMVFHENSGLQNLYDMVQYCQSKRQCRRSAFFRHFAEPLQECNGMCDNCAFSSEIKEVDASGHSKLLISLVREMQEKDQRVTMLQLVDRVKNKQKQLDFELKREEMEQLVVQLILDRVLKEEFQHTAYATNSYVTVGPRANQVMLGKKIIKMDVTSTSKDVDGYRKSSKHGVTLGLEFKLDKLRKELASHDKGIFPHSVLSSQQISSISAHLPNSIEELEKIIGKLKTEKYGGRILEEVKKYGNAEHPNNEVLNEEESSEIRPPRKKLKKANKQVIMVDSSNDESD |
| McRecQl2 | XP\_022158054.1 | *Momordica charantia* | MNAEEVLEELLNVEVQINEVQAEINVLLEHQDNLYQRKSELKSLLELCKETEDSDTHGKGTSTSQENWSGSFKWDSEADNVKLNIFGISTYRANQREIINAVMSGRNVLVIMAAGGGKSLCYQLPALLYDGLALVVSPLLSLIQDQVMGLAALGIPASMLTSATSKEDEKFIYKNLEKGEGNIKILYVTPEKISKSKRFMSKLEKCYHAGRLSLIAIDEAHCCSQWGHDFRPDYKNLGILKTQFPNAPVIALTATATQRVQNDLVEMLRIPKYVKFVSTVNRPNLFYMVREKSSVSKVVMDKIAEFIQESYPNNESGIIYCFSRKECEQVAKELCARGIAADYYHADMDSVAREKVHMRWSNSRLQVIVGTVAFGMGINKPDVRFVIHHSLSKSMETYYQESGRAGRDGLPSECLLYYRPGDVPRQSSMVFYENSGLENLYGIVQYCQSKKQCRRSAFFQHFAEPLKDCNGMCDTCAVSSEVKEVDICSHARVIISILQDVQNSNQRMTMLQLVDKLKVKHNELVSDLRREEIEQLIIQLLLDRVLKEEFQHTAYATNAYVTVGPLSRQVLQGKKAVKLEISSKQKVTGVKSRRKGIASSGLEYKLDELRKELASAGGGIFPHSVLSTQQIGVLSDQKPTSLDELETMIGKVKAEKYGKRILEEVEKWSIAQSQNASSQEEQELEDETRTAKRPKTINSHVIIESSDEES |
| OsRecQl2 | BAE96002.1 | *Oryza sativa* Japonica | MYEEDNIQGELLLVQAELDDIQGQISALIDRQEELYERESQLKAMLEVSKASNNTINNTPSVGPKDWSGSFLWDSRADDVRFNVFGDFFIPAESKRGKIINAIMSGRDVLVIMAAGGGKSLCYQLPAVLHDGITLVVSPLLSLIQDQVMGLAALGIQAYMLASTTNKEVEKFVYKALDKGEGELKILYVTPEKISKSKRFMSKLEKCHHAGRLSLIAIDEAHCCSQWGHDFRPDYKNLGILKVQFPSVPMIALTATATNKVQIDLIEMLHIPRCVKFVSTINRPNLFYKVFEKSPVGKVVIDEIANFISESYPNNESGIVYCFSRKECEQVAKELSERGILADYYHADMDVISREKVHMRWSKSKLQVIVGTVAFGMGINKPDVRFVIHHSLSKSMETYYQESGRAGRDGLPSECILYYRPGDVPRQSSMVFYENCGLQNLYDIVRYCQSKRSCRRGAFFRHFGEAAQDCNGMCDNCTSSLELKEIDATRMMILHQLGNFTVALNYILDTCMFFSLYFYKMVFLGDIFLGKISFMYIYTSIVSMTYCTDHTKIIVSLLHDIQLNDQRATLLQLVDKFKAKWKDLGCSNESIDLKKEGIEQLVVQLILDRVLKEEFQHTAYATNAYVALGPLWKPALQGNRPVKLSVAFHSQDKGSGSKRTKRNQMSNLEAKLDDLRRELSSSNGGVFPHAVLSAQQISLLNRQKPTTVAELEKLIGKVKTGKYGSAIIELMLLHIDSEVAGGKACASKRQKKDKEDVICVESSEEEDV |
| AtRecQl3 | NP\_195299.2 | *Arabidopsis thaliana* | MKKSPLPVQNVQSSDKNVAGKEALVKLLRWHFGHADFRGKQLEAIQAVVSGRDCFCLMPTGGGKSICYQIPALAKPGIVLVVSPLIALMENQVMALKEKGIAAEYLSSTQATHVKNKIHEDLDSGKPSVRLLYVTPELIATKGFMLKLRKLHSRGLLNLIAIDEAHCISSWGHDFRPSYRQLSTLRDSLADVPVLALTATAAPKVQKDVIDSLNLRNPLVLKSSFNRPNIFYEVRYKDLLDNAYTDLGNLLKSCGNICAIIYCLERTTCDDLSVHLSSIGISSAAYHAGLNSKMRSTVLDDWLSSKKQIIVATVAFGMGIDKKDVRMVCHFNIPKSMESFYQESGRAGRDQLPSRSVLYYGVDDRKKMEYLLRNSENKKSSSSKKPTSDFEQIVTYCEGSGCRRKKILESFGEEFPVQQCKKTCDACKHPNQVAHCLEELMTTASRRHNSSRIFITSSNNKTNEGQYSEFWNRNEDGSNSNEEISDSDDATEAANSVTGPKLSKKLGLDEKLVLLEQAEEKYYERNKQVKKSEKNAISEALRDSSKQRLLDALTRVLQLLACVEEIDSQKGSEFLENECYRKYSKAGKSFYYSQIASTVRWLGTASRDELMTRLSSVVSLAREQEPLEEPLLATEPVENIEEEDDGKTNTVESRVDEPTQELVVSPILSPIRLPQVPSFSEFVNRRKIKQNTLIDKSSEGFDDKKPAKIMKLQ |
| CsRecQl3 | XP\_010446884.1 | *Camelina sativa* | MKKSPLPVQNVQRSDKNVAGKEALVKLLRWHFGHADFRGKQLEAIQAVVSGRDCFCLMPTGGGKSICYQIPALAKPGIVLVVSPLIALMENQVMALKEKGIAAEYLSSTQAAHVRNKIHEDLDSGKPSVRLLYVTPELIATKGFMLKLRKLHSRGLLNLIAIDEAHCISSWGHDFRPSYRQLSTLRDSLADVPVLALTATAAPKVQKDVIDSLSLRDPLVLKSSFNRPNIFYEVRYKDLIDNAYTDLGNLLKSCGSICAIIYCLERTTCDDLSVHLTSIGISSAAYHAGLNSKLRSAVLDDWLSSKKQVIVATVAFGMGIDKKDVRMVCHLNIPKSMESFYQESGRAGRDQLPSRSVLYYGVDDRKKMEFLLRNSENKKSQSSKKPTSDFEQIVKYCEGSGCRRKKILESFGEEFPAQKCKKTCDACKHPNQVAHSLEELMTTASRRQNSSRIFITSSNEMTNEGQYSEFWNRNEDGSNSDEEISDSDDANEAAKSLAEPKLSKKLGLDEKLVLLEQAEEKYYERNKQVKKSEKNAISEVLRESSKQRLLDELTRVLQQLASVKEIDSQKASEFLENECYRKYSKAGKSFYYSQIASTVRWLGTANRDDLMTRLSSVVSSGGEEEPIKEPLLVEHSENIEEEDDGKINTTESHVDETTQKLVVSPSRSPIKLPHVPSFSEFVNRRKMKLNTSADKSSEGFDDKKPAKIMKLQ |
| RsRecQl3 | XP\_018447318.1 | *Raphanus sativus* | MKKSPLPVQNVHRSDKNVGGGKEALVKLLRWHFGHADFRGKQLEAIQAVISGRDCFCLMPTGGGKSICYQIPALAKPGIVLVVSPLIALMENQVMALKEKGIAAEYLSSTQATHVRNKIHEDLDSGKPSVRLLYVTPELIATKGFMLKLRKLHDRGLLNLIAIDEAHCISSWGHDFRPSYRQLSNLRDSLADVPMLALTATAAPKVQKDVIDSLSLRNPLVLKSSFNRPNIFYEVRYKDLIDNAYTDLCNLIKSCGNICAIIYCLERTTCDDLSLHLSSTGISSAAYHAGLQSKLRSTVLDDWLSSKKQVIVATVAFGMGIDKKDVRMVCHFNVPKSMESFYQESGRAGRDQLPSRSVLYYGVDDRKKMEFLLRNSENKKSPSSKKPTTSDFDQIVRYCEGSGCRRKKILESFGEEFPVQQCKKTCDACKHPNQVARCLEELTTTASRRHNSSRVFHHQVFSSDNKTNEGQYSEFWNRNEDGSNSDEEISDSDDGADAVESLAGPKLSKKLGVDEKLVLLERAEEKYYERNKQVKKSEKNAISETLRESSKQRLLNELTRVLQLLGVEEIDSQNASEFLENECFRKYSKAGKSFYYSQIASTVRWLGTASRDDLMIRLSSVVSYARGEEPSGESLPMTEPVENIEQEDINTYATELQVDEPTQLLVTSPSRSPIRLPEIPSFSEFVNRRKMKHSTQCSDGKKPAKIMKLQ |
| BnRecQl3 | XP\_013656465.1 | *Brassica napus* | MKKSPLPVQNVNRSDKNVAGKEALVKLLRWHFGHGDFRGKQLEAIQAVVSGRDCFCLMPTGGGKSICYQIPALAKPGIVLVVSPLIALMENQVMALKEKGIAAEYLSSTQATHVRNKIHEDLDSGKPSVRLLYVTPELIATKGFMLKLRKLHDRGLLNLIAIDEAHCISSWGHDFRPSYRQLSTLRDSLTDVPVLALTATAAPKVQKDVIDSLSLRNPLVLKSSFNRPNIFYEVRYKDLIDNAYTDLCNMLKSCGKICAIIYCLERTTCDDLSLHLTSTGISSAAYHAGLNSHLRSTVLDDWLSSKKQVIVATVAFGMGIDKKDVRMVCHFNVPKSMESFYQESGRAGRDQLPSRSVLYYGVDDRKKMEFLLRNSENKKSPSSSSKKPTSDFEQIVRYCEGSGCRRKKILESFGEEFPVQQCKKTCDACKHPNQVARSLEELTTTASRRHNSSRVFITSSSDNKTNEGQYSEFWNRNEDGSNSDEEISDSDDGADVVKSLAGPKLSRKLGVDEKLVLLERAEEKYNESNKQVKKSEKNAISETLRESSKQRLLNELTKVLQLLGVKEIDSQNASEFLESECYRKYSKAGKSFYYSQIASTVRWLGTASRDELMTRLSSMAREEEPSGEPILVTEPSQNIEQEDGTTYTAEPHVDETTQQLVISPSCSPIRLPEIPSFSEFVNRRKMKHSTEGSDGKKPSKIMKLK |
| GhRecQl3 | XP\_016696700.1 | *Gossypium hirsutum* | MKKSPLPVQNLGAKGKQRKCGREALVKLLRWNFGHPDFRGNQLEAIEAILSGRDCFCLMPTGGGKSMCYQIPALAKTGIVLVISPLIALMENQVMALKEKGIAAEFLSSTQTSQLRNKIHEDLDRGQPSIRLLYVTPELIATSGFMSKLKKIHGRGLLNLIAVDEAHCISSWGHNFRPSYRKLSSLRNQLQDVPILALTATAIPKVQKDVIDSLNLQNPLVLKSSFNRPNIYYEVRYKDLMDDAYADLCDVLKSAGDVCAIVYCLERTTCDDLSTHLSKNGISCAAYHAGLNNKLRSSVLDDWICSKIQVVVATVAFGMGIDRKDVRIVCHFNIPKSMEAFYQESGRAGRDQLPSRSLLYYGVDDRKRMEFILSIAESKKLQSSDSQHGLSKKSTSDFNLMVEYCEGSGCRRKKILESFGEEVSASLCKKSCDACKHPNLVAKYLEELTTAIAVRQRNGFSKILSSSTDAFENENFSEFWKRNDEASGSEEDISDSEDGFEVAKGISRSKFSKKTGINEKIELLQRAEENYYRNKAHDKQANKPDKNAISGALRESSKQRLLDALKQAHQRLGDLKVDFEASSTILENECFKKYGKSGKSFYYSQVASKVRWLSTTSSAAEITNQIGTGITSPLENITRKEEPSPRTVSAMLHDERKKEVNKVIGEQRCGDIESKTSVKASTPQMQTKLPAIPSFSQFVNSRKSKEMQQPKASEEKEHHHSPNKHTKKRMRLK |
| CtsRecQl3 | XP\_006467041.1 | *Citrus sinensis* | MKKSPLAMQSTSQTQRNKPLHEKEALVKLLRWHFGHAQFRDKQLDAIQAVLSGRDCFCLMPTGGGKSMCYQIPALAKPGIVLVVSPLIALMENQVIGLQEKGIAAEFLSSTQTMQVKTKIYEDLDSGKPSLRLLYVTPELTATPGFMSKLKKIHSRGLLNLVAIDEAHCISSWGHDFRPSYRKLSSLRNYLPDVPILALTATAAPKVQKDVMESLCLQNPLVLKSSFNRPNLFYEVRYKDLLDDAYADLCSVLKANGDTCAIVYCLERTTCDELSAYLSAGGISCAAYHAGLNDKARSSVLDDWISSRKQVVVATVAFGMGIDRKDVRLVCHFNIPKSMEAFYQESGRAGRDQLPSKSLLYYGMDDRRRMEFILSKNQSKNSQSFSTRERSSKKSISDFSQMVDYCEGSGCRRKKILESFGEQMPVSLCKNSCDACKHPNLLAKYLGELTSAVLQKNHFSQIFISSQDMTDGGRYSEFWNRDDEASGSEEDISDCDDGIEVVKKVANSKLPTKAGLNERINFLQHAEESYYRNKISDKQVNKPSKNAVSDVLRQGSKEKLLNALRQAQQRLRNLTIEFEASAIFLENECYNKYGKSGKSFYYSQVASTIRWLSTANSIELTNRLGIDTDSPSVNFISKEQPLAAPSPSLEQRPAQITGKELDGSCGSENSIGAFQTESESPSTSLPVIPSFSEFVNRQKVKDNQPNISCKESPKKNFDKRMRLQ |
| StRecQl3 | XP\_006342391.1 | *Solanum tuberosum* | MNKSLLPLQSNCGRQKNVIGKEALVKLLRWHFGHSDFRGKQLEAIEAVLSGRDCFCLMPTGGGKSMCYQVPALTKPGIVLVVSPLIALMENQVSTLKEKGIPAEFLSSTQTVQVKNKIYEDLESGKPAVRLLYVTPELIATSGFMSKLTKIHARGLLNLIAIDEAHCISSWGHDFRPSYRKLSLLRSHFPNVPVLALTATAAPKVQKDVIESLNLQNPLVLKSSFNRPNIYYEVRYKDLLDDPYADVCKLLKSCGNVCAIIYCLERTMCDDLAIQLTRSGISCAAYHAGLNNKMRSSVLDDWISSKIQVVVATVAFGMGIDRKDVRVVCHFNIPKSMEGFYQESGRAGRDQLPSRSVLYYGVDDRRKMEFILSNTKRKKDESSSLQDKSSKKSLDDFKQMVEYCEGSGCRRKMILENFGEMVPDSLCEKSCDVCKHPNLVTSNLEQLKTATAFRQRTGSSRIYMTSGSSLNAGEQLSEFWNRDDEASGSEEDISESDDALDAAKNAASSKTSAKLRLQDKMDLLQRAEENYYQNKSHDKQVNKLDKNAIPETLREAGKQRLLNAIKQNQQMVNDSRIDIDKSVVFLENECYKKYGKSGKSFYLSQMASTARWLSTAGPMELVNKLSSSSTAPPPENVTSIADCTPASSNLSVPAKANHEEVHDNAGPQDPISSPASPIHGSASAKLPPILSFSQFINSGKAKENLASASKRQSPDRGKNKLEKRMRFQ |
| GmRecQl3 | XP\_006587045.1 | *Glycine max* | MQKSALPLSDANANKKREELRRKETLVKLLRWHFGYPDFRDMQLDAIQAVLSGKDCFCLMPTGGGKSMCYQIPALAKAGIVLVVCPLIALMENQVMALKEKGIAAEFLSSTKTTDAKVKIHEDLDSGKPSTRLLYVTPELITTPGFMTKLTKIYTRGLLNLIAIDEAHCISSWGHDFRPSYRKLSSLRSHLPDVPILALTATAVPKVQKDVVESLQMQNPLMLKSSFNRPNIYYEVRYKDLLDDAYADLSNTLKSLGDVCAIVYCLERSMCDDLSTNLSQNGISCAAYHAGLNNKMRTSVLDDWISSKIKVVVATVAFGMGIDRKDVRIVCHFNIPKSMEAFYQESGRAGRDQLPSRSLLYYGVDDRKRMEFILRKSVSKKSQSSSSQEESSKMSLIAFNLMVEYCEGSGCRRKRVLESFGEQVTASLCGKTCDGCRHPNLVARYLEDLTTACALRQKNGSSRVFMTSSTDAINGEQLSEFWNQDEEASGSEEDISDSDDGNEVVNNLTRSKLQSKLGVSEKLAMLQRAEENFYRNNNAYKQSNKVDKNAISDPMRGSSRQRLQNALKQVQQRLDNFKIEMETSASFLEEECYKKYGKVGKSFYYSQVASTVRWLTTASSSELINRLSAINASTSMNVLSEAENLLIPANQPLTPAEQPLTSPPALDPYARDTSNEHSGTARSETSACVLPMEGSFSTNLPQIPSFSEFVNSRKAKGDQLHDTKRHSSRVEKKMRIQ |
| McREcQl3 | XP\_022154638.1 | *Momordica charantia* | MKKSSLPLQSNIGPEKHKYSKDSLVKLLRWHFGHSEFRGKQLETIEAVLSGKDCFCLMPTGGGKSACYQIPALATTGIVLVVCPLIALMENQVMALKEKGISAEYLSSTQSTQAKNKIHEDLDSGKPTIRLLYVTPELIATSGFMAKLTKIYSRGLLNLIAIDEAHCISTWGHDFRPSYRKLSSLRSRLPHVPILALTATAVPKVQKDVIVSLGLQNPLVLKSSFNRPNIYYEVRFKDLLDDPLADLSNQLKSSGDVCAIIYCLERATCDQLAANLTKNDISCAAYHAGLKNDLRKSVLEDWINYKIQVVVATVAFGMGIDRKDVRVVCHFNIPKSMEAFYQESGRAGRDQLPSKSLLYYGIEDRRRMEFILKNSSSADKKILPSSSSQERLSEKSLTDFTQMVEYCEASGCRRKRILESFGEQVPASICKRSCDACKHPNIVAANLEELSATCAVKRNNSSSKIFVSSSNMSDEGEFSEFWNRKDETSGSGEDISDSDDDTEVVKSLGTKSLKKSGLNEKIALLERAEENYYQNKISVKQNDKHEKNVVSASFREASRERLENALKQAQQRLGTFKIEVERHARFLEQECYEKYGRTGKSFYYSQVASTVRWLSTASSTELTSRLSITDDPCSVSEKNTRLPALASPAMDLSKSEISNEVFHSSSVLETSTFNLSKQSASPAPLLPPIPSFAEFVIGRMENASQSNRDEKYPVKRIRLV |
| OsRecQl3 | XP\_015622950.1 | *Oryza sativa* Japonica | MKRQLPIKGASGASGSGHGKKAPQELENVLKQHFGYSGFRGKQLEAIEAVLSGRDCFCLMPTGGGKSMCYQIPALVKSGIVLVISPLIALMENQVASLKSKGIPAEFLSSTQTSHNKQKIHEDLDSGNPSLKLLYVTPELVATSGFKAKLTKLYNRGLLGLVAIDEAHCISTWGHDFRPSYRKLSSLRNQFPDIPILALTATAVPKVQKDVISSLCLRNPLILRASFNRPNIFYEVRYKDLLDDVYSDISNLLKSSGNVCSIVYCLERAVCDDLTMHLSQQGISSAAYHAGLNSKVRSSVLDDWLSSRTQVVVATVAFGMGIDRQDVRIVCHYNLPKSMEAFYQESGRAGRDQQPSKSVLYYGLDDRKKMEFILRNTKNKKSELSSSSTELSEKALADFSQIIDYCENSTCRRKMIIESFGEKVQPTLCQRSCDACKHPNLVSSRLEELRRVPTCRYNKISPVFKSSLANPKHMETEFWNREDDASISVEDISDSDDGKEVVSNTAISKLPSKAGLDAKFEALERAENAYYQAKGQTKQQGGKLVDKKSISQTLRDASQKRLLNGLGQAKLRLGNLPFDEEPSAAHLEVECFKKYEKVGKTFYNSQIAATVRWLSSSSLDQIQDRLHALADQITDHGAAASSPSIVPESPPASPDVICKIPGEATSNEAKDIPLKNNTEEFVTTEHSDEIAKVAVLSENMELPKIPSFREFMSQKGRDRATSSSKVESLPSGVRRKVGIEKQGTTGPSKKMKS |
| AtRecQl4A | NP\_172562.2 | *Arabidopsis thaliana* | MINSNQMSRSHLPEVQKPRGPQTNWSEHAKALESSSSVTKFLSSNVLYALESQKPRDMAARSIAFPSVNVHTLAHPQISKAWRALSSLSVNNTYLRPGVTPPIDVGTNDSYSARERSTAKVISSTGGSVYSSTRPNLSAMNVSGTGRSFHSFPSSVPGDDKIVAEKFPRGNNEIRESEPSCTHLNGVEKSFGNSAFPAEQFESRKACLDDMDDDDILENIDVDQIVMEHYHSTSTPQPSVSNFSLRTPPVDRSASRLEEECNLPPELCSNCSHGIKLGLCPEASTHVEQMKDVLLAISNELLDDATDLSPDRVGQLRQERLRLKKQIQQLENHIRDKESQKSQFLSSTATRIFQYETPKSTNYKMDQPQTDFRAHVSDQGRYACDSWNTPRDSSFSVDRYGLSSAPVEREQYVPKIIDVTYTEGSNDKKWSSREFPWTRKLEVNNKKVFGNHSFRPNQREIINATMSGSDVFVLMPTGGGKSLTYQLPALICGGITLVISPLVSLIQDQIMNLLQANIPAASLSAGMEWAEQLKIFQELNSEHSKYKLLYVTPEKVAKSDSLLRHLENLNSRGLLARFVIDEAHCVSQWGHDFRPDYQSLGILKQKFPNIPVLALTATATASVKEDVVQALGLVNCVVFRQSFNRPNLWYSVVPKTKKCLEDIDKFIKENHFDECGIIYCLSRMDCEKVSERLQEFGHKAAFYHGSMEPEQRAFIQTQWSKDEINIICATVAFGMGINKPDVRFVIHHSLPKSIEGYHQECGRAGRDGQRSSCVLYYGYGDYIRVKHMISQGGVDQSPMATGYNRVASSGRLLETNTENLLRMVRYCENEVECRRFLQLVHLGEKFDSTNCKKTCDNCCSSQSLIDKDVTLITRQLVELVKQTGERFSSAHILEVYRGSLNQMVKKHRHETLQFHGAGKHLSKIEVSRILHYLVTEDILVEDVRKSDMYGSVSSLLQVNNAKATILFSGSQTIVMKFPSSVKVLKPSKQGATAAKGPLTSEKQSTLPLTTEDAPPKDVNLSANMYTALRKLRTALVKEAPDGVMAYHIFINSTLQQISRRIPRTKEELLEINGLGKAKVSKYGDQLLETIETTVNEYYGTNKKDSIISNDSPDSGKRRRDENISPNVAEDDDFEVSPSQSCKKTVRNKSNEVLHGECIDGDRRGMELDFDFKDEDGSEIRPEGRVLPW |
| CsRecQl4A | XP\_010458470.1 | *Camelina sativa* | MSRSYLPEVQKPRGPQTNWSEHAKALESPSSVTKFLSSNVLYALESQKPRDMAARSISFPSVNVHTLAHPQVAKAWRALSSLSINNAYLRPGFTPPVDDGGTNGSFSARERSTVKVVSSTDGSFYMNNRQNQSALNVSGTGRSFHSFPSSVRGDDEIIAEKFPRVNDESEPRCTHLNGVEKSFRNSAFPSEQLESGKACLDNIDDILENIDVDQIVMEHYHSTGTPQPSVSNFSLRTPPVDRSASRFEEDSCLPPELCSNCSHGIKMFGSTQLGLCPEASTHVEQMKDVLLSISNELLDDATDLSPERVQQLRQERLQLKKQIQQLENHIRDKDSKKSQFLSSTATRTFQYETPKSTSYKMDHPQTDFRPLPSDQGRYVCDSWNMPRDSSFSVEREQYVPKIIDVTYTEGSSDKRWSSHDFPWTRKLEINNKKVFGNHSFRPNQREIINATMSGSDVFVLMPTGGGKSLTYQLPALICPGITLVISPLVSLIQDQIMNLLQANIPAASLSAGMEWAEQLKIFQELKNEHSKYKLLYVTPEKVAKSDSLLRHLENLNSRGLLSRFVIDEAHCVSQWGHDFRPDYQSLGILKQKFPGIPVLALTATATASVKEDVVQALGLVNCVVFRQSFNRPNLWYSVVPKTKKCLEDIDKFIKENHFDECGIIYCLSRMDCEKVSEKLQEFGHKAAFYHGSMEPEQRAFVQTQWSKDEINIICATVAFGMGINKPDVRYVIHHSLPKSIEGYHQECGRAGRDGQRSSCVLYYGYGDYIRVKHMISQGGVDQSPMATGYNRVASSGRILETNTENLLRMVSYCENEVDCRRFLQLVHFGEKFDSTNCKKTCDNCCSTQSLIDKDVTLITKQLVELVKQTGERFSSAHILEVYRGSLNQMVKKHRHETLQLHGAGKQLSKLEVSRILHYLVTEDILVEDVRKSDMYGSVSSLLKVNNAKASVLFSGSQTVMMRFPSSVKVLKPSKPGATPAKGPLTSEKQSTLPLSTEDAPPKDLNLSANMYTALRKLRTALVKEAPDGVMAYHIFINSTLQQISRRIPRTKEELLEINGLGKAKVSKYGDRLLETIDSTVNEYCGTNKKDSIISNDSPHSGKRRRDENISPNVAEDDDFEVSPSQSCKKTVRSKSNDVLHGECADGDRVGMVMEKLDFDFEDEDGSEIRPEGRVLPW |
| BnRecQl4A | XP\_013657414.1 | *Brassica napus* | MINSDQVSRSHLPEVQKPKAPQTNWSEHANAFEDPSSRTKHLSSGFLYALESQKPRKSSDMAARSIAFPSVNAHTLAPPQIAKAWRALSSLSLNKTYLRPGITPPVDDGGTNGSYSARERSTVKVTCSTDGSFYSNNQQNQSQMGVPGTGRSFHSFPPPVPGDGKNFAEKFRRINDETREPETSSAHLNGVEKPFKNSTFAAEQLGSGEACLDEIDDDILQNIDVDQIMMEHYQSTSTPPSSVSSLPSRTPPVDRSASRREEECSLPPELCSNCSHGIKLGLCPEASTHLEQMKNMLIAISNELLDDDTDLSPDRIQELRQERLLLKKQIQQLEDHIRDKEKQKSQFLSSTATRASQYETPKSTNLRFDHPQTDSRAHFNEQGRYASDSWNMPKDSSFSVDRYGLSSAPVEREQYVPRIIEVTYTEGSNDQKWSSRDFPWTRKLEVSNKKVFGNHSFRPNQREIINATMSGSDVFVLMPTGGGKSLTYQLPALICQGITLVISPLVSLIQDQIMNLLQANIPATSLSAGMEWSEQLKIFQELSSEHSKYKLLYVTPEKVAQSDSLLRHLDNLNSRGLLARFVIDEAHCVSQWGHDFRPDYQSLGILKQKFPNIPVLALTATATASVKEDVVQALGLVNCVVFRQSFNRPNLLYSVVPKTKKCLEDIDKFIKENHFDECGIIYCLSRNDCEKVAQKLQEFGHKAAFYHGSIEPTQRALVQKQWSKDEVNIICATVAFGMGINKPDVRFVIHHSLPKSIEGYHQECGRAGRDGQRASCVLYYGYGDYIRVKHMISQVGVEQSPMANGYNRVASSGRLLETNTENLLRMVRYCENEVDCRRFLQLVHFGEKFDSTNCKRTCDNCSSSQSLIDKDVTLITRQLVELVKQTGERFSSSHILEVYRGSLNQMVKKHRHETLQFHGAGKHLTKLEVSRILHYLVTEDILVEDVRKSDMYGSVSSLLKVNKSKAASLFSGSQTIMMRFPSSVKVLKPCKAAPTPAKAPLVSADAPPEDVNLSAIMYTALRKLRTLLVKEAPDGVMAYHIFGNATLQQMSKKIPRTKEELLEINGLGKAKVLKYGDRLLETIESTVNEYYGTSKKEESMISPDSGKRRRDENISPNVTEEDDDFAESSSQSCKKTVRSKSSEVLHGECVAGDGVGMVMEKLDFDFEDEDGSEIRPEGRVLPW |
| RsRecQl4A | XP\_018491712.1 4A | *Raphanus sativus* | MISSIQMSRTHLPEVQKPKAPLTNWSEHVKALGTPSSVTKHLSSSFLYALESQKPRGCRDMAARSIAFPSVNAPTLAAHPQIDKAWRVLSNLSINKTYLRPGITPPVDDSGTNGSYSARERSTVKVTSRTGGSFYSNNRQNQSQMGVPGTGRYSHSFPSSVPGDDTIAAEKFSRVNDEVGEPETSCTRLNGVEKPFKNSAFAAERLESGEVCLDEIDDDDILQNIDVDQILMEHYQSTSTPQPSVSSFPLRTPPVDRSASSREEECCLPPELFSNCSHGIKLGLCPEASTHLEQMKNALIAISNELLDDDTDLSPERIQELRQERLQLKKQIQQLENHIRDKERETSETLSSTSTRSFQYETPTATNRNMNHPQTDSRAQFSEQGRYASDSWNMPRDSSFSVDRYGLSCAPVEREQYVPRIINVTYTEGSNDKRWSSRDFSWTRKLEVSNKKVFGNHSFRPNQREIINATMSGSDVFVLMPTGGGKSLTYQLPALICQGITLVISPLVSLIQDQIMNLWQANIPAASLSAGMEWAEQLKIFQELSYEHSKYKLLYVTPEKVAQSDSLLRHLESLNSRGLLARFVIDEAHCVSQWGHDFRPDYQSLGILKQKFPNTPVLALTATATASVKEDVVQALGLVNCVVFRQSFNRPNLWYSVVPKTKKCLEDIDKFIKENHFDECGIIYCLSRMDCEKVAEKLKEFGHKAAFYHGSIEPTQRALVQKQWSKDEINIICATVAFGMGINKPDVRFVIHHSLPKSIEGYHQECGRAGRDGQRASCVLYYGYGDYIRVKHMISQGGVDQSPMASGYNRVASSARLLETNSENLHRMLRYCENEVDCRRFLQLVHFGEKFDSTNCKNTCDNCCSSQSLIDKDVTLITRQLVELVKQTGERFSSSHILEVYRGSLNQMVKKHRHETLQFHGAGKQLSKIEVSRILHYLVTEDILVEDVRKSDMYGTVSSLLKVNNSKAASLFSGNQTIMMRFPSSVKVLKPTKPAPTPAKPPVTSADASPEDLNLSAIMYTALRKLRTLLVKEAPDGVMAYHIFGNATLQQISKKIPRTKEELLEINGLGKAKVTKYGDRLLETIESTVNEYNGTSNKDSRISPDSGKRRRDENTSPNVTEDDDFADMSIQSYKKTARNKSNEVDMVSEKLDFDFEDRDGSEIRPEGRVLPW |
| CtsRecQl4A | >XP\_006471018.1 | *Citrus sinensis* | MSWSNSGDGYNCGAKLPKVNWLQHANAHENFSRQNKFLTSNFLFSLETQKPRAEGAMGARLITGQIQNFPRLHSAEVEKAWHTLSSLQISRRNYIRPGLSTPVEHSDNDASHNVSRRASLQSSSDGSKFSEPMHNRQKGSQINFNVNEPARCTGSFHLSNNVRDAGAGKGLRGQNEIKASVVANAHFKFSDGFGNHTTEAGQIDESAEVLANKIDDDEILETIDVDQIVMEHYHSSCTPKPSISRLPSITPNAGNDKFARQDETCLPPELCSICNHGCKLGLCPETSSHIQDMKDMLIAISNELLDNATNLSPARTEKLRQERLQLSKQIQLLEGYRQAEERQKSHFSASTTRTYQYETPQPAVLKIDPIRFDTQVHLYNESEGYGNWNSSSVSFSSVDRLGVSSYPVEREPFIPKIIKVNYIEGSNDQKWSSWDFPWTKKLEANNKKVFGNHSFRPNQREIINATMSGHDVFVLMPTGGGKSLTYQLPALICPGITLVISPLVSLIQDQIMHLLQANIPATFLSGNMEWTEQQEILRELNSDYCKYKLLYVTPEKVAKSDVLLRQLESLNARELLARIVIDEAHCVSQWGHDFRPDYQGLGILKQKFPNTPVLALTATATASVKEDVVQALGLVNCIIFRQSFNRPNLWFSVIPKTKKCLDDIDKFIKENHFDECGIIYCLSRMDCEKVAERLQECGHKAAFYHGSIDPAQRAFVQKQWSKDEINIICATVAFGMGINKPDVRFVIHHSLPKSIEGYHQECGRAGRDGQRSSCVLYYSYSDFIRVKHMISQGVAEQSPFTPGHNRFNVANSGRVLETNTENLLRMVSYCENDVDCRRLLQLVHFGEKFDSAHCKKTCDNCSKIKSFIEKDVTDTAKKLVELVKLTGQQFSSSHILEVFRGSLNQYVKKHRHETLSLHGAGKHLAKSEASRILRHLVIEDFLMEEVKKSDVYGSVSSVLKVNQSKAHNLIIGRQNVVLRFPSAINSTKLSKSDVTPAKGSLMSGKLSPSRNDTPSQPQNELDLNLSAKLYSSLRMLRTLLVKEAGEGVMAYHIFGNATLQHLSKRVPRTEEELLEINGIGKAKVSKYGVRLLETIESTIKEFYKTDKNGSSSNDSNDSGKRRRDENEAPNANKGDDDDFTKSTARSKKRASKSQNKTVEVINHNEPDSYECVDDLDFDEYEYVYEMNGSTTKPDQNNGGRVLPRWSMFSENG |
| GhRecQl4A | XP\_016674984.1 X1 | *Gossypium hirsutum* | MPDQNDSVESQKCYDKLPNVNWLRHFDAHDKFACQNKFLCTNFLFSLEGQKPQGTMFARLTSRQIQNSQIFQHTQVEKAWQILSSLPASCRTYLKPGTSAPVKTSTDEISHNRRGRSTLVELSGMKRSEHMHVHPNSSETESKVNGFGRCMTSSFPSNNANTMESGNNLRGNSGITTSMFSHSNSKVSGGSLKNQTFHGVQQEQSADVLANEIDDDDLLKLLNLGFILMQSIGHIDCIKDIDVDQIVSEHYQSTCTPQPSVSKFLPITPSVDKNAFAGQETCLPPELCSNCSHGCKLGHCPEAASHVQEMKDMLIAVSNELLDNATNLSLEQIEKLRQDRLQLNKLIQQLEKYLSDVERQKSNFSASTATLSFQYGTPQTTSLRTNPIQFDTQVHSRNEPNGYDNWNSPTVPFSSVNSIGVPSGPIEREPYIPQIIDINYIEGSNDQKWSSRDFPWTRKLEANNKKVFGNHSFRPNQREVINATMSGYDVFVLMPTGGGKSLTYQLPALICPGITLVISPLVSLIQDQIMHLLQANIPAAYLSANMDWSEQQEILTELTSDYCKYKLLYVTPEKVAKSDVLLRHLNILNSRDLLARIVIDEAHCVSQWGHDFRPDYQGLGILKQKFPKTPVLALTATATASVKEDVVQALGLINCIIFRQSFNRPNLWYSVIPKTKKCVEDIDKLIKENHFDECGIIYCLSRMDCEKVAEKLQEYGHKAAFYHGNMDPAQRAFIQKQWSKDEINIICATVAFGMGINKPDVRFVIHHSLPKSIEGYHQECGRAGRDGQRSSCLLYYSYSDYIRVKHMISQGAAEQSPLITGHSRFNNSGRILETNTENLLRMVGYCENDVDCRRLLQLLHFGEKFNSTHCQKTCDNCCKTRSSVDKDVTNIAKQLVELIKLTGQQFSSSHILEVFRGSLSQFVKKHRHETLSLHGVGKHLAKGEASRIIHHLVVEEYLLEDVKKSDIYGSVSSVLKVNESKVKNLFSGSQAIIIRFPSTVKVGKLSKPEVTPAKGSLTTSGKLSPPIVDTPAQSQSIVDLNLSAKLYSALRMLRTILVKEAGEGVMAYHIFGNATLQHISKRVPRTKEELLEINGIGKAKILKYGDRLLETIEATIKEHYKADKISSGSSNDSNDSAKRRRNTNANIDNDDDFSRSTGRSKKRTVERQDKDGNSDNNHQYPADENDLDFDDLDYVYDVESKENRPQVEVNINGRVLPSWPRT |
| McRecQl4A | XP\_022149253.1 | *Momordica charantia* | MREDQGNSGXDLKSGGKCPKMNWLEHSKAHKDFTCQKKFLCSNFLYSLSEQKPSTIGATNSGILACQMQNTQRIQRSQIEKAWNVLSNLQISSRHYAKPGKTRQVKDVFADCPPGPGRITSNSLSDANASSQYMKIHKNVSEFGVDATKPSSFVSNLSASSSNIKAVEDQNGVDGKNVARPLMVNHSHSQRVDGSFNFAINQRNNCSSFLGDEDDDIIENIDVDQIVEQYQSQSACTPQPSVSKLPPITPIVEKDNFARQEESNFPDELCTNCSHGSKIGLCPEASGHLQEMKDMLISISNDLLDNVNNLSPVQIDKLRQERVHLNKAIQLLEKHLSLNAVNEERRRSHFLATTVTPKTFHFETPQGVEFRTDSKQNNFEVHLQSELRRNEPWNPMVSSYSVERFGMSSGPVEREQYIPKVVDVNYIEGSNEKKWSSLNFPWTKKLEANNKKVFGNHSFRPNQREVINATMSGYDVFVLMPTGGGKSLTYQLPALICPGVTLVISPLVSLIQDQIMHLLQANIPAAYLSANMEWSEQQEILRELSSDFSKFKLLYVTPEKVAKSDVLLRHLESLNARDLLARIVIDEAHCVSQWGHDFRPDYQGLGILKQKFPKVPVLALTATATASVKEDVVQALGLVNCIIFRQSFNRPNLWYSVIPKAKKCVDDIDKFIKENHFDECGIVYCLSRMDCEKVAEKLQECGHKAAFYHGSMDSTQRAFIQKQWSKDEINIICATVAFGMGINKPDVRFVIHHSLPKSIEGYHQECGRAGRDGLRSSCVLYYSYSDYIRVKHMISQGAAEQSPQVSGYNRTNVGSSGRILETNTENLLRMVSYCENDVDCRRLLQLIHFGDKFDPENCKKTCDNCLKSTNLIEKDVTDIAKQLVELVRSIRQQFSSAHVLEVYRGSMSQFVKKHRHESLSLHGAGKHLLKSEASRILHHLVIEDILTEEVRKSDIYGSVSSLLKVNESKAHNLFNGGQRILLRFPSSARTNKLSKSEATPAKGSLVSGKICSHIDTPVQPQSEIDVGLSAKLYSSLRMLRTNLVKEAADGVMAYHIFGNATLQQISRKVPRSKEELLDINGIGKAKVSKYGDRILETIESTIKEFYGTEKNGSNSNDSNDSAKRRRDGNKDADEYLEDNDVTKSFDRSKKRATKIQNKVPKIHSSLEPECLDHFVDSEMDFDDSYYETRDLDVKDDQDHRNGGRVLPSWS |
| StRecQl4A | XP\_006349359.1 | *Solanum tuberosum* | MEANSAGGSMSKDKLPKANWTQHVTAHDNFSCQDKFLSSNILFSLPTQRHCAREEMNARSMTCQIRSVTKLEAEKAWKLLTSLKLSPKSYTKPGKTLQLTKDTNAFSQHSNHTQIPRASDGNCAPARCRPVHQGVGEDGENSDSRRYAGNCFPPHSSGIAETGNVVNRQSGVDNSHARGVGEISSSHANGASQKTREAYTTCADETEEDDILLNIDVDQIVEHYQTNCTPQPSVSKFPSTTPVTNSQSLAGHEETNLPPELSINCNHGLQLGLCPGASDHLQEMKDKLIEISNDLLDNVSDLSSEQIEMLRQERSQLKLQIQHLEKFLQTVSGNEERKMSQCSASTLTSGFQYETPSAFQYATPSSFPSRINPTRLDTQFSGYNESSHFDNWNSSSLSFDVTGGYGLSTAPVEREPYIPKYLEVNYIDGSNDKKWSSRDFPWTKKLEANNKKVFGNHSFRPNQREVINATMSGNDVFVLMPTGGGKSLTYQLPGLICPGITLVISPLVSLIQDQIMHLLQVNIPAAYLSSNMEWTEQQEILRELNSDGSKYKFLYVTPEKVAKSDVLLRHLESLHTRDTLARIVIDEAHCVSQWGHDFRPDYQGLGILKQKFPTVPVLALTATATISVKEDVVQALGLANCIIFRQSFNRPNLRYTVIPKTKKCLEDIGTFIKNNHFDQCGIIYCLSRMDCERVAEKLQEYGHKAAFYHGSMDGTQRANIQKQWSKDEINIICATIAFGMGINKPNVRFVIHHSLPKSIEGYHQECGRAGRDGLPSSCVLYYSYSDYIRVKHMISQGTVEQSPFGSGYGRSNVAASGRNLETNVENLLRMVSYCENEVDCRRLLQLIHFGEKFESTNCRKTCDNCCKTQNCIEKDVTEVAKQLVELVKMTGQKFSSAHVLEVFRGSLSQYVKKHRHESLQMHGAGKKLAKGEASRVLRHLVTEDILVEDVKKSDLYGSVSSVLKVNESKAYNLFAGGQTMRLRFPSFVKASKLGKYEATPAKGSLTSGKQSPPRTDPSGVPQSTFDPTLSAILYSALRKLRTNIVRESGDGVMAYHIFGDDTLQLIGQKVPRTINELRDINGIGKVKINKYGDNVLETIEATVRDYYKSDKTSSSGNDNTDSGKKRRNSINVQNGNSKDEEFFTESTGCTKKRVLKKHAEVIDYRDLGYFDECIDGDLDFDETMMP |
| GmRecQl4A | XP\_003532993.1 | *Glycine max* | MRQGEANSTQGPKVNLLQHANALENFSSQAKFLSSTFLFSVPPKKPPHHAEPNPGTAGFVFRRSETIQGSHRVQVEKALTAHSSLQNSSRIYVQLGKTQVTPQLHEDRRTTSFHGRYENDSRICPDVTVTPIVNNHSSRGLDGLVNNHTNYTGQIIKSSNCMAVDIDDDDDAILANIDVDQIVEEHQSTCTPKPSISKFPPITPTADKDNFARQGDNVLPPELCLDCIHGYKLGFCPEAASHLQEMKDNLIAISNELLDNGENLNSTQIAKLRHDRSQLNKQIQQLEKYIHSGNLNEERQKSHFSASTAPPTSFVYETPQQTVLCNGSKRYDTQAYMGNETYGSSFQSLPSFSVDNCNMPLGSVGREAFIPKIIEVNYIEGSGDKRWSSYDFPWTKELEVNNKKVFGNHSFRPNQREIINASMSGCDVFVLMPTGGGKSLTYQLPALIRPGITLVISPLVSLIQDQIMHLLQANIPAAYLSANMEWAEQQEILRELNSDYCKYKLLYVTPEKVARSDNLLRHLDNLHFRELLARIVIDEAHCVSQWGHDFRPDYQGLGILKQKFPNTPVLALTATATASVKEDVVQALGLVNCIIFRQSFNRPNLWYSVVPKTKKCLEDIDKFIRVNHFDECGIIYCLSRMDCEKVAEKLQECGHKCAFYHGSMDPAQRASVQKQWSKDEINIICATVAFGMGINKPDVRFVIHHSLPKSIEGYHQECGRAGRDGQRSSCILYYNYSDYIRVKHMLSQGAIEQSSMTSGYNRSNMINSGRILETNTENLVRMVSYCENDVDCRRLLQLAHFGEKFNSSTCQKTCDNCLKITSFIEKDVTEIANQLVELVKLTGQRFSSSHILEVYRGSLSQMVKKHRHETVSLHGAGKHLAKGEASRILHHLVVEDFLGEEVKKSDFYGSVSSILKVNEPKVRNLFAGQRIILRFPSSVKASKPGKSDATPAKGSLTSEKLNVMQIDPPSPQTEVDHILSAKLYNALRLLRKSLVTEAGEGVMPHHIFGNATLLLISKRVPRTKEELLDINGIGKAKVSKYGDQLLETIEKTVNEHYKLDNIGSGSKGSADSTKKRRVPNGNSDTNVEDDDAPTKSTGRSKKRTVKRQNRKGVIYDSPEEDYFQGCPDEDLDFDIIEIDALDQVTCKNTAGRVLPQWTAS |
| OsRecQl4A | XP\_015633861.1 | *Oryza sativa* Japonica | MIKPRVNWSDHANAVQSSCIKDEFLSSSFLFSLPTQRPNQEADCTGMLPLRSAACRIQGLERLQAPSIEKAWRSLRNTQVARKNYLRPGLSGKVKDCDSDHAHTYGTSSSYNVNKMDSVSRNRNPTQESMHQTTESGTMEKNSSHLPAGTKSCTRTYLNNHVVQADTITTTNQSLARTGPELFKTAPFIDNMCDDAKLDAMDEDELLASIDVDRIVMEHYQATNTPRGSSKSPLEKCNFNGFDENNLPQELSIMCDHGSKLAFCPEAKSHLLEMKDNLLAISHELIDGQLSPQQSDDLHQKRALLKKQIELLGEYTARLTQDEERQQSHSMASTTAHQGHHPTSILSSSFVKDTNIFQSPIYTRNEPGESGLCFSSAPYSYMDGLSMPLPSVQRDYTPRAIDISYTEGSGDKQWSSTHFAWTKELEANNKRVFGNRSFRPNQREIINATMSGNDVFVLMPTGGGKSLTYQLPALICNGVTLVVSPLVSLIQDQIMHLLQANISAAYLSASMEWSEQQEILRELMSPTCTYKLLYVTPEKIAKSDALLRQLENLYSRGHLSRIVIDEAHCVSQWGHDFRPDYQHLGILKQKFPQTPVLALTATATASVKEDVVQVLGLANCIIFRQSFNRPNLRYFVWPKTKKCLEDIHNFIHANHNKECGIIYCLSRMDCEKVAAKLREYGHTASHYHGSMDPEDRANIQKQWSKDRINIICATVAFGMGINKPDVRFVIHHSLPKSIEGYHQECGRAGRDSQLSTCVLFYNYSDYIRLKHMVTQGFAEQGTSAPRGGSSQEQALETHKENLLRMVSYCENDVDCRRLLQLIHFGEMFNPSCCAKTCDNCLKELRWVEKDVTNIARQLVDLVMMTKQTYSTTHILEVYRGSVNQNVKKHRHDTLSLHGAGKHLAKGEAARILRHLVIEEILIEDVKKSENYGSVSSVLKTNHKKSGDLLSGKHNVVLKFPTPEKAPKMGVLDESSVPRINKTNQQSQVDGSLAAELYEALQCLRTQIMDENPQLLAYHIFKNETLKEISNRMPRTKEELVEINGIGKNKLNKYGDRVLATIEDFLARYPNATRKTSSGGSNEHSEAVKKRRGFSVTNTSTNCDDFEERTVQSKKRAAKTRTRQEISDAASIVQDVRYIDLELDGCEQVNEVPYSVQKPVASGRVLPAWQSARIA |
| AtRecQl4B | NP\_176289.7 | *Arabidopsis thaliana* | MVVTRGDKFAGSSLACKSMIGANKMSGSHLHEVNNSRSHFPQTNWLKVAKAFECIPSLNKFMGSNFLYSLESQKLGRDREMAARSIENIAPVTVQTLARPQIEKAWCTLINLSINNTYLRPGITPAIDNDSTSRTSSTKGSTFKVTSNADGSFCAHNHPEHSQRSVRGTAKSIDSFSSSSVGDNKIIIDKVPRVNYEVRDSVTVTNGMEMPPIKNSAQLARPVEPREVSLGEIDYDDIMEIIDVDQIAMEHCPSTCTKQPSVSKFVDIFTSRREEEQGLPPEICSNCSHGIKLGLCPEASTHVEQMKDTLLAISNEILDNTYDLGPDHVEQLHQKRLLLKKQIQQLEILIHNKERKKSQCLVSIPSHNTQYETPQTTNLEVVYGQTDSPTHVKEQGRCVTDNWNMPRDYLVSKERYDISSGSEEREQSVSEVIDVTDTESSNDKKWTSSDFPWTKNLEVYNKLVFGNHSFRPNQREIINATMSGCDVFVLMPTGGGKSLTYQLPALLCAGITLVISPLVSLIQDQIMNLLQTNISAASLSAGMEWAEQLEILQELSSEKSKYKLLYVTPEKVAKSESLLRHLEILNSRSLLARFVIDEAHCVSQWGHDFRPDYQGLGVLKQKFPNIPMLALTATATTSVKEDVVQALGLVNCVVFRQSFNRPNLWYSVVPKTNKCLEDIDKFIRENHFDECGIIYCLSRMDCEKVTEALRVFGHKAAFYHGSMDPGKRAFVQKQWSKDEINIICATVAFGMGINKPDVRFVIHHSLPKSIEGYHQECGRAGRDGQRSSCVLYYSYTDYIRVKHMISQGGLGQGQMKMGYNCKASSGRMLETNTENLLRMVSYCENEVDCRRFLQLVHLGEKFDSTNCKNTCDNCSSSKILIDKDVTVIARQLVALVKLTGERFSSAHIVEIYRGSLNQSVKRNRQDTLHLHGAGKHLTKSEASRILHYLVTEDILAEGVKKSELYGSVSSLLKVNRSKAASLLSGGQSITMRFPSTIKVSKQSKSTANPAKVPLKQTTLPMAKAAPQDSNLSGILLTALKNLRTDIVKESPDLVMAYHIFGNATLKEISKRLPRTKEELLDINGLGKAKVSKYGDRLLETIDSTINDHYKTRPGSGKRRRDENVNPNVAEDDDPDWSASQSHKKVVKNKK |
| CsRecQl4B | XP\_010418038.1 | *Camelina sativa* | MVVTRGNKIAGSSWACKSMIGANRMSGSHHLPEVKTNWSKHAKAFECIPSLHKFMGSNFLYSIECQKPGRDRDIAATRSIENIGPLTVQTLARPQIEKAWCTLINLSINNTYLRPAITPAIDDGSSNCSSSTKGSIVKVTSTADGSFYAHNHPEYSQRRVRGTAKSFDSFSSSSVGDDKITIGKVPLVKDEIRDSVTGYKYTNVMERPPIKNSTHPASLDEIDYDDIIEIIDVDQIVMEHCQSTCTVQPSVSNFTPIAPSVDIFASRREEEKCLPPELCSNCSHGIKLGLCPEASTHVEQMKDTLLAISNEILDDTTGLGPDHFEQLRQKRLLLKKQIQQLEILIQNKERKTSQCSVLTATQTLQYETSQTTNLQMVYAQTDSRAHVKEQGRYVTDNWNMPEGYLFSEDRDGISSGPVEREQIPEIIDVTYTESSNEKKWSSRDFSWTKNLEVYNKIVFGNHSFRPNQREIINATMSGCDVFVLMPTGGGKSLTYQLPALICAGITLVISPLVSLIQDQIMNLLQTNIPAASLSAGMEWAEQLEILQELSSENSKYKLLYVTPEKVAKSDSLLRHLESINSRSLLARFVIDEAHCVSQWGHDFRPDYQGLGVLKQKFPNIPVLALTATATASVKEDVVQALGLVNCVVFRQSFNRPNLWYSVVPKTNKCLEDIDRFIKENHFDECGIIYCLSRMDCEKVTETLRAFGHKAAFYHGNMDPGKRAFVQKKWSKDEINIICATVAFGMGINKPDVRFVIHHSLPKSIEGYHQECGRAGRDGQMSSCVLYYSYTDYIRVKHMISQGGLGQGHMTMGYNRIASSGRMLESNTENLLRMVSYCENEVDCRRFLQLVHLGEKIDSTNCKNTCDNCSSSKSLIEKDVTLIAKQLVELVKLTGERFSSAHIVELYRGSLNQMVKKHRHDTLHLHGAGKHLAKSEASRILHYLVTEDILAEGVRKSDLYGSVSSLLKVNRSKAASLLSGGQTIKMRFPSTVKVLKPSKSTANPAKVILKQTTLPMANAAPKDSNLSDHLLAALKKLRTDIVKESSDGVMAPYHIFGNTTLQQISKRLPKTKEELLDINGLGKAKVSKYGDRLLETIQSTINDHNRTGPGSGKRRRDENICPNVADDDDPDWSASKSHKKALKNKK |
| RsRecQl4B | XP\_018452745.1 | *Raphanus sativus* | MVLVTREDRLAGALPHVQPMIAANKMCGSHLHEAEKSRVHLPQTNWSKHANVFECIPSSNNFLSSNILYSLESQKPRRNRGTASRPIYNIIPVDVQTLAHQHISKAWCALTNLSINNTYLRPGITPAIDYINTNCSFSTGGRSTAKVTSNTDGSFYAHNHQEDSQKSIRGTATSFDRFSSSSPGDGKLTSGKVPWVNNEVRDSVTSCINGIMEVPPIRNFAHPARQVEVIEIDDDDMLESIDVEKIIMEHYHSTCTHQPSVNIFASRGNEEPCLPPELCSNCSHGVKLGLCLQASSHVEQMKDALLAVSNELLDDSTNLSPGHFEQLCQERLLLKKQIQQLEILIQDKERKNSECLASRRTHNIQYETPQTTNHKADYAQAESRAHVKEQGRYVSDNWNMPRDYLCSEDRSGLSSGPIERERCVPDIIDITYTDGSNDKKWSSRDFPWTKNLEVNNKRVFGNHSFRPNQREIINATMSGCDVFVLMPTGGGKSLTYQLPALICAGITLVISPLVSLIQDQIMNLLQANIHAASLSAGMDWTEQLEILRELSSENSKYRLLYVTPEKVAKSDSLLRHLESLNSHSLLARFVIDEAHCVSQWGHDFRPDYQGLGVLKKKFPKIPMLALTATATASVKEDVVQALGLVNPVVFRQSFNRPNLWYSVVPKTNKCLEDIDQFIKKNHFDECGIIYCLSRMDCEKVTETLRKFGHKAAFYHGSMDPGKRAFVQKKWSKDEINIICATVAFGMGINKPDVRFVIHHSLPKSIEGYYQECGRAGRDGQRSSCVLYYCYSDYIRVKHMVSQGGPGQSTMTTGYNRIASSGRTLESNTDNLLRMVSYCENEVDCRRFLQLVHLGENFDSTNCKNTCDNCSSSKTLIDKDVTLIARQLVELVKLTGERFSSAHIVELYRGSLNQTVKKHRHETLHLHGAGKHLSKSEASRILHHLVTKDILAEYVKKSELYGSVSSLLKVNRSKADSILSGGQTLNMRFPSAVKVVKPSKNGPTPARVALKQTTLPMAPAPPQDSVLSDTLFKALRKLRSDIVKESSDAVMSYHIFGNPTLQQISKRLPRTKEELLDIHGLGKAKVSKYGDRLLETIESTINNHYGTNKNEGTGSGKRRRDENTDPIVIDNDDDDPDWTPSQQSKKKAYAVHGQMFGEATC |
| BnRecQl4B | XP\_022548246.1 | *Brassica napus* | MVVVTRDDRLAGARPHVQPMSMSAASKMCGSHLPEAQKSRVHLPQTNWLKHANAFECIPSSNNFLSSSMLYSLESQKPSTSRETASRPIYNIIPVDVQTLAHQHISKAWCALANLSINNTYLRPGITPAIDDINTNCSFSTRGRSTAKVTSNTDGSFFAHNHQEDSQKRIRGTATSFDRFSSSSPGDGKLISGKVPRVYNEVRDSVTGCINGMEVPPIRNFAHPARQVEVIEIDDDDILKSIDVEQIVMEHYHSSCTHQPSFNIFASRGEENPSLPPELCSNCSHGVKLGLCLQAPSHVEQMKDALLAVSNELLDDSTDLSPGHFEQLCQERLLLKKQIQLLEILIQDKEKKNSECLASRPSHNIQYETPQTTNHKADYAQADSRAHIKEQGRYVSDNWNMPRDYLCSEDRSGLSSGPRERERCVPEIIDVTYTDGSNDKKWSSRDFPWTKNLEVNNKRVFGNHSFRPNQREIINATMSGCDVFVLMPTGGGKSLTYQLPALICAGITLVISPLVSLIQDQIMNLLQANIHAASLSAGMDWTQQLDILRELSSENSKYRLLYVTPEKVAKSDSLLRHLESLNSHSLLARFVIDEAHCVSQWGHDFRPDYQGLGILKKKFPKIPMLALTATATASVKEDVVQALGLVNTVVFRQSFNRPNLWYSVVPKTNKCLEDIDQFIKKNHFDECGIIYCLSKMDCEKVTETLRKLGHKAAFYHGSMDPGKRAFVQKKWSKDEINIICATVAFGMGINKPDVRFVIHHSLPKSIEGYYQECGRAGRDGQRSSCVLYYCYSDYIRVKHMISQGGPGQSTMTTGYNRIASSGRTLESNTDNLLRMVSYCENEVDCRRFLQLVHLGENFDSTNCKNTCDNCSSSKTLIEKDVTLIGRQLVEIVKLTGERFSSAHIVELYRGSLNQTVKKHRHETLHLHGAGKHLSKSEASRILHYLVTKDILTEYVKKSDLYGSVSSLLKVNRSKAASILSGGQTIEMRFPSAVKAVKPSKQGPTPARVALKQTTLPMAPAPPQDSILSDTLVKALKKLRADIVKESSDAVMSYHIFGNPTLQQISKRLPRTKEELLDIHGLGKAKVSKYGDRLLETIESTINNHYGTNKNEGTGSGKRRRDENTNPIVVDNDDDDPDWTPSQQSYKKAYAVRGQTSEEAIC |

**Table S2** Detailed interatomic contact analysis and structural evaluation of the of AtRecQl proteins

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | AtRecQl1 | AtRecQl2 | AtRecQl3 | AtRecQl4A | AtRecQl4B |
| All-Atom Contacts | Clashscore, all atoms: | 0.31 | 0.61 | 0.46 | 0.68 | 0.46 |
| Protein Geometry | Poor rotamers | 1.13% | 1.09% | 2.51% | 2.44% | 1.04% |
| Favored rotamers | 96.03% | 95.42% | 92.20% | 92.67% | 93.79% |
| Ramachandran outliers | 0.50% | 0.00% | 0.98% | 1.09% | 0.73% |
| Ramachandran favored | 93.52% | 94.58% | 91.18% | 92.36% | 94.52% |
| Rama distribution Z-score | -2.64 ± 0.38 | -2.90 ± 0.32 | -2.38 ± 0.38 | -2.99 ± 0.31 | -2.69 ± 0.32 |
| MolProbity score | 1.08 | 1.10 | 1.48 | 1.49 | 1.05 |
| Cβ deviations | 0.26% | 0.00% | 0.00% | 0.19% | 0.19% |
| Bad angles: | 0.83% | 0.64% | 0.52% | 0.75% | 0.62% |
| Peptide Omegas | Cis nonProlines | 0.78% | 0.40% | 0.00% | 0.73% | 0.94% |
| Twisted Peptides | 0.00% | 0.00% | 0.00% | 0.73% | 0.18% |

**List of software and access date**

1. The Arabidopsis Information Resource (TAIR) (<https://www.arabidopsis.org/>) (The last access date 12.09.2021)
2. The Gene Structure Display Server (GSDS) 2.0 program (<http://gsds.cbi.pku.edu.cn/>) (Hu et al., 2015) (The last access date 10.02.2022)
3. Domains were analyzed using SMART online database (http://smart.embl-heidelberg.de/smart/) (Schultz et al., 1998) (The last access date 19.01.2022)
4. Arabidopsis Gene Regulatory Information Server (AGRIS; <http://arabidopsis.med.ohio-state.edu/AtcisDB/>)(Davuluri et al., 2003),,(The last access date 14.08.2023)
5. PlantCare (<http://bioinformatics.psb.ugent.be/webtools/plantcare/html/>), (Lescot et al., 2002), (The last access date 17.08.2023
6. Plant Cis-Acting Regulatory DNA Elements (PLACE; <https://www.dna.affrc.go.jp/PLACE/>) ). (Higo et al., 1999) (The last access date 17.08.2023)
7. Gene ontology (GO) (<https://www.arabidopsis.org/tools/bulk/go/index.jsp>). (The last access date 14.08.2023)
8. ClustalW (Madeira et al., 2019) (The last access date 14.04.2023)
9. MEGA-X (Kumar et al., 2018) (The last access date 02.09.2024)
10. STRING website (<http://www.string-db.org>) (Franceschini et al., 2013) (The last access date 04.08.2022).
11. DeepTMHMM (<https://dtu.biolib.com/DeepTMHMM>) (Hallgren et al., 2022). (The last access date 04.08.2022).
12. Protein solubility software - Protein-Sol (<https://protein-sol.manchester.ac.uk>) (Hebditch et al., 2017). (The last access date 04.01.2024).
13. Stability curve of protein prediction - SCooP server (<http://babylone.3bio.ulb.ac.be/SCooP/index.php>) (Pucci et al., 2017) (The last access date 04.01.2024).
14. The secondary structure prediction method - SOPMA [NPS@ : SOPMA secondary structure prediction - NPSA - Lyon - France (inserm.fr)](https://npsa.lyon.inserm.fr/cgi-bin/npsa_automat.pl?page=/NPSA/npsa_sopma.html) (<https://npsa-prabi.ibcp.fr/NPSA/npsa_sopma/>) (Geourjon and Deléage, 1995) (The last access date 10.01.2024).
15. The protein structure homology-modelling server- SWISS-MODEL (<https://swissmodel.expasy.org/>) (Waterhouse et al., 2018). (The last access date 19.01.2024).
16. The Molecular probability for protein assessing software - MolProbity (<http://molprobity.biochem.duke.edu/>) (Chen et al., 2010). (The last access date 03.02.2024).
17. The protein structure analysis software- ProSA-web (<https://prosa.services.came.sbg.ac.at/prosa.php>) (Wiederstein and Sippl, 2007). (The last access date 04.02.2024).
18. The Yet Another Scientific Artificial Reality Application -Yasara Structure software (Land and Humble, 2018) (The last access date 12.02.2024).
19. Molprobity’s ultimate rotamer-library distributions for model validation. (Hintze et al., 2016)

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