

Supplementary Figure 2: Results of CLUSTAL OMEGA alignment of DNA-PKcs sequences from selected vertebrate and invertebrate species. DNA-PKcs amino acid sequences from the organisms listed below were analyzed by CLUSTAL OMEGA using the default settings.

A. The percent amino acid identity for each sequence in the alignment (from Clustal Omega).

B. Alignment of DNA-PKcs sequences. * represents identical amino acids (indicated in blue/bold), : represents conservative substitution (indicated in blue) and . represents amino acid similarity, indicated in purple. Unassigned amino acids are indicated by X. Major domains and regions of interest are indicated beneath the alignments. The conserved DXXXXN and DFG motifs in the kinase domain are shown in red/bold. The human sequence is highlighted in yellow. For additional information on sequences and phyla please see Supplementary Table 1.

A.

Sequence	Percent ID
HUMAN	100
PLATYPUS	75.07
TURTLE	71.87
ALLIGATOR	70.21
OSTRICH	69.69
CANARY	67.87
CAECILIAN	67.81
COELACANTH	65.4
STERLET	64.88
ESHARK	62.21
LANCELET	43.48
ACORN_WORM	42.81
STARFISH	42.6
SEA_ANEMONE	41.85
STONYCORAL	41.21
SEA_URCHIN	40.91
SOFTCORAL	39.86
OYSTER	39.34
SNAIL	39.34
PRIAPULA	39.26
ALVINELLA	39.25
TRICHOPLAX	38.87
CAPITELLA	37.26
SPONGE	35.54
SCORPION	34.38
TERMITE	30.27
SHRIMP	30.02

Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

CLUSTAL O(1.2.4) multiple sequence alignment

TERMITE	-----MMGSELIGFVEVINSI----SGNHLNKYIEAKSNISNIISYFE-DKRKR	47
SHRIMP	-----MAGGGREEELDLLGKLSFGPQNGQGDPAADKDVIVDIAELLA-VDLTPAQ	51
SCORPION	-----MNEITNSLHENILKLNDFI---KYQKD--EGHSSIVYIKDISEICLRGTLSEK	49
ALVINELLA	-----MEN	3
CAPITELLA	-----MARALQEQLAGLVSDT---RQPGVNNARISHESIGNIGAICL-NDVNASD	47
SPONGE	-----MESRIESLWESL---HSSSP-QRYSYATEVASDLYSLCV-EQITSESE	42
OYSTER	-----MAASLLEDNLRSLNECL---TTADN-SSKEQADSIVADISQICI-NESTDKD	47
SNAIL	-----MAATLEETLRSLHDQ-----SGA-SAYNLANGLIADIRQICL-HEISEKD	43
TRICHOPLAX	-----MASNLSQLLIDLHALL---NLQSL-HRGSNACDIASDITVLCL-QTASDAE	46
SEA_ANEMONE	-----MTDAISSRLLQLNELV---AEESP-LRQESAEIARDLRAHCS-QLRDESE	46
PRIAPULA	-----MARTVRIEDHVQTLLESL---PSDDREADPETAHSAVADLAHKCL-QDISKRD	49
ESHARK	---MAGPRGAADTLSAFSLHLL---SLSDVKSAAAESHSAVGSISRDFRCSSSDSQ	54
STERLET	MAQPGSCSVGAGGIQNLHLKHSFL---NATDAKSAAVESHNLIGNLQCEM-VSKNENE	56
COELACANTH	MAEEGSPSAVEGVSYLLKIHSSL---TVDTKSAIEIENIFGNLRQECV-VTSDENE	56
HUMAN	-----MAGSGAGVRCSSLRLQETL---SAADRCGAALAGHQLIRLGLQCEV-LSSSPAV	50
CAECILIAN	MSVPGVGGDSAVGVQGSLLRLHASL---SSKDPGLEAPVAQSLIRSLGEECV-TSSGDSV	56
PLATYPUS	-----MAGSVPGPQGSLLRLQRFL---EAEDAGVSAVAAYQLIRLGLQCEV-LSAGPAV	50
CANARY	-----MAGVQQLLQLHRC---QPGDAGGSALHGYSLLRSLAETCL-ASLASGE	46
OSTRICH	-----MCS-----ERKDVQADCV-F---ALP	17
TURTLE	-MAAAPVGGGGGIQGSLLHQLSCAL---QDPDPGTAALRGYHLIRGVGEACV-TSTGDGA	55
ALLIGATOR	-----MAALVPVV-IRTGDSA	15
SOFTCORAL	-----MTEVIDRYLNQLNSCL---KTLSSSRG-READICRDLRLYCI-ENINETQ	46
STONYCORAL	-----MSDLLNRYLTHLHSL---PSLDAPHCGLDASNTVVLDGSLFCL-ENVSSSE	46
ACORN_WORM	-----MPSSELQSKLAELLELL---DETPSQHTVEKCNLIGETQLICL-RTTSENE	48
LANCELET	-----MAGSGSLEARLSELHALL---AESDHGHGAVEAHNLVADIAQICL-RHTAERD	49
SEA_URCHIN	-----MAAAELQRHLAELHEVI---DSGGTAHGPETAQDLVVDIAQLCL-NQTRENE	48
STARFISH	-----MATADLPVKLSELNGLI---STRKSLHVAEKAQDLVVDLGHCL-RQLSENE	48

N-TERMINAL UNIT

TERMITE	-LDGAFVTLFDKKTGILQFIQKALKQDAFTEAIKESFTLLKQLIDVFKERMS----CHVV	102
SHRIMP	-YDLYISQVL-GEKGIITFGRSVSKDQSFVEAKKSTLDVLTLDKREAQKIN---KYVD	105
SCORPION	-RSYVCSLILRKEDGFLHFLEEAVNTPSLKDSLIEALQFLNLFNINIGNKVV---QYGI	104
ALVINELLA	-LGCCCALLFKSKETGITNFKKVVQKDEFLDCKVDALKMLLALVVKYDKKLL---SYSL	58
CAPITELLA	-VDLAYSVIFNHETGLIKFLKKIIQNDEFEGCKCEILELLKTFISKFPKGVH---PYAV	102
SPONGE	-LAYSSVLFNPDNGILKFLHDVTTLEEFASCHEELKLLSNFVKNLSRRVL---SHIV	97
OYSTER	-IDLCCSVLFDKRGKLVFSETVTKEEFQCKQKILEFLSEFVQRIGKKII---PYVF	102
SNAIL	-RDYCCSALFDKDIGIIAFLQKVAARDEFQSTKTNLDFIGDFLQKVGKLL---PYAI	98
TRICHOPLAX	-KAYCSALFQDYGVVTFLRKSLGDDLDKCKEDLLKLI TAYMEKIGGKIS---PYAV	101
SEA_ANEMONE	LGARCSILFDKKTGIIIRFLHKTIANQEFVECKTELLKFLQSYLQQLNTRVN---PYAV	102
PRIAPULA	-VDLTCVLFSEDRGVLIFLRRAIPLDEFKLAKEQLLHSHFINKGQTRIL---TYAV	104
ESHARK	-LALQCSMVFSKDGTLLVFLRKSRLFEEFRDSREDVLKLLSEVVERIGEAVG---RYAC	109
STERLET	-LVLQTSLVFSKENGLLAFVRKSLNIEDFRDTREEALKLLTTFLDRIAHKVNWEKKNYAC	115
COELACANTH	-LALHISLIFSKEIGLLIFLRKSLSEEFDRNREEILKFLTAFVEKIGQLN---PYAC	111
HUMAN	-LALQTSLVFSRDFGLLVFVRKSLNSIEFRECREEILKFLCIFLEKMGQKIA---PYSV	105
CAECILIAN	-LALQTSLVFSKEHGLLAFIHKSLGIEEFRCREETLKFLCIFLEKIGQKVV---PYAC	111
PLATYPUS	-QALHTSLVFSKEFGLPVFIRKSLDIEEFRCREAEALKFLCIFLEKIGQKIE---PYSY	105
CANARY	-QALHLSLVFSQEYGLLVFIHRSLTIEEFRCREAEALKFLCVFMEKVGDKIH---PYAC	101
OSTRICH	-AALHISLVFSQEYGLLVFIHKSLGIEEFRCREAEALKFLCAFLEKIGEKVH---PYAC	72
TURTLE	-RALQTSLVFSKDNGLLVFVRKSLSMEEFRECREAEALKFLCAFLEKIGQGVH---PYAH	110
ALLIGATOR	-QALQSSLVFSKQGLLVFIRKSLSIEEFRCREAEALKFLCTFLEKIGQGVH---PYAC	70
SOFTCORAL	-LAYCSLLFNQDDGLITFVKAVVQLDEFKCKEVIISFLAEYIAKVKTRIS---PYAT	101
STONYCORAL	-QAYYSLLFSGETSIVSFLRKVITLDEFQDAKIELLQFLQSYVMKMGKIN---PYVV	101
ACORN_WORM	-LAYHCSVVFHKETGILLFLKKTITIDQYVSSKERILEFVYNFMIRADKKIV---TYAL	103
LANCELET	-VAYCCSVLFQESTGITAFLRKVTLDQYLPKAVETLSFLLAFLLEKIGRKIQ---PHAV	104
SEA_URCHIN	-LAFCRSELQKETGITITFLQKAVSKDEYGGSKVQTFLEFLGQVQAKELVL---DHAK	103
STARFISH	-LAYCCSOLFNDNGILVFLNKAIPKDELKGSKEQLLEFLHAFLLKAGSRLL---ARTV	103

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N-TERMINAL UNIT

Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

TERMITE	QIKDLCKTCILLEKKAEEKDAFDVIQSVLENG---PWND-NLNVDELFDKLINPFKSNK	158
SHRIMP	DIRKYTYLYLYNVEKSTKVQAAALEVFCTLLAKCGSHIDIQ-EINVDFQIERLCIDIRS--	162
SCORPION	TVKDVVFSIFLRNQLAKVKILALSALIKVLELCSGAISS-QFNLQKIVNKIIEYLAQA-	162
ALVINELLA	DLKDVSMFLRDRFAKVKVVALDLDLIEVVTFVAGSEVAD-ELKISGIAEKLFTELVHS-	116
CAPITELLA	DVKDAQLQLITRDRRAVKNATPLLIPELLKQTSGLPVAG-DLQVBMIEERLKFELIKS-	160
SPONGE	PITDVCVFIEMREKSAKVNATLNLINTLELGCCKTEYSH-DLDIPKIAKFFQAALLP-	155
OYSTER	DIKDVCSLFFRERLAKIKNLSVPLAKVLELSVGSVNVQ-DLGIKDMINKFFMELTKS-	160
SNAIL	DKEACVSAFSDRYAKVNKNSALGVLVKVELTVGSPIRE-EMKIDNVEKLFRELTKT-	156
TRICHOPLAX	QIKDVCISLFTDRDKAARVNATFPPLLQLLSSKLSHSSVVE-ELAIKSLVDKYMSACKQP-	159
SEA_ANEMONE	AIKDICKMLLQESSKVKIETFLPLIQMLQTKLESSIID-EMDIPKIDRYFKACLQS-	160
PRIAPULA	DIKDTCLAVFSRDRQADVKNATFPPLLIKVLQLCRGSQTQA-KLDVPKLIDRYFNELTQS-	162
ESHARK	DIKGTCCVVVYTKKAAKCKAAALDLDLITLLHSLKSSSCLQ-QFKIGELFNKFGDLSQK-	167
STERLET	DIKDTCLVVYTKDRAAKCKVSALELLIKLHLI-TSPCLLQ-EFKVGMFNKFGDLAQK-	172
COELACANTH	NVKLILFPVFFF----FIFIFTYLLQLQSTKSPHCIE-EFKVSEMFKFYGELAQK-	164
HUMAN	EIKNCTSVYTKDRAAKCKIPALDLDLILKLLQTFRRSRLMD-EFKIGELFSKFYGELALK-	163
CAECILIAN	DIKNTCCVVVYTKKAAKCKVPALELLIKVLQILKNSYEIE-ELKVKEIFNKFYSELGVK-	169
PLATYPUS	DIKSVCSISVSKDRAAKCKIPALELLIKLLQTLRSRLME-ELKVGIFNKFYEEELALK-	163
CANARY	NIKQTCISVYIKERTAKCKISALELLIKLHLTLQRSCLEME-EMKVGEIFNKFYEEELAA-	159
OSTRICH	NVKQTCISVYTKKAAKCKIPALELLIKLQNLRRSCLME-EMKVGEIFNKFYGELATR-	130
TURTLE	DIKQTCISVYTKKAAKCKIPALELLIKLQNLRRSFLME-ELKVGEIFNKFYGELAA-	168
ALLIGATOR	DIKQTCISVYTKDKMAKCKIPALELLIKLQNVQCSSLMG-ELKVGEIFNKFYGELAGK-	128
SOFTCORAL	DIKDICLKLFTKDKNARVNKETFVLLQLFELKFEPTIVE-KLDVKNIVEKYFSACSQS-	159
STONYCORAL	EIKDICLKIFSQDHSNKAETAELPLMAEILDVKLESSVVE-KLDVPIFDKYFGACIQP-	159
ACORN_WORM	DIKDVCLSLFTDRDKMAKIKNRTFPPLNKLLELTANTPVAK-ELGVSKLIDKYFSQLMQP-	161
LANCELET	EIVKEVCMVFSRDRSRVKCATFPVLKVKVQLTIHSQDGD-ELRVSDMVDRMFLELTMK-	162
SEA_URCHIN	DIKDVCMVSLYTRDKLAKVKATFPPLVIELLKLTSGRMDDEAMGVDMALKKFFGELGQP-	162
STARFISH	EIKKICISAFMRDKSAKVKTKTFPVLIELLQRSASAQMEA-DLDIPKMIELYFEQLMQP-	161
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TERMITE	SNTMPAKVVQKHLHLGIIVHKYPECLRP-EETRLLLRIYLSELE-----MQTSHA-T-	209
SHRIMP	--AKGSTVLQHQLOTLGMLMYSYPQNLRH--QSPLILKIFKQQLV-----KHTGS	208
SCORPION	SSKITPTVKQQAAYLLGISSRHYPDCMQL--CSERLLNWLKDLK-----FHTTSN--Q	212
ALVINELLA	S-RHPS TVQQRMYQLLGVIAEMYPELMVR--HADRLVNMYVVTIK-----KQMTSKTS-	166
CAPITELLA	P-KPAASVKAHIFHLGVIAELFPEKMVR--GSDKLLNLYMTTLK-----QEIESKTH-	210
SPONGE	T-KHSATIRGGIYHLLGVVLCWEFPEHLVK--ISSRLIDIYMSNLK-----SEMTVKKTK	206
OYSTER	VSKLPASVKESIYVILGLLAEIYPEHMTQ--YAGKLVDIYLRALK-----AEMTSKTK-	211
SNAIL	S-KLVP TVKGN IYFLLGVIAEVYPELITQ--DSDRLVGLYVSALK-----AEMTSKTK-	206
TRICHOPLAX	T-KYSS TVKSGMYSLLGTIAEKFP EYIMP--HAQQLLTIYLN TLK-----SQMTGKNT-	209
SEA_ANEMONE	S-KQOSTVRFWLYTILGVFAEVFPEHMLG--NADRLIS IYINL LN-----SEMKS KGNK	211
PRIAPULA	S-RLTS TVKQGVYHLLGVIAESYPELMVA--YADKLIS IYVNE LK-----NQMKS KTK-	212
ESHARK	S-KFPD TVLEK VYEL LGVLAEVQPTEMLH--NSEKLFCAYLNE LR-----VQMTSATR-	217
STERLET	S-KIPD TVLEKIYEL LGVVLGEVQPSDMLN--NSEKLYRAYLSE LK-----SQMTSATR-	222
COELACANTH	S-KLPD TVLEK VYEL LGVVLGEVQPS EMLH--NSEKLFRAFLGELK-----TQMRSTTK-	214
HUMAN	K-KIPD TVLEK VYEL LGLLGEVHPSEMIN--NAENLFR AFLGELK-----TQMTSAVR-	213
CAECILIAN	S-KVPD TVLEK VYEL LGVVLGEVQPSDMLD--NSEKLFRAYLGE LK-----KQMTSTTR-	219
PLATYPUS	T-KITD TVLEKIYEL LGVVLGEVHPSEMLC--NSEKLFRAYLGE LK-----MQMTSSTR-	213
CANARY	S-RIPD TVLEKIYEL LGVVLGEVQPSDMIN--NSEKLFRAYLRE LK-----TQMTSATR-	209
OSTRICH	S-KVPD TVLEKIYEL LGVVLGEVQPSDMIN--NSEKLFRAYLGE LK-----TQMTSTTR-	180
TURTLE	S-KVPD TVLEKLYEL LGVVLGEVQPSDMDV--NSEKLFRAFLGELK-----TQMTSATR-	218
ALLIGATOR	S-RVPD TVLEKIYEL LGVVLGEVQPSDMLD--NSEKLFRAYLGE LK-----TQMTSATR-	178
SOFTCORAL	T-KKSSVSYGIYSLGLTLAEYFPEYMVD--KADRLVQIYVGV LK-----AE-MRKS G-	208
STONYCORAL	V-KHSS TVKYWLFSL LGTIKVFPECVIS--HSDHLVKHYVSVL KLENLIPQMTRKTK-	215
ACORN_WORM	S-KLAATVKHGIYHLLGVVFAQYYP ELMTK--YSDRLN VVMKAL K-----DQMLSKTK-	211
LANCELET	S-QTTATVKSGALS LGVISEVY PDLMVQKDHDPDRLLKVYISMLK-----EQMESRTR-	214
SEA_URCHIN	S-KLSQSVKLG IYQTLGAFGEYYPQLMMH--YSDRLFNVLVST LK-----QQMTTKTK-	212
STARFISH	S-KLSQ TVKQGIYCL LGVLA E IY PVLMSG--YSERLLSVYIATLN-----QQMTSKTR-	211
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N-TERMINAL UNIT

Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

TERMITE	AVKYQIIAGCLNGLTEFLYVPLKPQE--KEARRIYDCVTAVARKHK-----EMRVAPR	261
SHRIMP	KPDLNALAGVLRGLALYLHHPPEGIDDDPQLFTELYKHIHKVLNPDL----NLPRRDAQR	264
SCORPION	KSESSIIVGCLQGLNEFMYQFPLQDTEDEKAYQLFKFIRIILSKR-----DVKTYDMAK	267
ALVINELLA	KPDIPLITGSLKGLCHLVHFTQSAEEAAHSCDIYKYTCAAISKEA--NEKLSKYEMAE	224
CAPITELLA	EPYVYIAGCLQGLTHFMVNFQTSADEGAETHAYSIIKYCVTMDQ----NLKKRYEMPK	266
SPONGE	KPELPIISGCLYGLTAYLNNFQSASSEGSVYAQDIYKYTRMAIDPLA----NLTRYEVPR	262
OYSTER	KPELSVISGCLGLASCLVNFTEDE--EDSQNSYETFKFARMAIDPDI----NYTRYDVPR	265
SNAIL	KPEFPVIVGCLQGLTAYLVNFQSSDEGSSHSYEIFNYARMAIDHKV----EFSKYDVPK	262
TRICHOPLAX	KLDMPVIYGCLRGLTSYLYNFQTSVEEESKYAADIYKYARLAIDPKV----ELPRYDLPK	265
SEA_ANEMONE	SPDKQVIAGCLRGLSSYLNVFQTSAAEGSKFARDIYEFTRMAIDVQG----TLQRYDVPR	267
PRIAPULA	KPEYPIVIGCLRGLTCYLNFTFSQSADEGSGYARDVYDCVMRCTGQHL----SEIRRYDVAK	269
ESHARK	EPKFLVVSGCLRGLTALMINFTKSMEDDPKASKDIFDYALKAINPQI----DLKRYAVPL	273
STERLET	EPKLPVVAGCLRGLTALMINFTKSMEDDPKSSKEIFDFALKAISPQT----EFKRYAVLL	278
COELACANTH	EPKLSVVAGCLRGLTALMINFTKSVDEDPKTSKEIFDYAVMAISPQV----DLKRYAVPL	270
HUMAN	EPKLPVIAGCLRGLSLLCNFTKSMEDDPQTSREIFNFVLKAIRPQI----DLKRYAVPS	269
CAECILIAN	EPKLSVVAGCLRGLTSLMINFTKSMEDDPKVSKEIFDYSVKAISPV----ELKRYAVPL	275
PLATYPUS	EPKLPVVAGCLRGLSALMCNFTKSMEDDPQTSKEIFDFAVKAISPQV----DLKRYAVPL	269
CANARY	GPKLPVIVAGCLRGLVALMYNFTKSVDEDPQTAKEIFDFAMKAISPQV----DQKRYAVPL	265
OSTRICH	VPKLPVIVAGCLRGLAALMYNFTKSEDEDPQTSKEIFDFAMKAIRPQI----DQKRYAVQL	236
TURTLE	EPKLPVVAGCLRGLTALMYNFTKSMEDDPHTSKEIFDFAVKAINPQV----DLKRYAVPL	274
ALLIGATOR	EPKLPVVAGCLRGLTALLYNFTKSMEDDPRTSKEIFDFSVKAINPQV----DLKRYAVPL	234
SOFTCORAL	KPDMPVIVAGCLRGLDSTLVNFQTSVNEGSIYAKNIYFSLRSAIDSKI----NYARYDVPR	264
STONYCORAL	KPDMLIIVAGCLRGLTSYLYNFQTSVEEGSKFAKDIYTYGRMAINPQV----SLSRYEVPK	271
ACORN_WORM	QAEPLVVAGCLRGLTHLLVNFQTSVEEDGKHTLDIYKFASLAMPDST----QLLRYGVPE	267
LANCELET	KPEMLVIVAGCLRGLTHLVNFQTSVEEGSAHCKDIYNFTRAVSPQV----EMARYDVPK	270
SEA_URCHIN	KPEMTVIVAGCLRGLSHLLVNFQTSVEENSKCKDIYQYVTVMSVDPGYPYRSGTKPRYIIPK	272
STARFISH	KPELTVIVAGCLRGLGHYLVNFQTSVEEGAKHCKDIYRFARMAIDPTV----DHTRYELNK	267
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N-TERMINAL UNIT

TERMITE	CALGLIQAHGGLAKFLYDEYK---FWHEFLKWINNSAG--EDHKAGVSAALDVFYQVASI	317
SHRIMP	AALLELIHTHGAKFSSQLFEDCT---QVFQWVFKWCGSRNRDDHKAALPAMDTFIVVIANM	321
SCORPION	ASLTLSSHAALLAQFLYEDSM---NIYKIIETWNSNRVRSGLYNALDAVFKQISDM	324
ALVINELLA	SGLKLLAKHSAQFNKFLLEDEYK---IMYERLAFWCHHHNRVMMHLGFSAMEAFFKQISAH	281
CAPITELLA	ASLGLMAKHSAQMSDYLLDDFK---DLYETLSYWTNHNHREMAHIGMLALEDFLVQISSA	323
SPONGE	AGLSLISRHAAQFREYLKVDSE---HMYESELSSWSNHKNKECRVVAVNAIGSFFREVSTQ	319
OYSTER	AGLKLFSRHSAQFQKSLADDYQ---GMYQKLKSWSKHNNRELLHLGTAAMEAFLTQISEV	322
SNAIL	AGLQLFARHAGQFSQFLVDDYE---NMYTKLQAWSKHQNRDVLHGHVAAAMDALFRQIAEA	319
TRICHOPLAX	AGLNLIKHAHQFCDYISREAE---ALYEVIIYRWRHRNRDIRAAAFHAALEEMKQIAEY	322
SEA_ANEMONE	AGLNLLSRHAGQFQEICTEHNVSLIVYPAIYRWCCQNRETKYAALDAMDSDLKQVSEY	327
PRIAPULA	SALWLLAKHAAQLDRFLLDYK---AVYSLRWSRHHNRDVQIACYAALAVLKQIASV	326
ESHARK	AGLRLFTLHSAQFGTCLMDNYR---TVFEKMKKSCGHTNSEMKKASYSALDSFLKQVAIQ	330
STERLET	AGLRLFAKHAGQFSSCLMDNYR---SLYEVMSKWCGHTNIEMKKAGYHAALEAFLKQVALL	335
COELACANTH	AGLRMFALHANQFNCLMDNYR---SLFETMSKCCGHANGELKRAGYAALLENFLKQVAAM	327
HUMAN	AGLRLFALHSAQFSTCLLDNYV---SLFEVLLKWAHTNVELKKAALSALDSFLKQVSNM	326
CAECILIAN	AGLHMLAIHSAQFGSCLMDNYR---SLYEVMSKWCGHTNADLKKAGHLAALSFLKQIASI	332
PLATYPUS	AGLHLFTVHSAQFGTNLLDNYV---YLFEVMAKWCGHTNDELKKAALSALDSFLKQISLM	326
CANARY	AGLQLFIWHSAQFGALLLDNYV---SLYEVMSKWCGHTNDELKKAALSALDSFLKQISLM	322
OSTRICH	AGLQLFGRHAAQFGTFLLDYV---SLFETMCKWCGHTNDELKKAALSALDSFLKQISLM	293
TURTLE	AGLHLFSMHAQFGTFLLDNYI---SLFEVMSKWCGHTNDELKKAALSALDSFLKQISLM	331
ALLIGATOR	AGLRMFLHAAQFGTCLLDNYV---MLFEVMSKWCGHTNVDLKKAGHSAALDSVLKQISLM	291
SOFTCORAL	AGLNFLARHSAQYKEYLTKDYE---SVYNTLFDWCRRKKNELRVKGFALAEFLKQVAEC	321
STONYCORAL	AGLYLFAKHSAQFKEYLAKDYE---VMYGDLYRWCKHNNKETSAAAYAAAMEAFFQISLY	328
ACORN_WORM	AGLWLLAKHAPQFNKYLDDHE---EMYDKLFSWCQHNNRDMKSAGYASLEAFLKQVASM	324
LANCELET	AALWLLAKHAAQFNEYLMDNYE---DMYRKLIEWSQHPNRDLKQAGYAALSFLKQISDM	327
SEA_URCHIN	AGLNLIIRRHADQFNEYLRYDHE---MVYNRLKYWSHSHNSEMKWAGYDALQAFKVVSHM	329
STARFISH	AGLNMFALHSAQFGPYLYSDHQ---DLHEAFNKWSAHNNPAVKAVGFAAQEAFLQIAEI	324
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N-TERMINAL UNIT

Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

TERMITE	LKDNTSE---TGHHVFLYFINF F KNKMLSSSTSSYDMKLV I KAFGLFAAPCRVYMTPQD	373
SHRIMP	LELQAMED-DKRGVKIFKYLLEQ E YNKMLETS-ESTSKLSLAVKGYGLSGACRQFLSPVE	379
SCORPION	LEQNYEDS---CKAE I FKFFLEK F Q L MIKC-SENIRRVSTAIRGFGYFAKVCKLYLTEKD	380
ALVINELLA	LVLLANEG--RKERSIFMFFMEE F RKIMDNPESSSKEISLAIHGYGYFATPCRIFLSQDD	339
CAPITELLA	LVTKKEG-NRKEGAVFKFFIQK F RDI M DNSSGSKEIAIAIKGYGYFAAPCKLYLTPKD	382
SPONGE	ISDPSIS--RELGISNYKFFM K CFRSLMNDPDINHRLLSIAVKGYGHFAKPCRLYGSMED	377
OYSTER	LVTKAREG--KKEAAMFKFV T R F KEIMENSSASAKMSLAIRGYGLLAAPCREFLQQKD	380
SNAIL	ITEKAKRG--IKEGGIFKFFVQ V QT M QNSSASSEVSMAVR G GLFAAPCSIFLEPAD	377
TRICHOPLAX	LVNENDA---ANINIFKFFL K KFRSIDS G SSDAKELAIAIRGYGYFAAPCKTLKDD	378
SEA_ANEMONE	IVLDEA----EAVNPKEDFIQ R FR I IDS S STTQ M SI A IRGYGFFAKPCKLFMTAED	382
PRIAPULA	LVEGGEET-RQRDTIVFTFFV R E F R T IEA-GTDTRDVAIAVRGYGSFATPC K FLSEAD	384
ESHARK	VAENALHL-----KDKLEYIMQ O F Y DI I RTP E SSMKELLSIAIRGYGLFAAPCKAVN-SND	384
STERLET	VAENALHL-----KSKLEF F MRQ F Y T IV I R T L D SS T KE L SIAIRGYGLFAAPCKAVC-LGD	389
COELACANTH	VAENAELH-----KNKLEYFMKQ F Y G I R T L D S SNKELLSIAIRGYGLFAAPCKAVC-PED	381
HUMAN	VAKNAEMH-----KNKLOYFMQFYGIRNVDSSNKELLSIAIRGYGLFAGPCKVIN-AKD	380
CAECILIAN	VTHDAETH-----KSKLQ F MD Q F Y RI I RK L D S SNKELLSIAIRGYGLFAAPCKVIN-AKD	386
PLATYPUS	VAKDVELH-----RSKLQ F ME Q F Y EI I RK I D S TN K ELLSIAIRGYGLFAAPCKVIN-PND	380
CANARY	VAKDAELH-----KSKLR F ME Q F Y G T I R RD S SSKE L SIAIRGYGLFAAPCKAIH-PED	376
OSTRICH	VAKDAELH-----KSKLQ F MD Q F Y G I IR R D S SN R ELLSIAIHGYGLFAAPCKAIR-SKD	347
TURTLE	VAKDAEMH-----KSKLQ F ME K F Y DI I RK M D S SNKELLSIAIRGYGLFAAPCKAIN-SKD	385
ALLIGATOR	VAKDAEMH-----KSKLK F ME Q F Y SI I RK M D S SNKELLSIAIRGYGLFAAPCKAIN-SKD	345
SOFTCORAL	LVTEDFET-TVECGDIFKYFI K EF R RI I NS N ESL T RE I SI A IRGYGYFAKPKVFLKDED	380
STONYCORAL	FVGRHG---DKSDLAMFMYFI K T F R R I I D S V L SD T RQ M AIAVRGYGYFSKPKLFMQADD	385
ACORN_WORM	LVEEGNKD-KRNK T IFKAF I R K FR S I D N R ES G TRE I CIAIKGYGLFAAPCKFLSEDD	383
LANCELET	LVARHEKENNKADLAVFKFFI R E F R T I D T E AG T RE M SI A VRGYGFFAAPCKMFLSESD	387
SEA_URCHIN	LVENADKK-RSSDVAVLKYFI K S F R S T I D A SS S SK L STAIRGYGVFAAPCKAFMKEAD	388
STARFISH	LVERAAKR-DASDMAVFRFV K R F R D I D N P Q S D T RALSSAVRGYGYFAAPCKLFMTDDD	383
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N-TERMINAL UNIT

TERMITE	VLYMFTVVMQRAEQIYFKEG-----DISNADLQNLDPYIESLSSIMRQLSAVTNEQLV	426
SHRIMP	VHTMFSQVLTASQHFYQSG-----DMLENKLTNLPYSIESLAIIISNMDVVNSGLE	432
SCORPION	VKYMLNDVIKKSEQHCLNEE-----KILDERIQILPSFLDSLSSIVLQLEISESSLN	433
ALVINELLA	VKFMFTEVMQRSEQLIVQA-----EYLD R ITSLPHFL E ALASIIKELSEVTD T LIL	392
CAPITELLA	VLFMFNEMLRSEQLFLSGA-----EQND D RII G LH S FLGALASIVEELDQFSETFLF	435
SPONGE	LHFMFGEMVQRSEQLFLASVDFTTSSSSVAFEERFLPTFIEALANISKEIQNLDPVCLS	437
OYSTER	VQYMFSEMITKSEQYLSSDK-----EDI D KLYSLPSYLEALGNIIRQLDHVPETYAT	434
SNAIL	VTFMFSEMITKCEQEF L R T N-----EPVHEKLSLDPY L HALASIIKVVTKVSEVYAL	430
TRICHOPLAX	VRFMTMDLLQRSEQLFFID-----VNV D KIQYLP S FL E AFASILN I LDEVND T FTR	429
SEA_ANEMONE	VKFMFTEMMQRSEQIYLRQS-----EMQEDRVQQLPNFLEALS F IEE L DDI S DGFLV	435
PRIAPULA	VQYMF T DMV V RSRQIFHSGE-----EMIDSRMVELPPLLEALASIVTEL D QVSE S FLA	437
ESHARK	VDFMYIELIQ R CKQMYL T EA-----D T EDDNVYQL P SFL S IASVIFH L DKIPGVYTP	437
STERLET	VDFMYTELIQ R CKQMYL T ET-----D T EDDNVYQL P SFL S IASVIFH L DRIP E VYTP	442
COELACANTH	V D LMYTELIQ R CKQMYL T ET-----D T EDDNVYQL P SFL S IASV I FH I DRIP E VYTP	434
HUMAN	VDFMYVELIQRCKQMFLTQT-----DTGDDRVYQMPSFLQSVASVLLYLDTVPEVYTP	433
CAECILIAN	VDFMYIELIQ R CKQMYL T EA-----E T EDDNMYQL P HFL Q S I ASVIVH M DSI P EVYTP	439
PLATYPUS	VDIMYIELIQ R CKQMYL T EA-----E T ID D H L FL Q PSFL Q S I ASVLLHL D DKV P EVYTP	433
CANARY	V D NMYVELL Q RCKQMYL T EA-----E T ID D HLYQL P SFL Q S I ASVIFH I DKV P EVYTP	429
OSTRICH	V D MYVELL Q RCKQMYL T EA-----E T VD D H I YQL P SFL Q S I ASVIFH L DTI P EVYTP	400
TURTLE	VDFMYVELL Q RCKQMYL T EA-----E T AD E H V YQL P SFL Q S I ASVIFH I DTI P EVYTP	438
ALLIGATOR	VDIMYIELL Q RCKQMYL T EA-----E T AD D NVYQL P SC L Q S IASVIFH L DTL P EVYTP	398
SOFTCORAL	IKYMF T SIQ M SEQMYFNDS-----ELKE E KLQNL P SFL E ALGFIVEE I DEI P PAFLS	433
STONYCORAL	VRFMFSEIMQRSEQYLSQS-----DL S EDRAQHLP T FLEALSSIEE L DKI S DSVLA	438
ACORN_WORM	VKFMFNEMIQRSEQLYFSQN-----E L V D ET I PHLP S FL E ALACIV R EL D VSD T FLS	436
LANCELET	VKFMFSEMMQRSEQLYFGTA-----D S MED K VHHL P SFL E ALASIVQHL D QLSD M FVT	440
SEA_URCHIN	VRFMFNEIILRSEQQLVQ-----E - ERL S QL P TYLEALASIVGQL D T V SD T FLT	438
STARFISH	VKFMFTEMIQRSEQLY L Q Q -----E V S D DK L NQL P NFLEALASIMRQL D VLS D S F QA	436
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N-TERMINAL UNIT

Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

TERMITE	ALQCLTVQLIENFPKLPKP--FHWLAIIRAI	TVTLLSSLAESGGTFLFEFFLSNVVYQGIIRS	484
SHRIMP	NVQQLSALVEHFPLVSSF--KRFLAYRAL	FRLFFT VYNK--PGYFHEFLHTFVYKAI VLS	489
SCORPION	YLEKLAVFQIQNFYPYLPSP--YHFLCYNSL	LKFLAVHHSK-GPQFKGFLNKIIYQGIIRT	490
ALVINELLA	LVEKLI LLVVEHSPKLPEK--LHYIFVVT	ILKVCFSLTPK-GSVFRSFI SRFVYQALLRT	449
CAPITELLA	SLERLVVLQMQVLPRLHVK--LHNQCYIAL	IRLFLGLALK-GSIFKGF LERI IYQSLIRS	492
SPONGE	SLQKLSVLLFHCYPFLSSH--VRYQGSVSL	LKLIMAVSSI-PTSFKQFLSHIVYQGVIRS	494
OYSTER	SIERLMIILAENFPTIHQK--QHFFSVKSL	LWVLT LMPK-GEVFSQVLSGFVQMLIRT	491
SNAIL	TLERLLVLLLENIPTIYRG--FHFTCLKGI	LHLLIVLQSK-GSTFNKVL SGFVYQGLIRT	487
TRICHOPLAX	SLEKLTIVLFENFPYVINE--LHSLCYKSL	FELLLLALHSK-GAALKNF LSRVYQGLIRT	486
SEA_ANEMONE	SLERLIIVLFESFPRLSKS--AKYLCHKAL	VKMLINISAK-GSVLKNFLSEVYQGLIRT	492
PRIAPULA	SLEQLVVLFGNVPLLRRESRLDHRACGA	VVRVLLALRSK-RATQRSLV KRVVFQGLLST	496
ESHARK	VLERLLVVQIDSFPLY SAR--MQPICCRS	IVKV FVALAGK-GPVLWNFI STV VHQGLIRV	494
STERLET	VLERLLVVQIDSFPQYSQR--MQPVCCRS	ILKVFI ALAGK-GPVLWSFI STV VHQGLIRV	499
COELACANTH	VLERLLVVQIDSFAQYSQK--MQPTCCSI	IVKV FVALAGK-GPVLWSFI STV VHQGLIRV	491
HUMAN	VLEHLVVMQIDSFPQYSQK--MQLVCCRA	IVKV FVALAAGK-GPVLRNCSI STV VHQGLIRI	490
CAECILIAN	VLERLLVVQIDSFSQYSVK--MQSVCCRS	IKVFLALAGK-GPVLWNFI STV VHQGLIRV	496
PLATYPUS	VLERLLVVQIDSFPQYSIK--MQSACCKA	IVKIFLALAGK-GPVLWNFI STV VHQGLIRV	490
CANARY	VLEHLVVLQINSFPQYTEK--MQPVCCRS	IVKVFLSLSGK-GPVLWSFI STV VHQGLIRI	486
OSTRICH	VLERLVVVQIDTFPQYSEK--MQSVCCRS	IVKVFLAL TGK-GPILWSFI STV VHQGLIRI	457
TURTLE	VLERLIVVQIDSFPQYSVK--MQSACCKS	IVKVFLALAGK-GPVLWSFI STV VHQGLIRV	495
ALLIGATOR	VLEHLIVMQIDSFPQYSEK--MQPVCCRS	IVKVFLALAGK-GPVLWNFI STV VHQGLIRV	455
SOFTCORAL	FLEHLVVLIEKFPPELGRG--PQFICLKAM	LKFLAL TTR-GASLKSFLSEIVYQGLIRT	490
STONYCORAL	CMERIVRVLFDFKFAILNKG--GKFLCCKAL	IRVLFHLSSK-GAILRNFLSEIVYQGLIRT	495
ACORN_WORM	SLETMIVVILMENFPRFGKA--LHYTCYKS	ITAVLVVALSPK-GATLRNFSRIVYQGLIRT	493
LANCELET	SLEKLVVLFENFPRLGKK--MHLICQKAI	ILKVLLALVPK-GATLRTF LSRIVYQALIRT	497
SEA_URCHIN	SLEKLVVLVFGSYPHQARS--SQWTSHTAI	LQILIALSAK-GTSLQGF LSRVYQWILIRT	495
STARFISH	ALERLVVVQVSSYPRVFNK--YOYLHQAI	LLVLIALSSK-GATLKNFLSRVYQALVQT	493
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N-TERMINAL UNIT

TERMITE	CKHQIAIDVELQKG-----	QFHENVFTYKDYIPLWKE	LLSVNNFQKR	526
SHRIMP	CSHAPVEVSSPGEQGSWRG---	KAGGEEWGLKNEVVTFSSYIPL	WTALMVPEKVANI	546
SCORPION	CSYPVRFEIEAREENMS-----	GDNLELKNPREITSKSYSSLWEN	LLYIVRNKEL	540
ALVINELLA	CSDPAVTTTFDDDGQE-----	LDPEYRTRRIITYKDYLMWKC	LLTCSRFKEL	496
CAPITELLA	CSDPIVLESQEAKSEN-----	VDEVN LKVDVSYQDYLPMWKA	LLTAGK LKAL	539
SPONGE	CSLPVIIEAVQGDSDAVVT-----	AAPLADSNDKVMSYLDVYQL	WLIQ LIDYK K LKM	546
OYSTER	CSDPPIETEDMTESN-----	QSEQTGTKVTFKDFIELWDT	LFNSPRIKEF	537
SNAIL	CSDPVMGADENQEIS-----	TAETDLTVKQITYKDYLE	VWVSGLLESGIKDL	535
TRICHOPLAX	CSDHPVYVETSDNLNIS-----	QDSVILETGPRISYKDYISL	WKNLIQATEIKGL	535
SEA_ANEMONE	CSDPVLDEGPDVDKQ-----	VGVVTGSRSDQVTFKDYLE	PLWEHMLDKTKFKMY	541
PRIAPULA	CSDHPVAMETSSVFSQN-----	ADDVDDDFQERDPRNIYIDY	MDMWRHLLGSDKMKGL	549
ESHARK	CSKPVLLPGEGTGRSESLQ---	QSSASEVMWTKWVSPSYKDY	LDLFRSLLNCGRMKEF	551
STERLET	CSKPVVLTGEEGGQGGG-----	QPVEKGQVHTGKWKVPSYR	DYLDLFRNLECDKMKDT	553
COELACANTH	CSKPVPLSTEGIGKGLQSEEEA	PAAPGEVRTGKWKVPSYKDY	LDLFRNLECDK LKQS	551
HUMAN	CSKPVVLPKGP----ESESE---	DHRASGEVRTGKWKVPTYKDY	VDLFRHLLSSDQMMDS	543
CAECILIAN	CSKPVTLGKEGSGKSPGSE---	EPPVAEEVRIKWKVPTYKDY	LDLFRSLLDCDRMKES	553
PLATYPUS	CSKPVFLKEAYGRDASESD---	DSSAFGEVRVGRWKVPTYKDY	LDLFRSLLNCD E MKDS	547
CANARY	FSKPITFSKDFSVKETSGETE---	EAFEAGEVGTQRSKLPTYKDY	LYLFRSLLSCDTMKES	543
OSTRICH	FSKPITFSKEYFGKKTSGSE---	ESPAAGEAGAKWKVPTYKDY	LYLFRSLLNCD T MKES	514
TURTLE	CSKPITFSREIFGKEVSKLE---	ESTTAGEVRTGKWKVPTYKDY	LDLFRSLLNCD T MKES	552
ALLIGATOR	CSKPIVFSREFDGKASKSE---	EPPAVGEVRTGKWKVPTYR	DYLDLFRSLLNCDAMKES	512
SOFTCORAL	CSDPVLDEGVDM-----	EGVTEFDVRHISYKDYLE	LWECFLDGGQYKDQ	536
STONYCORAL	CSDHPVILKEVNGESTIME-----	EREVEGSTPNTSLKDYLE	LWELLDKDKL KDE	546
ACORN_WORM	CSDHPVLEGE MYDV-----S-G-	DE--TSDELLIDARKVSYKDY	LDLWNHLLDSSQLRI-	543
LANCELET	CSDHPNIEGVTAEDDLPVASG-	EEGGEQQPPVKKRFSYR	DYLELWGNLLDSSRLKEL	556
SEA_URCHIN	CSFPVLLESGGD-----	EGE-EQRSDEMEIEQDSRRV	SYKSFMDLWTRLLDSKFIKTS	547
STARFISH	CSDHPVLDGSPSID--HPVLGN-	DDQDTEADILADARHITYKDY	VKLWASLLDSTHVKEV	550
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N-TERMINAL UNIT

Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

Sequence alignment table showing DNA-PKcs protein sequences for various species including TERMITE, SHRIMP, SCORPION, ALVINELLA, CAPITELLA, SPONGE, OYSTER, SNAIL, TRICHOPLAX, SEA_ANEMONE, PRIAPULA, ESHARK, STERLET, COELACANTH, HUMAN, CAECILIAN, PLATYPUS, CANARY, OSTRICH, TURTLE, ALLIGATOR, SOFTCORAL, STONYCORAL, ACORN_WORM, LANCELET, SEA_URCHIN, and STARFISH. The HUMAN row is highlighted in yellow. Column numbers 574-600 are on the right.

N-TERMINAL UNIT

Sequence alignment table showing N-terminal unit sequences for various species including TERMITE, SHRIMP, SCORPION, ALVINELLA, CAPITELLA, SPONGE, OYSTER, SNAIL, TRICHOPLAX, SEA_ANEMONE, PRIAPULA, ESHARK, STERLET, COELACANTH, HUMAN, CAECILIAN, PLATYPUS, CANARY, OSTRICH, TURTLE, ALLIGATOR, SOFTCORAL, STONYCORAL, ACORN_WORM, LANCELET, SEA_URCHIN, and STARFISH. The HUMAN row is highlighted in yellow. Column numbers 626-654 are on the right.

N-TERMINAL UNIT

Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

TERMITE	YKVISESSNKPLVSGFYKLLTVALQLCDRLHYFSDYGDMLN-----	667
SHRIMP	WFVVTQSSLQPLVSAHYNATTVLTCSRQTFQFSRK-----	685
SCORPION	LEIIQFINKNPYISGFYKLLITVCLTICKKTRYFQHVKKLTKKEEI-----	692
ALVINELLA	HQLIVHSTMHPYVSGFYKLLSVSMTVASRIDYFQIGKIEREDANWCQDIKQTAIEDME	655
CAPITELLA	HQLILQSSKPLVSGLYKMLTVMQVASQISYFKEMNRQLKIETSD-----SIKME	691
SPONGE	QEVVSLATRYPLVSGFYKLLTVCLSICNKTHTFDVHDLGGQGTGD-----DDV---	701
OYSTER	HTLILQSTKPLVSGFYKLLAVSMKIANKLYFQGMVSLSPVKK-----EVKME	690
SNAIL	HTVVVQSTEFPLVSGFYKLLAVTMKIANKLEYFKDIAVENSFKK-----EEQMD	686
TRICHOPLAX	KNLVLVSTRLPLVSGFYKLLIEICMTISSSLSYFEDLNIEVTKCT-----IN-----	679
SEA_ANEMONE	RDLVVSSSRFPVSGFYKLLLEVCMKICKRLRFQYEVTA-----D-----	688
PRIAPULA	HEVILLSTRWPVSGLYKLLTVCLSICSSLQYFKAMRKVNDSQLH-----SEAME	707
ESHARK	YELILRSTQFPLVSGFYKLLSATMKIACKINRYFKGVSTNTWKQCH-----	702
STERLET	HELILQSTRFPLVSGFYKLLSVSMKIAKRIKYFQGVSPRSCKTSP-----	705
COELACANTH	HEVILQSTRPLVSGFYKLLSVSMKIAKRIKYFEGVSSKSKQNS-----	703
HUMAN	YELILQSTRPLISGFYKLLSITVRNAKKIKRYFEGVSPKSLKHSP-----	695
CAECILIAN	YELILQSTRPLISGFYKLLSVAMKNAKRTKYFEGVSPKSHKKCP-----	704
PLATYPUS	YELILQSTRPLISGFYKLLSIAIRNAKMKRYFEGVSPRSLKKS-----	697
CANARY	YELIVHSTRPLISGFYKLLSVTMKIAKRIKYFEDISPRSLRRC-----	694
OSTRICH	YELIIHSTRPLISGFYKLLSVAMKIAKRIKYFEGVSPKSLRKC-----	665
TURTLE	YELIVQSTRPLISGFYKLLSVAMKIAKRIKYFEGVSPKSYQKCP-----	703
ALLIGATOR	YELIIQSTRPLISGFYKLLSVVMKIVKIKRYFEDVSPGTQKKYP-----	663
SOFTCORAL	KELVLSARFPLVSGFYKLLDIVMKISRKLDFYFKGMTLKDVTGTC-----VD---DM-	696
STONYCORAL	RDIIIMSSRFPVSGFYKLLLEVCMKCEKLSFFKNIKAEKPDLC-----NENL-	707
ACORN_WORM	HEVIVHSTRPLVSGFYKLLSVCMTISQNIQYFQGINENAKVAVP-----RHIEEKAS	707
LANCELET	HALLILHSTRPLVSGFYKLLSVCMTICTKVYFKDLDTKLSFS-----EESMD	709
SEA_URCHIN	HELILQSSQLPLVSGFYKLLTICMTMSRKTAFYFKEVNPVNFRT-----VNEEPPMD	704
STARFISH	HEVILLSCRLPLVSGFYKLLTVMCNICTQIQFFKCIKPSDLSSQ-----EDSMD	702
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N-TERMINAL UNIT

TERMITE	-----QPTQKASYSLLCRFLQE-----LLIRLQYKNDLQVACL	702
SHRIMP	-----QDPEVETS IHLMSYVRE-----LLQRCRQYRDQLLASCI	720
SCORPION	-----SMSEKCLIAFELFAKFSRE-----VVIYLQYKDELASCI	729
ALVINELLA	IDS-----LTDSDRSQREASFM LFSKFTKE-----VLVKKQSKDDLASCL	697
CAPITELLA	MDE-----EFRTSTAQEEACFM LFTKFAKE-----VMTRLRQYKDDLASCL	733
SPONGE	-----AMETEERTDRQSCYFLFSSFIKE-----VVVQMQQYKDDLASCL	741
OYSTER	VDS-----DQKADIHQ RATCFQLIQFTKE-----VLVRMKQYKDDLAAACL	732
SNAIL	VDE-----TGIDGQTEKHLTYILIKKFSSE-----VLVRMKKFHDDLASCL	728
TRICHOPLAX	-----AAAEAESIDKYLCYLYYKFYKE-----VLVRLKQYKDDLHVSCCL	719
SEA_ANEMONE	-----DMEIVDTS DCTNCF LFRKFIKE-----VLIKMKQFKEDLLSCL	728
PRIAPULA	-----TDSPDAVDNAEILNCF LFKFSKE-----VLVKKMFRGDLVACL	749
ESHARK	-----TDPKACACFALFGKFGKE-----VTIRMKQYKDELIVSCL	737
STERLET	-----EDPKYACFALFAKFGKEVSTILGKEVSVRMKQYKDELLASCL	748
COELACANTH	-----LDPKAYACFALFAKFGKE-----VCARMKQYKDELLASCL	738
HUMAN	-----EDPEKYSFCFALFVKFGKE-----VAVKMKQYKDELLASCL	730
CAECILIAN	-----KDPERFACFALFAKFGKE-----VSAKMKQYKDELLASCL	739
PLATYPUS	-----EDPEKYSFCFALFAKFGKE-----VAVKMKQYKDELLASCL	732
CANARY	-----EDPEKSSCFALFVKFGKE-----VAAKMKQYKDELLASCL	729
OSTRICH	-----EDPEKSSCFALFLKFGKE-----VTAKMKQYKDELLASCL	700
TURTLE	-----DDPEKSSCFALFAKFGKE-----VTAKMKQYKDELLASCL	738
ALLIGATOR	-----EDPEKSSCFALFAKFGKE-----VAARMKQYKDELLASCL	698
SOFTCORAL	-----ETDQLDFSDCRNCF LFFHKFAME-----VVVRMKQYKDDLKSCL	736
STONYCORAL	-----NLEIVDTS DCMKCFVLFHKFTKE-----IVVRMQYKDDLFSCL	747
ACORN_WORM	-----TKDMCTLADKVAAFHLFKKFTKE-----VLIRLQYKDDLASCL	747
LANCELET	TEG-----RDRPSEGGQACFTLFRKFVKE-----VLVRLKQYKDDLASCL	749
SEA_URCHIN	VDDDESIASTRTPSNVSLSDKQACF LFSKFSKE-----VLIRLQYKDDLASCL	756
STARFISH	IDL-----NFSSSSSCVSASDRICFTLFAKFSKE-----VLVRLKQYKDDLASCL	749
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N-TERMINAL UNIT

Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

TERMITE	ETVIAAPVALVVP LPHAVPAFEVI FRVGRSMLPLARLGLSALDKWYCTLPS---- <td>758</td>	758
SHRIMP	TLILHLPLCIVQEIFPQLVSP LQMALQLGVSYLPLAEVCLALQLWTKSLSQ---- <td>776</td>	776
SCORPION	EVILSLPTEIVSEINILIPAVQISLQLGLSYLPLAMSCLEDALETWLYSLPS---- <td>785</td>	785
ALVINELLA	LFILSLPYEIVITELHAIVPALQIALQIGSYLPLANAALDALDWTWSQKIPD---- <td>753</td>	753
CAPITELLA	GFILALPREIIALDVTFVPALQRSLEIGRSYLPLARTSLNTELESWSKSLPP---- <td>789</td>	789
SPONGE	HLILVLPKEMVVSDFKELIPAIKALRIGMGYLP LAKSVMEALEKWTLYIVESDKMDTLQ	801
OYSTER	TFILTLPKEIVSEIQMSSVPAIQLTSLIGLSYLP LAMIALDALDYWSDTLPA----SVIR	788
SNAIL	TLILTLPKEIIAQQMSKIVPAIQLTFSVGLSYLPLAEVGLDSLWVWSQVLP-----EVLA	784
TRICHOPLAX	SLILALPYQLIQDDMALIIPAIKVSNIIGLSYLP LANAADALERWSSDLPQ----NIIG	775
SEA_ANEMONE	SLVLSLPYEIVAVDVAAIVPALLETFKLGLSYLPLAQAGLALEEWNASLPG----DVL R	784
PRIAPULA	QLVMALPYEIVVDIVPEIVPAVQVALKIGLSYPPMAHTTLDAL EMMWANLPA----DVMQ	805
ESHARK	NFVLSLPHDIIELDIKAYIPALQAAFKLGLSHTPLADAGLDALEDWSAHI PK----HIIQ	793
STERLET	TFVLSLPHDIVALDIKAYIPALQNSFKLGLSHTPLANTGLYALENWSQFI PK----YVMQ	804
COELACANTH	GFILSLPHTIVELDVKAYIPALQMAFKLGLSHTPLADSGLDALEEWSNRIPK----WVLQ	794
HUMAN	TFLLSLPHNIIELDVRAIVPALQMAFKLGLSYTPLAEVGLNALEEWSIYIDR----HVMQ	786
CAECILIAN	IFILSLPHDIIIMLDIKAYIPALQTAFLKGLSYSPLADAGLDALEDWSAYIPQ----YVIQ	795
PLATYPUS	TFVLCPLPHDIIIMLDIKAYIPALQMAFKLGLSYPLADVGLNALEEWSIYIPR----HVIQ	788
CANARY	IFLLSLPHDIIIMLDIKAYIPALQNAFKLGLSCTPMADLGLDALEDWSAHI PR----HMQ	785
OSTRICH	SFLLSLPPDIIIMLDIKAYIPALQNAFKLGLSCIPMADLGLDALEDWSAHI PK----HIMQ	756
TURTLE	TFVLSLPHDIIIMLDIKAYIPALQNAFKLGLSYT PMADLGLDALEDWSAYIPK----HIMQ	794
ALLIGATOR	TFVLSLPHDIIIMLDIKAYIPALQNAFKLGLSYT PMADVALSALEDWSSHIPK----NIMQ	754
SOFTCORAL	QLVLSLPNELVLCDDIIPFLKTAFLKGLGFLPLAEAAALDALDWTWAE LPS----EILH	792
STONYCORAL	LVVLSLPLELVTLDLVSSVAALKLTKLGLSYTPLAEAGLDALESWT TALPA----DKLK	803
ACORN_WORM	FLVLSLPHDIIIMLDIKAYIPALQNAFKLGLSYLPLAHAGLDALETWAFRLQH----NALQ	803
LANCELET	LLVLSLPHQIVQSEISTLVPALQTFRLGLSYLPLAHAGLDALEWRLLNLP R----SALE	805
SEA_URCHIN	FLILSLPHQVVENQVHDVIPALKTAFLKGLSYLPLAESGLSALQAWIRYIP S----DVLK	812
STARFISH	LLVLSLPHDIIIMLDIKAYIPALQNAFKLGLSYLPLAEVGLNALEEWSIYIDR----HVMQ	805

N-TERMINAL UNIT

TERMITE	PLLMQVLPYLPDPFLRSQGVASGDV I I--EKELMVLGRRNRNYSQNKKVA-----R---	808
SHRIMP	EHMPHVLPLLPLPYLRSQETGGAEV---HTRVITVKMAFA----RQRRKVDQKMK---	825
SCORPION	EHYCKLLPSLNDYFLASDNISLQPLKNIHT-----FTKQS---LVVKKKLP LKISQYKK-	836
ALVINELLA	PFYTDILQYLDYLYK SATD TDFSASAATDQMIILSTTKSNH--KFGRRKIPKVLKQKRK	811
CAPITELLA	PFYEQLLPYLDAYLTSSADEKND-----TSLVQKDPMK--KQGKKKIPV KLLKQTMF	840
SPONGE	CLVNEILPLLADYLYKATSVQLKEEEDGGRG-----KQYAT--KRYAR---MKMVEKVS-	849
OYSTER	PFYPQILPCLDSYLYKTMDQGADDVS---ENTMEM-NKSKSG--KGRKK-LPVRI LKGPK-	840
SNAIL	PHYANILPCLDSYLYKTVD TGAEDVS---VETLVTVSSSKSK--YRGKK-LPVRLVKERP	838
TRICHOPLAX	PYFSDILPCFDDYLYKSSADDTTETLVEDSSKALK----AR--TGKAKKLP----VKVV-	823
SEA_ANEMONE	RHLRNILPYLDGYLYKSATDAVEEEDQVSRRTATLRSTYSR--LGKILSLYI DFVSKR-	841
PRIAPULA	PYYKQILPHLDGYLYKTTEGADSV P----TPTVAIT SANAT--RGRKK-IPV KLLQSGS-	856
ESHARK	PHYKDILPHLDGYLYKTA AF-NEAQN---NWEGMNI NNPSR--KGGSK-VLFHHTKSK-	844
STERLET	PHYKDILPYLDGFLKTTASND EEQN---NWEVMSLSRSTE--KGYGR-VLMRL LKKA-	856
COELACANTH	PYYKEILPCLDGYLYKTSISAGDTPS----SWEVLR LRSASQ--KGDHK-VLIRLLKKA-	846
HUMAN	PYYKDILPCLDGYLYKTSALSDETKN----NWEVSALSRAAQ--KGFNK-VVLKHLK KTK-	838
CAECILIAN	PHYSEILPYLDGYLYKTASSADEYQN----SWEVMRLSRAAQ--KGFNR-FLVQRLK KTK-	847
PLATYPUS	PYYKDILPCLDSYLYKTALSDETKN---NMEVTMLS RATQ--KGFNK-VVVRHLKKA-	840
CANARY	PYYKDVLPLLDGYLYKSSTSTVESQN---NWEVRKLSQAAQ--KGRNK-VVIQRIRRAK-	837
OSTRICH	PYYKDVLPLLDGYLYKNSASTVEPQD---NWEVRKISRAAQ--KGFNK-VVIQHLRRAK-	808
TURTLE	PYYKDVLPLFDGYLYKTGSADESQN---NWEVRKLSRAAQ--KGFNK-VVIQRLKKA-	846
ALLIGATOR	PYYKDVLPLLDGYLYKTATSPDEFQN---NWEVKKLSQAVQ--KGFNK-VVIQRLRKA-	806
SOFTCORAL	PYLREVLPLQLDGYLYKTASELETSNEKETL-----RSR--KSGK---TKASKSSK-	837
STONYCORAL	PFLREILQCLDGYLYTTLGDIQLHNE---CNTIVLITSSHHT--SRGRK-LPLKLLKMKP-	856
ACORN_WORM	PYYKDILPCLDGYLYKTVDSTNAENA---SSQTVSLTMTTRTG--KRRNK-IPIRLLK PAT-	856
LANCELET	PHFPHILPYLDSYLYQTAADTGSSSSSD-GFQTVSLTAASST--RGRKK-IPV KLLKAAA-	860
SEA_URCHIN	PYYAQVLPQLDGYLYGAGSGSEDEGS---RPEVLVIQTASSR--VGRRR-IPSKLLKKA-	865
STARFISH	PHLKVILPLLDGYLYRGITITQGS DAADVQTVTMASASSSGR--AGRKK-LPAKLIKAS-	861

N-TERMINAL UNIT

Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

TERMITE	KKIIIEHPESLSQLQHEIISFLGQLDSTTCLALLKDPQQ--EEDVIPWATCLQQPLVFP	865
SHRIMP	-ESKRVEETAMQKIQLMILRLIGSLDPLLRHTIP-QDPDTIASAAVRWNV--QKLVKFA	881
SCORPION	IKQTDLHESELIKVQHRILRFLGSLGQVGNQYNFAMIS-ADKIKIHEVAVAVDINKQNHKIFY	895
ALVINELLA	TLSERNQESQLAEIRRRCVLLGSLGGIVNMLVK-SSTEQVTKSAMAWDN--VKHLKHF	868
CAPITELLA	-DAEKKESELKEIQRKCVLLGSLGGSINHALVF-GQTAN-PPDLVAVDS--DQHLKFD	895
SPONGE	EGLHQGSRDDITSVRRIRLLLLGSLGGVNVNESLSKVP----SQHSLVSWDS--DRRLGFA	903
OYSTER	TDSKQVFETQLAKVKQRVMTYLGRLGGEVNHALLS-G--SDVCEEAIAWDA--EQHLRFD	895
SNAIL	VLDLKGYESQLSVVKQKIVTYLGLSGGSMNFALLA-RREEEISRRAIAWDT--EQHLRFD	895
TRICHOPLAX	NPTGGSKDSPLAQVRLRIVQLLGRLLGGNTNSLVIR-KGNDGSSQAVAWDN--HKRLPFA	880
SEA_ANEMONE	NILPQVGESSLVTIRVQILRLGLGQGGHTNLCLLG-SDGGVDSGSAVWDT--VKHLPFA	898
PRIAPULA	R--KMAEDSALTARMRIVRFLGGLGGANNISLIS-CDAEDIAKVAVAVDA--EKNLKFG	911
ESHARK	E-FLVSEDSAITAVRRRIVRLLGSLGGQNNRSLVTAESAEMMKRCIAWVT--EKPLSFA	901
STERLET	R-FSLTEDSPALVRRRVRLGLHGGQINRSLVTATSAEEMMKFVAVDS--EKRLNFA	913
COELACANTH	A-VSLNEDSSLGAVRGRVVRVLLGSLGGQVNRSLVTAASSEEMMKFVSWDT--EKRLSFA	903
HUMAN	N-LSSNEAISLEEIRRVVQMLGSLGGQINKNLLVTSSDEMMSYVAVDR--EKRLSFA	895
CAECILIAN	T-LSLDQDVS LASIRNRVQILGSLGGQINQSLVTASCAEEMMKYVSWDT--EKRLSFA	904
PLATYPUS	A-TAPVEDLSLESVTRVVRLLGSLGGQINRNVTAASADEMMKKCVAWDT--EKRLSFA	897
CANARY	T-LSVDNSPLQAVRTRVARLLGSLGGQINHLITATSAAEMMKKCVSWDT--EKHLSFA	894
OSTRICH	T-SL-VGDPSELEAVRTRVARLLGSLGGQINHLITATSAAEMMKKCVSWDT--EKRLSFA	864
TURTLE	T-LSLEDNLSLEAVRTRVVRLLGSLGGQINRLLTAASTEEMMKFVSWDT--EKHLSFA	903
ALLIGATOR	A-LSLNEDLSLEAMRSRVVQLLGSLGGQVNRSLVTAASEEEMMKFVSWDS--EKHLNFA	863
SOFTCORAL	RNPNEENSPLNKVRHRILILLGLTGLGKCNLGLLE-GGEGSVASSGIAWDT--KQHLSFA	894
STONYCORAL	QSQHQMTLTPLAKVRHKILRMFGGLGGETNILLDNTGI--NSSNAVVDWT--ENHLTFA	912
ACORN_WORM	Q--DGSDESPLTIVLKLIVHLLGLLGGSTNGYLLE-SSKEEIAKKA VAWDT--ENHLQFP	911
LANCELET	E-RNQVQESDLVKARLRIVRFLGSLGGHTNACLVTGLTAEDLAKRAVWDT--QTHLQFA	917
SEA_URCHIN	D-NDQSQDSPLRVQLQILRLLGSLGGSVNVGLLE-TSAQELSNVALAWDS--QPRLNFP	921
STARFISH	T-TGQTQDSPLRVQLRILHLLGSLGGQTNAYLLE-TSAEEIAKVA VAWDT--QPRLQFA	917
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N-TERMINAL UNIT

TERMITE	L PF KDMKLNINLEKLI PR VVELAMTSSDRYTRFT ACEL LHGIVMLI LG SGQEAQTSHP--	923
SHRIMP	T PF EHIKID IY LDL LP HVVDLAVN SS DRQTKVA ASE LLHS II ILM IG TGAQKSQETQL-	940
SCORPION	L PF IDV KLE I FL DK FL PRIV LT STASQ RQ TKVA ACE LLH AV VT FM VGCGAQ QP ELQA-	954
ALVINELLA	V PFVD IK PV IY LDV FL PRV VEI ATTS SEC QTKAA ACE LLH SF VLY ML GRSS SQ PKTKA AR	928
CAPITELLA	L PF LD IK TS IY DA FL PK VV LAT VS SDRQTKVA ACE LLH SL VLL ML GRS AS QPT----	950
SPONGE	V PFSD LK PE IY LD PY L PT VC EL ALS SS DRQTKVA ACE FL HA AM LF V IG KGT Q QSV-- QK -	960
OYSTER	V PFMD MK P QI Y FD PF L PRIV EL AT KS GD RQ TKVA ACE LLH SL ILL CV GRS AT Q PAR -- E -	952
SNAIL	I PF FD M KP SI Y FD PF L PH V EL AT Q SS NR QTKV SACE LLH SL ILY TL GR S AQ QP GE IQ K-	954
TRICHOPLAX	I PF Q DM KP II HL DP FL PRV EL AT S SS DR QTK IA ACE LLH AL V LY MI GR GA Q QP GG TGS -	939
SEA_ANEMONE	V PF Q DM KP TI Y LD PF L PR V EL AT T SS NR QTKVA ACE LLH TL VLY ML G K GV TQ PD V K V -	957
PRIAPULA	V PF AD M KP VI Y FD V FL PR V TEL ALS SS DRQTK VV ACE LLH ALL LY IL GT GA Q Q PD S IK S-	970
ESHARK	V PF MD M KP II Y LD SF I PR IS EL ALS AS DRQTKVA ACE LLH SV VAY TL G K GS Q ISE G Q QE -	960
STERLET	V PF AD M KP VI Y LD TF L PR IV EL ALS T ND RQ TKVA ACE LLH SV V FM L G KGS Q IP E GE KS -	972
COELACANTH	V PF AD M KP VI Y LD SF L PR IA EL ALS SS DRQTKVA ACE LLH SV V VY M L G K GS Q IP ER CG G -	962
HUMAN	V PF RE M KP VI Y LD V FL PR V TEL ALT AS DRQTKVA ACE LLH SM V FM L G KAT Q M PE GG Q G-	954
CAECILIAN	V PF VD M KP II Y LD SF L PR V TEL ALS T SD RQ TKVA ACE LLH SM V VY M L G K AS Q M PE K D Q S -	963
PLATYPUS	V PF AE M KP VI Y LD V FL PR I TEL ALS AS DRQTKVA ACE V LH S IV MF ML G K AS Q IP E GN Q G-	956
CANARY	V PF AD M KP VI Y LD LF L PH V TEL ALS AS DRQTKVA ACE LLH G IV TY M L G K AS Q M PE GC Q G-	953
OSTRICH	V PF AD M KP VI Y LD LF L PR V TEL ALS AS DRQAKVA ACE LLH S IVAY ML G K AS Q M PE GC Q G-	923
TURTLE	V PF AD M KP VI Y LD LF L PR V TEL ALS AS DRQTKVA ACE LLH S IV MY M L GT AS Q MP D G PP G -	962
ALLIGATOR	V PF VD M KP VI Y LD IF L PR V TEL ALS AS DRQTKVA ACE LLH GL V FM L G KAS Q M PE GR Q G-	922
SOFTCORAL	V PF Q DM KP TI Y LD PF L PR V EL AT S SS DR QTKVA ASE V FH SL V LF ML G K S V Q IP DA-- SS -	952
STONYCORAL	V PF Q DM KP SI Y LD PF L PR V EL A AK SS DR QTKVA ACE LLH SL V HY M L G K S V T Q P Q G-- FK -	970
ACORN_WORM	V PF MD IK PV IC FD PF L PRV EL AT T SS DR QTKVA ACE LLH SL VLY VM V GR GA Q Q PD ST Q V-	970
LANCELET	V PF MD M KP TV CL DP FL PR IC EL AT TSS DR QTKVA ACE LLH SL VLY VM V Q GA Q Q PG EM Q A-	976
SEA_URCHIN	V PF VD M KP PE IY LD AF L PR IV EL ALT SS DRQTKVA ACE AL H TL V LF ML G K GS Q Q PD Q RE A-	980
STARFISH	V PF VD M KP NI LD RY L PRV EL ALT SG DRQTKVA ACE SL H TL V LF ML G K GT Q Q PE Q R A-	976
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FOREHEAD

Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

TERMITE	-DKYSELFRKLSLPLKLGCDPDPAIHRLYNLLVQLVHWYSKFKLKSKEVEILIQTLM	982
SHRIMP	KEPMALPYRHIFSAMLRACDPDHVTRQLFLTLSYQTIHWFNNRNFENVDTMVLLEALM	1000
SCORPION	IYSMKKLYKNVLPALLQLACDVEVARKLFEPFFQLIHWFTTKRMINSDETKQFVQVIW	1014
ALVINELLA	GEEMDKLYQKLFPPVLLQLACDTEQVARQLFGPLVMQLIHWFTSVMMFQSEGTKILLECIM	988
CAPITELLA	GNPMAAIYRKLFPQMLKLATDVEQVSRQLFEPMLQIHWFTKSNNSHRPDTEALLNSLM	1010
SPONGE	KNPMTKLYQKLFPPVLLQLACDVEQVSRQLFEPMLQIHWFTTRNTQYESPDTVTLLLEAIL	1020
OYSTER	RYSMPLYKKMFPSILQLACDVEQVSRQLFEPMLQIHWFTTRNTQYESPDTVTLLLEAIL	1012
SNAIL	RNPMDSLYRKLFPALLLSLSCDVEQVCRQLFEPMLQIHWFTGNKMAESPESMALLDSIF	1014
TRICHOPLAX	VTNYGNLYKKIFPAILTLASDVEQVSRQLFEPMLQIHWFTGNNSYESPETIALLNALL	999
SEA_ANEMONE	ALPMQNLLWKKLIPVLLQLACDVERVSAQLFHPVLMQLIHWFTNNRKYESPETIALLDALL	1017
PRIAPULA	KRPMSALYSRLLFPVLLRLGCDVEQVSRQLFEPMLQIHWFTLNRMFESPETMCLLDAIM	1030
ESHARK	--TLYKLNRLFPVLLRLGCDVDTVTRQLFEPMLQIHWFTSNRKFESRDTVAMLEAIL	1018
STERLET	TPPMYRLYKRIFFVLLRLACDVEQVSRQLFEPMLQIHWFTNNTKFESQDTVAMLEAIL	1032
COELACANTH	VPPMYRLYKRIFFVLLRLACDVEQVSRQLFEPMLQIHWFTNNTKFESQDTVAMLEAIM	1022
HUMAN	APPMYQLYKRTFPVLLRLACDVEQVSRQLFEPMLQIHWFTNNKKFESQDTVAMLEAIL	1014
CAECILIAN	LPPMYQLYKRTFPVLLRLACDVEQVSRQLFEPMLQIHWFTNNKKFESQDTVAMLEAIL	1023
PLATYPUS	SPPMYQLYKRTFPVLLRLACDVEQVSRQLFEPMLQIHWFTNNKKFESQDTVAMLEAIL	1016
CANARY	PPPMYLHKKRFPVLLRLACDIDQVARQLFEPMLQIHWFTNNKKFESQDTVAMLEAIL	1013
OSTRICH	PPPMYQLYKRIFFVLLRLACDVEQVSRQLFEPMLQIHWFTNNKKFESQDTVAMLEAIL	983
TURTLE	SPPMYQLYKRTFPVLLRLACDVEQVSRQLFEPMLQIHWFTNNKKFESQDTVAMLEAIL	1022
ALLIGATOR	SSPMYQLYKRTFPVLLRLACDVEQVSRQLFEPMLQIHWFTNNKKFESQDTVAMLEAIL	982
SOFTCORAL	KSPLEKLNKRVFPVLLQLACDVEQVSRQLFEPMLQIHWFTNNKQYESPDTIILLETLL	1012
STONYCORAL	KSPMEHLWKHFVPTLLQLACDVEQVSRQLFEPMLQIHWFTNNRKYETPETMALLDAIV	1030
ACORN_WORM	KAPMEKLYKVLFPVLLQLACDVEQVSRQLFEPMLQIHWFTCNKKFESPETIAMLDAIL	1030
LANCELET	KNPMTRLYKRVFPVLLQLACDVEQVSRQLFEPMLQIHWFTNNRKYESPETIALLDAIL	1036
SEA_URCHIN	KSPMQLYKRVFPVLLQLACDVEQVSRQLFEPMLQIHWFTSGNKKYESPETIALLDAIL	1040
STARFISH	KSPMQHLYRRVFPVLLRLSCDVEQVSRQLFEPMLQIHWFTGNKKFESSETTALLNAML	1036
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FOREHEAD

TERMITE	DGIHPTDATALRDFSAARCLHEFVWVSVKQGS-----HVNIKYVMQIYSFCLHPSPSK	1035
SHRIMP	EGIVTANDPALRDVSAQCLAEFVKWSRKQCR--QNSVSSNIKSIKRIFSFCKHPSAFK	1058
SCORPION	DGLVQSKDAVFRDFSAARCLKEFVQWSIKQTSVREQEENPIGMNVLLNCLYNSLHPNPYK	1074
ALVINELLA	DGLVDPNTALRDFSAALCVHEFLQWAIKQTTKKQLESPYNVEMLMNWIYNLARHPSAFK	1048
CAPITELLA	DGIVSPDSAVRDFSAKCIREFLWWSIKQTSKQEQERSPMNPKRLLKRMYSLLEHPSMM	1070
SPONGE	EGIEHPTNASLRDFSAQCIREFLWWSIKQTSKQEQERSPMNPKRLLKRMYSLLEHPSMM	1080
OYSTER	DGIQPNDTALRDFCAVCLREFLWWSIKQTK--NVEKSPINAKSLLKRLYSYALHPGAFK	1070
SNAIL	DGLVQDNTMLRDFAAQCLREFLIWSIKQTSKQEQERSPMNPKRLLKRMYSLLEHPSMM	1074
TRICHOPLAX	DGVIHSTDSALRDFCAKSLREYLHWSIKQTTKKQEQERSPMNPKRLLKRMYSLLEHPSMM	1059
SEA_ANEMONE	EGVVHPTDTSRDFSAQCIREFLWWSIKQTSKQEQERSPMNPKRLLKRMYSLLEHPSMM	1077
PRIAPULA	EGIVDATDAALRDFCGSCIREFLWWSIKQTTVRRQEQERSPMNPKRLLKRMYSLLEHPSMM	1090
ESHARK	DGIVDPVDSTLRDFCGQCVRREFLWWSIKQTTPEQQAKSPANTKSLFKRLYSYALHPNTFK	1078
STERLET	DGVVDPVDSTLRDFCGQCVRREFLWWSIKQTTPEQQAKSPANTKSLFKRLYSYALHPNTFK	1092
COELACANTH	DGIVDPIDSTLRDFCGLCIQREFLWWSIKQTTPEQQAKSPANTKSLFKRLYSYALHPNTFK	1082
HUMAN	DGIVDPVDSTLRDFCGRCIREFLWWSIKQITPQQEQKSPVNTKSLFKRLYSYALHPNAFK	1074
CAECILIAN	DGIVDPVDSTLRDFCGHCIREFLWWSIKQITPQQEQKSPVNTKSLFKRLYSYALHPNAFK	1083
PLATYPUS	DGIVDPVDSTLRDFCGQCVRREFLWWSIKQITPQQEQKSPVNTKSLFKRLYSYALHPNAFK	1076
CANARY	SGIVDPVDSTLRDFCGQCIREFLWWSIKQITPQQEQKSPVNTKSLFKRLYSYALHPNAFK	1073
OSTRICH	GGITDPVDSTLRDFCGQCVRREFLWWSIKQITPQQEQKSPVNTKSLFKRLYSYALHPNAFK	1043
TURTLE	DGIVDPVDSTLRDFCGQCIREFLWWSIKQITPQQEQKSPVNTKSLFKRLYSYALHPNAFK	1082
ALLIGATOR	DGIVDPVDSTLRDFCGQCIREFLWWSIKQITPQQEQKSPVNTKSLFKRLYSYALHPNAFK	1042
SOFTCORAL	DGIVHPTDATALRDLALALEFLRWSIKQATKNQLEKSPINIKSLLKRLYSYALHPNAFK	1072
STONYCORAL	DGIVHPTDATALRDFSAQCIREFLWWSIKQTSKQEQERSPMNPKRLLKRMYSLLEHPSMM	1090
ACORN_WORM	DGICHPTDATALRDFSAKCVKEFLYWSIKQTSKQEQERSPMNPKRLLKRMYSLLEHPSMM	1090
LANCELET	DGLVHPTDATALRDFSSRCVREFLWWSIKQITPQQEQKSPVNTKSLFKRLYSYALHPNAFK	1096
SEA_URCHIN	AGIVHPTDATALRDFCARCISREFLWWSIKQTSKQEQERSPMNPKRLLKRMYSYALHPNAFK	1100
STARFISH	DGVIHPTDSTLRDFSAACCLKEFLWWSIKQTSKQEQERSPMNPKRLLKRMYSYALHPNAFK	1096
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FOREHEAD

Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

TERMITE	RLGAALVLNSVYTVLREEESVVNQFWLELLYHVMNLSLSEETDSILGGQEQVVTAVNHI	1095
SHRIMP	RLGGALAWNSIYREIREDDGQAVDIWTLDLLAHLMTSLDLAQVDDPALGTHEQTKSAINH	1118
SCORPION	RLGAALAFNSIYTFREEESLVDKFTLEIAVHFIESLAIAHYDDKILGTQDKCKQALNHL	1134
ALVINELLA	RLGASLAFNSIYTFREEDSLVDIFTFEIMVVFVESLAIAHQDDKSLGTQKQAKQALSHL	1108
CAPITELLA	RLGGALMFNSIYSVFREEDALVDQFSLQILSVLVNSLALAHRDDKSLGTQEQCKSALLHV	1130
SPONGE	RLGAALAFNSIYTVLREEESLVDVFIIEMLVVMVNSLKLAKDAQSI GTVDQCSLSLDHM	1140
OYSTER	RLGAALAFNNIYTVFREEDNAMVNLYTFQILVHFVESLAIAHEDESSMGTQTQCKMVLDMH	1130
SNAIL	RLGAALAFNNIYMVFREEQSLVDRFTFQILVLFVESLGIHQDEASLGTQEQCKKALEHV	1134
TRICHOPLAX	RLGAALAFNNIYVVLREESTLVDTFIFEILVNYVNSLALSHTDEKSLGTQEQLSKALAH	1119
SEA_ANEMONE	RLGASLAFNSIYTVFREERSLVDVFLIEILVYTESLALAH TDDPAQGTQDQCSQVISHL	1137
PRIAPULA	RRGATLVFNNIYTVLREEEMLVDTFIEILVTFVDSLALAHNDEKSLGTQEQCAQALDHI	1150
ESHARK	RLGAALAFNSLYREFRQESALVDQFIFEVLVYVESLALAHADDNSLGTVQCCDAIDHL	1138
STERLET	RLGAALSFNSIYRQFREESTLVDQFIFEELLVVFVESLALAH TDEKSLGTLQCCSDAIDHL	1152
COELACANTH	RLGAALAFNNLYKEFREESALVDKVFETLVVYMESLALAHMDEKSLGTVQCCDAIDHL	1142
HUMAN	RLGASLAFNNIYREFREEESLVEQFVFEALVIYMESLALAHADEKSLGTIQCCDAIDHL	1134
CAECILIAN	RLGAALAFNNIYREFREENALVDQFVFEILVYTESLALSHQDEKSLGTVQCCDAIDHL	1143
PLATYPUS	RLGAALAFNNIYREFREEDSLVDQFTFEALVIFLESALATHADEKSLGTIQCCDAIDHL	1136
CANARY	RLGAALAFNSIYREFREENSLVEQFVFEALVVFLESALAH TDEKSLGTAQCCDAINHL	1133
OSTRICH	RLGAALAFNSIYREFREENSLVEQFVFEALVVFLESALATHADEKSLGTTQCCD TINHL	1103
TURTLE	RLGAALAFNNIYREFREENSLVEQFVFEVLVYTESLALATHDEKSLGTVQCCDAIDHL	1142
ALLIGATOR	RLGAALAFNNIYREFREENSLVEQFAFEALVIFIESLALATHDEKSLGTTQCCDAIDHL	1102
SOFTCORAL	RLGAALAFNNIYRVFREESLVENFTIEILVYTESLEMAHEDEIISLGTQSQCIEVISHL	1132
STONYCORAL	RLGAALAFNNIYTVFREESLVDIFVLEILVNYLECLCLSHGDEEARGTQEQCVQVVIHL	1150
ACORN_WORM	RLGSALAFNSIYTVYREEDSLVDQFVLEILVYINSLAMAHFDDKSLGTQEQCVRVVDHL	1150
LANCELET	RLGAALGFNSIYRDFREESSQVDMFTFELLVTFVESLALAHHDEKSLGTQAQCVAVLTHL	1156
SEA_URCHIN	RLGAALAFNSIYTFREEEVLVDQFTFELLVVFVESLALAHHDDKSLGTQEQGSEVLKHL	1160
STARFISH	RLGAALTFNH IYTVFREEDSLIDQFVCEILVTFVNSLALAHHDDKSLGTQLHGVEVLNHL	1156

FOREHEAD

TERMITE	ERVLKEKASLFNKE--DNIRRKPPPEFEGI----LLKDAVSWLLKCGTVQVECRHKCMELV	1150
SHRIMP	ERIIRVKSDLFQKK--SGQRRLLPPGFQDG----TLVDVLKWLFEQCGRPKALVRHTCMELL	1173
SCORPION	ERIMEVKAKLLSKT--SKKRRPLRNINDS----ILPEVVEWLLKNCGLQTECRHKCMELV	1189
ALVINELLA	DRIIKKKADLLSCA--SKKRRKPKYWKEA----TLQICLCWLVRCGRPQTECRHACMELV	1163
CAPITELLA	ERILIKKQVTFNKD--SKQRIKPRGWRDA----NMTAVRWLLRQCGRPQTECRHVCMRLV	1185
SPONGE	SRIIKAKSSTCLSKANKNRRVPRGLKSA----DLSILTAWLLAQCGSIE TEARKMCRKLL	1196
OYSTER	ERIIKVKANVLSKE--DKNRTEPKQWSVV----KLDIAVRWLMRQCGRPQTECRHACMKLV	1185
SNAIL	EKIVCKRVDILRKP--SPHRKEPSEWSKQ----TLDIAVRWLVRCGRPQTECRHACMQLM	1189
TRICHOPLAX	ERIIKAKASTLNKE--SKNRRTPTFGM--TK--TVT LHHVWNWLVRCGRPQTECRHQCMQLV	1176
SEA_ANEMONE	ERIIKT KATLLDKE--NKQRRIPRGFQMLD--SITLSHLIPLLIKLCGKPQTECRHQCMKV	1195
PRIAPULA	ERILRGKAHLLNKD--KKSRRRPKEFTDA----TLFTVGVLLQCGRPQTECRHKCMELV	1205
ESHARK	NRIIKQKASALNKP--IKGRVPRGFPDQ--PVS LKEVVMWLLTQCGRPQTECRHKCMVLF	1195
STERLET	KRIIKQKAASLNAEKTSRRRVPGRFPDQ--PVCLLDVIMWLLVQCGRPQTECRHKCMELF	1211
COELACANTH	KRIIEQKAPSLNKA--ATTRVPRGFSPDK--VFCLSDVVMWLLVQCGRPQTACGHKAMELF	1199
HUMAN	KRIIEK KHVSLNKA--KKRRLPRGFPPSA--SLCLLDLVKWL LAHCGRPQTECRHKSIELF	1191
CAECILIAN	KRIIIHKAPSLNKT--LKRRLPRGF PSTKSFCLSDLVVPWLLGQCGRPQTECRHKAIDLF	1201
PLATYPUS	KRIIEK KHSFNEE--KNRRLPRGF PNAR--SVRLLDLVYVWLLGQCGRPQTECRHKSIELF	1193
CANARY	KRIIKHKAPSLNKE--GKRRVPRGF PPTK--SVLEDIVMWLLVQCGRPQTECRHKAMELF	1190
OSTRICH	KRIIKHKAPSLNRA--GERRVPRGF PATK--TVCLLDIVMWLLVQCGRPETECRHKSMELF	1160
TURTLE	KRIIKHKAPSLNKA--EKRRIPRGFPNAK--SVCLLDIVMWLLVQCGRPQTECRHKSMELF	1199
ALLIGATOR	KRIIKHKAPSLNKA--EKRRIPRGFPAPAE--SLCLLDIVMWLLMMQCGRPQTECRHKSMELF	1159
SOFTCORAL	ERIIIVSKSSVLLNV--NKKRRVPRGF SAD--TTTLRHLPWLVKCGCSQTECRHQCMRLV	1189
STONYCORAL	ERIIHSRAQLLVKE--NHRRRIPRGFASQS--SITLIHMIPWLVKQCGRPSSECRHQCMRLI	1208
ACORN_WORM	ERIIRVKANMLNRT--SKTRRVPDRFNRDD--CPTLSHVVTWLLQCGRLQTECRHQCMILV	1208
LANCELET	DRIIITTKADLLNKH--SKVRRVPRGF DRES--PPTLPDLVTWLLQCGRPQTECRHRCMLV	1214
SEA_URCHIN	ERIMRVKAALLNKE--SKNRRVPRGLPEDC--SPTLSHMVMWLLMTCGRPQTECRHQCMVLV	1218
STARFISH	ERIIRVKADMLNKE--SKIRRIPREFPAGV--CPTLSMLVIWLLRQCGRAPQTECRHQCMILI	1214

FOREHEAD

Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

TERMITE	YVLAPELLPV--CKSGSEFVSWYAAT--HSWTSIIIRIC ^{ES} SKE-----SGGITVTP ^{TL} KLHL	1201
SHRIMP	ASLAPQVKG--CASVRDFIEKYVGI--SKLSEIVDIL ^{EGG} GEEA--KMGISYVKNPTASSK	1227
SCORPION	FQLAPCLSG--FNGCKDYFSHLET--KGGKF ^{FL} NC ^{FE} SEMSN-----TVPSF	1233
ALVINELLA	YSLSTSLPG--VKRPHDF ^{FS} SAL- ^{IK} --GD ^{KY} LL ^{QR} FE ^{SG} MYCLKEEQHGISKRPKV ^{TDM}	1218
CAPITELLA	CQLAPCVHE--INGAREL ^{FS} VLLSQ--GNSEY ^{FI} QR ^{FE} FGMYSS--ARMGLNQKPTMSRV	1239
SPONGE	VQLAPPSSN--VVNIRMWIRKTIES--EGGNY ^{FV} TR ^{FE} ESHGH-----SGILKAPT ^{LAPA}	1246
OYSTER	HQLAPCITG--IKSTKDY ^Q TFYKS--EKASY ^{FI} NR ^{FE} EGKQQ-----KYGLLSCE ^{MTAV}	1236
SNAIL	YKLAPLIPG--ISSPF ^{FD} Y ^F KAALDI--QNASY ^{FV} VR ^{FE} EGGQV--GDRGGLCG ^{HPT} SKV	1243
TRICHOPLAX	YGLAPQLSG--VSTIQDW ^V KTIIGS--SSV ^{TF} FI ^{TR} FE ^{EGG} -----SKYIGIRY ^{QTALDI}	1227
SEA_ANEMONE	CQVTP ^{LLHG} --IGSAAI ^{WM} KN ^{THKE} ---HDS ^{FV} VR ^{FE} EGGG---RGNGILTY ^{PTLADM}	1246
PRIAPULA	CKLSMHQSKLPVKSAAEF ^{FR} LLLDL--HRAEY ^{FI} ER ^{FE} EAGGIP--GGAT ^{CLS} ---NQQEG ^F	1259
ESHARK	YELVPLPG--NKTPSCW ^L ADVLKE--RGVS ^{FL} IG ^{FE} SAGSD--HAKCSGIY ^{QPT} LDL	1250
STERLET	YEFVPLPD--NKSPASW ^L DDILKK--QGV ^{FL} IS ^{RF} ESAGRE--DGGCSGIL ^{SQT} TLHD	1266
COELACANTH	YEFVPLPG--KKSPA ^{AW} LDEVLKK--QGV ^{FL} IQ ^{FE} EGGNT--DDR ^{LSG} IL ^{SQ} PT ^{CDL}	1254
HUMAN	YK^{FV}PLPG--NRSPNL^{WL}KD^{VL}KE--EGV^{SF}LI^{NT}FE^{EGG}CG--QPSG^{IL}AQ^{PT}LLYL	1244
CAECILIAN	CKFIPLPG--NKSPSSW ^L NDHLKE--EGIS ^{FI} IS ^{RF} EGGSD--GDH ^{QSG} LIA ^{QP} TL ^{CDL}	1256
PLATYPUS	YK ^{FV} PLPG--NKSPASW ^L NDILKE--EGV ^{SF} LI ^{SR} FE ^{AG} TG--NDH ^{LSG} IL ^{VW} PT ^{LLDL}	1248
CANARY	YEFVPLPG--NKSPSSW ^L ADTLKK--RTV ^{FL} LI ^{NK} FE ^{GG} TD--AKSPGIL ^{SQ} PT ^{LHGM}	1245
OSTRICH	YEFVPLPG--NKSPSSW ^L ADVLKE--KGCS ^{FL} IN ^{KF} EGGGRD--ADSPSGIF ^{SR} PT ^{LHGI}	1215
TURTLE	YEFVPLPG--NQSPSLW ^L GDLLKK--QGI ^{SF} LI ^{NK} FE ^{GG} ND--GDN ^{LSG} IL ^{SQ} PT ^{CDM}	1254
ALLIGATOR	YEFVPLPG--NKSPSSW ^L GDVLKK--QDS ^{SF} LI ^{NK} FE ^{GG} NQ--DDN ^{LSG} IL ^{SQ} PT ^{LHLL}	1214
SOFTCORAL	SVLAPLPE--CSSV ^{QT} WM ^{KT} VES--DGEY ^{FL} IR ^{FE} ECGFA---GKSGIQ ^{KHP} TL ^{SSI}	1241
STONYCORAL	SKLAPLLPG--VNSAADW ^M KK ^{THE} ---DHPS ^{SF} VH ^{RF} EGGGG---GQK ^{IE} QY ^{PT} LA ^{HI}	1260
ACORN_WORM	CKLIPLPG--NNSASTW ^M HRT ^{MAE} KGR ^{GP} DY ^{FI} TR ^{FE} EGGGK--GGH ^{KTG} IS ^{KHP} TL ^{NTV}	1265
LANCELET	CS ^{FL} PL ^{LP} R--KPSQAW ^M KERLKE--DGP ^{DF} FI ^{TR} FE ^{GG} GK--TG ^{HKS} G ^{IK} K ^{HP} K ^{ISTM}	1269
SEA_URCHIN	YGLTSLPG--RNTPATW ^M QNTARE--RGAEY ^{FV} GR ^{FE} EGGGHK-----SGIQ ^{KQ} PT ^{LASV}	1269
STARFISH	YKITPLPG--HNTPTW ^M QNTLKE--KGP ^{DY} FV ^{SR} FE ^{GG} VK--AAS ^{RS} G ^{IS} KY ^{PT} LT ^{STM}	1269

FOREHEAD

TERMITE	RNEVALVYVVRWLRMVLTS ^{FD} CY ^{VW} LFGEELVKPSVLWGTEGLDNTSETRIFEA ^{AVY} FI ^Q	1261
SHRIMP	HIGSSLKDINIFLEALSAS ^{LD} GY ^{CW} LIGQGI ^V PAAKLLNHSE-----LQL ^{FS} AT ^{TY} FI ^N	1281
SCORPION	NQNDGLKPIINWLEGLHTMLDCY ^{YW} VFGQSVLKLSDIFNDAS---NRESK ^{FF} PSI ^{EF} FL ^K	1290
ALVINELLA	CDR ^F AL ^{KSV} L ^{TW} FDYLLCT ^{LD} CY ^{TW} IFGQSLINPSRILVVPD---EKGT ^{VL} FT ^{VL} SY ^{FFD}	1275
CAPITELLA	QENFSLNAACT ^{WF} DLV ^{LAT} LD ^{CY} TW ^{FG} ERLMSPNQILIASN---NKG ^{TI} IF ^{QV} LH ^{HF} ME	1296
SPONGE	---PNINIAINW ^{LQ} S ^{LQA} AVD ^{NR} W ^L LKEQ ^{YV} SPRE ^{IFS} S ^{TS} -----SSN ^{LF} K ^S ID ^H FL ^K	1298
OYSTER	DSSF ^S VQNAV ^S W ^{FD} H ^{YLA} ALD ^{CY} I ^W TFGESLNPDDIFSGEG---RKQ ^S K ^L LQ ^{AM} Q ^H FL ^S	1293
SNAIL	AEN ^{FS} L ^{KAV} LS ^{WF} D ^{MLLA} V ^{LD} CY ^{CW} VFGEGLLSPAKMFESSG---FKG ^{TR} V ^{FSS} LQ ^Y F ^V T	1300
TRICHOPLAX	SDTFNLRSMKNWYDYFLAALD ^{CY} SW ^{VF} SEK ^{MS} PEQIIGDKAQ---LG ^{SCK} IF ^{GS} IE ^{FF} FL ^S	1285
SEA_ANEMONE	GGAF ^{SL} K ^{ET} LL ^{WF} H ^{YLLA} ALD ^{CY} TW ^{VF} GEQLPPADLLRSKY-----SSV ^{LF} T ^{SL} S ^Y FL ^S	1301
PRIAPULA	EAPIS ^M T ^{TAL} S ^{WF} D ^{HMLA} ILD ^{CY} TW ^{VS} AKLLQPTALFAGGTG--KREERTCFAMVSD ^{FMR}	1318
ESHARK	QEP ^{FS} V ^{RAAL} Q ^{WMD} M ^{LLA} ALD ^{CY} NT ^{FV} RLAMV ^{KP} SELLGTSQ---ETG ^{FM} K ^{AMN} F ^{FL} K	1305
STERLET	QEP ^{FS} L ^{RAV} LQ ^{WMD} M ^{LLA} ALD ^{CY} NT ^{FI} GLHLV ^{KP} HEV ^{LGA} KV---QSG ^{FL} KA ^{IE} F ^{FI} T	1321
COELACANTH	QEP ^{FS} L ^{RAV} VQ ^{WMD} M ^{LLA} ALD ^{CY} NT ^{FI} ELRM ^{IN} PRE ^{IF} GTTS---VSG ^{FL} RA ^{VE} F ^{FL} T	1309
HUMAN	RG^{PF}SL^{QAT}LC^{WLD}LLLAALD^{CY}NT^{FI}GERT^{VGA}LQ^{VL}GTEA-----QSS^{LL}K^{AV}A^{VF}FL^E	1299
CAECILIAN	KEP ^{FS} L ^{RAV} VQ ^{WMD} M ^{FLA} ALD ^{CY} NT ^{FI} WMRA ^{IK} PNE ^{IL} STTT---QSS ^{FL} RT ^{CE} F ^{FL} Q	1311
PLATYPUS	EGP ^{FS} L ^{RAV} LQ ^{WMD} M ^{LLA} SL ^{ECY} NT ^{FI} E ^{EKT} V ^{KA} HE ^{IL} GTQA---KSS ^{FL} RA ^{IS} F ^{FL} E	1303
CANARY	QEP ^{FS} L ^{QAV} MQ ^{WMD} M ^{FLA} ALD ^{CY} NT ^{FF} ELQ ^{MI} K ^P DEV ^{LGV} NE---SS ^{FL} K ^{AV} Q ^F FL ^D	1300
OSTRICH	QEP ^{FS} L ^R TV ^{MQ} W ^{MD} M ^{FLA} ALD ^{CY} NT ^{FF} ELR ^{MI} K ^P HE ^{IL} GVNE---RSS ^{FL} K ^{AV} R ^F FL ^E	1270
TURTLE	QEP ^{FS} L ^{RAV} VQ ^{WMD} M ^{FLA} ALD ^{CY} NT ^{FI} EQ ^{MI} K ^P NE ^{IL} GTKM---RSS ^{FL} RA ^{VE} F ^{FL} K	1309
ALLIGATOR	QEP ^{FS} V ^{RAV} VQ ^{WMD} M ^{LLA} ALD ^{CY} NT ^{FI} EQ ^{RM} F ^K PEN ^V LGTN-----SS ^{FL} RA ^{VE} F ^{FL} E	1267
SOFTCORAL	NET ^{FS} L ^{TT} TK ^H W ^{FD} L ^{VLA} ALD ^{SY} I ^W S ^{FG} RL ^{LT} PS ^{SIF} Q ^{KT} ----TSV ^L WR ^T LL ^Y FI ^E	1296
STONYCORAL	GGH ^{FS} L ^{KET} IL ^{WF} E ^{FVLA} ALD ^{CY} TW ^{SF} SEHLLSPSW ^V FTSSED--NEMPSVLLV ^{SL} K ^F FL ^S	1319
ACORN_WORM	DKT ^{FS} V ^{KVAS} N ^W FDL ^{FLA} ALD ^{CY} TW ^{VF} GEKLLGPIELFAGKA---NKPT ^N V ^{FKS} V ^D F ^{FLS}	1322
LANCELET	DST ^{FT} V ^{KTA} V ^S W ^{FD} LLLAALD ^{SY} C ^W V ^{FG} Q ^R FL ^{SP} SD ^V LSGSG---KK ^{PS} Q ^L F ^T A ^L E ^{FF} L ^T	1326
SEA_URCHIN	EQQ ^{FS} V ^{KATI} T ^W LEY ^{LLA} ALD ^{CY} V ^{VW} L ^{GES} LLTPAAV ^F K ^T IK---GK ^{KS} V ^L F ^Q T ^{IDS} F ^{MK}	1327
STARFISH	GQP ^{FS} V ^{KLAC} S ^{WF} D ^{HLLA} ALD ^{CY} TW ^{VF} GEKLLSPSV ^V YTATA---RR ^{PS} V ^L F ^Q S ^L Q ^Y FL ^S	1326

FOREHEAD

Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

TERMITE	HVCHRDASSVTCLLSTDTK----DVLEITPW E AESFDR T KCFVVTIRLLD M ISTV L KS G EA	1317
SHRIMP	EMALLTVSEYMKNHDAF-----QNAVATPY E TEATA K LKCTVIVRLLD F VSV V LQ E GP K	1335
SCORPION	FLCIDFDQRVQAFFTHES----VKKQIFSP K EDYLR L NC F IIVRLIN F VTT I VEN Y H L	1346
ALVINELLA	KLAQGDIEKAAVLFGDK-----PQQIFTPW E QEEY N RS K CTVIVRTID F L V V L L K NY Q	1329
CAPITELLA	ELAQEDISAAVKLFPKVAD----GSSIFTP R ERED Y N Q T K CTVIVR T LS F ICT M F G NY K T	1352
SPONGE	CIALVGIEGVVNSPE-----VAMATSI H ER G EY Q R N K W CTIE L LL T F I E L LL T K T HS	1350
OYSTER	QVVMEDMDEVGKMRHEP----LTDVYTP K ERDE Y NR T K C TAVV R T L N F FC V L V AR S PS	1348
SNAIL	EMALGDLVAAKQFQRKA----EAVFFTP K E K DD Y N K V K CTV L IR M W N F L T V L I AR Y PS	1355
TRICHOPLAX	KLCLHSLDET V KLL Y SK-S----TLQL F TP R E I E E Y N M C K T TIV R LIN F LAV L L Q MS P T	1340
SEA_ANEMONE	NLAMLGIQAAIKCFPK T TH----ITDVAT P K E MDE Y NR V K C TVIVR I M N F F TV L L Q AY P D	1357
PRIAPULA	PSGEERR-----RRRRWADRRRH V HP E ME K Y N RS K CM V IR A MD L F S IL L N M A--	1366
ESHARK	TLARHDITAAEECF T L G V----K G V L F S PR E RE E Y N Y C K T I I V R IME F AC L I L E G L Q	1360
STERLET	ELAVQDISAAELCF S VG P ----K G AL F SP R E R E D Y N Y S K T I I V R MM F V S M V LE N C Q P	1376
COELACANTH	RLATQDITAAEQCF T AG S ----K D TM F SP R E R E D Y S Y S K C T I I V R I L T F V S M V L E K C Q P	1364
HUMAN	S I A M H D I I A A E K F G T G A ---- A G N R T SP R E G E R Y N Y S K C T V V V R I M E F T T L L N T S -- P	1353
CAECILIAN	KLCLHDITAAEQCF R T G P----S G N I AS P Q R E D Y N Y S K C T I I V R I M E F V S M I L E N C Q	1366
PLATYPUS	RIAFHDITAAEQCF G T G S----K G S M F S P Q E R E E Y N Y S K C T I I V R I M E F A T M L L N T Y-- Q	1357
CANARY	TIALHDIHAAEQCF D S S ----K G S M F S P Q E R E D Y N Y S K C T I I V R I L E F V T V I L E M C Q	1355
OSTRICH	TIALHDIQAAEQCF D C L ----K G S V F S P Q E R E V Y N Y S K C T I I V R S M E F V T M V L E S C Q	1325
TURTLE	TIVLHDISAAERCF D T G S----K G N M F S P Q E R E E Y N Y S K C T I I V R I M A F V S M I L E T C Q	1364
ALLIGATOR	TIALHDIHAAEQCF F Y T S----K D N V F S P Q E R E E Y S Y S K C T I V V R I R F V S M I L E T C Q	1322
SOFTCORAL	KL S L N G I E K A F E C F P T S D G --V N T H A F SP S E I Q E Y N R A K C T V L V R I I A F I T L L L Q M N A K	1354
STONYCORAL	HLAMFGITEAT S CF T S G PS--R G M G D I FP K E I D D Y F R A K C T V I V R V L N F L T I L L Q D FP Q	1377
ACORN_WORM	KL A L E D V Y A A A K I T S S----A G L I F T PR E I D D Y N K Y K T A I V R L L D F I S V L L A V H T K	1377
LANCELET	KL A L S D I D A A A R C F E SH G ----A A T L F T PR E T E D Y N Y K C T V I V R I M D F F TV L L G AF P	1381
SEA_URCHIN	VA Q -Y D L F A F A K -----G C G S M E T A F T PR E E D Y N R T K C T V I I R L F Y F M G A M L G S H T K	1379
STARFISH	SL S L L D I T G A A R G I E Y G S K T S A F H Q V F TP R E S E Y N Q E K C T V I V R L W D F L T V L L E N Y A S	1386

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M-HEAT/CIRCULAR CRADLE

TERMITE	-----GCLPHSLLNL Q L W Q L I V AC V L H P G S L G F D L Y N T E V T D G L P K N I Q L L G V L Q E T L P	1372
SHRIMP	V--ASLLSQHSVWSAT M FS L I T C C T L D P AS V G F D I K D TE V S K H L PS R LEE I L G I L A R R G P	1393
SCORPION	Q---LNTIPST F WS I N F W N C I Y S S V L N P K F L G F D M T D T Y I F N Q F P K E T R T L L K V F Y E Y M P	1403
ALVINELLA	D--SLKVIPDD F WSD S L W Q T L A S C V L T P SS I G F N M A N M E I L E K L P L Q T Q L L T I L K Q L P	1387
CAPITELLA	E--SLKVIP S FWSS N L W D T L L L A V L Q P T Q L G F N M G Q V E M N H L P E Q T L G T L Q I L M R S L P	1410
SPONGE	ET V S F E Y V P D S L S W S Q L Y T I V M D S L F Y S S L V N T A P D D P S T A K R I S E A A V S C L T A M C T S L P	1410
OYSTER	S--VKKLL P SE I L G K D L W N L I S M C V L Q P S A V G F N L G D V E I I K N L P T E M E Q L L K V L N A K L Q	1406
SNAIL	E--AFK V I P Q T L F C D D L W R L C I R C V V Q P S S V G F N M G D I E I T K L P H E M M Q V L K V L S K Q L P	1413
TRICHOPLAX	S--I I E G I P R Q I W S Q N L F E M I F L C I L T P H Q L G F N V G D I E V L E K L P Q Q M K D V C G L F Q M K L P	1398
SEA_ANEMONE	Q--G F K I V P T S L S W D D L F T V V F S C A L E P A L I G F N V G D V E V I E K L P E Q V S M T E A A W H I S M F	1415
PRIAPULA	---S L Q V I P D S T W S M E L W D V V L S V L D P T R V G F N M A D I E V E K L P E Q T E R L L I A L S W K L P	1423
ESHARK	D--CW K V L E K D L L N S D L F E L I A M V I D P T S I G F N M A D V Q V M K N L P N V C V L L N A V M K S --	1416
STERLET	E--FW K L L E Q N I L N P T F F E L I T T T V C D P S S I G F N M A D V E V M K N L P D I C V R L L K A L A K S --	1432
COELACANTH	D--L W K V L E K D L L T P A L L E L T V R T V C E P A S I G F N T A D V Q V M K N L P E I C V R L L K A L M K S--	1420
HUMAN	E -- G W K L L K K D L C N T H L M R V L V Q T L C E P A S I G F N I G D V Q V M A H L P D V C V N L M K A L K M S --	1409
CAECILIAN	D--F W R L L E K D L L N N N L V E L T V L T V C D P S S I G F N V A D V Q V M K N L P D V C I K L L K G L M K S--	1422
PLATYPUS	D--T W K L L E K D L L N A T F M E L V V E I V C D P S S I G F N V A D V Q V M S N L P D V C V S V M K A L K S --	1413
CANARY	D--F W K L L E K E L L N A S F I E L V M T V C D P SH V G F N T A D V Q V M K K L P D I S V R L M K A L M K S--	1411
OSTRICH	D--F W K L L E K E L L N A S F I E L L V M T V C D PS H V G F N T A D V Q V M K N L P D I S V R L M K A L M K S --	1381
TURTLE	D--F W K L L E K E L L N A N L I E L L V R I V C D P A N I G F N T A D V Q V M K N L P D V S V R L I K A L M K S--	1420
ALLIGATOR	D--F W K L L E K E L L N L N L I E L L V V T V C D PS A V G F N T A D V Q V M K N L P D N T V R L M K A L A K T --	1378
SOFTCORAL	E--Y L E I V P S E L W T G K F F E A L C T S V L E P Q S L G F N V A D L E V L E K L P E Q T F E L C K S L A S K L P	1412
STONYCORAL	E--T L K T L P P E F W S E D L F E V V L S C V L E P G V V G F H M G D V E V E K L P E Q T G V L C K L L V Q R L S	1435
ACORN_WORM	D--L S K S I P L S F W S T N L F E V I S C V L D P S S V G F D L A D I E V I S N L P K T T G Q L L M F M T Q K A P	1435
LANCELET	D--A Y K V V P D A V W K S P L Y D M V V T A A L E P T A L G F N M G D V E I M E K L P E Q T K Q L L L L M C R S L P	1439
SEA_URCHIN	E--A L E V I P S K L W T G L F A E I L C G C V L K P A S L G F N M A D T V I M N A L P Q T T N R V L D L L Y T K L P	1437
STARFISH	D--A V K V I P K S I W Q D S L F D L V V T C I L Q P T V V G F N M A D V E I M N L P K T T R K L L R L M S T H L P	1444

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M-HEAT/CIRCULAR CRADLE

Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

TERMITE	SSQLEELNSELGKAVSSMQTDVLSNLQ-DSLR---NDKVTLEQRQLLKGLEIHLKHC-GM	1426
SHRIMP	SEVIGEYSDYLEKQLQK-PENDI IKMLPLSL---ETAHINLRSRHVIEGIGILEKS-GW	1448
SCORPION	KPLYNNFNHEHLYEYL--ESKCNINLFLPLNLN---DKDLKILEIQEMLLGYEQLIEN-KL	1457
ALVINELLA	QNILVCFDLILKNMINSQGSADLFQLLPDKFD---ETKSEDLKLLQLVKGHEQLHLA-GL	1443
CAPITELLA	RNLAQELIESVSRHLMN-SSCDLSSKLP IPLL---EPNQDYIQLRLLVSGFEQLNSA-GL	1465
SPONGE	IDVKQNLIAYIASNINTGQTNVNLRLPVSYNST-TSSGILLFNRLVQGHYLAESNKC	1469
OYSTER	PDVLAAMCKEFGRL--QGDRDLSGLLSRPLD---DPSTDHVFLQQLVSGYQLHSV-GL	1460
SNAIL	LPERKELVKILEQEL--KGKGLDFGQIPISLT---SSSIDYTNLQQTVEGYCQLHDV-RI	1467
TRICHOPLAX	KDKRELMII TLKELLSRNRSYNLPDLLPIRFDRDNELNIDFERLTFLIKGYKQLLTM-GI	1457
SEA_ANEMONE	LG-----F SRCNLF EKLP I PLAGE-DSRVDHLYLSHLVTGYKQLHAA-GL	1458
PRIAPULA	NAPKKELHSRVARSL---SEKKYNILPRLPCLMTDTGDDTRYLSSSLVCGYEQLYKA-EL	1478
ESHARK	-PFKETLVDSVRKRITAQSI EALCNVD---LYSPGARTDHAGLRSILSACQQLHKA-DL	1470
STERLET	-PYKQLEIISMKRRI SYKSVEELCGVD---LCNV DARS DRARLVFVLSACKQLHKA-GL	1486
COELACANTH	-PYKDTLEASIRKRITARSIKELCSVD---LYNPDARLDHIRLGSILSACKQLYDA-GL	1474
HUMAN	-PYKDILETHLREKITAQSI EELCAVN---LYGPD AQVDRSRLAAVVSACKQLHRA-GL	1463
CAECILIAN	-PFKNDLEFSIKKRITSESIKDLCDVD---LYNQDARHYHARIGSILSACKQLHKA-GL	1476
PLATYPUS	-PYKDALEGNIKKRVT AQSI EELCTVD---LYKPDARFDRPRLASILSACKQLQRA-GL	1467
CANARY	-PYQESLKLCLKERITPQSLEDLCSVD---LFNSEARLDQVRFAGVLSACKQLQKS-GL	1465
OSTRICH	-PYKESLKLKLERITPQSLEDLCSVD---LFNSDARFDQVKYSAILSACKQLQKA-GL	1435
TURTLE	-PYKSELELSIKDRITQSIEELCSVE---LYNPDARFDHVRSSILSACRQLHKA-GL	1474
ALLIGATOR	-PYKSSLELSIKKRITSHSIEELCSVD---LYDPDARFDRVRISILSACKQLHKA-GV	1432
SOFTCORAL	KQFLIHLLTTLMSKISLGGRCNLFELLPPLSGEECDQMDHTRLQLLVRGYQLHRA-EI	1471
STONYCORAL	GECLERLKGTELEKIALGSHCNLFDQLPFPPLSNPQEHQVDCRLRAYLVQGYQLHCA-GL	1494
ACORN_WORM	GNVSSMEMKCKLQEKLPKPSMHLMNITPSILKGD-DKGINVVKLTHMVSQYEQHLHKA-NL	1493
LANCELET	SQQGALLKSQVAAKLSRRSSHDLFSLHPEVSAGV--AELDHVRLTLMVSGYQLHNA-GL	1496
SEA_URCHIN	TEQLKLETVIHKRITASRSEDLFSILPMLFSNESDLGLDHVQLHLVNGYKQLQKA-KL	1496
STARFISH	ANLRNNLSKAVTRSVTKSSHDLTKLLQSMFGRDEGLTTDHGKLIHLVKGYEQHLQA-NL	1503

M-HEAT/CIRCULAR CRADLE

TERMITE	LSHIVKELPNQYG-LDGNQIVKH---LFSALVEGQGD-M-KRTVVLPAAFSYAESLLKFA	1481
SHRIMP	LAKCN-----VVSYSVAKELVDW---LC-GSIFKEQNLVSVSGISPHPSLLKFLYTMQLA	1499
SCORPION	W-----PKQNCNKS KKLACDMLSS---VWESCILETEIG-CCIPILNPSVLNFGKMLTVA	1509
ALVINELLA	LQSVLNK--SRQTESVSVQL-----	1461
CAPITELLA	LSNTLVS--KSS-EKLAEDLVNT---VFMGMVTAVDG-KPFLVNLSVPSVQSLAEKMLTTLA	1518
SPONGE	LSDVLKSMGISEEESLAMRLYTNALTIIRGISSSPGDGT-PGYMPPHLKLTGELLKLG	1528
OYSTER	LSKVM--ATLPLD-LANKLLEY---VHSSLICVEGG-TKKSQTPSPTAQVTATRMLELS	1513
SNAIL	LLEVLG--KHGQPEKLAELLFDS---VLKGITEKKG-DKKTVSLSPAHRFASQLLKL	1521
TRICHOPLAX	LKTTPADHK----DLIEKIMKS---V--VDCFRGEMNGDRALTALSPAQQKVAEELDLA	1507
SEA_ANEMONE	LMDVMLTRGSTKPLEYGSRLNA---VYEGACRAAVRTSGSIIVLSPASHQLACKLLELA	1515
PRIAPULA	LLPALQEAAPAL---PASLLTS---VFEGCTLSRPGVSSLTGMSPSVRELGGRLRLA	1531
ESHARK	LNSAIDCEAGLSLSSLSLKL LSV---VYKGIAPGDERK--SLPSIDVSSKQLADGLLQLS	1525
STERLET	LNSALQSQAAAFGLSLGSKLLSV---VYKGIAPGDERK--SLPSMDVSSRKLADGLLQLA	1541
COELACANTH	LNSAVQYQSGDFNLQLGSTLLSV---VYKGIAPGDERK--SLPSIDISSKRLADGLLQLA	1529
HUMAN	LHNILPSQSTDLHHSVGTLELSL---VYKGIAPGDERQ--CLPSLDLSCQLASGLLELA	1518
CAECILIAN	LNSVLQSQTAGLQFTVGSKLLSV---VYKGIAPGDERK--SLPSLDISSKRLADGLLQLA	1531
PLATYPUS	LHAAVHPQASHLQRPGSTKLLSV---VYKGIAPGDERQ--SLPSLEISSKQLASGLLELA	1522
CANARY	LHSVLHGQDEGSHFVSGKLLSV---VYKGIAPGGERM--SLPCLDLSRKRRLADSLQLA	1520
OSTRICH	LHSVLHNQDEVPHFSLGCKLLSV---IYKGIAPGAERL--CLPSLDISSKRLADGLLQLA	1490
TURTLE	LHSTLQSQGSLHFTVGSKLLSV---VYKSIAPGDERK--SLPSLDISSKRLADGLLQLA	1529
ALLIGATOR	LHSVLQSQGSLHFTVGSQLLSV---VYKGIAPGDERK--CLPSLDISSKRLADGLLQLA	1487
SOFTCORAL	LLPALAKEGEWSAEKCEELLS---VFQGFIVQSD-VFRIVNLTASRELAKLLDLA	1527
STONYCORAL	LLPALKAQARNASEEYAVKLF TA---VYDGVKPSLVNGLQTVILDPASQHLASKLLDLA	1550
ACORN_WORM	LLPALQKTGMASGDKFSQQLLTA---VFESISTKQSN-SLIVSHLSPTAHELAVRLDLA	1549
LANCELET	LLPA---LGTNSGKSLASELVSA---VFKSMVTRKD-GHPTAASLPPSFHQLTGGLLQLA	1549
SEA_URCHIN	LTRQT--TNQALS-----ILDF---VMRGLVVRGENGQ-EARKMTPSEIDLQRLLELA	1544
STARFISH	LSAAT--TGHGSGSSFAVKLFIT---VFDLSLTSDEAGKLLQANLTPLSVELAESLLDLA	1558

M-HEAT/CIRCULAR CRADLE

Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

TERMITE	FLLNKEVTTV-ICCIKEQASIQNPATN-----SSVLHGDIYFFVTFRSAILEHMLACFE	1533
SHRIMP	ITLDPKVKHLLSWATNSDTSVSGTSGQ-----EVEKGSVHLSILGPKLIPQFLESPP	1551
SCORPION	LKLDISSEDL-LKKLLDEQQLYVSNLK-----TKTRRGLIMFSTYQQEISLFAGINSK	1561
ALVINELLA	FDVVFKNEDL-ISRLLDKSPVKNM-AV-----HSSSDHGMFYACFKSTVNQHLVANCA	1513
CAPITELLA	FQMGYPEKNL-VELIFNSNNIHGVSTN-----VQCSPHGTLYFAAFKSVVNLNFKSVE	1571
SPONGE	LLESDSVEPF-LLLVLSPAQSG-----AGASFAAQDGLLLYITYSGLINNKLKLLHIK	1579
OYSTER	FCLGVQIKKV-VMCILDDESMVEGTAKG-----YSQSHGELMFTAFKTTVSVHLAKAMA	1565
SNAIL	FQLGLPAEKL-VEGILDIRIQGLSLG-----IEYMLGDHFFTLFKTPISSHVAASS-	1572
TRICHOPLAX	FELNETIDIF-FRYLLDETK--LY-----GDSNSATATLGMTLYYTFNSNINAFKLVSN	1559
SEA_ANEMONE	FDLGIEVITI-FRRAVNILLIQMI----CFLFDGSSVGVAFYITTFQASINTYLIKNAQ	1569
PRIAPULA	FTMKVESDSL-LSLLFDDTRLLGVSAK-----QTTKGSMPFYSTFGHEINNHVGMAT	1582
ESHARK	FSLGGQCEEL-VSLLLNTMELSVPLSG-ATQKNFITFSSHGEYFYSLFSETINAELLKSLK	1583
STERLET	FSLGGQCKEL-VDLLNNSIMLSVPLSD-TSQKNFITFSSHGEYFYSLFQETINSELLKND	1599
COELACANTH	FSFGLQSGEL-VCLLLNRVTLVPLSG-TSQKNFITFFHGEYFYSLFMETINSELLRNLS	1587
HUMAN	FAFGGLCERL-VSLLLNPAVLSTASLG-SSQSVIHFSHGEYFYSLFSETINTELLKND	1576
CAECILIAN	FDLGGQCEEL-VSLLLNTVKLSVPLSG-TSQRNISFSSHGEYFYSLFSETINTELLKND	1589
PLATYPUS	FAFGGICEEL-VSLLLNTVVLVPLAG-TSQRNLSFSSHGEYFYSLFSETINTELLKND	1580
CANARY	FALDICEEL-VSLLLNTVVLVPLSE-ASQNLNMFSSHGEYFYSLFSETINQQLKND	1578
OSTRICH	FAIDGQCEEL-VSLLLNTVTLVPLLG-ASRKNLVNFSHGEYFYSLFSETINEQLKND	1548
TURTLE	FAFGGQCEEL-VSLLLNTMMLSVPLSG-TSQRSLSFSSHGEYFYSLFSETINQELKND	1587
ALLIGATOR	FAFGCQSEEL-VSLMLNTAMLSVPLSE-AAPRNLLSFCHGEYFYSLFSETINHELLKND	1545
SOFTCORAL	FDLGLKIESV-LHCILNKSCCLADAKGS-----SSTVGMVYQTFHNTIEHLLKNSS	1578
STONYCORAL	YDLGLQFNYL-MESIMEDSND-----NPGSSCGCTFYRIFQTSINGFFIERAN	1597
ACORN_WORM	FLLASQSKEL-VSCLMKNKTPVKTGRVD-----SSAGYCGLSFYSHFKVPINTQLAQHGQ	1602
LANCELET	CQLHPQGHDL-LDCVMNKTPLMTGGGK-----KSSTFQGMVFFSTFKSCICQQLIKTCA	1602
SEA_URCHIN	FQLGVQTSNL-IDCLETPVVSSTRSLTSKLSASQTSGLVFLFTYKQPIMDQLVKHQA	1603
STARFISH	FLGLIEAKML-VSCLLDKALFSGRS-----STSKGAVFYTFKTKLNGEMAVQAQ	1608

M-HEAT/CIRCULAR CRADLE

TERMITE	HSVSCLIKDISANNVQWVISTVTEILQYYAKIRKSKHQ--DSTTLCAFERSIVNHNKLS	1591
SHRIMP	DALSRCEMIREGRFLPAMGFASALITCLIRNADIRK----KYSVKVVQSFLKHPTLA	1606
SCORPION	HFISSLMNNINKSKTT-VLKILVGLDLSIGKVEFRY----RYGKDIINSIMCQWSRLQ	1615
ALVINELLA	EFLDHLLKWAHDETTT-VGCILISMLEYIRQDRQLRK----NLGSSVIKALLDRFRLH	1567
CAPITELLA	KFVPLLMRHLAANGET-LSSVLIGIAESVISDRPLRK----SHGKMVSRAIVSQWSSLS	1625
SPONGE	MAIDVLLKNAKTHPQQ-VSVILNLLLEYVQKDFKINNNNNKNETVETLCTELISHWQDLS	1638
OYSTER	QAVPVLCEHAQKQCYR-VMSILVTMVDTVSKDKNLRK----QISANVVTSVVEKWKSSIS	1619
SNAIL	DVVSLLMNKATVDPHR-VCNVLVAMLENVAQDRRIK----SNGPRIIVDMVASKWHHLE	1626
TRICHOPLAX	RCLPMLDLAASKSFM-ISGILSGLLDFILDRDGLRQ----SKGIHISKILSSWNSLK	1613
SEA_ANEMONE	SHIPQLVSMATSYSSH-VCSILNSILDQFNDRKTSRK----RYGSSVVCASIVNSWEVFS	1623
PRIAPULA	VLIIPKVLDRINRESV-VMTILTDLDDQVGKDRERK----RYGSGVVNTVLQCVGHLR	1636
ESHARK	SAVTQLMRSAAENPKM-VSTVLNGMLDQSFDRDTRK----TQGVLLVSAVLTNWRLE	1637
STERLET	TTVAQLMKSAENPKM-VSMVLNGMLDQSFDRERSVRK----TQGSQLVGGVLSWTSLQ	1653
COELACANTH	TAVSQLMNSAAENPKM-VGAILNGLDQSFRRNTRK----QQGSQLVDTVLQNWTKLS	1641
HUMAN	LAVLELMQSSVDNTKM-VSAVLNGMLDQSFRRANQK----HQGLKLATLILQHKKCD	1630
CAECILIAN	TAILQLMKSSVDNPRM-VGTILNGMLDQCFDRDTRK----QQGVKMVIQVAVLQNWKKLD	1643
PLATYPUS	TAVLELMKSSVDNAKM-VGTILNGMLDQSFDRDTRK----QQGEKLVDAIILQNWKRLD	1634
CANARY	VFIVRLMKSSISNPQM-VGSILNGMLDQSFDRDRAVRK----QQGAKLVTAVLRNWEKLD	1632
OSTRICH	VIIQLMMESSVSNPQM-VGSILNGMLDQSFRETRIRK----QQGVKLVTAVLRNWKRLD	1602
TURTLE	VAIQLMKSVDSPKM-VGTILNGMLDQSFRRERAVRK----QQGKLVTAVLRNWRMLD	1641
ALLIGATOR	VAIQLMKSAVDNPRM-VGTILNGMLDQSFRETRVRK----QQGMKLVTAVLRNWRMLD	1599
SOFTCORAL	EHLPKILEYNRDEAQW-VSSTVIALLDMSVMDKELRK----MNGRKMFTVLLSWERLS	1632
STONYCORAL	IHMANILMKAASSPFL-VLSLLNGLDQVIRDKILRT----RNGSSFVAVLLNNWTSFE	1651
ACORN_WORM	EVVPLLLRHVVADSTI-VSTILNGLDHIITNNRELK----KKGLTVHAAIILSNWSSLK	1656
LANCELET	ESLPVLLQQLTAEPVW-VGSILHGLDHLAKDKTLRK----KEGAALCDSILLQSWPKLA	1656
SEA_URCHIN	DTVYELSNRVREDRGT-IGMIYGLLEHAVGNREIRK----RYGMAIYSAVLTQWDTLS	1657
STARFISH	KVIPLLVREGGKDVTV-VSSVLNGLLDYLTSSREVRK----THGMSVHSAILTQWDILM	1662

M-HEAT/CIRCULAR CRADLE

Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

TERMITE	SFVEGNS---EQVYQLLGLVNVNLARIMPPQDRGLA---RCEALQKVVITQLTSRDLQLHY	1645
SHRIMP	AQAGKTS---LHQDSVLSLLSSFLIDREGTIKSHCTSSRSDMVVFNGLLADAKVELQA	1663
SCORPION	QCLEESC-DIDLQNDIITLITKMFLLIDSSFLKGNVN-YDSNSIFFFFITLLQKSEMSLEF	1673
ALVINELLA	AWWHGESATKETQSMALNILLTKMILIDSKAVCNVQQ-KGFSHMFDMYLNMVLVKRSLSF	1626
CAPITELLA	VVWSESTASLDTKMVAITLLTKMLQIDSTVLIIDVKN-KSFYVVFKMFLGLISDKNNTLQF	1684
SPONGE	LWWEDGS-K-DLKSAAVTLLOKIIALKPKLLLSKAD--VSKPLVDMYTAMIGDEKLELNF	1694
OYSTER	SWCLA-T-P-ELHSMAMLLTKLVLLDSKVVDSSS-GHFPEVFETYLSMLTEKKTLSV	1675
SNAIL	SWWQAGS-S-DLQGLAVLTLTKLLLVDKAVLNVEK-SHFTTVFVTSYCTILAEKKTNLAF	1683
TRICHOPLAX	CWWLTPD-AQDLLQISVNLNKCLTLDPQFATQSN-D-SFETVFNFFLSLLSGTSTSLAF	1671
SEA_ANEMONE	SLWDMSS-SSELKQALLEIMKLLLLSDPKCLIDPAK-PAFQIVLKMFTSVFDDKNLTLTF	1681
PRIAPULA	DLWVATS-TPDRKDMLLMLLRKLLLIDSSVATKGS-SAHRDVYDTCCLLVDAGTSLAF	1694
ESHARK	SWWSENS-SAESKMAVLTLLSKVLQIDSSVSFSSNH-EAFAMVFHTYTTIITDSTLALNL	1695
STERLET	SWWASS-SAESKMAALTLLSKVLQIDSSVSFNTH-LAFVAVFSTYTTITDSTLPLNL	1711
COELACANTH	SWWIRSS-SPELKMAALTLLSKVLQIDSSVSFNPNH-AAPPAVFNTYTTITDQTLALNL	1699
HUMAN	SWWAKDS-PLETKMAVLALLAKILQIDSSVSFNTH-GSPPEVFTTYISLLADTKLDLHL	1688
CAECILIAN	SWWDKNS-APESKMAVLTLLAKVLQIDSSVSNAHH-EAFSAVFNTYTSILTDQKGLNL	1701
PLATYPUS	TWWAEDS-TPESKIAVLTLLAKVLQIDSSVSNTNH-AAFSAVFNAYSLLIDKKLGNL	1692
CANARY	GWWAKGS-SAESKMALTLAKVLQIDSSVSFNTH-EAFTA VFNTYTSLLTDQNLGNL	1690
OSTRICH	SWWAKGS-APESKMAVLTLLAKVLQIDSAVSFNTH-EAFTA VFSTYTSLLIDQNLGNL	1660
TURTLE	SWWAKDS-APESKMAVLTLLAKVLQIDSSVSFNTH-EAFSAVFNTYTSLLIDRNLGNL	1699
ALLIGATOR	TWWAKDS-APESKMAVLTLLAKVLQVDSVSFNTH-EAFFAVFNTYTSLLVDQNLGNL	1657
SOFTCORAL	HWWENG-EEL-KRSTAILIRNIIIVDPKCLSEVK---SSRGMFKTYNGLKDKTITLTV	1687
STONYCORAL	IFWRTHS-AMDLRHSILMILKMLILDPKAVTDCNR-LTFPPLFEMYLKDKSTTLAF	1709
ACORN_WORM	SWWSEGA-THDQRSSTLILLKLLQIDSKFASDPH-AAFPKVFDMYLMVTDSTSLAF	1714
LANCELET	PWEEGA-LQDSKSTALTLRKILIDSVSRDPAH-PAFQPVFMYLDMTDSRSTLPP	1714
SEA_URCHIN	NL-----GQEDDFMLNLMKVKVLQIDFKFATDPTH-PTFRPVFNQYLSMLRDSKSLAW	1709
STARFISH	GGLKKG-STDLQSFALLMLRKLQIDAKFVSDTTH-PVFSVLEAYSFMLTDASTLTF	1720

M-HEAT/CIRCULAR CRADLE

TERMITE	KSRA LDLL VLVCLAG--PQEDTNQELRSALQTLREQHFPQLS TEL HS GS VGYSGFVN AF RKI	1703
SHRIMP	KIKVL KLL PPFFT---MGEDIAKSVSEALEM LSL NH FPL H S TEFSEGGARDREYHQAICEI	1721
SCORPION	KICV LDLL PPFLC---DAPLCKVQAA LN DLFTNH FPLY SSELKPGSSQYNDYHLAFTKL	1729
ALVINELLA	KS NVLD ILAF FC S--LPEDYI WQL KE LER FVDN FQK S DQY RK SP KYNE YI ISFNKI	1684
CAPITELLA	K TRVLD LLI FF FCN--LPAAENKQLESCL NQ FVAD CFPM SLEFHAGSQQKCYIT AL DRL	1742
SPONGE	KAVMI DLL PS FL LLSSP-EHQSQLKGS LN R LV S LQ F PLT SSEL PAG GPLLE NY TNIEKL	1753
OYSTER	CK KILE LLPPFAT--LPEPHL KL KRS LD R LV ADH FP IK ST DL PE SSPH F KDYIAA DR L	1733
SNAIL	KN RALD VLP PF FAA--VPDAKL---KDV LD GLVADN FPL R S SELTKGTP RF V Y ISAIDKL	1738
TRICHOPLAX	KKYV LD LLH FF LV--SSDKRIRE RE H LD RMIV DK F PL KS AE FV VG SPDYNDYVACIDKL	1729
SEA_ANEMONE	KSRA VEL LP Y FKN--LPDNYQSQLKSCID TL V T DN FPL KS TE FIPGSPRYNDYIAT LD KL	1739
PRIAPULA	K TRV MEL L H F YCE--LPEQET T K RE N LD RMVAD F FPL R S SDFIVGSPKYHDYVAAMS QL	1752
ESHARK	KSQAMI IL PPFAH--LPEENLAVLRHALD Q VAAH FPM K S DEF FP K GT LKYNNYVDAIK KL	1753
STERLET	KSQALI IL PPFTN--LLGSTLADLHNA LE V LV ASH FPM Q S DEF FP K GT LRYNNYIDS IK KF	1769
COELACANTH	KSQAVI VL PPFTN--LPEDHLADLKNALD Q LVA FN FPM K S DEF FP K GT LKYNNYVDCI KKF	1757
HUMAN	KGQAVTLLPPFTS--LTGGSLEELRRVLEQLIVAHFPMQSREFPPGTPRFNNYVDCMKKF	1746
CAECILIAN	KSQAI IL PPFTN--LTGDSLNDLKNALD Q LVA FN FPL K S DEF FP K GT LKYNNYVDCV KKF	1759
PLATYPUS	KSQAVI IL PPFTN--LTGDR LN DLKNAL EQ VAF FN FPM N S DEF FP K GT LRYNNYVDC T KKF	1750
CANARY	KGQAVI IL PPFTN--LTG E KLNDLKNALD Q LVA FN FPM R S DEF FP K GT LKHNNYVDC T KKF	1748
OSTRICH	KSQAMI IL PPFTN--LTG E KLNDLKNALD Q LIA FN FPM R S DEF FP K GT LKHNNYVDC T KKF	1718
TURTLE	KSQAVI IL PPFTN--LTGDR I SELKNALD Q LVA FN FPM K S DEF FP K GT LRYNNYVDC T KKF	1757
ALLIGATOR	KSQAVI VL PPFTN--LTGERL KEL KDALD Q LVA FN FPM K S DEF FP K GT LRYNNYVDC T KKF	1715
SOFTCORAL	KIQCLE LL PC F TSATIPSE Q TEALRSAL KT L I ADN FPL S S KEFNEN N PKYSDYIAAL DK I	1747
STONYCORAL	KGQVLE LL PY F TK--STEEYL R RLKEGL NA FVTNNI PL K S TEFV T GGPQYNDYVQ T DKL	1767
ACORN_WORM	KS R VLE IL Y F FTR--IPEQEL S LLQGR LN RLIADN FPL K S SEFV V GGSPKYNDYVAA F GKI	1772
LANCELET	KSQV LD LLPPFTV--LPQTQ L AELKAR LD RMVADN FPL K S AE F PAGSSKYNDYVGA V TKL	1772
SEA_URCHIN	K TQ V LD VLY F FAN--VPEKE E KELK S ALD LV ANH FPL K S T D LEAGSPRYNDYI M ALN KI	1767
STARFISH	KAQVMD VL FFFTS--LPDGE Q T K LR S ALD R LVADN FPL N S SE F RVGSPKYIDYAGAL N KI	1778

M-HEAT/CIRCULAR CRADLE

Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

TERMITE	LRGLEESGSCVILLSVVAMAASES-QHVLEDDQIQKSLQIFIKRLEDK--QQVKAIEAVFK	1760
SHRIMP	LTALELSLSPILLQFVNVNLFPCRED-KHRYEEVMHESLEKFMKKLP--KQOETLKHIIYD	1778
SCORPION	LIALELTGNEMLLKFFVIQIMCREP-THLLEENIQKCLKCKKRTDSN--KERLIAEVPLK	1786
ALVINELLA	LSALELSGNLMLELLISIIICKEE-AHAEHEHIQKTLTKMAKRLPVD--KQKPAIEVPYR	1741
CAPITELLA	LLAMELSGSLMLLNLIISVICKEV-KHTHENAIQSAFQRFIKRRLPKD--KHKLALDVPYK	1799
SPONGE	CNSLVASGSLVLELIIINIMCREV-RHVCEEKIQTSLHQFISKLSED---GVDALKFVYE	1809
OYSTER	LTSLELSGSEMELLELLISIFCREP-KHVYETKILESINRFRTRVPAA--KQKSMVDVAYN	1790
SNAIL	LSALELSSSLVLELLELISIFCREEGRHVHEDAIQQSLNFTARLPAE--KQKDALDVPYK	1796
TRICHOPLAX	LANLIKSGNLMLELVISVMCREK-KHAYEEQIQKSLLLFISSLI PKDA--LGALDVPFK	1786
SEA_ANEMONE	LVTMVTSGSLVLLQVITAVLCREE-RHVHEEIQKSLAAFQRLAPSSSLVKGAVDVTYR	1798
PRIAPULA	LDVMEVSGSTMLLRLVISIVCREP-KHAMHDQLQTSLSRFIHRLSAD--KQKLAADSGYS	1809
ESHARK	LDALELSQSPMLLKLMIAILCRDS-RHVMEEGFQVCFQRLAKTGSCE--KQVALLEAVYG	1810
STERLET	LDALELSQSPMLLKLMTGILCRDN-KHVMEELFQTCFKRIARRGSC--KQVSLDVTYQ	1826
COELACANTH	LDALELSQSPMLLRLMTEILCRDS-KHCELELFLRCFKKI VRRGSCD--RQVTLDDTVYK	1814
HUMAN	LDALELSQSPMLLELMTTEVLCREE-QHVMEELFQSSFRRIARRGSCV--TQVGLLESVYE	1803
CAECILIAN	LDALELSQSTMLLKLMTTEILCRDT-KHFMEELFLTSFKRIARRGNC--KQVALLETVHD	1816
PLATYPUS	LDALELSQSPMLLQMLTEILCRDQ-RHFMEELFQMSFKRIARRGSA--KQVALLEAVHG	1807
CANARY	LDALELSQSPMLLQMLTEILCRDN-RHFMEELFQASFKRIARRSPD--KQVLLDVTYK	1805
OSTRICH	LDALELSQSPMLLQMLTEVLCRDH-RHFMEELFQASFKRIARRSNSD--RQVLLDVTYK	1775
TURTLE	LDALELSQSPMLLQMLTEILCRDH-RHFMEELFQTSFKRIARRSSYE--KQVLLDVTYK	1814
ALLIGATOR	LDALELSQSPMLLQMLTEILCRDH-RHCEMELFQTSFKRVIKRSDCN--KQVLLDVTYK	1772
SOFTCORAL	LSALVLSGSLMLFDLLISIVCREE-SHSHHEEIQIQAFAKFIKRLKQ--QARKALDICFD	1804
STONYCORAL	LAAFVNSRSLILLEVLI AIFCREP-QHVHEDQIQSFI AFIQRLHPEPDQAKAAMDVCLS	1826
ACORN_WORM	LSALVLSGSLMLELLISIMCREP-KHVCEDDQIQASLITFIKHLPAD--KQKPAVDVAFD	1829
LANCELET	LSALELSSSLMLELLISVMCREA-KHVMEEDDQIQTSLSRFIKGMGAD--RQKPAIDIPYG	1829
SEA_URCHIN	LTSLVMGSLMLELLISILCRDD-KHSYEDKIQQALSSFAKRLPSE--KQSAANIPFE	1824
STARFISH	LTAMVLSGNLMLELIVISIMCRDE-KHAYEDEIQESLAAFIKRLPEE--KQTAAGVAVYQ	1835
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M-HEAT/CIRCULAR CRADLE

TERMITE	VFVD--DQYDPSVRLGCAQRVFRPLLQGCRRSAAREFYRHCIQDLQGMNVTLDCRGQLQ	1818
SHRIMP	MYND-PTCIKQNLRYNIMDLVLTPLLQQAQAEVPTQNFLLTVISAVMAGMSAPVHGRSDE	1836
SCORPION	MFLE-DELYPSDMRIHIEKVFVRVILGMISKITLKYFFIDHIKEIMQIVKSKRKS----S	1841
ALVINELLA	IFCN-ESTFKNARRAALERVCVTL LRAVSVPALKEFFYDHIKDIMFSIELQFSQL--SV	1798
CAPITELLA	IFSQ-EGRFNTNQRRAACEKVSLSL MRLVHSSALTEFYCEHIKEIMKIIIEAKPTKAPHA	1858
SPONGE	MFKN-DKDFPVAAVKIGIGERLCVPLFTECCSAVLEFFVVLKISDVCMIMEAKLARVTDPK	1868
OYSTER	IFCQ-EKLYPGEVRRRTIEKVALPILRLVHKSALLEFFTDHMGDLRTTVEAKLVKGS--G	1847
SNAIL	IVFC-ESGFQDMIRRTTLERVCLPILRCVHKAALIEFFLDHILDLMRIVEQNLAGGPESI	1855
TRICHOPLAX	MFVD-DKSYRPDIRRAAIEVRCLPMLQKASLKITKDFYVSHIKEIMDIIETKLVKTA--D	1843
SEA_ANEMONE	IFTN-ERDHTSNVRLAVLDRVSVTL LCNASKAGVSEFFSSHVKEIMEIEAKQLKTYDPG	1857
PRIAPULA	ILAE-EGNFPGEIIRRSCLDNVLLLLRQCCHHAVVEFFRCHLVEIIGIEAKVVKLPERQ	1868
ESHARK	MFEN-EGGLSNARQSVMDRSLTLITHCSLDALKEFISKIKDAMGILQSRFTKTSSESS	1869
STERLET	MFQN-DELHSNTARQAVLDRSLLTL TLHCSLDALKEFFCTTVGDIMGTQARFTKSSEST	1885
COELACANTH	MFQD-EGLLSNTTRQAIMDRFTLIMLNCSIDALKEFLCKNILDVMGTQARFTKSNESA	1873
HUMAN	MFRK-DDPRLSFTTRQSFVDRSLLTL LWHCSLDALREFFSTIVVDAIDVLSRFTKLNES	1862
CAECILIAN	MFKT-ENLWSNTRQITVDSLLIL IWHCSLDALKEFFCKI IHTMDTLKGRFTKSNELA	1875
PLATYPUS	MFLR-DDHLSSTTRQAFVDRSLLTL LHLCSLDALKEFFYRIIVGAMDMLKSRFTKSNES	1866
CANARY	MFQS-EELLSNAARQAFVDRSLLTL LWHCSLDALREFFGKIIVEAMDTLNSRFTKSHEHT	1864
OSTRICH	MFQS-EDLRSNVTRQAFVDRSLLTL LHLCSLDALREFFGTIIVQAMDTLNSRFTKSNES	1834
TURTLE	MFQS-EALLSNATRQAFVDRSLLTL LHLCSLDALKEFFFSKIIVLEAMDTLKRFTKSNESA	1873
ALLIGATOR	MFQS-ESLLSNVTRQAFVDRSLLTL LLYCSLDALKEFFFSKIIVLEAMDTLKRFTKSNETV	1831
SOFTCORAL	VFTKKDTEYRNLTRRAAIDKVLVLLRASSTVFREFFYVDHIKNIIMEIIETRFSKATDSV	1864
STONYCORAL	IFFN-ERDYQTHSRRAVIERICITFLKSTTARRAFYQDQIQKLSVLEAKELKPTDPN	1885
ACORN_WORM	VFHK-ENVYPNDIRRAALERVGLPLRLVDIPTLSTFFISHVNQIMNTIEAKQIKVPES	1888
LANCELET	IFRR-EGSPNEIRRSALERVCLPMLRLVHPAALTEFFTDHIREIMDIIGAPQTKAGEAS	1888
SEA_URCHIN	IFKQ-DKRYSKAIRKAAIQVCIPLRLQASRDATVTFYKGHIHDIISVLEARLTKNPVPA	1883
STARFISH	IFCQ-ENSFSKEIRRAAIEVRVCIPLMRLAGVKALSSFFKECIKNIGGIIDAKTIKAPETV	1894
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Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

TERMITE	TEHQLVGRIGAWNILEPLFVHLESSELESKECVITAAAFPGA---VKTGKEL-ISDLTSR	1874
SHRIMP	QHKTLVTKVGSFMILQIMYSKLPREKLFAPGSEINAAFRPGD----QSGKEL-TKEIFRY	1891
SCORPION	NEIQLVSKIGAFQLIEILYTLKSKEEVS-KESQINCSY-----GKEL-TREATGF	1889
ALVINELLA	SESQMVTKLCNFELLEVMYSRLTREEVRSKNSTINQKYCYPK--TDVEGKEL-TAAITKA	1855
CAPITELLA	FEAQLTSKIGCFELLEVMYSRLPNTDVNSKSSINKSFCSPK--IPDTGKEM-NLTITKV	1915
SPONGE	LECQLVHKSCCFQFIEILYTRLPSSLISSMESTVNTAYCNGS---PQTGKEL-TQAITKC	1924
OYSTER	LENQLTSKLCFCQLEELMYGRLSKEEVFGKSSVINKKFCEVKSVMVDTGKEM-TQVIMRT	1906
SNAIL	LKTQLTSKVCCFQLEELMYGRLSKEEVNSLSSEINKKVCFGK---PETGKEM-TQKIKA	1911
TRICHOPLAX	LENQLTSKLGSYKMLKMLYSRLSKQDVNTAESIVKAYTGRP---TEDGKEI-TKSITKA	1899
SEA_ANEMONE	FESQLVSKMCAFRMIEVLYSRLGKAELNSPQSSINLAYCPN----DNTGKEL-TKAITKS	1912
PRIAPULA	YESQLISKICSLKLEELMYACLPKEDVYGDAAALGQVFLASR---PAGSKEL-TPVITRL	1924
ESHARK	FDNQLTRKIGCYKLEEVTYIRLPKDDIYSEDSKINRAFHSS---NMEGNKLLSKSLKLL	1926
STERLET	FETQLTKKNGCYKLEEVLYSRLPKEDVYSKSLINQAFCRPN---KAEGNEL-SKSLLSK	1941
COELACANTH	FDTQVTKKTCGYKLEELVMCSRLPKDDIYSEQSRINQAFHGSC---SAQRNGL-SKTLKLL	1929
HUMAN	FDTQITKMGYKILDMYSRLPKDDVHAKESKINQVPHGSC---ITEGNEL-TKTLIKL	1918
CAECILIAN	FDAQIMMKMSYKMLEVMYSRLTKEDIYSKGSRIQAFHGSS---NAEGNEL-TKILVKS	1931
PLATYPUS	FDTQVTKKLGYYKMLEMMYSRLPKDDVHSKESRINRAFHGSS---VIEGNEL-TKTLIKS	1922
CANARY	FDTQVTKMGYKILDMYSRLPKDDVHSKESRINQAYRGS---SVEGNEL-TKTLIKS	1920
OSTRICH	FDTQVTKKTYKYLEVMYVRLSKEDVYSKDSKINQAYCGSI---SVEGNEL-TKTLIKS	1890
TURTLE	FDTQVTKMGYKILEVMYSRLSKEDIYSKDSRINQAYQGST---NVEGNEL-TKTLIKS	1929
ALLIGATOR	FNTQVTKMGYKILEVLYSRVSKEDVHSKDSQINQAYQGT---NVEGNEL-TKMLIKS	1887
SOFTCORAL	FESQLVSKLCFCFLLALLYARLEKTDVSSMESRINRAYNN-D---VKTGKEL-TMAITKA	1919
STONYCORAL	FESQVTSKLCFCFLLVILYSQFSKSELNTLESTINKAYVGGD---VKTGKEL-TLAITKA	1941
ACORN_WORM	FETQLVSKIGCFELMELVYSRMTKEELNTPQSKVNIYCRDS---VKSCKEM-TMALTKI	1944
LANCELET	LRTQLTNKLCFCFQLEELMYSRLPKEDVNTPPSRIVRAYKGE---VKAGNEM-TTAITKF	1944
SEA_URCHIN	FENQLVSKICYFELIEVLYSRLSKDDLNSKDSALNREYRHHG---VEKGNEM-STALTKA	1939
STARFISH	FQNQLVSKTCCFQLEELMYSRLVKEDLFSMDSAINKAYTN-D---VKTGKEM-TQALTKA	1949
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TERMITE	AYKYRSETLHDLNLTGNVQLVELFRQSQCAAFNTLVAIISNVKCELRFFTGGLFSENKAK-	1933
SHRIMP	AAK----ISKGELRHDQTHAELRLCACAAYNAIIAVLACVQNDLRFYTNFLFSANPTKG	1947
SCORPION	AIA----ARKENLEGESISKEFCRKYCACAAYNAIIAICCTQTDKSFYSTFLFQENFAKG	1945
ALVINELLA	AHH----TKRENLOQEPVFLLELQRQYRCAAYNTLIAVICCTQTEIKFYNGFLFSENINMG	1911
CAPITELLA	SNA----TKGENMNGETLLIPLRRLALCAAYNTLIAALICTQKEKKFYTAFLFTEENPAKN	1971
SPONGE	CHG----AKSEDLHGDRTHYETRQYHCHAYNTLMSVICTQSKPQFFVGFFLFKEDVVKG	1980
OYSTER	AHE----AKGEDVRGETSCEVLELRQYHCAAYNLLIAVLSSTQTDKAFYTAFLFKEDFAKG	1962
SNAIL	ANN----AKSEDLRGETRSMVELRQYHCHAYNLLIAIICCVQNEHKFYKGFQDNQTSKG	1967
TRICHOPLAX	AHA----CKSDLRGETRSMVELRQYHCHAYNLLIAIICCVQNEHKFYKGFQDNQTSKG	1955
SEA_ANEMONE	AHA----AKSEDMRGETVAFELRQLHCAAYNALLIALISCTQTELKFYTAFLFNENPVKG	1968
PRIAPULA	CYD----ACREDMRGERALLELRQYHCTAYNVCVASVSRKTEPVYSSLLQENPAKG	1980
ESHARK	CYD----AFTENMGTQKLEKRRQYHCAAYNCIMAVVTCIFTEAKFYQGFFLFSEKAEKN	1982
STERLET	CFD----TFTENMAGETQLEKRRQYHCAAYNCAITVISCFSNETKFYQGFFLFSEKPEKN	1997
COELACANTH	CYD----EFTENMAGETQLEKRRQYHCAAYNCAIAVISCIFTESKFYQGFFLFSEKPEKN	1985
HUMAN	CYD----AFTENMAGENQLLERRLYHCAAYNCAISVICCVFNEKLFYQGFFLFSEKPEKN	1974
CAECILIAN	CYD----SFSENMAGETQLEKRRQYHCAAYNCAIAVISAFTDAKFYQGFFLFTEKTEKN	1987
PLATYPUS	CYD----AFTENMAGETQLEKRRQYHCAAYNCAIAVISCVFNETKFYQGFFLFTEKPEKN	1978
CANARY	CYD----AFTENMAGESQLEKRRQYHCAAYNCAIAVISCVFNETKFYQGFFLFSEKSEKN	1976
OSTRICH	CYD----AFTENMAGESQLEKRRQYHCAAYNCAIAVISCVFNETKFYQGFFLFTEKTEKN	1946
TURTLE	CYD----AFTENMAGESQLEKRRQYHCAAYNCAIAVISCVFNETKFYQGFFLFTEKPEKN	1985
ALLIGATOR	CYD----AFTENMAGESHLLGKREYHCAAYNCAIAVISCVFNETKFYQGFFLFTEKPEKN	1943
SOFTCORAL	AHA----AKSENMQGETVLLPLRREYHCSAYNLIASVIRSQTLKLFYNGFLFSEDLKSG	1975
STONYCORAL	ARA----ASIEDMRGETVAFELRQLHCAAYNALLIALICCTQTDKLFYVAFFLFSENPIKG	1997
ACORN_WORM	AHA----AKGEDIRGESVLELRLRQYHCAAYNALLIAVSCVQNDIKFYNGFLFAENHAKG	2000
LANCELET	GHA----AKSEDLRGETGLLDLREYHCAAYNALLIAIISCTQTDKLFYTAFLFQENHAKG	2000
SEA_URCHIN	ALG----ARNEDCRGETVAVELRQLHCAAFNCSAIISCVQDNKIFYNAFLFSENHAKG	1995
STARFISH	CHA----AKSEDIRGETNALELRQLHCAAFNALLIAIISCTQTDIKFYNAFLFSENHAKG	2005
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Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

TERMITE	EVPWGKLVNCKEYALALDWEIIPARRKQLVSI RCQARAQRRETLG-----FASQSV	1985
SHRIMP	EVIWECLVDCSRNLEFDVEINFKPASKKRFVAVRQKLRRETAREEGA-----VVAGTV	1999
SCORPION	EYIWENIDLNKEYTFPIELDT-IERRRKFISVRHENRELNKNTLN-----FASSL	1996
ALVINELLA	ECLWDNLVDQKKEYEFPVELQNPHHK--KLVAIRSEHRESE---NT-----DSSLPSV	1959
CAPITELLA	QLHWNIVDQDVVYEFPLEMENPIERRKKFVSIRTSVRDVPDPSDEP-----TGPASSV	2024
SPONGE	QLLWDNIDCEKKYEFQVDFEAPLKRKQITSI RDDLKQSTAAGNSS--GSPSSSPSTRP	2038
OYSTER	QFVFDNLDDKAYVFSSELKAPLSRKKQYVSI RNEVKESNSQNGE-----ADEGESS	2015
SNAIL	QFLLENIVDRDQKYEFPLELESQFERKKKFAIRSEM QEKQS-----DKDGAIS	2016
TRICHOPLAX	QFLWENLIDMEREYAFIEI ELSYQDKQKTTFRSLREQSRSSVSES ADEAD--SGIAMPAS	2013
SEA_ANEMONE	QFLLDNLIDTRKYEFEVELS TPLERKKQMTSIRINARVQS--DQVEEAL----SQGRSV	2022
PRIAPULA	QLLWDNIDCHRRYGFDR ELSAPLQRKRQFVAIRTA VREIDRDADGQ-----GAPLPSV	2034
ESHARK	IFIFENLIEAHRTYNFPVIEIEVPLEKKRRFISIRKEAREAGDGDGSG-----EP	2030
STERLET	QFIFENLIDAKHTYSFPVIEIEVPLERKKKYVAIRKEARQGGEGDSD-----EP	2045
COELACANTH	LYILENLIDMKCSYNFPIEIEVPIEKRRKYVAIRKEARGSTIGDLD-----EP	2033
HUMAN	LLIFENLIDLKRRYFPVIEIEVPMERKKKYIAIRKEAREANGDSD-----GP	2022
CAECILIAN	LLIFENLIDLQRCYTFPVEIEVPLERKKKYVAIRQEARNTANGESD-----AP	2035
PLATYPUS	LFIFENLIDLKRCYTFPVEIEVPMERKKKYIAIRKEARDSVNDNSD-----EP	2026
CANARY	LLIFENLIDLKREYTFPVEIEVPLERKKRYIAIRKEARDAGNSSQD-----EP	2024
OSTRICH	LLIFENLIDLKQYSFPVIEIEVPLERKKRYIAIRKEARDSGNNGED-----EP	1994
TURTLE	LFIFENLIDLKHRYSFPVIEIEVPMERKKRYITIRKEARDAVNRDSD-----EP	2033
ALLIGATOR	LLIFENLIDLKHQYSFPVIEIEVPMERKKRYIAIRKEARDTVNGGPD-----EP	1991
SOFTCORAL	QFLLDNLVDCTKKLHFEMEL SAPLDRKRTLLSIRCEARATRMNSSEN-----YEHGVS L	2029
STONYCORAL	QLLLDNLVDNCRNTYTFEVELSAPLERKKQFRMQR---IPSPKENS L--EESAGRTGLSI	2052
ACORN_WORM	QFFLDNLVDADKVYHFEIEMSPMERKKKFAIRKEVRDASEEDDLQDSAVGL-YGTGGV	2059
LANCELET	QFLLDNLVDTNKLYQFDAEF SAPVSRKKQFVSI RQELRGQDSPEAG-----SS	2048
SEA_URCHIN	QFLLDNLVDPKKEYGFAIEMDAPVERKKRFVAIRTA QARETNTPEES-----GYVSGPA	2048
STARFISH	QFLLDNIDITKNYSFEIEMNAPMERKKRFVSI RNQIQD TVAGSSSQSDSGIEMSGYTG	2065
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TERMITE	RYIPASQYLFDSL NEDVTLFDFSTSVVSTE ARP GHDEK-----	2025
SHRIMP	QYM--ASHYLSDSLRE DMSQDFDNNSVVLAMSQTEKSSER----VTGA-----	2042
SCORPION	KYA--PSQYLSDSLSDVDSQDFDSSSEELAFSQDMKNKNRKEEI-----	2038
ALVINELLA	NYL--ASQYLADSSLMDVDSQDFTVSVQTSYTS TPSSKKHKH SRLTKG-----NSK-	2010
CAPITELLA	HYL--ASQYLADSSLTDVDSQDFDGSMSVSSADSSF DNQR-----S-	2063
SPONGE	RYI--SSQYLSDSLSDVDSQDFDTLPHHHYQSGVGG---GAS-----TESSSI-	2082
OYSTER	SLHL--ASQYLADSSLHEDLNQYDF TATPQ--MSEGS PREKVLTV-----RKSSYT	2062
SNAIL	SYHL--ASQYLTESSLSEDL SKYEF TVSGSAQNTSGIPKTKASLR-----KNSSY-	2064
TRICHOPLAX	YHL--SSQYLADSSLNEISQDFD FNSSTVQGYSENN-SIKQIPT-----	2054
SEA_ANEMONE	RYL--SSQYLADSSLSEEVSQDFDSTPVQVNI INYL-KR-----	2058
PRIAPULA	HYL--ASQYLADSSLSEDL SRYDFNVSTQIRERGD----PRAERKPEGEAEQE EEAAM	2087
ESHARK	QYLS--SQSYMADSSLSEEMSQDFDSTGVQSFYSN SQ---DPRGH-----AVR	2030
STERLET	HYLS--SQSYMADSSLSEEMSQDFDSTGVQSFYSN SQ---DPSAR-----AAR	2088
COELACANTH	QYMS--SQSYMADSSLSEEMSQDFDSTGVQSFYSN SQ---NRAAA-----VVH	2076
HUMAN	SYMS--SLSYLADSSLSEEMSQDFDSTGVQSFYSN SQ---DPRPA-----TGR	2065
CAECILIAN	HYLS--SQSYMADSSLREEMSQDFDSTGVQSFYSN SQ---DPTAA-----QFH	2078
PLATYPUS	HYLS--SLSSMADSSLSEISQDFDSTGVQSFYSN SQ---DVKST-----GYH	2069
CANARY	KYLA--SSSYMADSSLSEEMSQDFDSTGVQGFYSN SQ---DVTAS-----STR	2067
OSTRICH	KYLP--SASYMMDSSLSEEMSQDFDSTGVQGFYSN SQ---DVTAS-----SPR	2037
TURTLE	QYLP--SASYMVDSSLSEEMSQDFDSTGVQSFYSN SQ---DPTAS-----SIH	2076
ALLIGATOR	QYLP--SASYMVDSSLSEEMSQDFDSTGVQSFYSN SQ---DPTAT-----SAR	2034
SOFTCORAL	RYL--SSQYLADSSLCEEVSQDFDSTPIQALSQSESTEQD-IA-----GG---E-----	2072
STONYCORAL	HYM--YSQYLADSSLSEDISQDFDSSPIQVHSGTEA--RQPLY-----	2091
ACORN_WORM	RYL--SSQYLADSSLSEISQDFDMNTGCLYHTNLCMSIFACMLHVLPH-----	2107
LANCELET	RY--MQSYLAGSSLSEDISQDFDSTSGTQVKHSQTFSS TQERYSQASQG-----SSRL	2098
SEA_URCHIN	HYL--SSQYLSDSLSEDVNQDFDSSSVRHFGSSM-ESQRDGGSQSQGS---QRPGSM	2101
STARFISH	RYL--STQYLANSSLSEDIQDFDSSGGVQQFNASI-DKQQLSQRSSVPH-----IKK	2115
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Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

TERMITE	-----T----PKESGAESTEVILESDDLNMHECMATLCGVIEHMDVQGISPTPDAETKD	2075
SHRIMP	-----NEMGG---VLMFVHMDQSDYNGHEVMANLTAVINHMVDAEIMVLHKGDTVP	2090
SCORPION	----DSNPSNEAKDDDLVSNITVVELEIDDLNQHCEMNSLTMVLVQHMEKIQLL-----SSSP	2090
ALVINELLA	EDKDVLDTEVTVQGDY-----VEIEMDELNKHCEMAPLIGLLKHMARNNI TPSVTKGETP	2065
CAPITELLA	RESSIEVPDVVLKEHY-----IEMEDALNQHPCMAALSALLQHMKNLQITPEVEKGSKP	2118
SPONGE	----DEDSGNSQEASSYVVSVEEQLEEDDLNIHECMTPLMKLLDHMI INKITPAPSGD--S	2136
OYSTER	DEEDDTDKVMVEDDY-----VELEMDLNOHEGMANMIALLKHMQRAKI IPLVESHG-VV	2116
SNAIL	----GGDNKVRLDGDY-----VELEMDALNSHECMAPLVALLKHI HKNNIFPAAQSDASS	2115
TRICHOPLAX	---RETGDSEKAKTI INKFADEELELDDLNKHCEMALLTLLDHMAVNKINPAIEKDTTP	2111
SEA_ANEMONE	-----TGKPDQLG-EDSYEIGEDVEMDELNSHECLTKICSLLTHMKESNISQPDKGALP	2112
PRIAPULA	DVNEEESGSATLAGDY-----VEMEMDELNOHECMASVALINHLATTVCP--IQAASSP	2140
ESHARK	SRRKEQAELSVVQSDI-----MELEMDLNOHECMAMPALINHMQRNNI TPQVEEGKTP	2128
STERLET	GRRRERVE-SLVQDDV-----VELEMDLNOHECMASMTALLNHMQRNNI TPKVDEGTVP	2142
COELACANTH	SRRKERTE-SVVQDDV-----MEFEMDELNOHECMAAMTALINHMQRNKI TPQVEEESGP	2130
HUMAN	FRRREQRD-PTVHDDV-----LELEMDLNRHECMAPLTAIVKHMHRSLGPPQGEEDSV	2119
CAECILIAN	SRKREHPE-FTVQEDV-----MEFEMDELNOHECMAAMTGLIKYMQKTQITPKVEEGTVP	2132
PLATYPUS	FRRREYRD-PVTQSDV-----LELEMDLNOHECMATMTALIKHMQRNNI TPKVEEGSGS	2123
CANARY	FRRKEPTE-YKVLNDE-----MELEDEFNOHECMASMTSLIKHMERNI TPKVEEGTVP	2121
OSTRICH	FRRKEPTE-YMALDDD-----TELEMDLNOHECMASMTTLIKHMQRNNI TPKVDEGTVP	2091
TURTLE	FRRKEPTE-SMDPDDL-----MELEMDLNOHECMASMTTLIKHMQRNNI TPKVDEGIVP	2130
ALLIGATOR	FRRKESTE-SMVLDD-----MELEMDLNOHECMATMTTLIKHMQRNNI TPQVDEGAVS	2088
SOFTCORAL	---NSGTPASPKESSDISSEEELEMDLNRHDCMTTLVGLINHLVKNKISFPQEQGKEA	2128
STONYCORAL	-KLNESSTAEQTDDWYEVSEDTLEMDLNRHESMAKMISLLKHLVDDKISPEQVKDVPP	2150
ACORN_WORM	FVFSLLPPSAFVKGDY-----LEMEMDELNOHECMASMTALIKHMQRNNI TPQVQKGAAP	2162
LANCELET	QARQQQDSSVNIHGDF-----LEIEMDELNOHECMSSMSAVLQHMARNNI TPQVQKGAAP	2153
SEA_URCHIN	ASRQDSKPVFSPGGEY-----LEMEEDALNOHECMAAMTGLIKHMQRNNI NPDITKATKA	2156
STARFISH	RYSNEETPTVVVQGEY-----IEMESDALNOHECMASLTAIVKHMQRNNI TPQVQKGAAP	2170
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TERMITE	--AALPPWMESMRKCLSDYS--QPRNIRLFLFKIILNVESKFHPYAHHWMNSILKAITD-	2130
SHRIMP	KATDVQWMTLVQQKLDSD--TPRNVKLFLLRVMNNARIFEPYAAHFVSTILTCLVD-	2147
SCORPION	--KEIPKWLNDLCKKLEDYS--VHRNIKLFTKLFINNAEIFKPYAVFLQLPLINLILN-	2145
ALVINELLA	--ASLPTWMSNIKNKLQCP--TSRNRFLFLVLIINTEEVFKPYAKDWFGLVQIITR-	2120
CAPITELLA	--SSMPDWMKNIHDKIKNSD--TQLNIRLFLAKVILNGESVFRPYASFVQPLVALAT--	2172
SPONGE	--PEMPPWMTPLHKRMTDSR--TGRNIKLFIIVRLITNRPKIFQPYAKHWLPLVLTQFILSG	2192
OYSTER	--PELPAWMKLNLDKLRSPR--THNNIKYFITKLIINTAEIFRPHYARDWIRPLTQLIIS-	2171
SNAIL	--QDMPQWVFLHDKMTKNTGSDTLNIRLFIKLIINTSEIFQPFARLWLRPLCQLILS-	2172
TRICHOPLAX	--SEMPSWMVALRKKASDHT--TNRNIRLFIKLIINRPKIFRPHYAKFWLPLIQLIV--	2165
SEA_ANEMONE	--KDMPSWMSALHKKLTNFE--THLNIQLFIKVIINQSQVFEPYARFWLSPLMELILKL	2168
PRIAPULA	--AHMPAWMELLHGKFSHVE--TPLNVRVFIARLVVLCALAHFRPCASWLAFLMHLVNV-	2195
ESHARK	--QELPPWMKFLHGKLGNS--IPLNIRLFIKLIINNSEEVFRPHYAKEWLGPLLQLVVS-	2183
STERLET	--ADLPPWMKFLVHGKFGNAS--THLNIKLFIAKLIINTEEVFRPHYARHWLGPLLQLVVS-	2197
COELACANTH	--VELPPWMKFLSHKLANPA--TPLNIRLFIKLVINTEEVFRPHYAKHWLGPLLQLVVS-	2185
HUMAN	--RDLPSWMKFLHGKLGNI--VPLNIRLFLAKLVINTEEVFRPHYAKHWLSPLLQLAAS-	2174
CAECILIAN	--QDLPWMKFLHGKLGNTS--TPLNIRLFIKLIANTEDVFRPHYAKQWLGPLLQLVVS-	2187
PLATYPUS	--TNLPPWMKFLHGKLANPL--GALNIRLFLAKLIANTEEVFRPHYARHWLGPLLQLVVS-	2178
CANARY	--ADLPLWMKFLHGKLGNS--VPLNIRLFIKLIINTEEVFRPHYAKHWLGPLLQLVVS-	2176
OSTRICH	--VDLPLWMKFLHGKLGNS--VPLNIRLFIKLIANTEDVFRPHYAKQWLGPLLQLVVS-	2146
TURTLE	--RDLPPWMKFLHGKLGNS--MPLNIRLFLAKLIINTEEVFRPHYARQWLGPLLQLVVS-	2185
ALLIGATOR	--VALPPWMKFLHSGKLGNS--VPLNIRLFLAKLIINTEEVFRPHYARHWLGPLLQLVVS-	2143
SOFTCORAL	--NEMPPWMSYLHKKLSHHS--SELNVRVFIKLIINLPEVFEPYAKFWLDSLMELILL-	2183
STONYCORAL	--TDMPAWMAPLHKKIASS--THLNIKLFIAKLIINEAKIFEAHAKFWFNPLMELILQI	2206
ACORN_WORM	--HELPGYMSYLQKKLSGSP--TNPVKLFIKLIINAEVFRPHYAKFWLAPLMEMWILG-	2217
LANCELET	--KDMPPWMSCLNKKLGGSS--THKNVKLFLAKLIINNEEVFRPHYARFWLSPLMEMIVR-	2208
SEA_URCHIN	--EEMPQWMSGLQKKLSSQS--TEHNIKLFIVRLVINAQDVFRPHYARFWLSPLMQFLAG-	2211
STARFISH	--SEMPGWMASLQKKLTSQS--THVNIKLFIARLIINNNEVFTPHYARFWLSPLLQLLIS-	2225
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Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

TERMITE	---GV-----VG--RAPNYLLSDTVAMLADWCRKTTSLPAKSDHHLVSQLLYLLISKVHH	2180
SHRIMP	---GT-----IG--DKINYPFCDDVMVMVMGWSKAVPQDVTVMGRNIVGRVRLRYLCMNTPO	2197
SCORPION	---AT-----FG--REINYPFLDLMVVLSSWSSIAIPEDSSIGRHAASGLLEFLMSKCFH	2195
ALVINELLA	---GD-----LGT-NGINYMISDLTITLLSWHTVAIPEDNSADKAMACQLLKVLVASCHH	2171
CAPITELLA	-----NM-GGLNYFSLDIIIVTLLSWHEIAIPEETVTDIAMTSHLVKYIVQNCYH	2220
SPONGE	DSTAGMGGAVGGGGLDYFTVDAIATMLSWSSTAIED----RFLGSQLELEYIMLRSNH	2248
OYSTER	---GL-----F---TGLNYFVIDIVVTIMSWHQVAIPQDVTVEDRAMSSRLVEFVMGYVYN	2220
SNAIL	---TS-----LCD-NGINYPIMDLLVTMLSWSHSTAVPQNSSTERAMASRLVEFLVRNVHH	2223
TRICHOPLAX	---EG-----KES-DGIHYFIVDLMIILLSWADVAIPKQVD-EILQANRLMEFLMRNAFY	2215
SEA_ANEMONE	IEEEG----ENK-RGLNYFVVDLLVTLLSWATTAIPEDSYGDRHLASRLVQTMVRTRTH	2222
PRIAPULA	---GN-----CGVAAIHSLTADVVMVLSWTPVARPQDNMTERSLASRLLEFLMRNARH	2247
ESHARK	---GN-----NGG-DGIHYMVVEIVVTVLSWTSVATPKGNMKDEILANRLLEFLMKNSFH	2234
STERLET	---GN-----NGG-EGIHYMVVEIVVTVLSWTSLSAPKGNTRDEILANRLLEFLMKNAFY	2248
COELACANTH	---GN-----NGG-EGIHYMVVDIVVTVLSWANIAAPKGNTRDEILANRLLEFLMKNTYH	2236
HUMAN	---EN-----NGG-EGIHYMVVEIVATILSWTGLATPTGVPKDEVLANRLLNFLMKHVPH	2225
CAECILIAN	---GN-----NGG-DGIHYMVVEIVVTVLSWANVATPAGLAKDEILANRLLEFLVTHSFH	2238
PLATYPUS	---GE-----NGG-EGIHYMVVEIVATVLSWTSIATPTGVTKDELLANRLLEFLMKHVPH	2229
CANARY	---GN-----NGG-EGIHYMVVEIVVTVLSWTSVATPKGNIKDEILANRLLEFLMKNAFH	2227
OSTRICH	---GN-----NGG-EGIHYMVVEIVVTVLSWTSVATPKGNIKDEILANRLLEFLMKNAFH	2197
TURTLE	---RD-----NGG-EGIHYMVVEIVVTVLSWTSVATPKGNIKDEILANRLLEFLMKNVPH	2236
ALLIGATOR	---RD-----NGG-EGIHYMVVEIVVTVLSWTSVATPKGNVKDEILANRLLEFLMKNTFH	2194
SOFTCORAL	---PT-----FKN-SELNYFVIDIVVTMLSWSSVTIPEDSYSSRRLTSRLLEYLMETCNH	2234
STONYCORAL	KDTEP----AGT-EGINYPFIVDLVVTLLSWSTTAIPEDSHNDRHLASRLGFLMSRTRH	2260
ACORN_WORM	---GQ-----TGG-DGIHYMIGDIVVLMVLSWISAIKPEAGD--RILASRLVEYLMHHTHH	2266
LANCELET	---GE-----ASG-EGINYPFIVDLVVTMLSWGPVAIPEDSAMGRALTSRLHFLMANAFH	2259
SEA_URCHIN	---GQ-----GINYMLVDIMLVMLDWSSTLAVPEDNR----LASGLRFLMKNSYH	2256
STARFISH	---GN-----TGG-EGIHYMVVDVVVLLGWVTVAIPEDKR----LANRLLEFLMHFCHH	2272

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TERMITE	DRRDVFKHNLELIRTVVELWKNPFDIPVQLLYDMIKMHDRKDPTVSEPGIQVAAILANR	2240
SHRIMP	TRADIFKYNLDVVRVSVVECWKSLTVPYTYVIYSLMEVKDGA-EREVEAGLQLLGIILANG	2256
SCORPION	IRKDVFRNNLEMIKTVVQCWKERLDIPYTIIFESMRNLDTK-VKDNIVGIQLFGIIVSNG	2254
ALVINELLA	DSQQILKNNLELLKVLVEVWKPRLVPTNLIYENFSHYDLK-TKRNMGTGIMTGVILANG	2230
CAPITELLA	QNRQIMRNNLEVLKTLVEAWKSTIRIPTQDIYENFIDREDK-GKRNVVGLQIVGVFLANG	2279
SPONGE	KNRSILRNNLEIVRTMVELWKKIDIPTRVLYDQFSNSDKS-TVSNLSGIQLVGVIAVANE	2307
OYSTER	DTRPVRNNLELLKTLQVWKRDRVEIPYNIYKHLKQPEDT-KKESCVGIQLMGVLSAK	2279
SNAIL	ETRAIFRNNLEMLKTLLECWKDCIEIPYQEVYQNLKMPDPS-SKSSLIIGIQLVGVIMTCN	2282
TRICHOPLAX	PNRSVLRNNLEIIKTAVELWKNHIEIPYRIYKNSNPDKD-KKDNSTGIQCLGLVVANG	2274
SEA_ANEMONE	ENRAVFKNNLEIVKTMVEVWRERVVPTKVIEEALSNPHDP-KKDNATGIQLLGVVLANK	2281
PRIAPULA	ATMSVFRNNLEIIKTLVECWDRDVPVPSQVIYENMCAGDIT-MRDNSVGVQLLGVVVANN	2306
ESHARK	EKTAVFRHNLEIIKTVVECWKDCLSVPYSLIFSRFSSTDPN-SKDNSVGIQLLGIVLANN	2293
STERLET	DKRAVFRHNLEIIKTVIECWKDLAVPYSLIFDRFSGKDPN-SKNSVGIQLLGIVLANN	2307
COELACANTH	EKRAVFRHNLEIIKTVVECWKDCLAVPYSLLYQRFSGKDPN-TKDNTVGIQLLGIILANN	2295
HUMAN	PKRAVFRHNLEIIKTLVECWKDCLSIPYRLIFEKFSGKDPN-SKDNSVGIQLLGIVMAND	2284
CAECILIAN	EKRAVFRHNLEIIKTVVECWKDCLSIPYRLIFERFSNGNTN-SKDNSVGIQLLGLIILANN	2297
PLATYPUS	QKRAVFRHNLEIIKTVVECWKDCLSIPYRLIFEKFAFGDPN-TKDNSVGIQLLGIVLANN	2288
CANARY	PKRAVFRHNLEIIKTVIECWKDCLSIPYSLIFQRFSSGDPD-TKDNSVGIQLLGIVLANN	2286
OSTRICH	PKRAVFRHNLEIIKTVIECWKDCLSIPYSLIFEKFSGGDPN-TKDNSVGIQLLGIVLAND	2256
TURTLE	QKRAVFRHNLEIIKTVVECWKDCLSIPYRLIFEQFSGGDPN-TKDNSVGIQLLGIVLANN	2295
ALLIGATOR	QKRAVFRHNLEIIKTVVECWKDCLTVPYRLIFEQFSGGDPD-TKDNSVGIQLLGIVLANN	2253
SOFTCORAL	PTRSIFKNNLEVIKTFVEVWKERIDVPYKLIYERFSNASVN-TKENSVRGIQLMGVIVANK	2293
STONYCORAL	RHRSLFRNNLEIVKSVVEIWKSIHVAEVIKNSFSDPPDV-KKDNAVGIQLLGVVVANG	2319
ACORN_WORM	SNRQVLRNNLEMVKTVELWRDCIEVPSRVIFEAFSGKDPK-GKENATGIQLLGVILSNQ	2325
LANCELET	KTRAVMRNNLELIKTAVECWKTRVEVPTKVIVHDQLCGSDAS-SKANSVGIQLLGVVLANN	2318
SEA_URCHIN	ERKSVMKNNLEVIKTLVECWKDVIVDVPTRVYIYESLQDRSPD-KKDSAVGIHLLGVILANN	2315
STARFISH	SNRQVLRNNLEMIKTLVECWKEIISVPTSVIYRILATPPDP-VKDSSTGLQLLGIVLANG	2331

M-HEAT/CIRCULAR CRADLE

Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

TERMITE	LEPWSST----GKLFRLALLRNI D-TEKRSIFQSSAEVAGMALELLAANGSGMLEGDD	2294
SHRIMP	LPYYTVD--SETEKKRCESLVRLLG-AHYASVYGAAAEV MGLILKYTSQKDGSV--EAL	2311
SCORPION	LDPYQNT--SRIDKISYLKTLTVN LK-NKYKEIYESASEVCGMSMKYYFDKDDDV-YSEF	2310
ALVINELLA	LSPYRPN--SGVDKDRFYKNLAKNMQ-HTSKAVYMSSEAVVGMALKHMTEETEKEEDDKTW	2287
CAPITELLA	LSPWQPD--AEVSKDRFYQYLAMN MN-QPDKQVYSASAEIVGMALSSLQN---TESDKEW	2333
SPONGE	LNPDYDNTAGSLDQGLYKIFVNNLT-FKYKLIYAAA AEVLGMIMKRMAESYDPF-LDRL	2365
OYSTER	FPPYAPT--APVDQEKFFTTVAQYMR-NRYKAVYAA TAEVVGMI FKH LAEKDRQT-EGTF	2335
SNAIL	YAPYGPS--ASVDRNR YFTTLASSMT-NSSKMI FAAAAAEVVG MVFAYLADKENET-DGQF	2338
TRICHOPLAX	LSPYRYD--VEVDEM---LALAENLQ-FKYKEVYEA VAEVLGMIMKHLASVKKET-EGPI	2327
SEA_ANEMONE	IHPFSSD--SSVDENTFYTALSDNLT-FKYKD V HAPAAEVS GMLMKYLIEERKVT-ECSL	2337
PRIAPULA	LPYYSHT--TAVDSEKFFQAI VRCLA-NKYKEVYAAA AEVLGMILHRMVEREDEEAEGAL	2363
ESHARK	LSPYVPK--CEIGYERYFQRLVYNI SLTRYKEVYAAA AEVLGLV LHYFAENEKQV-DGLV	2350
STERLET	LPYDYPK--CGIDSESYFQALATN I SFGRFKDIYAAA AEVIGLIMQYLAKNEKQL-EGPI	2364
COELACANTH	LPHPDPT--CSIDMESYVKALANNL SFTRYKEVYAAA AEVLGLV LQYRAEKEKEL-GGPI	2352
HUMAN	LPYDYPK--CGIQSSEYFQALVNNM SFVRYKEVYAAA AEVLGLI LRYVMERKNIL-EESL	2341
CAECILIAN	LPYDYPK--CGIDVERYFQALANNI ALT KYKD IYLA AA AEVLGLALHYVAEKEKTL-EGPL	2354
PLATYPUS	LPYDYPK--CGIDSARYFQALANNL SLV KYKEVYAAA AEVLGLTLQYVSEKETML-EDSI	2345
CANARY	LPYDYPK--CEIDRVRYFQALTSN MGLLKYREVYAAA AEVLGLALQYIAERENIL-EDPV	2343
OSTRICH	LPYDYPK--CEIDRVRYFQALISN MGLLKYREVYAAA AEVLGLALRYVAERENIL-EDPA	2313
TURTLE	LSPYDYPK--CEIDSVRYFQDLANNM SLIRYKEVYAAA AEVLGLI LQYMAEKENIF-EGPV	2352
ALLIGATOR	LPYDYPK--CEIDSTRYFQALVNNM ALLKYKEVYAAA AEVLGLTLRYIAEKENIT-EGPI	2310
SOFTCORAL	ITPFPKG--CGVDEKRFYQDLVKNL S-FKYKDVHGAA AEVIGMILKYLSEENDKESCDGL	2350
STONYCORAL	LFVVTSD--STIDEDRFYGTLVN NLT-FKYKD V HAAAAAEVIGLLMQLAKVKKIF-DGPL	2375
ACORN_WORM	LPYDYPK--CGIDKDRFYTTLSANL S-FKYKDVYAA SAEVVG V-MKYMAEKEKVT-DGTF	2380
LANCELET	LPYDYPK--CGIDKDRFYTTLSANL S-FKYKDVYAA SAEVVG V-MKYMAEKEKVT-DGTF	2377
SEA_URCHIN	LHPSPPT--CDVDADR FY SALASNI D-NRYKAVHGAA AEVIGMAMKQMAENDKIT-DGRL	2371
STARFISH	LHPIDKA--SDIDEERFYAALSYNLK-NRYKAVHAAAAAEVIGMAMKQKADVDKVT-DGFL	2387
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M-HEAT/CIRCULAR CRADLE

TERMITE	AE-FLSGIVDKLNL---TKDQSKDKFLTCLFAVQEQEYPRIVD-----	2332
SHRIMP	ED---AVVKRVTEL---TVKMQGGLTCIYNIHKHYPSFVK-----	2346
SCORPION	CK---IVKTEISSL-----NAKDQYLTCLYKINTHFPIFIDS-----	2344
ALVINELLA	HKEFIDHISLLIGF---QSNKPDFRISCVYGMQLHFPTIAD-----	2326
CAPITELLA	CRAYGDNIQKMLLGI---HGNKPDQFLTCHICIQHFSAFVE-----	2372
SPONGE	EE---MVGEQLFKLSQPLEKSEDKFITCLHKITLCYNKIVP-----	2403
OYSTER	HD---YVVNLMNSL---QSNPGNFFLCLHRMHLHYPPIAD-----	2370
SNAIL	HS---HVESVL-----GKVAPHNFFLVCVHCIRHYPPMAD-----	2370
TRICHOPLAX	FD---YVTQHLSSMVSAGRMDVARFILCLYRVQLHYPIAD-----	2365
SEA_ANEMONE	IA---LVEAKLSPMATKGGKDIGFITCVHRLQLNYPRIVD-----	2375
PRIAPULA	RD---AVVTAMSTL---HADAKQNFIVCLQKMTLHYPAIADREVMTAVSDRYLGQVCGD	2416
ESHARK	HD---LIAKELKQL---QSKEDKFI VCLSKIVKNYPPFADR-----	2386
STERLET	FD---FTVKELKHL---QNTKEDKFVECLSKVVKNFPPFVLD-----	2399
COELACANTH	ID---SVVRELKQL---QSIKEDKFI VCLSKIVKNFALLAD-----	2387
HUMAN	CE---LVAKQLKQH---QNTMEDKFI VCLNKVTKSFPPFAD-----	2376
CAECILIAN	FD---CVIKELKQH---QNAKEDKFI MCLNKVVKNFSPFAD-----	2389
PLATYPUS	CE---LIVKQLKQH---QNSREDKFI VCLNKAVKNFPPFAD-----	2380
CANARY	YD---CVIKQLKHH---QNTQHDKFI QCLNKVVKNFPPFAD-----	2378
OSTRICH	YD---CVIKQLKHH---QNTQDDKFI QCLSKVVKNFPPFAD-----	2348
TURTLE	YD---CVIKRIEQH---QSTKEDKFI VCLNKVAKNFPPFAD-----	2387
ALLIGATOR	YD---CVVQLKQH---QNTKEDKFI LCLNKVVKTFPPVAD-----	2345
SOFTCORAL	SG---LLNEKLSS---MTKDLDKFI LCVHQLQIHFPPIVD-----	2384
STONYCORAL	HD---MVGQKLLSLVNRAPPELDFITCVHKLKLNYPPIVD-----	2413
ACORN_WORM	HD---NVFREISSS---QSSRPEVFI TCIYKQLYKPFPTD-----	2415
LANCELET	HT---QVERYLLPL---QVNQDDVFI TCVHKLHLHFPFAD-----	2412
SEA_URCHIN	HE---VTYKELSQLH---LGSKEVIFI TCLHKIHLHYVPFAD-----	2408
STARFISH	HS---IVTSELTKI---SEIKPDVFI TCIHKLHFHYPEFAD-----	2422
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M-HEAT/CIRCULAR CRADLE

Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

TERMITE	AFMNHVLFHLPKTYGIFRTMCLKIVYSRLEILGDDTYAEMKSKNLFKTLSDRDPDQONLA	2392
SHRIMP	RLINKLLNLLPKLYGIHRKNVLECLIAHSATM-EDIYHLHKEQNLLEDLAKKEASTQLVA	2405
SCORPION	SFLNKLLYMLPNVHGIFRKQLEIINSHVENI-ENAFaelknQGLLNMLEHRDESIOFSS	2403
ALVINELLA	GFLAKVLFILPKVHGEFKTHSLEILQNRISQI-DNAFLEMKSKGISDILSQRNEANQHAA	2385
CAPITELLA	RFIHKVLFMLPGLYGVFRTYALEIIAAGIENI-EGAFVEIKNKNIIGILRERDELSQLMS	2431
SPONGE	RFVEKLLFLLPSLQGVFRSSCLEILDTOADVQ-PQFYLKLKDKGFHTMISHRDEATQTAS	2462
OYSTER	RFMNRLLFVLPNLHAEFRNRCLIVLTRIDTL-ENVYVELKSKGLLAFLTRDDEATQVIA	2429
SNAIL	RFLNKLFLMLPGLHGEFRVQCLEVI MGCIEQL-DDAFRELOSKGLLNFLTQRDEDTQIVA	2429
TRICHOPLAX	RFVNKVLFLMPSLYGEFKTKCLEIILARADHI-KELYTELKSKGLKDMLLHRDESKQVVS	2424
SEA_ANEMONE	RFMKHIMFHLPTIHGVFKAQCLEIVLSRVSDI-PDLFTELKSKGLNVMFEHRDEGVQVAL	2434
PRIAPULA	RLMSKLLFMLPSLQGSFRSQCLEVILTRVAHT-QNLFLELKSkgfLGMITHRDEATQLAS	2475
ESHARK	RFLNQVFYLLPKLHGVLKTHCLEVVMHRAETI-IDIFQELKNKNFVQIMSYSDEERQRIC	2445
STERLET	RFLNAVLFLLPKLHGVLKTHCMEILMSRAEEV-TDIYLOLQKSKDFAQIMSHRDEMQRVC	2458
COELACANTH	RFMSVVFLLPKLHGVLKTHCLEVMSRAEEI-PDIFLOLQKSKDFIQLMHRDDARQRVC	2446
HUMAN	RFMNAVVFLLPKFHGVLTTLCEVLCRVEGM-TELYFOLKSKDFVQVMHRDDERQKVC	2435
CAECILIAN	RFMTVVLFLLPKLHGVLKTYCLEVVMCRAEEI-PDLYIQLKSKDFNQIMSHRDDRQKVC	2448
PLATYPUS	RFLNAVVFLLPKLHGVMKTFCLEVLCRAEEI-TDLYLOLQKSKDFAQVMHRDDERQRVC	2439
CANARY	RFMNAVFLI PKLHGVMKTYCLEVIMCRAEEV-PDLHLQLKSKDFIQIMNHRDDERQRVC	2437
OSTRICH	RFMSAVFLLI PKLHGVMKTHCLEVIMCRAEEI-TDLHLQLKSKDFIQIMNHRDDERQRVC	2407
TURTLE	RFMNAVFFLI PKLHGVLKTYCLEVVMYRAEEI-TDLYLOLQKSKDFIQVMSHRDDERQRVC	2446
ALLIGATOR	RFINAVFFLLPKLHGVLKTSCLEVVMCRAEEI-TDLYLOLQKSKDFMQVMNRRDDERQRVC	2404
SOFTCORAL	GFINQILFVQHVHAQKTLCLEIILSRVGI-PNLFLELTKGFLNLTTRDDEATQVAC	2443
STONYCORAL	RFVNQILFLLPSVHGDFKSYCLEILCSRVEHI-PNLFTELKGRGLKEMLSQRDDGIQIGV	2472
ACORN_WORM	RFINKLLFMLPQIHGQPKTYALEVVLGRVDSI-DKIFLEMKNKRILEMLRHRDETQOLVS	2474
LANCELET	RFVSKLLFMLPKLHGIFRTHCLEVIRGRVNI-DNLFLELKRNFGLMTHRDDGLQAIIV	2471
SEA_URCHIN	RFMNKLLFMLPSIHGQPKTECLQIITARIEHI-DNAFIEMKNKNI LALLTHKDEADQLTS	2467
STARFISH	HFTNKLLFMLPSLHGQPKTLCEVVASRVSHI-PNIFLEMKSKGIVELLTRDEGTQLVS	2481
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M-HEAT/CIRCULAR CRADLE

TERMITE	LSIVHKMVPHLKPEQLEELVHE-ICKFETQRSVKCRSVMYEILKWIYDHCQDIGG-----	2446
SHRIMP	LQLVNAVMPRLTPSQLLYFMPG-VVAFASHPAPSCRETMYDVLFWVYDNFSNNDT-----	2459
SCORPION	LNIIQKLLKELDIDKMLNVFPI-ISKVHKSaETICRKVMYIEMHAYEKFNTKNG-----	2457
ALVINELLA	LRLVKGLCNQKPAEILYLLPV-LTEFASHPSASCRaQMYNILLMWIYDNYRDDGT----	2440
CAPITELLA	LKIIRLLEKLEASQLLYLLPA-ICEISDLSVLCREMYQILMWCYDNYKDEAQS----	2486
SPONGE	LSIVQKLLVQLTNDQLSEIVPILIASFSKHGSIQCRIVLYNILLMRVYNKLTDDQSESD-	2521
OYSTER	LKIVKSIQSKLQPSVSELLPL-ICGFCVSPSIPCRNVMYDILMWVYDNYREDES-----	2483
SNAIL	LGIVNAMVPKLSATELQTFPLPA-ITGFSNHPSVTCRQIMMKILLMWYDNYRDNES-----	2483
TRICHOPLAX	LDLVRAMLKNLDISQILYLAEL-VATFKTNPSAACRQKMYGIFMWIYDTRFQEIDK--N-	2480
SEA_ANEMONE	LKI IQGLLEKLMSEIEYVVPs-IATMATSSSTACRELIYDIFMWVYD TYRSDETF RNE-	2492
PRIAPULA	LHITNALLSSLSPGELLFLLPA-VTSGITHPRAPCRQLMYDILMWVYDSYRDSEG-----	2529
ESHARK	LDIVYKIIAKLKAEEVKVFLVP-VIAFISHPSVPCRERMYDILMWIYDNYRDAES-QSD-	2502
STERLET	LDIVHKILAKLPVELKELLIS-VTAFTHPSVPCRERMYDILMWIHDNYRDPES-QSD-	2515
COELACANTH	LDIVYKIMFKLPVEMKEFLVA-VTGFISHPSTVPCRERMYEILLMWIHDNYRDQES-QAN-	2503
HUMAN	LDIIYKMMPKLPVELRELLNP-VVEFVSHPSTTCREQMYNILLMWIHDNYRDPES-ETD-	2492
CAECILIAN	LDIIYKMLPKLKPMELGELLNT-VVTFSSHSPMCRERMYDILMWIYDNYRDPES-QAN-	2505
PLATYPUS	LDIIYKMLAKLPGELELLNV-VVEFISHPSVPCRQMYNILLMWIHDNYRDPES-QAD-	2496
CANARY	LDIVHKMLSKLKPLELKELLPG-VTGFISHPSVPCRQMYDILMWIYDNYSDPES-QAD-	2494
OSTRICH	LDIVYKMLPKLKPLELKELLPG-VTGFISHPTVICRQMYDILMWIYDNYSDPES-QAD-	2464
TURTLE	LDIVYKMLPKLKPLELRELLPG-VTGFISHPSVPCRERMYDILMWIYDNYRDPES-QAE-	2503
ALLIGATOR	LDIIYKMLSKLKPLELRELLPG-VTGFISHPSVPCRERMYDILMWIYDNYRNSES-QAD-	2461
SOFTCORAL	LRILGRLSQMSVGDITQLLPS-VTDFLSSKSVACRGLMFDILWIYD TYRFD ETFK NED	2502
STONYCORAL	LRI IKHLMKKTIPELKFIPL-LTSFVSHPNLLCRDLMYDIFIWIYDSYRADEAFQAE-	2530
ACORN_WORM	LKIVNSMLKRLNEEELLYLMP-TVVSFSKNLSPACRETMYDILTWIYDNYKDEES-ST--	2530
LANCELET	LQIVYALLQKLVKEELLYLLPS-VAAFASHPAPECRRTMYDILMWIYDNYREAS-QQE-	2528
SEA_URCHIN	LKLVGDMLPKLKPSELRYLLPA-VKDFVSHSPSPCRDTMYSILLMWIYDNYRDEDK-REG-	2524
STARFISH	LKLVNAMLPNLPKDEILYLLPP-VRTVFNLPSPACREVMYDILMWIYDNYRDEES-RTE-	2538
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M-HEAT/CIRCULAR CRADLE

Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

TERMITE	-----VLEEAKGILLKGLRDDDPHLQDSIFEFYWNDAQQRDASTDRLLFILTDLYCPA	2501
SHRIMP	-EDGHQLESQARGVLLRAVKEEDAALRQIVLNFWLQGAR-SMTLT-QCLLHILRKMYSPE	2516
SCORPION	-IKEKEISRYAKEMLLHGLADSDLTLRLLTVHNFWSQNNH-LPAETFSRIKAVLQKMYSP	2515
ALVINELLA	-DT-EQIIQSVKETLLRGLSDKDIKNRVTLQNFWSHSTR-LPDSTVDRLVALLETMYSPA	2497
CAPITELLA	-ESRDEIITLTKDVLRLGLSDDDLTNRLTVQNFWSHETR-LPGETVERLVAMLEAMYP	2544
SPONGE	-DSVKMIRSISRDLQLLGLGDESNEVKLKMIEYWNQESN-LSSNTLDRLTQLLVTLYSK	2579
OYSTER	-ETADTIMQQTKESSLKGLGDEDMQCRLLVNFWSSETR-VPGNTLDRLVAMLEAMYSV	2541
SNAIL	-KEGQEIFMKVTQESLLQGLCDNHLHCRMTQNFWSSESR-LPDGTVDRMISILEAMYP	2541
TRICHOPLAX	-DETKQLINFCQDQLLQGLNDSSEENRLQLINFWSNNNR-LPSGTLERLSSVLYALYSN	2538
SEA_ANEMONE	-EGSEEILATAKDYLLRGLADNKKILKLLQNFWSDETR-LPNTTLERLVDVLRAMYSTN	2550
PRIAPULA	-EEEDKLASLARDSLLQGLNDSDDSLRMIVTNFWSHATR-LPTQTLPRLLAIAQTYLSPA	2587
ESHARK	-PDSKAVFVTTKDTLLQGLTDDNPALQLYVRNFWSHENR-LPTGTHDRMLAILRSMYSN	2560
STERLET	-SVSTEVFNLAKETLLQGLTDENQGLQLYVRNFWSHESR-LPTSTLERMLVLRSLYSSK	2573
COELACANTH	-NESREVLKLASEVLLQGLTDENPGLQLYVRNFWSDENR-LPVGTLDRMLVILKAFYCNK	2561
HUMAN	-NDSQEIFKLAQDVLLQGLIDENPGLQLIRNFWSHETR-LPSNTLDRLLA-LNSLYSPK	2549
CAECILIAN	-DDSQEVFSRANDVLLQGLIDENAGLQTVRNFWSETR-LPVVTTDRMLALLNSFYSPK	2563
PLATYPUS	-EESREVFKLAKELLLQGLVDENHGLQLIVRNFWSETR-LPSNILDRLA-LNSFYSTK	2553
CANARY	-DDSEILKVAKEVLLQGLIDENAEQLIVRNFWSETR-LPTNTLDRMLLSSFYSTK	2552
OSTRICH	-GDSQEVKLAKELLLQGLTDENAEQLIVRNFWSETR-LPANILDRMLALLNSFYSTK	2522
TURTLE	-EESQEVFKLAKEMLLQGLMDENSGQLIVRNFWSETR-LPTNTLDRMLALLNSLYSTK	2561
ALLIGATOR	-EDSQEVFKVAKEMLLQGLTDEISELQLVVRNFWSDETR-LPTNTLDRMLALLNSFYSTK	2519
SOFTCORAL	SEGSEVLCRTKNVLLQGLADENKEMRLKLRNFWSDETR-LPNSTLERLVQVLRAMYSPI	2561
STONYCORAL	-EGSADILADAKDHLQGLADHHRDLQLKLRNFWSDEAR-LPGTTLERLVEVLRALYSTT	2588
ACORN_WORM	---AAEVLSTKEILLQGLSDEESYLRLRVSNFWSETR-LPVGTLDRMVSMLECMYSPD	2586
LANCELET	-S-AGRVLTGAKDCLLQGLSDEESYLRLRVSNFWSETR-LPTGTLERLVAMLECMHSPR	2585
SEA_URCHIN	-QGDDEALSIAKDTLLQGLSDQDNYLRLRVSNFWSETR-LPKETLERLISMLGCMYSPG	2582
STARFISH	-DGADDILCAKDTLLQGLSDEEASHRLRVSNFWSETR-LPTGTLERLVAMLECMYSPG	2596

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M-HEAT/CIRCULAR CRADLE

TERMITE	TEHIF-----LGYSTQYLLLEATAGTP	2522
SHRIMP	TEDSF-----LQMAIYVLLLEATRHSA	2537
SCORPION	IEHMFSSDECFITYISLIVDNFWSNEKRLPLGTVERLIALMKNMLQYSTFLMEMTSKSP	2575
ALVINELLA	SEHQY-----LYATNLLLEMTSRSP	2518
CAPITELLA	TELHY-----LSYATNLLLEMTTKSS	2565
SPONGE	TETQY-----LYHATNLLLELTSRSP	2600
OYSTER	TEKQF-----LSYATNVLLEMTSKSP	2562
SNAIL	SECNY-----LSYATNLLLEMTSKSP	2562
TRICHOPLAX	AESFY-----LSYSTNLLLELTSRSP	2559
SEA_ANEMONE	TEQQY-----LSYTTNVLHLTSFSP	2571
PRIAPULA	TEPHF-----LSYATYLLLQLTSLSP	2608
ESHARK	IETQY-----LSIATNLLLEMTSRSP	2581
STERLET	IEAHY-----LSLATNLLLEMTSRSP	2594
COELACANTH	IETQY-----LSLATNMLLEMTSRSP	2582
HUMAN	IEVHF-----LSLATNFLEMTSMSP	2570
CAECILIAN	IESHY-----LSLATNFLEMTSKSP	2584
PLATYPUS	IEMHY-----LSLVTNFLEMTSKSP	2574
CANARY	IETHY-----LSLITNFLEMTSKSP	2573
OSTRICH	IETQY-----LSLITNFLEMTSKSP	2543
TURTLE	IETQY-----LSLATNFLEMTSKSP	2582
ALLIGATOR	TETQY-----LSLATNFLEMTSKSP	2540
SOFTCORAL	TESEY-----LSYTTNLLLHLTSQSP	2582
STONYCORAL	TEIQY-----LSYTTNLLHLTSLSP	2609
ACORN_WORM	AENQF-----LSYATSLLLEMTSKSP	2607
LANCELET	TEPQY-----LSYCTNLLLEMTSRSP	2606
SEA_URCHIN	TENRY-----LGYATNLLLEMTSKSP	2603
STARFISH	TEHQY-----LSYASSLLLEMTSKSP	2617

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M-HEAT/CIRCULAR CRADLE

Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

TERMITE	DYNQKIFKEPLQKCFEDFR-MLLSWRAQNATV-APMFADLASQLIQTQSL-----	2572
SHRIMP	DYQRNIFDQPLTECKFREM-KVSTAWRARHASM-IPMFAEQASNDTSLNLSLSYT--QG	2593
SCORPION	DYNLKIIFQNPLSTCAFQNYA-ISSSWKKRHATL-TPWFVDSLSSAASFSDTS-----	2625
ALVINELLA	DYKRPIFEHPLSDCKFKDFH-VRQSWRQRHSTM-TPMFVDQSTQTSSDGSS-----	2568
CAPITELLA	DFNRVLFDTPLSECKFQDFA-VSSTWYQRHAAM-TPMFLDTQSSQSNDS-----	2612
SPONGE	DYNRVLFDTPLESECKFEDYKEIDLSWQQRHLQM-TPLFAATQLSQTQSDTG-----	2650
OYSTER	DYQREMFESPLEDCFKQDYN-VKSSWKQRHAAM-TPLFANMATQSMDDDD-----	2611
SNAIL	DYDRQIFEHPLSECTFRDYS-VQSSWRQRHAVM-TPLFAVQGGSETMEDVE-----	2611
TRICHOPLAX	DYKLSIFDHPLESECKFHQDYN-VNYSWQYRHAMM-TPLFAATQLGSGQSMASF-----	2609
SEA_ANEMONE	DFERLMFEQPLSECKFEEYP-IDYSWQQRHVVM-TPLFAATQGGSTQSHSQ-----	2619
PRIAPULA	DYKELVFTQPLSDCKFQDYN-IATSWQSRHAAL-TPLFTEQASQASSTQQT-----	2658
ESHARK	DYTREMFEEYPLSECKFQDYN-IDSSWQQRSTIL-TPMFVEQATQNSSRSQS-----QE	2633
STERLET	DYTRDMFEYPLSDCKFQDYI-IDSNWRHRSTVL-TPMFVEQVTQGGTQYHT-----QD	2646
COELACANTH	DYTRIFEHPLSECKFQDYI-IDSNWRHRSTVL-TPMFVEQASQSTARFRS-----QD	2634
HUMAN	DYPNMFHEHPLSECFQEYI-IDSDWRFRSTVL-TPMFVEQASQGLQTRT-----QE	2622
CAECILIAN	DYTREMFHALSECKFQDYI-IDSNWRHRSTVL-TPMFVEQASLSASRYRS-----QE	2636
PLATYPUS	DYSRHFHEHPLSECKFQEYI-IDSNWRFRSTVL-TPMFVEQASQSALRSRS-----QE	2626
CANARY	DYSRKFHEHPLSECKFQDFV-VDSWRYRSTVL-TPMFVEQASPSSTRNLS-----QE	2625
OSTRICH	DYSRKFHEHPLSECKFQDFV-IDSSWRYRSTVL-TPLFVEQASQSTNRSLL-----QE	2595
TURTLE	DYSRKFHEHPLSECKFQDFI-IDSNWRHRSTVL-TPMFVEQATQSAKRNRS-----QE	2634
ALLIGATOR	DYSRKFHEHPLSECKFQDFI-IDSNWRHRSTVL-TPMFVEQASQSASRKR-----QE	2592
SOFTCORAL	DFGRLLFEQPLSECKFQDYE-INFAWQQRHSTM-TPLFVSLMPSGSSQSS-----F	2632
STONYCORAL	DYERLMFEQPLSECKFEEYQ-IDYSWQQRHLAM-TPLFAATQGGSHGSGMTPT-----Q--	2660
ACORN_WORM	DYKREIFEHALSECKFEDYQ-IDHSWKQRHAALISTPMFVEQSTQIGSDSQ-----	2657
LANCELET	DFSREIFQHPLSECKFQDVQ-IDHSWKQRHVAM-TPMFVEQSSHPASSQSQ-----QS	2659
SEA_URCHIN	DFKREIFEHPLSACKFEGVQ-IDHSWKQRHAALISTPKFVEQVGGQSGSI-RGSPSSQSM	2661
STARFISH	DYKREIFEHPLSECKFQDVT-IDHSWKQRHLAISTPMFVEQSSQASSGSGSQSPDPS--	2674

ABCDE Loop starts 2577

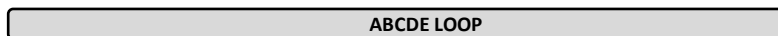
T2609



TERMITE	SGTGEHTGAGPLLRAT-QASLAFQPTIE----QS-----GS-SIGSL-----	2608
SHRIMP	SDTNMETHDGPAGVQAT--QANVFSAFOA-----PGATYNWVTDSTFDTTLADMEYEATH	2645
SCORPION	-----VKNIDEQIRST--VDVREFDPTQD---QASKKAFNWLTTQT-SIDTLGDWGS---	2670
ALVINELLA	---DGGSTSPIQLRAT--QDVQFQFATQGG---VGTSKGPYDWTQTS-SIDTFADSD---	2615
CAPITELLA	---PDAGLSTGQLRAT--QDAAQFTQFOA---DGSSKGPYNWLTQTS-SLDTFSDSQN---	2660
SPONGE	-----SIGTGLRATVQQLSALFTPTQ-----QESSYNWMTPSAQSS--VDYSV----	2691
OYSTER	-----ESYSGEIRAT--QDAQQFTATLD---ASKAPFNWLTGTS-SLDTFDYST---	2654
SNAIL	-----DSLGGVVRAT--VDVEQFTATME---TGSNAPFNWLTQTS-SLDTFADASL---	2655
TRICHOPLAX	SLSGSSSTDEHLRATQSTNLQFTPTQD-----TDARNWLDPSVVDKSIQSYAAFLQQ	2662
SEA_ANEMONE	--GGSL--EPGALRAT--QLRVEFSPMD-----QSLSQAFDWNLPSSQADSQSFQTV---	2666
PRIAPULA	---VAAAMQTGEIRAT--QVVPEFTATQD---VAGGRSTYNWLTQSSSIDTFADQSL---	2707
ESHARK	GSLTAQGTIGGLVRGT--QTHYFPTPTQD---PDAR-NFNWLTGN-SLDTFAEYSL---	2682
STERLET	---SPQGTIGGQVRAT--QAQLEFQFOA---AGRSSFNWLTGGS-SIDTLSEYSL---	2693
COELACANTH	GPEQVQSGSLGGQVRAT--QVQFDFPTPTQD---TGIRSSFNWLTGTS-SVDTFAEYSL---	2684
HUMAN	GSLSARWPVAGQIRAT--QQQHFQFTLQTT---ADGRSSFDWLTGTS--STDPLVDHTS----	2672
CAECILIAN	GSFPAQSSSLGGQVRAT--QQQYFPTPTQD---IGGRNSFNWLTGN-SIDTLAEYGV---	2686
PLATYPUS	GLLPQGGLLLGQLRAT--QQYFPTPTQD---TDGRNSFNWLTGTS-SVDTFDYPG---	2675
CANARY	RSLSPSGSVRGQVRAT--QRQYFPTPTQD---GSRSSFNWLTGTS-SIDTLAEYAV---	2675
OSTRICH	RSPSTSGSGGGRVVRV--QQQYFPTPTQD---ISGRSSFNWLTGN-SIDTLAEYMV---	2645
TURTLE	GSLSTQGSLLGGQVRAT--QQQYFPTPTQD---VNGRSSFNWLTGTS-SIDTLAEYTV---	2684
ALLIGATOR	GSLSTPQSGQAQVRAT--QQQYFPTPTQD---MSGRKSFNWLTGTS-SIDTLTEYTV---	2642
SOFTCORAL	GSHSMDITDGGQLRAT--QNP-QFSMTQTAGATGPTAQTYDWNLPS-SLDTSQSS--S---	2684
STONYCORAL	--ESMSVDGSPGLRAT--QNL-QFPTQD---QRRSTAFDWNLPT-QESNLQPSQS---	2707
ACORN_WORM	---SFIETIGNQVRAT--QDV-QFSATQ---EVDGKKTAYNWLTTG--SQDTFSEF--S---	2702
LANCELET	LSQGGQDTLGGQLRAT--QDVLQFQFATQ---ASAAPKNAYNWLTTG-SLDTFADY--S---	2709
SEA_URCHIN	TSSGMSMGGGQLRAT--QATQNFTATQ---DNAASSHKNGYNWLTTG--SQDTFADY--S---	2712
STARFISH	-----SLSRGEIRAT--QDAHQFIATQQLDAVASRKNAYNWLTTG--SQDTFADY--S---	2720

T2638

T2647



Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

TERMITE	-PSF-----SLSSLLFTTGSFFENQRK-----SYKMGPFGSSKLPPIPEVSDE	2652
SHRIMP	AP-----TQGSTSGLIFNVGASGQKDRRRF-----KRPGLGNSRMRPADE-PDG	2688
SCORPION	-----SSTSSLLFTIGSDTKKIPN-----IDENNRN-----SNQ	2700
ALVINELLA	-VNMS----TETQSSLLFTIGATSSKSAPSHRQR---VQQRPGPRFGKHSLQQGKA-GNR	2666
CAPITELLA	-LTLA----TQSESSLMFTVGSSRIKS-----SKKTPGSEFGQRKVRSDVR-VS-	2703
SPONGE	-PSFTVGATPTSDSSLLFTRPTMRPPL-----KNPL-----RISAERLGKV---GES	2734
OYSTER	----V---GSETSSLLFTVGTQDMALRTGLK-----PKRKPDPGFGFRPR-----A-GAS	2696
SNAIL	----M---ETNSLSSLLFTVGSSSKGADSKTRVATRHHTGTGSNFGQMARTERT-GNS	2707
TRICHOPLAX	SLSST---SSETSSLLFLSKSPRQ----RPL---QMKPLSKDFGQQKLSSETA-SQP	2710
SEA_ANEMONE	----G---SSEAQSLLF--GTKPRA----SQR---SLKPVPHDFGSRRLAPTQS-DSQ	2708
PRIAPULA	---SSVS---SISSSSSSPYSSPSADHH-----ETPTE-AKRRGAT---GEE	2745
ESHARK	-PSLA---SEPGSSLLVFSRWSERL----HRP---AKKPVGPDFGKKRLALP---GDE	2727
STERLET	-PSSA---DSVSSLLVFGKRGDKS----QQA---ARKPVGSDFGKKRLGLP---GDE	2737
COELACANTH	-PSSS---ESLASSLLAYGKRSEKS----QRA---AMKPVGPDFGKKRLALP---GDE	2728
HUMAN	-PSS-----DSSLFAHRRSERL-----QRA---PLKSVGPDFGKKRLGLP---GDE	2711
CAECILIAN	-PSSS---ESLSSLLFASKKSEKS----RRT---SLKPLGPNFGKKRLGLP---GDE	2730
PLATYPUS	-PTSS---ESLST-LLFTHKSSRT-----QKA---GFKPLGPNFGKKRVGLP---GDE	2718
CANARY	-PSSS---ESLSSMLLVSKRSEKF-----KQA---TFKPVGPDFGKKRLGLP---GDE	2719
OSTRICH	-PSFS---ESLSSMLLVSKRSEKF-----KQS---AFKPVGPDFGKKRLGLP---GDE	2689
TURTLE	-PSSS---ESLSSMLFVSKRSEKS----QRA---TLKPLGPNFGKKRLGLP---GDE	2728
ALLIGATOR	-PSSS---ESLSSMLFVNKRSEKS----QRG---TLKPVGPNFGKKRLGLP---GDE	2686
SOFTCORAL	-ASFS---VGSQPSSLLFKSNPNMRRF-----K---TLRPQSEQPST-----SSA-AQS	2725
STONYCORAL	-FAMA---STQTQSLLLFSTSQSHKRR-----K---MLKPVGDFGSKLSQASS-SRI	2753
ACORN_WORM	-SSTG---TETSQSSLLFTITGTTKKA-----I---TRKPVSSGFGKDKMGAG---KDQ	2746
LANCELET	-VPLG---TE-TQSSLLFTDASKKAKARR-----LKPVGPGFGSDRLSAG---RDQ	2754
SEA_URCHIN	-SSSS---A-SESSLLFTMGSLPKRTAQGFRGV---K---QDAGAGGSRD-----	2751
STARFISH	-TSSA---S-DQSSLLFTLGASKKM-GRGRQGV---SKTATDAGFGKEKQLQSDQP-RGR	2769

ABCDE LOOP

TERMITE	VDS-----RSDRLAPN LHRRFL RDDQ--KRIFHASREIQRSARQ QLEQ ERGRLEA	2703
SHRIMP	NDA-----ADTMQSKL IRRRFV KNDREKQSIYFAKIEERRSKLRE KL EKERKFRREA	2741
SCORPION	DTSK-NKIEKLSSSNTF LRRRFL KDREK--SRLHFIRMEMRKQQLR QERE KEQKQREG	2757
ALVINELLA	NDS-----DDGLEIL QLKRRFI KDSDG--RSAYFARREARQ RAIREI AQEQRQRREN	2717
CAPITELLA	AMD-----EANKEIMR LKRRFI HDQES--TARF FM KNRNVRM KKMRE DIQREQMKREH	2754
SPONGE	EG---GETKKEKRKQVL QLKRRAL KDKEM--VSSFAMNEARK MMREEL KKQRRARQS	2789
OYSTER	SKPAERSRNEDQDSEMYR LKRRFL DDEEQ--TKTY F IKRHRTRLE KMRE ALREQKSRRRH	2754
SNAIL	AGPK-NDNNTPDENVW LRRRFL KDRST--ASKY F ARREI KEKSKRE ERLQQRRLRREN	2764
TRICHOPLAX	-QS--QSVS-QPSSSN LHRRRYI KSEMA--NNA F YAKRER RKKQLREI LKQOKIAREN	2764
SEA_ANEMONE	-QAT-PAMG-SQQQEILR LKRRFT KDSQT-KDRQ F IRMHEK RQMLQ QTQSRLKAARES	2764
PRIAPULA	PREE-ASAA-GGGDDVMR LRRRFL KDQEQ--TRV F ARREARR KQRRE EAETLSRQRREG	2801
ESHARK	VDSK-TKGIVDQRADILR LRRRFL KDREK--VSLI F AKRGIREQ RAEQKI TEKRMERDA	2784
STERLET	VDSR-TKVK-DQRADILR LRRRFL KDQEK--VSLI Y AKKGVRE QKQAKEN VAEQKLKREA	2793
COELACANTH	VDSR-TKVA-DQRDLILR LRRRFL KDQEK--VSLI Y ARKGV IQKEEQ KMAELKMKQDA	2784
HUMAN	VDNK-VKGA-AGRTDLLR LRRRFMR DQEK--LSLM Y ARKGV AEQKREKEI KSELKMKQDA	2767
CAECILIAN	VDSK-AKGI-DDRSDILR LRRRFL KDQEQ--ISKI F V RKGV AEQ KREKEI TAERKMKRDS	2786
PLATYPUS	VDSK-TKGI-EERTEILR LRRRFL KDQEK--LSLI F AKKGV VEQKREKEI KSELKMKHDA	2774
CANARY	VDSK-TKGI-EERAEILR LRRRFL KDQDK--LSLI Y ARKSLAE QKREKEI KSELKMKYDA	2775
OSTRICH	VDSK-IKGI-DERAEIL LRRRFL KDQEK--LSLI Y ARKGV AEQKREKEI KSELKMKHDG	2745
TURTLE	VDSK-AKGI-DERAEILR LRRRFL KDQEK--LSLI Y ARKGV AEQKREKEI KSELKMKHDA	2784
ALLIGATOR	VDST-TKDI-NERAEILR LRRRFL KDQEK--LSVI Y ARKGV AEQKREKEI KTELTMKRDA	2742
SOFTCORAL	DDPS-NENS-SQLQNIR LKRRFV KDRKE--TDV F AKKEIAR QKLRT ESVQRQKVAREN	2781
STONYCORAL	SSHQ-SQDP-NEKKEIL LKRRFL KDQSQ--ISAF F AKQAL KRNKFR EQALQRQKAAREG	2809
ACORN_WORM	TDST-EDTS-QTDREIMR LKRRFL KDQEA--SRAF F ARREIR LKKMRE EAQKEQKLRRHN	2802
LANCELET	TDGR-AAED-SQQSEIMR LKRRFL KDQDV--TKAY H ARRQ IRMQKMR ERVKEQRAKRG	2810
SEA_URCHIN	KEAR-KAPS-EGEKEV QRLKRRFM KDQSS--QSA F AKRAT RQKELRE VQKSQRERRFA	2807
STARFISH	DEVD-AQQS-GEDKKINR LKRRFL KDHSS--SQAY F ARRE MKRKQLKEKI LEEQRERKFS	2825

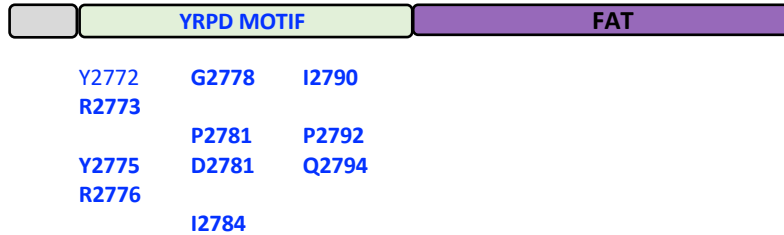
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ABCDE LOOP

Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

TERMITE	NIASFREYRS ^G DFPDI ^E ISYSAI ^I KPMQ ^E LAKRDAAVARHLFVLLFDGLLGELYD-----	2758
SHRIMP	QVTMYRQYRVG ^E LDPDVQ ^I IPHRALIGPLQ ^A LSQRDEKVARLLFEVLAQGVINSAGTAMHHR	2801
SCORPION	QVTIYRQYRIG ^D LDPDIEINYS ^S IIVPLQ ^A LQHDDDEICRMLFQSLILSVCCYMKS ^N Q-VT	2816
ALVINELLA	QVILYRKYRIG ^D LDPDIQ ^I EYFNIIAPLQ ^A LAKD ^S SRMAMLLSTLFEAIIHAELVTV--CA	2775
CAPITELLA	QVTMYRQYRTG ^D DFPDIQ ^I KYSFLIAPLQ ^A LQRDSTIAKLLFVAVFQAIFTQIESEKTER	2814
SPONGE	YVVMYRKYRMG ^E LDPDIQ ^I KHSELIRPLQ ^A LQND ^S GLARLLFCSLFNSIFSQLDHLLTEE	2849
OYSTER	QVTMYRKYRK ^G DLPDIQ ^I KYSYIIAPLQ ^A VAHRD ^S SVAKLLFGAIFKGFISKMDEVKTER	2814
SNAIL	QVTLRYR ^R YRIG ^D LDPDIQ ^I KYSYIIAPLQ ^A LHRD ^N TIAKLLFGAVFKAIYQEMDKVKTDQ	2824
TRICHOPLAX	KVVMYRKYRD ^G E ^L DPDIQ ^I KHSELIAPFQ ^A LQV ^C YLDQNYRY---VNLSVNDLVENFNDE	2821
SEA_ANEMONE	QVVMYRKYRAG ^D LDPDVQ ^I KHSELIAPLQ ^A VAQC ^D STLAKQLFSVLVQAILSQMDEKLTEQ	2824
PRIAPULA	QVXMYRKYRIG ^D XPDVQ ^I QFCHLISPLQ ^A LQRDARVAQLLFS ^S SLCDGVVRRAGDTATER	2861
ESHARK	KVTLYRSYRF ^G DLPDIQ ^I KYS ^S LIAPLQ ^A LAKD ^H SLAKQLFSALFSGILEEVHKS ^K TA-	2843
STERLET	QVTLYRSYRQ ^G DLPDIQ ^I QHSSLIAPLQ ^A LQRD ^P TLAKQLFSS ^L FSGIL ^E MEK ^S KS ^S QS	2853
COELACANTH	QVTLYR ^R YRQ ^G DLPDIQ ^I HYSSLIAPLQ ^A LQRD ^P TLAKQLFS ^N LFTGIL ^E MEK ^S RS ^S DS	2844
HUMAN	QVVL^YRSYRH^GDLPDIQ^IKHSS^LLITPLQ^AVAQRD^PIIAKQLFSS^LFSGIL^EKEM^DKFK^TLS	2827
CAECILIAN	EVTLYRSYRH ^G DLPDIQ ^I AIY ^S NLIAPLQ ^A VAQRD ^P TLAKQLFSS ^L FFGIMKEMDK ^L KSS ^S	2846
PLATYPUS	QITLYRSYRQ ^G DLPDIQ ^I EHSS ^L LITPLQ ^A VAQRD ^P TLAKQLFSS ^L FAGILKEIDK ^F KS ^S QS	2834
CANARY	QVTLYRSYRVG ^D LDPDIQ ^I EYCSLIAPLQ ^A LQK ^D PTFAKQLFSS ^L FSGIFHEV ^K KS ^K HPS	2835
OSTRICH	QVILYRSYRVG ^D LDPDIQ ^I EYSSLIAPLQ ^A GLAQK ^D ATFAKQLFSS ^L FTGILREVEK ^S KT ^P S	2805
TURTLE	QVTLYRSYRQ ^G DLPDIQ ^I EYSS ^L LITPLQ ^A GV ^A QRD ^P PLAKQLFSS ^L FTGILKEMN ^K FN ^P S	2844
ALLIGATOR	QVTLYRSYRQ ^G DLPDIQ ^I EYSS ^L LITPLQ ^A GV ^A QRD ^P TLAKQLFSS ^L FTGILKEMEN ^S KS ^S PL	2802
SOFTCORAL	KVVMYRKYREG ^D LDPDIQ ^I KHSD ^L LITPLQ ^A LQC ^D SYIAKQLFSGIFRGIFSQIDENVTDT	2841
STONYCORAL	AIVMYRKYRS ^G DLPDIQ ^I KYSELIAPLQ ^A LQCD ^N TFAKQLFSALFRGIFSKIDEK ^L PER	2869
ACORN_WORM	MVTLYRSYRQ ^G DLPDIQ ^I KHMY ^L IAPLQ ^A LQRD ^T AIARQLFSS ^L FCGVFAQIAE ^E KTER	2862
LANCELET	LVTLYRQYRVG ^D LDPDIQ ^I KYSYIIAPLQ ^A LQRD ^S MLARLLFSS ^L FRGIFEEIENV ^K TER	2870
SEA_URCHIN	QVTMYRQYRTG ^D LDPDIQ ^I KHSD ^I IAPLQ ^A LALR ^D STLSRLLFSALFRGILARIGDMCTDG	2867
STARFISH	TVTMYR ^R YRTG ^D LDPDIQ ^I KYSD ^L IAPLQ ^A LQRD ^A SLARLLFSS ^L FRGIFSEIEEV ^K TER	2885

FAT begins 2801



Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

TERMITE	EKEVYTKQVKAMGSIVSTTKDYTTMVMGAVMEIALCHSRYITLQAEDITTVSRFSGLLA	2818
SHRIMP	EEQEWNQELHEALNGILSSSYMCCPQMLRVTVLHLMINN--DVRTNPESLTAACLGSRLEA	2859
SCORPION	EYSEFCRSLSSALNEILKKSVMHYHPQLVAFCECLNCDVKEMDIDYEQICTASQASHKQS	2876
ALVINELLA	DNRSIHARISNSLNTMLSTTNQYYAPFINCILHMAYSNIHNLTLSPNISSACLTLGLQQP	2835
CAPITELLA	ESQSLVAKIESSLNKILETSYQYFSPFICGVLEIAYLFPKQLKLPQGVVSTVCNMSDQQP	2874
SPONGE	DAAAATKGVIEGININTILDCTSYQYFSPFICGLDICYEN--SLKIKPPSITSSSLASKQEF	2908
OYSTER	EVQETIQQIQKSIQVVLTTSTYQYFSPFICGLDVLVYSLRSKLVSDVSSAAMFQNIQP	2874
SNAIL	EMEETKEKISDSLGRMLSTS IHYFTPFMGCVMDILHTLRSSLKVEVSELSIAAKISNLQP	2884
TRICHOPLAX	DAAEKAEIKASLSNIVKKS KHYFPPFIACVQDICYQK--ELSIQSSFASVASLASSQQP	2880
SEA_ANEMONE	DAEKTVTDIQGALDNIMTSSYQYFSPFISCIEDICYHKS--MLKVQPSVSTASLASLQQP	2883
PRIAPULA	DVDATMEKLESAVSVMASSSTSYFSPFICGLDVCYRNISILRLDPAVVTTVSQTSMQQN	2921
ESHARK	ETKDISKQLVENFNYLLKATTLNFPPFVACIQDMSQHKDLLGLDSTSVRSTSLASLQQP	2903
STERLET	EKKRITTEEILGDMNFLSKTQYFSPFVTCVQDMSYRHKELLNIEPSSVSSCLASLQQP	2913
COELACANTH	ERKTILLELLGNFNGFLSNTVYFSPFVTCIQDMSYQHAELNLDPASVSASCLASLQQP	2904
HUMAN	EKNNTIQKLLQDFNRLNTTFSSFFPFVSCIQDISCQHAALLSLDPAAVSAGCLASLQQP	2887
CAECILIAN	EMKDITQKLLADFNRLNITTSYFPPFVACIQDMSYHHTTELLNLDPSNVSTCLASLQQP	2906
PLATYPUS	EKRNTITLKLQDFNHFLLSSTVSSFFPFISCIQEMSFOHTELLNLDANCVSTCLASLQQP	2894
CANARY	EKNAIQKLLNDFNFLSMSLSYFPPFIACIQEMS YQHRELLDSANVSTCLASLQQP	2895
OSTRICH	EKKIIIQKLLKDFNQFLSMSYFPPFIACIQEMS YQHRELLDLSANVSTCLASLQQP	2865
TURTLE	EKNCITQELLQNFNRLSMTVSYFPPFIACIQEMS YQHRELLDLSATVSTCLASLQQP	2904
ALLIGATOR	EKTHIVQKLLQNFNDFLSISVSYFPPFIACIQEMS YQHKELLDIDSTSVSTCLASLQQP	2862
SOFTCORAL	QADEIFRDIQDALNNMITSSYQYFPPFIACIQEMSVNVCYNEG--KLSLEAGKVTASIGSLQQP	2900
STONYCORAL	EAAVTSDLRSAMNHMLSSSTQFPPFIISSIQDICFHECKLRSVDSASVSTACLTSLQQP	2929
ACORN_WORM	ESEEIKKINEHLNSMLSNTSYQYFSPFICGLEDIAYHNCKELMLDAQGISASLISQQQP	2922
LANCELET	EAEADLTEQISRFLNTALSNSKEYFPPFISSIQEMICYREPRKLPSPDASVIQQTGVISLQQP	2930
SEA_URCHIN	ETELHVKGIERHLNQMLTDSNQFDPAFISCMLEIGFYHSEQLTLDPAAISQCLTSRQLL	2927
STARFISH	EAEKSTKVEINRHLNMLSTSYQYFPPFISCVQEMISYHSEQLTLPSTISTASLTSQQMH	2945
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TERMITE	LGCLSLEELIQKDTVSE--AGSSKRSKTFE---PSTEEILWLSLADLYKHMDEWVVRGI	2874
SHRIMP	LGIIVLERQALLSKRGEPEHPARKKMRKDAEALS--QDDSLWLSIAEMYKNLNMWVVRGV	2918
SCORPION	LGIILLEEDHLLICYNFKS--SNPAKRKIKLNKPLIS--DELSIWLKMAEIKYKLSDYDSVHGI	2934
ALVINELLA	MGIMLLEKMLIHAENP--T-CQPSKK--HRTIGPQVSRDINVWLELAKLYKSGDYDTLGGI	2892
CAPITELLA	LGIILLEEGLLHSPED--Q--SPASKRRRDRSRITQDTEPWLELAKLYKSIDYDVLVGI	2932
SPONGE	TGIMLLEKQLLNVD--S--SKSAKRRTNKSN--EVTETWIELARLYKSLDYDVLHGI	2962
OYSTER	LGIICVLEEQQLISQDE--D--ERPSKRRGRSDNAVVS--TDTLSWIELARLYKSVKEYDVLVGI	2930
SNAIL	LGIIEVLEERLITEDSG--G--ARPSKRSRYDVTPT--KDDMQWIELAKLYKSLGDFDVLHGI	2941
TRICHOPLAX	LGIILLEKQIMHLDT--E--EPPSKRIKT--SSAS--EATSNWIELSKLYKSIDYDVLVGI	2934
SEA_ANEMONE	MGILLLEKQLLSQEA--E--PKSHKRMRTHESSPSS--DTTAAWLELAKLYRSVEEFDVLHGI	2939
PRIAPULA	LGIIVLEKMLMQGACDDE--SRPAKRRMRAGSGMGVSOHTDWTWIELARLYKSLGDYDTLHGI	2980
ESHARK	MGILLLEKSLIHSTTN--E--EPPTKKARGRQELPPDTPDVARWIELATLYRS LGDYDVLVGI	2961
STERLET	MGILLMEESLIKGLVP--E--EPPAKRRARGRRELPPD--TARWIHLAKLYRS LGDYDVLVGI	2969
COELACANTH	MGVLLLEQGLIQLLAA--E--EPPAKRRARGRRELPPD--TIRWLELAKLYRS LGDYDVLVGI	2960
HUMAN	VGIRLLEEALLRLLPA--E--L--PAKRVRGKARLPPD--VLRWVELAKLYRS IGEYDVLVGI	2942
CAECILIAN	VGILLLEERSLSLVDVT--E--EPPRKKMRGKTELSPD--VVRWIELAKLYRS LGDYDVLVGI	2962
PLATYPUS	VGILLLEQALIRLGPPE--E--EPSSKKRRGKQLPPD--VVRWIELAKLYRSVGEYDVLVGI	2950
CANARY	MGILLLEERAMALSPA--E--EPPSKRRMRGRTELPPD--VIRWIELAKLYRS LGDYDALVGI	2951
OSTRICH	VGILLLEHALISLSPA--E--EPPSKRVCGRRELPPD--VIRWIELAKLYRS LGDSVVLVGI	2921
TURTLE	VGILLLEQALTRLSSSE--E--EPLSKRRMRGRAALSPD--VIRWIELAKLYRSVGDYDVLVGI	2960
ALLIGATOR	VGILLLEQALIHLSIT--E--EPPAKRMCGRTELSPD--VIRWIELAKLYRSVGDYDVLVGI	2918
SOFTCORAL	TGIMLLEKQILQMAEDPG--ERPRKRRKQTGGNPSP--ESTATWIELSKLYKSVEDFDVLVGI	2958
STONYCORAL	IGIMLLEKQLLEIEGK--S--QNSRKRKAKTSTVPPS--EVTTCWIELSKLYRSVGDYDVLVGI	2986
ACORN_WORM	LGLLLEEYLVQKSGE--E--ERSRKRPRGSASLLS--QEISTWIELSRLYKDLDNFDVLVGI	2979
LANCELET	IGIVLLEEQVLVQKAGV--E--EPRSRRARTSSPVS--AETATWIELARLYKSLGDFDVLVGI	2987
SEA_URCHIN	IGIRVLEEVLIKSGD--D--ERSRKRARTSRPESN--QEMSTWIELARLYKAMGEFDVLVGI	2984
STARFISH	IGIRLLEENLIQKPWQ--E--EKSAKRARFVSREPS--PEISTWIELARLYKALGDFDAVQGV	3002
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Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

TERMITE	FHKYLCN-GENVHKALKWE ^T SGHWDKARMEYEAALSSM-----DDQDGLSDYYEALY	2926
SHRIMP	VQKGLGAIKEETQKAL ^E EATN ^N HVKAFLLYRQSLDTT-DWEE--EPLAAENRLWEEWYS	2975
SCORPION	FSNSLNI-QEETKQAL ^E ESRGEYLLAVKLYSKLYDQT-EWSAE-EPNQAIEDLWDNAIL	2991
ALVINELLA	FGSKLGT-KEIT ^L EAMEAEMSGDYQTAVQLYKALVCT-DWDE--EPDELEKDFWDASSL	2948
CAPITELLA	FSSQIGS-KPATRLAL ^E EAETRGDYRSALQLYNESLAKE-EWDDGHEPTEAEINMWSSRI	2990
SPONGE	FTNLDDT-KDVTRKAL ^E EERGDYLTALNLYKKAIDF--DWPQGESPPQVEEDLWEDSLL	3019
OYSTER	FSGRIGT-QDIT ^K EAVQMEARGDYKAVKLYNQALSCN-DWDE--NPPTIEVDMWDESRM	2986
SNAIL	FSGMLKT-KEVTQ ^L ALIEESHSEYKAAIALYNKALESA-DHDP--RPLEAEIDLWDESRM	2997
TRICHOPLAX	FSGHLGT-KDIT ^Q RAL ^E ESRHDYAAAVKYYNQAMDCS-SWPDG-EPQAEEDLW ^E ISRL	2991
SEA_ANEMONE	FSDHIGT-KPIT ^R LAL ^E EARGDYAQA ^L KIYNEAMSCD-DWSS--KPQQEEDLW ^D DARM	2995
PRIAPULA	FNDKIGT-QTCT ^Q EAL ^Q AESCDYK ^L ARKLYQRALEM--EWGESEGPQGGERDLWDISLM	3037
ESHARK	FSEKIGT-KPLTHT ^A L ^L EA ^K SDYAEAVRLYDQALNTE-EWMDG-NPMETEKDFW ^E IAAL	3018
STERLET	FSGKIGA-KSIT ^S MA ^L QA ^E AKSDYAEAVKLYNEALNTE-EWTDG-EPAAEAKDLW ^E IAAL	3026
COELACANTH	FSGMIGT-KQIT ^Q KAL ^L EA ^K SDYSEAVRLYDEALNVE-EWPDG-EPTAEKDFW ^E LAAAL	3017
HUMAN	FTSEIGT-KQIT^QSAL^LEA^RSDYSEAAKQYDEALNKQ-DWVDG-EPTAEKDFW^ELASL	2999
CAECILIAN	FSGKIGT-KPHTKD ^A L ^L EA ^K SDYATAAKLYDEALNMP-DWSND-EPTAEKDFW ^E VAAAL	3019
PLATYPUS	FSGEIGT-KHVT ^Q I ^A L ^L EA ^K SDYSEAAKQYNEALNMQ-HWEDG-EPSEAEKDFW ^E LAVL	3007
CANARY	FSGIGT-KEIT ^Q KAL ^L EA ^R NDYAEAAQYD ^K ALSQE-DWQDG-EPTAEKDFW ^E LASL	3008
OSTRICH	FSGKIGT-KEIT ^Q KAL ^L EA ^R SDYATAAKHYDEALSKE-DWQDG-EPTAEKDFW ^E LASL	2978
TURTLE	FSGKIGT-KEIT ^Q NAL ^L EA ^R SDYAEAAKQYDEALSQK-DWPDG-EPTAEKDFW ^E LASL	3017
ALLIGATOR	FSGRIGT-KEIT ^Q KAL ^L EA ^K SDYVEAVKQYDEALSQK-DWSDG-EPSEARDFW ^E LASL	2975
SOFTCORAL	FNSHIGT-QSIT ^K DAL ^E AEGRGDYTEALKLYSQA ^T NCNCD-EWPAGSSPLQAEEDFWD ^S SIL	3016
STONYCORAL	FTGHIGT-KDIT ^R EAMEA ^E ARGDYSQA ^L KLYNEAIGTDDVWIKE-ELRQEEDLW ^D VSRL	3044
ACORN_WORM	FSGKVT-QPVT ^R EAL ^E AASANYQAANLYDEALGCT-DWPDG-RPEQVEEDLW ^D DCRL	3036
LANCELET	F ^S RKVT-QVT ^T YEA ^L EAEARGDFK ^A VELY ^N QAMQET-EWPDG-QPLAVEEDLW ^D DSRL	3044
SEA_URCHIN	FGALIGT-KDVT ^Q EAT ^Q AESRGDYSEALELYSKAIS-S-DWGPD-GVAREEEDFWD ^E EARL	3040
STARFISH	F ^S ACIGT-HEIT ^K TAL ^E A ^E ARGDYSTA ^L KLYNQAFE-M-DWDEG-AVSQVEEDLW ^D ESRL	3058
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TERMITE	KCLAHLS ^D WKGLNNQVRR-----QVENNL ^D QLW ^T DEWLQEKLLPQIL ^L SEIQMMLDKGV	2980
SHRIMP	NCAAIL ^G QWSELENFVEKRF ^L QDDG ^E VDLNRVWLLPKPTATAPALV ^H SKLMNILDGSE	3035
SCORPION	QCYDYL ^T QWDL ^L QLS ^I IN-RIDENQ ^K QPNL ^K IEWEPYQENYLPFL ^I KSKLKLLENR-	3049
ALVINELLA	HCYEH ^L TQW ^N KLLECTLT-NLDD-VRSAN ^L DRIWEDTYYQDTYLPYL ^I HSKLKLLENGE	3006
CAPITELLA	ECAEN ^L TQWR ^D VETLST---SD-LEGS ^S L ^A VWDS ^T YHQEVYLP ^P MLRSKIKLILNGDT	3045
SPONGE	NAYSH ^L TKW ^D LEKASTC-NIGE-ETNS ^K LEQLW ^K DSYCQEHYLP ^F VLS ^S KLKLWCTDD-	3076
OYSTER	ECLDNL ^S QW ^K LEGVAMS-GIS---SNS ^I SQV ^W KD ^T YQEHYLP ^Y I ^R SKVKLMLQGDG	3041
SNAIL	ECLNRL ^T EW ^K LEMVTTD-ALSQ-EGE ^I SLAS ^V WDD ^T YMETYLP ^Y L ^I RSK ^L KLHLHGDE	3055
TRICHOPLAX	ECLYNL ^T QW ^D KLEYSLV-NVD-NNDPP ^S FDKI ^W EDN ^Y QENYLP ^L FL ^K S ^K AKVMCENDL	3049
SEA_ANEMONE	QCFAN ^L AKW ^G DLEEYSKT-GVDDEGNPP ^D L ^D KI ^W TD ^T YQEHYLP ^F IM ^R SSI ^K LICEGEE	3054
PRIAPULA	QCLDR ^L TDW ^T ALDAHTKECL ^I PEGS ^E ADL ^L Q ^L LWED ^T Y ^E ENHLP ^F V ^M RA ^R LK ^R LLVEG-	3096
ESHARK	ECYNH ^L TEW ^K AL ^E YCSTV-NIDD-KTPAD ^I ENI ^W SD ^T FYQET ^Y LS ^Y M ^I RS ^K V ^K LLQSGE-	3075
STERLET	ESYSH ^L TEW ^K SLQ ^Y YCSTV-NIDD-SSPAD ^L EKI ^W GD ^P FYQEA ^Y LP ^Y VM ^R SV ^K LLQLGE-	3083
COELACANTH	ECYSH ^L TEW ^K AL ^E YCSTV-NIDD-KTPAD ^L ENI ^W ND ^P FYQET ^Y LP ^Y LM ^R SV ^K LLLLGQ-	3074
HUMAN	DCYNHLA^EW^KSLE^YCSTA-SIDS-ENPPDLN^KIWSE^PFYQET^YLPY^MIRSKLKL^LLQGE-	3056
CAECILIAN	ECYNRL ^T EW ^K PLE ^Y CSTV-NIDD-SKPAD ^L NKI ^W ND ^P FYQET ^Y LP ^Y M ^I RS ^K V ^K LLLQ ^G K-	3076
PLATYPUS	ECYNH ^L TEW ^K SLE ^Y CSTV-NIDS-ESPP ^D LN ^K IW ^N D ^P FYQET ^Y LP ^Y M ^I RG ^K LKL ^L LQGG-	3064
CANARY	ECYDHL ^T MW ^K SLE ^Y CATV-NIDS-GKPP ^D L ^S KT ^W ND ^P FFQET ^Y LP ^Y I ^R SK ^L KL ^L LSGE-	3065
OSTRICH	ECYDHL ^T EW ^K SLE ^Y CATV-NIDS-GQPP ^D L ^N KT ^W ND ^P YQET ^Y LP ^Y I ^R SK ^L KL ^L LNGE-	3035
TURTLE	ECYNH ^L TEW ^K SLE ^Y CSTV-NIDS-GQPP ^D L ^N KT ^W SD ^P FYQET ^Y LP ^Y I ^R SK ^L KL ^L HHGG-	3074
ALLIGATOR	ECYDHL ^T EW ^K SLE ^Y CSTL-NIDS-EQPAD ^L N ^K T ^W SD ^P FFQET ^Y LP ^Y I ^R SK ^L KL ^L HHGG-	3032
SOFTCORAL	ECCRR ^L TLW ^D KMDHNCIV-NFDEANG ^V L ^D L ^Y WRDD ^Y YKEHYLP ^F L ^C SK ^T KKFCIGD-	3074
STONYCORAL	QCLAD ^L TKW ^K ELEKCSVE-SIDD-KNPP ^D L ^D KV ^S DT ^F YQEHYLP ^H L ^I TS ^K LKL ^Q CQGS-	3101
ACORN_WORM	QCYE ^Q L ^T DW ^Q LEQASTI-NIDD-NDPP ^D L ^D KI ^W DD ^T YQEHYLP ^V IV ^K SKLKL ^L MEDDD	3094
LANCELET	QCYDHL ^T QW ^N KL ^Y EVSTV-NIDE-DSPP ^N L ^D KM ^W DD ^T FQEHYLP ^F T ^I RS ^K LKL ^L LEGE-	3101
SEA_URCHIN	QCCN ^Q L ^T KW ^D MESFSTD-QIEG-KGSND ^L SQI ^W ND ^D YQEIYLP ^Y M ^R SK ^L KRLMEGS-	3097
STARFISH	NCCN ^Q L ^T QW ^K ELQ ^N YSTV-NIDD-NSPH ^D L ^G KI ^W SD ^T FYQEL ^Y LPH ^M RS ^L K ^L Q ^L MEGG-	3115
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Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

TERMITE	DSKRE FL Q Q VDRWLRDRD K SDY L SSHYCE E LAAIFLIQDKLD Q AHQVHSLTMFLDSW	3040
SHRIMP	--TDGN L IA F IDQSMGDHRR R SM L EGD L PL Q LGVLAHQEK F EQ A NVYANTATSM L LL L	3093
SCORPION	--NDQ S LL C FID S ALKEEN K K Y LE N FSE L L L LYIIQENYD R AQ Y YS Q L C LQDF L KEW	3107
ALVINELLA	--GDD L AT F IDNAMKV T ERR A LESQ S VE L L L YIWQEEYD R AMSHVDQ A I Q L F LQ N W	3064
CAPITELLA	--SQD N LL S FIE S LE K TP V H K AFIE G S F SS E LALVCIHQ E LYD K AK H YANMS L QAF I Q D W	3103
SPONGE	--SDH G L A S F L D K S LSE A NR S V L ESHYP Q EL T LSYVLRDDYD R A Y Y L SL S L K AK Q Q I W	3134
OYSTER	--DQ Q LL T FID D CM K Q T E Q K A LIE S RYSE L AL M YIWQADYD R AR H YST L AT Q Q F LL D W	3099
SNAIL	--K Q S L LS F ID D SM K NP Q H R A L ESRYCE D LAL M YV W Q K NF D LAR H YAR L AV Q S F Q D W	3113
TRICHOPLAX	--AGSD F I Q Y L N K SLANDE H LS V LEN R H C D L AL I H V L L E K YD R AR Y Y L DF S I Q K F LQ D W	3108
SEA_ANEMONE	--R P C F LE F LR H SM N EE R K A FL E SRYG D L L ALL F IL R DDY G RA R Y H VT N CF Q AF L K D W	3111
PRIAPULA	--ARD Q T L LS F VD A AT G HP D RR A VIE T W H GE L L L LYI V Q G DY T RA R H H AAR C L Q AF L R D W	3155
ESHARK	--VD Q S L LT F VD R AM K VE Q R K AVIE T Y S Q E LS L LYI L Q D D V D R A K Y I INN C ME V F M Q N Y	3133
STERLET	--PD Q S L LT F VD N AM K VE E R K SI E TSY S Q E LS L LYI L Q G D F D R A K Y Y V N CM Q V F M Q N Y	3141
COELACANTH	--GD Q S L LT F ID N AM K VE E R K AL E THYS Q E L S L LYI L Q D D F D R A K Y Y V G NC M Q V F M Q N Y	3132
HUMAN	--AD Q S L LT F ID K AM H GE L Q K AI L E L HYS Q E L S L LY L L Q D D V D R A K Y I Q NG I Q S F M Q N Y	3114
CAECILIAN	--DD Q S L LT F ID N AM K VE Q R K AL E T N Y N Q E LS L LYI L Q D D F D R A K Y I D N G I Q V F M Q S H	3134
PLATYPUS	--SD Q S L LT F ID E AM K KE K Q K T L IE T HYS Q E L S L LYI L Q D D F D R A K Y I D Y C I Q I F M Q N Y	3122
CANARY	--ND Q T L LT F ID E AM K TE Q K A IE M HYS Q E L S L LYI L Q D D F D R A K Y I S N G M Q I F M Q S Y	3123
OSTRICH	--ND Q T L LT F ID E AM K TE Q K A IE M RY S Q E LS L LYI L Q D D F D R A K Y I S N G L Q I F M Q S Y	3093
TURTLE	--ND Q S L LT F ID E AM K IE Q R K ALIE M Y S Q E LS L LYI L Q D D F D R AR Y Y I S S G M Q A F M Q N Y	3132
ALLIGATOR	--SD Q S L LT F ID E AM K IE Q R K ALIE M HYS Q E L S L LYI L Q D D F D R AR Y Y I S N G M Q V F M Q N Y	3090
SOFTCORAL	--R D EV F FN F IF D SL K NE E R K V I LEN K Y S D L ALL F IL D E D YD R AR Y Y T S I CL Q AF L E D W	3132
STONYCORAL	--G D MT L NE F V A KAM T S E R A AL L RS R Y S D S LAL M YV L Q D NC D S A S Y AA L SE Q S F L S D W	3159
ACORN_WORM	--T D D Q S L LT F ID K SM Q H K ER K ALIE N RY S E L AM L Y L L Q D D YD R AR Y Y T AN C I Q S F LQ D W	3153
LANCELET	--MD Q S L LN F VD S AM Q K P DR K AL E SRYCE L AM L Y L Y Q D D Y G RA K Y Y V G NC T DA F L Q E W	3159
SEA_URCHIN	--E D D S LL G FID S SA K D Q E K R V IE S RY T E L AAL S IL K E D Y N RA K Y L AN S T S S F L Q E W	3155
STARFISH	--E D ET L L Q FID A SM S D A D K RA F LE A RY S E L ST L Y T I Q E D YD R AM F Y L AN C R Q S F L H D W	3173

FAT

TERMITE	AAL N PS S HN L --RT K Q L L D L Q KT A EL K AC L AFATNGE H SK - Q E --LL A K E L V K R W K N K NP	3095
SHRIMP	S Q Y S V L TP N P--LL D T L Q N V Q LL T E L SD C L N V K Y A DR D F Y SS--K V K Q T V T S W K K Q K C	3148
SCORPION	S S L N VM P II--R K T K L Q S L Q K H I E L Q E FL N FID T Y R N - ID E ---Y H F K N L T D R W L K R Y P	3161
ALVINELLA	A G L D AL M S N S--R L H L R T L Q K L E M H E FL Q IM K N K H - S--IS F Q S V I Q A N A W M R R S P	3119
CAPITELLA	AN L S T TR T ST--R A T K L Q K L Q E FT E M Q E F LS V I K T T S G -E--D F P R Q I D R T L H K W E A R S P	3158
SPONGE	S V Q D G I SS S T G AV S S T V Q S L Q R L T E M NE F IF M K S N D N - F S S P --G P V N LL R K W R K R F P	3191
OYSTER	S S T D SL M S V S--R K S Q L Q R L Q P L V E L Q E FL S F M A S E G N - F T S V --T P AN S L I E R W Q A R A L	3154
SNAIL	S S T D SL M T A S--R T H L Q R L Q P L L E L Q E F L D F V A D K N N - F T S F --E P S H Q L I A R W E Q R Y P	3168
TRICHOPLAX	S A L D ST L L Y S--R A S K L Q S L Q T L T E M Q E FL Q F M D D G R N - F E S V --T P V L S L I S K W S T R F P	3163
SEA_ANEMONE	S G L S SM V S S --R A S K L Q S I Q K I T E M Q E FL E F V V K E G K - LL K ---K T L E D L F S R W S V R F P	3165
PRIAPULA	A S L D AL M L A S--R A A R L R S L Q K L T E M NE F L D A I T A P D A F TR N --D T A R A L V D R W M D H M P	3211
ESHARK	S S I D T L L H Q S --R L T K L Q S L Q A V T E M Q D F L H F I S K E Y N -F I S E --V P L R K L L R T W T G R Y P	3188
STERLET	S S I D T L L P G S --R L T K L Q S V Q A L T E I Q D F L N F M T K D ---V S Q - T S L K S L I R I W T D R Y P	3193
COELACANTH	S S I D T L Q H K S --R L T K L Q S V Q A L T E M Q D F L G F I S K P D H -L N S R --A S L R R L L R N W S D R Y P	3187
HUMAN	S S I D V L L H Q S --R L T K L Q S V Q A L T E I Q E F I S F I S K Q G N -L S S Q --V P L K R L L N T W T N R Y P	3169
CAECILIAN	S S I D T L L N K S --R L T K L Q S V Q A L T E T K D F I H F I S K P S N -L T S Q --T S L K R L L R I W S S R Y P	3189
PLATYPUS	S N I D ALL L Q S --R L T K L Q S V Q A L T E I Q D F T N F I S R P S N -L S S Q --A S L K R L L R I W T N R Y P	3177
CANARY	S S I D S L L Y Q S --R I T K L Q S V Q A L T E I Q D F I N F M T K R S N -L A S E --A S L K R L L R T W T S R Y P	3178
OSTRICH	S S T D T L L H Q S --R M T K L Q S V Q T L T E I Q D F I H F M T K T S N -L A S Q --A S L K R L L R I W T S R Y P	3148
TURTLE	S S I D T L L H Q S --R L T K L Q S V Q A L T E I Q E F I N F I S K P S S -L A S Q --V S L K R L L R I W T S R Y P	3187
ALLIGATOR	S S I D ALL H Q S --R L T K L Q S V Q A L T E I Q D F I N F M R E P S N -L A S Q --A S L K R L L R I W T S R Y P	3145
SOFTCORAL	S G L D S I M T S S --R S A H L Q S L Q A L T E M Q E FL D F I S H E D N - F T S I S - S V K S L L K R W S S R E P	3187
STONYCORAL	A G L D S N L R S S --R S I K L Q S L Q K I T E M Q E FL E F I A E E G N - F--S S P M P V L S LL N K W Y S R L P	3214
ACORN_WORM	S G T D T L M G T I --R S S K L Q C V Q K L S E M Q E FL F I T N E R N -F D E H K--P V S D L I S K W T K R L P	3208
LANCELET	S G M D R L M T S S --R A A K L Q S L Q K L T E M Q E FL E L I S N D R N - F--E T P W P V T R L L E K W S S R Y P	3214
SEA_URCHIN	S G L G P L M L T S --R L S K L Q D I Q K L T E A E Q F L Q L A N K P F S -E G L K S--S A T R L V S D W S R N L P	3210
STARFISH	S G L G P L M I S S --R R A K L Q C I Q R L T E K Q N F L K L A I K P D L -Q E A I G C Q S L E L L D R W S G C H L	3230

FAT

Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

TERMITE	SA-FDSSLRWDIRAMYRKKFTNRIDQMLENT-----GA-----	3127
SHRIMP	RIDDNPL-MTQCLASYRDLYLHLEKLPED-----S-----	3179
SCORPION	DI-FDSVNIWDDIIMNRSLYMEKIVSKLQETFNQSTFSLEESMDTISVD-----S	3211
ALVINELLA	DPVVDPTTIWDDVMSYRILYLDQMAQHLKNI-----SK-----	3152
CAPITELLA	DRLLDSVVIWDDNIILNRNVYMDHFAEHLTSI-----DA-----	3191
SPONGE	DPKLDPVPIWDDIITTRWMMLRKISTKLQDS-----VLSQQCEYLLDDDG-----	3236
OYSTER	HPLLDTEAVWDDVVTNRMVFLDHSNRLSTS-----LV-----KKE	3190
SNAIL	HVQLDLVDIWDVVTNRNVYMDKIRDQMLSS-----NL-----MEE	3204
TRICHOPLAX	NEVIDPINVWDDVIVNRCMYLRKILLQYRVIQTAFT--STEDSME--IDGEDRVIYT---	3216
SEA_ANEMONE	NSKLRHPISVWDDVITNRRIFGLTVC-----V--YRPDSMD--VDGEWS-CPS---	3207
PRIAPULA	HPTLDPVSIWDDTVINRCLYMDHLSRHFHGN-----QP-----	3244
ESHARK	DAKMDPMSIWDVITNRCFFLDKIQERLVSV-----QADESME--VDREGEVETRMEV	3239
STERLET	DAKMDPMNVWDDIITTRCFFLDKIQEKLTPS-----EADNSME--VDGGEDTGVKMEV	3244
COELACANTH	DAKMDPVNIWDDIITNRCFFLDKIQEHLCKV-----PADESME--VDGEGDASPRMDV	3238
HUMAN	DAKMDPMNIWDDIITNRCFFLSKIEEKLTPS-----PEDNSMN--VDQGDGDSRMEV	3220
CAECILIAN	DSKMDPMNVWDDIITNRCFFLDKIREKLPHF-----QADDSME--VDGGGDASDRMEL	3240
PLATYPUS	DAKMDPMNIWDDIITNRCFFLSKIQEKLQAGL-----QADDSME--MDGGDTPDRMEL	3228
CANARY	DAKMDPMNIWDDIITNRCFFLDKIQEKLPSD-----QANDSME--VDGEYSAGDQMEV	3229
OSTRICH	DAKMDPMNIWDDIITNRCFFLDKIQEKLPRD-----QANDSME--VDEKDDIGDQMEA	3199
TURTLE	DDKMDPMNIWDDIITNRCFFLGKIQEKLQNI-----QADDSME--VDGRGDVGDQMET	3238
ALLIGATOR	DAKMDPMNIWDDIITNRCFFLDKIQEKLQNV-----QADDSME--VVEAGDIGDEMEV	3196
SOFTCORAL	DPKLSVGVWDDVMTNRSVFLDKILLKFGQS-----SQ-----LHSEDSMEI	3230
STONYCORAL	HPILHPIGVWDDIVTNRVLFMSKFLQKFEAM-----GA-----EERSGIC---	3254
ACORN_WORM	DVKRDSNTNTWDDVITNRFVYLRKLFQKSGDA-----ME-----G--D-----	3243
LANCELET	DNRMDDPISVWDDIITNRCFLYLDKLNKDFEQM-----AA-----RGVLD--TEV	3255
SEA_URCHIN	DPKRPDISVWDDVTQYRCLYMDKLCNLLGDS-----GG-----GGGGGDSMET	3253
STARFISH	DSKKDPINIWDDVVSNRLLYMDKLGSRFIRS-----ES-----QQAGE-----	3268

FAT

TERMITE	-----SNA----LSRTELAMVDSALYQENFYIARKYLREAREKMS---NSGTPMELQ	3172
SHRIMP	----LDVSNLIKDTKNFTHRFVIRAAALHNRYHLANRHLKISSLSEDEYSKA----Q	3229
SCORPION	EPNSYFDESEKFLKEQRLKMKLKFVEAALLQGNLQVAVKHLKWSQQIAKE--LKADHHWIN	3269
ALVINELLA	---ESGMDDDIFNEHKVFNRLKQAEANQNNFPVALKQMKATFNLVKGG--VKNKTLHIE	3207
CAPITELLA	---KCI----DPFGKQRVVMSLAQVDAASLQGNHVSARKLLKSAKDLVKV--VDSEELSVL	3242
SPONGE	---SSCVDSMMKNENINMFMRAADAARTQSNYPVAENYLIKIVEKSILKDFPDNYFIQLR	3293
OYSTER	EDAMEEDEEDLFLASKIHLRLKMDSSCHKRNHKLALNILADIHKNYRD--KENEILNLE	3248
SNAIL	----DHDSSIFEDIKLRQQLKLAHSCQEQNNFNLTLRILKETYCKCR--EKSELLVVE	3257
TRICHOPLAX	---FPALKKRIAEEVSLYLKLADTARLQSNYPVAIKHLRQTLYHINQELDKDELLTVK	3272
SEA_ANEMONE	---VDALRERITREVALQLKMQAAREQSNFPVAHRYLRESLKSIED-----NLHVK	3257
PRIAPULA	-----AGSDPFLEQKFNFLAYQQSAMQRNPQVALKHLRTTNQLLK--KLDSDSLAVQ	3296
ESHARK	DK-EEEDINMAIRSCFNMKLMKMAESGTKQNNFVAMKLLKELHKES---KARDDWAVK	3294
STERLET	DE--PEDVGS MIRGCKFSMKLMMADSARKQNNFVATKLLKELHRES---KNQEDWLVR	3298
COELACANTH	DE--EPNISAMVQSCFNMKLMKMAESARKQNNFVATKLLKELHRES---KSRECLTR	3292
HUMAN	QE-QEEDISSLIRSCFNMKLMKMAESARKQNNFVATKLLKELHRES---KTRDDWLVS	3275
CAECILIAN	GG-EEEDITSMIKSCFNMKLMKMAESARKQNNFVAMKLLKDLHRES---KTRDDWSVR	3295
PLATYPUS	EK-QEDDIYSMIESCKFSMKMKMIESARSQNNFRVAMKLLKDLHRES---KTKDDWLVR	3283
CANARY	DQ-QGENIHSMIKSCFNMKMKMIESARKQNSFAVAKKLLKDLRKEA----RWREDWLVR	3284
OSTRICH	DQ-QGEDISSMIRSCFNMKMKMIESARKQNSFVAKKLLKYLHREA----KTREDWLVR	3254
TURTLE	DM-QEEDIHSMIRSCFNMKMKMIESARKQNSFVAMKLLKDLHRES---KTREDWLVR	3293
ALLIGATOR	DQ-QEDNIHSMIRSCFNMKMKMIESARKQNSFAVAKKLLKDLKRES---KTRDSWLVR	3251
SOFTCORAL	DGLNNTQLEEIFLRERVLFSRLSEVATGQVNFVAKKQLQSSLHLIRDRKNDSELEVL	3290
STONYCORAL	-L---DDIKDKFFKQEVLELKLCMANAQEQGNFYVAHRCLEALYKI---PQGNENLNIS	3307
ACORN_WORM	DG---QAMVNAISKDKLLMELKLVDSVVSQNNFVAKKYLKRNKADA----RDDDARLI	3296
LANCELET	GG---EPFSHRAQREQLLRVLVADSAREQANFPVALKHLKNTLKDF---TEDDPLRLR	3308
SEA_URCHIN	ED---QKFDDLVRRKVLKMKMADSACQANFCVAKHLKSTHRGL---VEFEDLRPA	3306
STARFISH	EE---TALEKRILRERLWLELKMADSACQGNFVAQKHLKATHGSL---SAHEDLKP	3321

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Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

TERMITE	CSLAYSKAKWLQAQLK--NTTDEKLLKGLDWSVIEDQR-----FEQ	3212
SHRIMP	FYFLMAETHILRGQGK----QTDRLKYLVEAWAKYLGRVSSM-----SILDQNPVVEIQ	3279
SCORPION	CIHLYCKIDLKAK---NQNYPEQLDTLCA-HKQLAKLDLH-----FPKKLDVSTMN	3318
ALVINELLA	CYHEWTRIQHKKCKVA-SLTTNEKIKALLET-MNVLEQ-----RAVDDSRVKCS	3254
CAPITELLA	FTHSHANANKRKCASG-SEP-SERLNLVVEV-KKRLDKCSES-----STLKLNAALLCD	3293
SPONGE	WLHSLIKVRLDRIH---QDPSPDTMEAVISL-TCQMDNFKGRLGGSGKGAISS-KPFISQ	3348
OYSTER	WSHLYAKTHQLSAMSADTDWTNDIFSSVIT-IDLKGFKDS-----SLFEREAGLR	3301
SNAIL	WSHLYATTHQKALSCSGIWSKDMLYNVLST-LDPLSKVAES-----KMLREKPALGMR	3310
TRICHOPLAX	WTHIYTKVHCDSL---LTPPDERLKTLLTA-NSQFEKVKDL-----SVILENTTLMRE	3322
SEA_ANEMONE	WTHAYAVTQQKKAH---GLMAIDAVQTALST-VSKLGKP-SI-----NTLANDPVIALR	3306
PRIAPULA	WTHSYVRTWQQIATGH-QRDSADRLHRLDIT-IKELDKHAGK-----AVLHQQRGLARE	3348
ESHARK	WHTYRSRLSHRRSQ---RQARPEQVVTVLKS-IPLLVEI-NV-----DYLNTHTRILRD	3343
STERLET	WVHSFRFSHTRSH---TQSSSEQILTVLKT-IPLLEER-KI-----DYTKATTRIVRD	3347
COELACANTH	WVHSYSRFGHSRSQ---SQSCPERIQVMKT-ISLLEES-KA-----DYLKNTALRLD	3341
HUMAN	WVQSYCRLSHCRSR---SQGCSEQVLTVLKT-VSLLDENNVS-----SYLSKNILAFRD	3325
CAECILIAN	WIHSYCHYTHRSRQ---SQTSPDQVLSVIKT-VSLEET-KA-----DYLRENTREFRN	3344
PLATYPUS	WNHNYCRCSSHSQSQ---SQSSPEKILTVLKT-VSLLDDN-LS-----SYLSKNIVASRN	3332
CANARY	WNYAYCRFTHSSSR---NLSCEPERVLSVLT-LSLEEDT-KS-----DYLKNIAMFRN	3333
OSTRICH	WNYAYCRFTHSSSR---NLSCEPERVLSVLT-LSLEEDT-KS-----DYLKNIAMFRN	3303
TURTLE	WNHSYCRFHSRSQ---SQNSPEQMLTVLKT-ISLLEES-KS-----DYLKNIAMFRN	3342
ALLIGATOR	WNHSYCHVSHSSCQ---TQSSPQQILTVLKT-VSLLDEN-VP-----DHLKSNIEILRN	3300
SOFTCORAL	WTHSYGDLNCKKCP---NLLPEAVDTAISA-LDQLDKIKDS-----KVLQENASTGIR	3340
STONYCORAL	WSHTYAEVHFRKIQ---TLTAVGAVETALLV-AGQLDKFSAS-----KILEIEPLRGIQ	3357
ACORN_WORM	WTLSYARLHQKCL---TLPPSKRVINLTT-LDQLGMFTG-----CEPSYRKQ	3342
LANCELET	WTHCYARLHQKAS---LLTGADKLNNTT-FEQLDKFSSC-----RVFEDLAVAKQ	3358
SEA_URCHIN	WTHSYVSMTQRKAL---LLKPYERTSLKA-LDHLGKLPVS-----HNLGSDLFLCD	3356
STARFISH	WTHSYVQMNQKIL---TIELKEQVMTLTT-FDPLAKLSNT-----PALTGDYCLTRH	3371

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TERMITE	YPMLEHAETLQHVSVMAAGILQQLEQQPGVLTKLPA-----AEVKKLADRIG-APDCSQ	3264
SHRIMP	YKLESHLCLC-----ICRAIQDMGDDWTFEDNQYMQVL---SKFE-----NANGK	3322
SCORPION	HYLLQSEIIEEM-----AADIVKYNDVHA-----EKIQELTDTFSIQSK	3356
ALVINELLA	QHILQEQALFQ-----LISLLKDDIHVLEDEYRN-----EI---QNITH-CGTYDH	3295
CAPITELLA	QHLQGEHLVT-----MATILQNVKIDIDALDQ-----KLEKITESVG-SPALSH	3338
SPONGE	HHVLLGKLLNK-----MAEIFATPEDGMLALS-----LSNDGNTKLNLSLIGG-TPSTST	3397
OYSTER	HFVLLGQAFGL-----LVKGVQSENCFFSS-LSD-----KNSEKIMGISK-ASKLNP	3345
SNAIL	HMILESRTFDA-----VVTGLMSVGNLEE-LGD-----KTCEKLQYTK--SPLNK	3353
TRICHOPLAX	HLLLRSRLDM-----TSKILAESDASIL-----DLLNEKESLYQLANV-NQHDSK	3368
SEA_ANEMONE	HHILRSRCFDI-----LTDIAGAGRSTLATYKLIICLINQPVDKSYPCNV-CLQ---	3355
PRIAPULA	NLLKGRSIEA-----VAREVLTTRPASLHTLPA-----AT--REKLSLVAG-AREHDH	3393
ESHARK	QNTLLGSSYCI-----LADALNKEPTCLQRIKE-----DQ--AERVIEHSG-SSSEEI	3388
STERLET	QNILLGTTYHI-----MANALTRDGLALEHIGE-----DK--AGKVLDDLQ-TTSDNL	3392
COELACANTH	QNILLGTTYNI-----IANALNKTPSTLQDIGE-----EK--ARKIQDLGSG-AQSDHP	3386
HUMAN	QNILLGTTYRI-----IANALSSEPACLAIEIE-----DK--ARRILELSG-SSEDS	3370
CAECILIAN	QNILLGTTYSI-----IANALCKDPRCLQRIDK-----NK--ADKVLQLSG-TMSEN	3389
PLATYPUS	QKLLGTTYRI-----MANALSKEPASLEQIER-----NK--ARKVMELSG-ASFVNV	3377
CANARY	QNLLGTTYQI-----MANALSQDPRCLQIEK-----EK--ARKISLISG-ESLENP	3378
OSTRICH	QNLLGTTYRI-----MADALSHDPRCLQIEE-----EK--ARKVSVLSG-ESLESP	3348
TURTLE	QNLLGTTYHI-----LASALSKDPGCKLEKIEE-----EK--ARKVVMLSG-ERPENS	3387
ALLIGATOR	QNLLGTTYRI-----MAVALSKDPRCLVELEE-----DK--VRKVSMLSG-EKPDSP	3345
SOFTCORAL	HHLKSRNLDA-----ITNVLSIPGTW---DSLE-----KEAKEKLHGLCSS-KNPEQL	3385
STONYCORAL	HHILRSKTFDI-----LCKAMLDGGVVIATLES-----QAKN-ALVKLCRI-DETESQ	3403
ACORN_WORM	HEILSGRSCHL-----VAQTIQEAGDDIFDVIH-----LKCRKS-----LRSLIE	3382
LANCELET	HHTLTSLSYEI-----VAHALIQEGGAILTGLK-----DTRHAQLLTAAGV-SPDTSV	3405
SEA_URCHIN	HRIILTSKTYQS-----MASALQEEKGEMLTRLS-----DAGKLDKLLSKAE-CQESKP	3403
STARFISH	HHTLTSKSYDL-----VAITAIQKGGADILTGLR-----NVGKLDKLLGLVG-QNATRP	3418

FAT

Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

TERMITE	DTLMQN L KQYGLSSSLKTAAEVVT-----RGNSEQAVAKAYLQVAKY C RAHSNTS	3314
SHRIMP	ESWQRE L LSCSYKSLQLAVNCAEGKLVKS--DALNQDDSKKSDSDAHLALVKY C ECECVIKW	3381
SCORPION	SKLEID L FCNKNEYKCRaidI IQEVEQK-----MIEFDQATIGETyFK F ANyCNKILRMQ	3411
ALVINELLA	EKVIM L TEECYRQMKAAVVASDSSC-----SDDTKINMAHMA L VSYCDTYLRQS	3346
CAPITELLA	QEIVAS L HEAAYNSFKSGVGAAS--Q-----PESVCVNKAYMS L VH F CDQVLRQR	3387
SPONGE	KAISEG L WIQALSSFNAGVRSgTTLNP-----LTKDPVPTVQSLEEL F G F CDNALRQE	3450
OYSTER	RELAR L VEEGYNQMRKSLSYDGRG-----TRTCRYGLEEAYLALAQY C NKFLRMA	3396
SNAIL	GD L IKELIHHGYESLRKVISEVPED-----SSRDAVCLQDDVQLALAKY C DKYLRLA	3405
TRICHOPLAX	EKIAAK L TSHACQALHQAV-----KAS-----KEERGSSYIEAMMM V N F CDDILRHE	3417
SEA_ANEMONE	--IVS L Q L ITRSFTSLQEANKAAKQAATS-----SSDGSTTCMVEAMM V PFCDRALRRK	3408
PRIAPULA	TALV S GLISAGFRELREAVDVGDEEESSASLAS-----SPSAAHVAMAS V CDYFLRVR	3446
ESHARK	QEVVIG L HRKTLHYLERAVRKAEEVQSL---AGEHVDIAGVIEAYVNLAN F CDRCLREK	3445
STERLET	EQVVV L HRKALQHLQNAVKKAEELQSR---STEHDIPGAIEAYMT L VN F CDKRLREE	3449
COELACANTH	EQIVIS L YRKALSYLQTAAKKAEQVQSR---STEHDVAGVIEAYMT L V F CDKRLREV	3443
HUMAN	E KVIAG L YQ R A F Q H L S E A V Q A A E E E A Q P P---S W S C G P A A G V I D A Y M T L A D F C D Q L R K E	3427
CAECILIAN	DEVAAS L FKKSFHYLDSAVKKAEEVQSR---AMENVDTTGVIKAYMT L V F CDTHLLKK	3446
PLATYPUS	KQVIAG L HRRAFQYLTHAVRKAEEVQSH---SSEHVDTTGGVIDTYMT L V F CDKHLRNE	3434
CANARY	KKVLG L NKKAFQCFSCAVRKTEEEVQSS---SVDHVMVGVDAYLTL I S F CDQYLRE	3435
OSTRICH	EKVLG L NKKAFQCFSSAVRKSEEEVQSH---SMEHVDVAGVIDSYMT L V G FCDQHLRRE	3405
TURTLE	EKVIAG L NKKAFQYFSTAVRKAEEVQSH---SMEHVDLTGVIDAYM L V F CDKHLRKE	3444
ALLIGATOR	EKVIAS L NKQAFQYFSAVNRKAEEEMQSR---TMEHVNLTGVIDAYL T L V D F CDKHLHKE	3402
SOFTCORAL	DKILGH L TTKSFTTLQRAIKIAQTNNENN---QKNAESVRNLVTSMT M AN F CDRLLRMK	3441
STONYCORAL	KKVVS D LMTRSFVSLQSAIKAAKNAEGK-----CNTTQTSGTVDAMIAM V N F CDNCLRKK	3458
ACORN_WORM	ALIVN G LQNKAEHYFKKGVKLASDEEDA-----IDMDREGVIDAYV S M A T F CDKMLKQQ	3436
LANCELET	DQTISS L LQKGHACLQKAVKLASDEEKA---RQDTSLDKSGIVDAFMA V G F CDKILRHQ	3462
SEA_URCHIN	EKV C Q S L F M K S K Y L DDAVGTIKLDPASHLSSSAKREEQSMAKAHMA L V S FCDQLLRQQ	3463
STARFISH	EQIC S T L Y S KAYSELQAVSLADKDDA-----VTSQSERSMTEAYM L V S FCDRLRLK	3472

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TERMITE	RE-----DNFGTDIVTSI L RAMRYGSK D AR Q L F P R L L Q L PGLDTS	3354
SHRIMP	KDH-----VDVSQYKSLMVSV L RAMANGSR D A H F F P R L I N L MNEDAS	3425
SCORPION	EEEEK T L S -----LSFETYPSVLTNS L N A L K NGNL N A I K L F P R L L Q I I EVYPD	3460
ALVINELLA	ENDES G Q K -----ILPVLSSFPAAVTVSL L A A M K NNCS E AR Q R F P R L L Q L TEQYPE	3397
CAPITELLA	ENDEIS G T-----KCESEDFPLALVTS L S A M K NS S K D AR Q L F P R L L Q I IERFPQ	3438
SPONGE	DHDDE G S T -----GLDTKSFP S I I INHT L T A MS L G S S K ARE L F P R L L Q LVEAHPD	3500
OYSTER	EDDT D KES L N L S-----KECQKNFPETITVCL L N A M K LDS M EAR Q R F P R L L Q L VEMYPE	3450
SNAIL	EEND G L-----VA-----SESMEVFPATAVKCL D A M RAG S A E ALER F P R L L H I IEHYPD	3455
TRICHOPLAX	EDGRAN Q -----PKGL---IDTKIFPEV I RY T L E A M AYNS M DAR Q R F P R L L Q I VERNPN	3469
SEA_ANEMONE	EDES D G P S F I S PFGLHYEFV Q R F PEFVV R Y V L K AMEHG S E A R N R F P R L L Q I VELYPH	3468
PRIAPULA	EDDG T TV-----LPTDGYAETVIT S L R A M ALGS S E A R D S F P R L L Q L VDLYPD	3494
ESHARK	EESAT A IN-----FSEQQTFPACVVE K I L K A M K YNS K E A R L K F P R L L Q I VKLYSA	3495
STERLET	EESAEV S T-----FSELPTFPVVVD T M L K A L K LNS K E A R L K F P R L L Q I IELYPA	3499
COELACANTH	EESAEV S H-----FSELQTFPAVV V EN L R A L K LNS R E A R L K F P R L L Q I VELYPA	3493
HUMAN	E ENAS V I D -----S A EL Q A Y P A L V E K M L K A L K LNS E A R L K F P R L L Q I IERYPE	3477
CAECILIAN	EDTT A VID-----HSHLQ Q FP T IVVE K M I K S L K LNS K DAR L K F P R L L Q I VELYPA	3496
PLATYPUS	EEG T S V I D -----AVVLQ A Y P A L VVE K M K A L K L NS R E A R L K F P R L L Q I IERYPE	3484
CANARY	EEGL L E I N-----TVDLQ Q FP A IVVE K M I K A L K LNS R E A R L R F P R L L Q I IERYPA	3485
OSTRICH	EEGL L E I N-----TADLQ L FP A IVVE K M I K A L K LNS R E A R L R F P R L L Q I IERYPA	3455
TURTLE	EEG S S D V S -----ALDLQ T FP A IVVE K M I K A L K LNS R DAR L K F P R L L Q I IERYPA	3494
ALLIGATOR	REG L S D I S -----AVDLQ T FP T IVVE K M I K A L K LNS R E A R L K F P R L L Q I IERYPA	3452
SOFTCORAL	EED S E Q T P -----RLDM K LP G I V IR F V L K S M A F S A E AR Q K F P R L L Q L VELYPG	3491
STONYCORAL	EVS V AP V E-----VDTK L FP G IV V RY M L K S M C Y S S K E AR Q K F P R L L Q I VHKYPD	3507
ACORN_WORM	EQNE D G A V-----SRSS K SP S FR S V V F H L L K A L K LNS V E A I Q R F P R L L Q I VETYPD	3488
LANCELET	EDDE E G T E-----LSS I P L AA A V S N L Q A L R H D SP E AR Q R F P R L L Q L VEIYPD	3512
SEA_URCHIN	DDDD C N P D-----Y L P L M E A Y P S T V V N S T L Q A M N L NS P E A R Q H F P R L L Q L VEKYPD	3514
STARFISH	ESDEV P M T -----Y L P Q T D N F S Q T V V H Y T L K A M H Y S S Q E AR Q R F P R L L Q L VEACP D	3523

FAT

Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

TERMITE	-LSELFHKESSAVVWVWFLGWVNLACLGTPVGPVLDHIILRLAETYPQSLIYAFQLSR	3413
SHRIMP	-LLSSFKEEYEKVPWVWFLWLSHLIYVDKVPGLAQPVVERLAAEYYPQAVIYYPFGISK	3484
SCORPION	-TIPEFIAKSKVVPWVWFLSWINQLLTLDDKPEATAVQYI IKEIGTNFPNALVYYPFKLSY	3519
ALVINELLA	-NMSLFIQKTSSVPTWVWFLGWISQITALLDDKPESPAIQDILKRLAVEYYPQAVVYYPFKMSC	3456
CAPITELLA	-TREVIRKSRDIPWVWFLGWVSVQICAILDDKPESSAIEHILLNADIYPNALVYYPFKLSN	3497
SPONGE	-TMDLMINKSSTIPWVWFLGWINQMIALVDKPEASRAVHDILIRIADTYYPQSLIYAFRMS	3559
OYSTER	-IRSTFVEKSGQVPCWVWFLWISQMMALLDDKPEGSTVHHILTELAETYPQAVVYYPFKLSS	3509
SNAIL	-TTDMFLKKSETIPWVWFLWISQMMALLDDKHQAHAVRPIILRIATEYYPQAVIYYPFHISQ	3514
TRICHOPLAX	-TIDGFMKSSAIWVWFLWISQMMALLDDKPEARAVQEIILFRIADEYYPQAVIYAFKVS	3528
SEA_ANEMONE	-TLDSFVKKVETVPCWVWFLGWINQMVALMDKKEARAVHGI VTEIAKNYPQALCYAFKVS	3527
PRIAPULA	-TLPLLTskVESVPCWVWFLWISQMVALLDDKREARAVQGILLSIAESYYPQAVIYPLNLSR	3553
ESHARK	ETLDDLKKEVSSVPCWVWFLGWINQMMAELDDKKEAVVQHIIEEIAADSYYPQAVIYPLMISS	3555
STERLET	ETLDDLMAKESVPCWVWFLWISQMMALLDDKKEAVAVQHVKEIAEYYPQAVIYPLFMISS	3559
COELACANTH	ETLDDLMAKMGSSVPCWVWFLWISQMMALLDDKKEAVAVQHIIEEIAEYYPQAVIYVNFMISS	3553
HUMAN	ETLSLMTKEISSVPCWVWFLWISQMMALLDDKQAVAVQHSVEEITDNYYPQAVIYVYPIISS	3537
CAECILIAN	ETLDMTREVSSVPCWVWFLWISQMMALLDDKKEAVAVQHIIEEIAADSYPEALVYYPFMISS	3556
PLATYPUS	ETLDMTQEISSIPWVWFLWISQMMALLDDKKEAVAVQHTIEEIAADNYYPQAVIYVYFMISS	3544
CANARY	ETLGLVTQELSSVPCWVWFLWISQMMALLDDKDEAVAVQHTVEEIANYPQAVIYVYFMISS	3545
OSTRICH	ETLGLVTRELSSVPCWVWFLWISQMMALLDDKDEAVAVQHTVEEIANYPQAVIYVYFMISS	3515
TURTLE	ETLGLMAREISSVPCWVWFLWISQMMALLDDKDEAVAVQHTVEEIANYPQAVIYVYFLISS	3554
ALLIGATOR	ETLSLMAQEISTVPCWVWFLWISQMMALLDDKDEAVAVHHTVEEIAHNYYPQAVIYVYFMISS	3512
SOFTCORAL	GDIEAFKRKSSDVPCWVWFLWISQMMALLDDKRESHAVQGIQLQDLAKHYYPQALLYPLKISA	3551
STONYCORAL	-TLEAFVKKAADVPCWVWFLGWINQMMAIDKPEGKAVHGI VSEIAKRYYPQALWYYPFKISS	3566
ACORN_WORM	-TMDTVELTSETPCWVWFLWIGQMLLALDDKVESISVQGILLEIANYPQALVYYPFKVSS	3547
LANCELET	-TMDLFIKVVSHVPSWVWFLWISQMMALLDDKPEAVAVHGI LTRIAEQYYPQALVYVPLKISS	3571
SEA_URCHIN	-TMQSLVKKASIIWVWFLWISQMMALLDDKPESLAVQGI LKAIKADYYPQALVYYPFKISS	3573
STARFISH	-TMQLMIKEVSDVPCWVWFLWISQMMALLDDKPEGPAVHGILTDIAYEYPQALCFYYPFKISS	3582

FAT

TERMITE	EKYNLESGHV--SLKALVDQLASLLFTD---PVIDIFLRAFSCLGQPRKMLYHFVEKLEQ	3468
SHRIMP	QQYNFSS-HEGKLAKAMCDKVEALLSSH---KLLHQFVSAMSLMVVPSIACKDAIQNVLQ	3540
SCORPION	EMYKFPDTLQGENKEFVVKLSSLSQL---KLVDQFVNALDLSVPELLYKEYFKEILQ	3576
ALVINELLA	DGYKFSNDEQGKAKAVMIRVNEELSKN---PLIGKFINALEQLGQPDLSLFDWYQNLEW	3513
CAPITELLA	HNKFTSDAVSSKSKSVCDRLHQMLSKN---PLIDRLIFSLMMHEPAVLIKDWIMDMKN	3554
SPONGE	SGYKFGHNS--EGKELFEKLEKLSQ---QLMDEFIAALEQLNSPELAWKDWYDNEK	3613
OYSTER	EGYKFTNKD---EAFVTKLSTLQDE-QLPLVPKFISALEHMSQPDQIFKDWFDTRL	3564
SNAIL	ESFTFGSTAEDRRNKQIEELDALLSEE-RVPLVRTFISALEQFSQPVMQFDWSDRITK	3573
TRICHOPLAX	EQYTFEETSVGRQNKTAVKLSKLSQL---PLIESFVRALEQLSQPDLVFKDWVDEVKG	3584
SEA_ANEMONE	EQVFDSSPEGNTNRKAVERIRKLLS---PLMDSFIAALEQLHNPMAFKDWCDGEIK	3583
PRIAPULA	EHYFTVDAAGAEAEAYLHRLLATLSTCMDMSQLQLVVALEQLSSPHMLFSDVADARP	3613
ESHARK	ESYTFEQTARGNTNKEFVERIKNKLDKG---GMVEVFINSLEQLSNPDMFLKDWVDNFRS	3612
STERLET	ENYVFEDSATGHRNKEFVARLKSQLDKG---GVVKNFIDALQQLTNPMLFKDWVEDVKK	3616
COELACANTH	ESYFEESSPKGKKNKEFVARLKSQLDKG---AVVEDFIHALEQLTNSDMI FKDWVDVNRN	3610
HUMAN	ESYFPKDTSTGHKNKEFVARIKSKLDQG---GVIQDFINALDQLSNPELLFKDWSNDVRA	3594
CAECILIAN	ENYSFEDTATGHKNKEFMLRIKSKLDKG---GMVQDFIQSLEQLSNPDMIFKDWIEDMKN	3613
PLATYPUS	ENYSFKDTSAGHKNKEFVTRIKSKLDKG---GVVQDFIQALEQLSNPEMLFKDWVEDIKI	3601
CANARY	ESYCFKDTAAGCKNKEFVERIKNKLDRG---GVVQDFVHSLQLSNPVMI FKDWAEVDRN	3602
OSTRICH	ESYFPKDVTGCKNKEFVERIKKLDRG---GVVQDFVHSLQLSNPMMFLKDWTEVDRN	3572
TURTLE	ENYSFKDTATGHKNKEFVARIKSKLDRG---GVIQDFVHALEQLSNPVMLFKDWVEDVKN	3611
ALLIGATOR	ENYSFKDTATGHKNKEFVTRIKSKLDRG---GVIQDFVQALEQLSNPEMLFKDWVDVNRN	3569
SOFTCORAL	EQFKFGGSIEEQKNKFVESLNSLSF---PASDDLQALEQLTNPPEMVFKDWMDVVKV	3607
STONYCORAL	EHFVFENSEDGKANEAVKRLRSSLEH---PLLDDFIAALEMLTNPPEMVF RDWCEGPMK	3622
ACORN_WORM	ENFSFENTVTGKRNKEKVSQLAAILDNV---PLVMHFICALQQLTNPHEICKDFTDDVLV	3604
LANCELET	ENFEPEDSVTGRNRQEAVTSLKKTLVSIY--SLVDKLIIGGLEQLSHPDQLFKDWGDDADL	3629
SEA_URCHIN	EDFKLGDKSKEKQRKDAVKEIEDILSTV---PLVENLTLALQRLTHPGFIKDWISVIN-	3629
STARFISH	ESFTFDESNTGRKNASARKIGAILESI---PLLDDFICALQQLNPEFVFKDWADDVMK	3639

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FRB 3582-3675

Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

TERMITE	LLN-----AKRPNCDLHMHYDTMMKELFPSSYKGIHG---AL-----FKDI	3507
SHRIMP	EKD-----KQKMEEGLSEIVSEFLKVQNRSSKGNAE-----EKGEA	3576
SCORPION	MKK-----DKGDKNEIVKLYKKLCHLELFNYNPRDKMK-----E	3609
ALVINELLA	KECFSQ---PEK--NKTHILTMKYKMYDQLLATET-----NDK	3546
CAPITELLA	AKGPGG---SSQSLSMAYVKERYQELYKELLCIESEDGSL-----Y-----SDSADCSM	3600
SPONGE	PLVGS---VTVPKRDKNAIKRVWEQMYSQLLETRSGGLGDK---SLYG-----GSPSLQK	3661
OYSTER	KFM-----KMKPKKAMKEEYQIMYKKVLEFTEVGRGASQ---RSQTEETLSMVDK	3613
SNAIL	ILE-----KRP-AAEIKKKYKEIYDMLLEMPHKGEQSGTQ-----AQQTSTFGAVSM	3618
TRICHOPLAX	L-----KKSIGSIAESIRICYQKLRDGLLDVSNSESE-----AASLSTSGELIEF	3629
SEA_ANEMONE	QLL-----QTKNKAKEAFRSIYKQLFDSSVNRATDSSQ-----PAAEEM	3624
PRIAPULA	LLM-----TRRADPARFRKIYASLFDTRRSQEE-----PGGR	3647
ESHARK	KLE-----KK-ENKTQLKNLYSEMYSNLANAG-----APGI	3642
STERLET	ELE-----KPKTDKLLKNMYEEMYSALGNPR-----CQGI	3647
COELACANTH	ELD-----KPQRNKANLKRMYEEMYANLGNLR-----APGL	3641
HUMAN	ELA-----KTPVNKKNIEKMYERYMAYALGDPK-----APGL	3625
CAECILIAN	ELA-----KSQRNKNNIKLYEEMYNLGNLK-----APGI	3644
PLATYPUS	ELT-----KTPINKNNLKRMYEGMYKTLGNLK-----APGL	3632
CANARY	ELS-----KPQRNKKLKEMYERYMKNLGNLE-----SPGL	3633
OSTRICH	ELV-----KTQRNKNLQDMYERYMYRNLGNLE-----APGL	3603
TURTLE	ELG-----KTQRNKNLKEMYEGMYRNLGDLQ-----APGL	3642
ALLIGATOR	ELG-----KAQKNKALKEMYEGMYRNLGNLQ-----ASGL	3600
SOFTCORAL	LLS-----TKGNAVKIRESYGEMSKLLLNVKKR-----GTNSDGLF	3644
STONYCORAL	QLLED---QIKRNDSQAVKQCFGAMFQLLMDCRKRTKS-----GSQTRGTES	3666
ACORN_WORM	PALRAR-----NPTAVKKAVERGLYTRVFDSCRQSSQD---SLF-SESDAVTQSLPF	3652
LANCELET	KRLKLVDPKRTKEDKVTIKRLYDEMYDSLDFRSASQDSSMSLFGSQSSDLESQSVGF	3689
SEA_URCHIN	SXM-----NSKERDHPAIKQEQYQQLYQQLFES-----GGR---QGGPSSSSQTVEP	3672
STARFISH	PLL-----NVAKRDKNKIRQACHEIYMNLINHRSTVTDGTAG---SSQDSQSSPSVGF	3689

KINASE

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TERMITE	QEYRKRLEKAES---NIKCG--NKKVL----KDICFIKEKLYI-----IQD	3545
SHRIMP	YTRQDRAKKQMAEAFTKAFGENLKKAKLSI-RDIQRELGSMGRVLQ-----LSPEEM	3628
SCORPION	RKLHLKVAKVCVSVVSEFGKDGKILSMPL-KEASVKYETLLKKITT-----MSE	3659
ALVINELLA	GPYRTRFAEKYRRDFNHAFGTGGKELQOFTY-AKFQEEGNKILQ--KI-----NNF	3594
CAPITELLA	GPYRSDFVKQFISQFDEYFGKMGSKLPLGTF-MKVLSWLSDKSEKVKK-----AFS	3650
SPONGE	GARQKTFQAQYAKNIEDKFGKGGAKIISMSG-TQLASAFNEVYNKMR-----LNK	3712
OYSTER	GKYPKFAERFKKDVDSFCFKNGEKILLDMSF-SKLAGAYKKVYKMDM-----FEVKEKN	3666
SNAIL	GEFHRRFQAEVFNEDNHFGVDGSKLVTMTA-KEFSGILRNLQ--AQ-----FEKHKAD	3669
TRICHOPLAX	GSHKRRFIQHFQKVIQYFGKDGSKLQSMKA-SDFEKIASRLIQEIS-----GKI	3678
SEA_ANEMONE	GPFRKFSKEHASRFENIFGKDGEKLVNMSL-KTAK-----L--KQ-----QMV	3665
PRIAPULA	GRYWSVFTRTWAREVEEKCGRDGSKLLAMAA-ADANQVLSALGKEMK-----TKA	3696
ESHARK	GAFFFFRVTFGKFKKIDQHFQKDGLLLLNMMNL-KAFNVAVGQIMET-----QK	3688
STERLET	GAFRKKFAQHFQKFDKTFGKGGAKLFDMKH-DAFRKASDSLWGSISE-----EQKK	3698
COELACANTH	GSFRSNFVKAYGKEFERVYGRGKELLDKMS-SDFFKVSDQLLTSMR-----KF	3689
HUMAN	GAFRRFIQTFGKFEFDKHFGRGGSKLLRMKL-SDFNDITNMLLLKMN-----KD	3673
CAECILIAN	GEFRFRFVQAHAKDLDTHFQKGGSKLVDMKE-DAFAKTAYSLFNNMR-----GS	3692
PLATYPUS	GAFRKRFIQAFGNFDDHFFGRGGSKLLQMKL-SDFTSITNSLNSKMK-----ES	3680
CANARY	GMMRKRFIQAFGKDLDDHFFGRGGSELLNMKT-SDFDAIANSLSKMI-----KT	3681
OSTRICH	GLLRRRFIQAFGKDFDHFQKRGSKLLNMKA-SDFDAITSALLSKMT-----KS	3651
TURTLE	GLFRKRFVQTFGKDFSSHFGKGGSKLLDMKA-DDFNRIAFSLLSKMK-----D-	3689
ALLIGATOR	GLFRFRFIQAYGKEFDTFQFGKGGSKLLDMKD-NEFKIVNALLAKMR-----DG	3648
SOFTCORAL	GSIRRFQAEFSGNVVVCVEDGSKIIDMSI-KAFESAMKTTNEKM-----KA	3691
STONYCORAL	GPFRKFAQEFANVQRIFGKEGEKLVGVKM-TDFSKWCRDIQQKMKVFK-----RNR	3717
ACORN_WORM	GPFPKQKFAQFVQKQKRFGERGCKILSMQHQKFMNFRNEVDQLMR-----KKK	3702
LANCELET	GPFRFRFAQQFAKECEKMFQKDGSRILDMKE-KEFMKLSGLQNMMDGFYRKAFFPREKAN	3748
SEA_URCHIN	GPYWKKFGREWQKRFDSFQDGSKLAAMDY-KTWSKLRQDI-----CAKMT-----G	3720
STARFISH	GNFRFRFAQEQKKEFAAFQKDGTKVIDMQL-KTFSEHYGKL-----YKEMAAK---R	3738

KINASE

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Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

TERMITE	IKPPVQLKDYSPWLSFQGGKHCFLLELEIPGQYTGESKPLIQHHVKIAGFKQTVVPMKTL	3605
SHRIMP	RKLPRQLKAYSFWLANFQASKY-SEVLELPGQYTGMSKPLPEYHVKISSFDENVLLMSSM	3687
SCORPION	MNKEAKLRDFSDWLSFHSIKY-SELEIPGQYTGKRKPIPEHHVKICNFQDKVDLSSSL	3718
ALVINELLA	EKPPEDIAEYSEWLANFQGCEF-DQEIEIPGQYIGKAKPLPQYHTKISSFHSVVKTLQSM	3653
CAPITELLA	NKQPRKLKEYSQWLAEFQAGNH-EASLEIPGQYTGVEVCPLEHYHAKISSFDSQVTVLRSL	3709
SPONGE	FSSSALLKDYSPWLDTFRQEDY-LQVIEVPGLYDGRSKPLPEYHAKITRFDAKVLILSSSL	3771
OYSTER	LKPPANLKDYCQWLANFNPSIQ-GKDLIEIPGQYDGVKPKMPEYHVKVVGFDQRVKVMTSI	3725
SNAIL	LTPPTNIGKYCSWMANFNPNHE-SRELEIPGQYDGLRKPMPYHVVKVAGFDERVLMVSSSL	3728
TRICHOPLAX	KNRPENLKEYCPWLSNFQAANF-TYSIEVPGQYTGGRSKPLPEYHLKIASFGERLLVLKSI	3737
SEA_ANEMONE	SKPPGNLKEYSPWLTNFQADSH-AQKLEVPQYTGQSKMPPEYHVNIAGFDEKVLVLASI	3724
PRIAPULA	ADSPGNLKEYSTWLTDFHSSPA-TCQIEIPGQYRGRSKMPPEYHVKIAGFDEKVLVMKSL	3755
ESHARK	PEPPGNLKEYSPWMSNFKPQFL-GNELEIPGQYDGGKCKPLPEYHAKITGFDERVKVMSI	3747
STERLET	EKEPGNLKEYSPWMSNFKPEVL-RNELEIPGQYDGGKCKPLPEYHAKITGFDERIKVMSM	3757
COELACANTH	QREPGNLKEYSPWMSQFPEFL-RNELEIPGQYDGGKSKMPPEYHAKITGFDERIKVMAI	3748
HUMAN	SKPPGNLKECSPWMSDFKVEFL-RNELEIPGQYDGRGKPLPEYHVRIAGFDERVTVMASL	3732
CAECILIAN	QPEPGNLKEYSPWMSNFKPEFL-RHELEIPGQYNGRSKPLPEYHVKISGFNERVKVMSI	3751
PLATYPUS	SKPPGNLKECSPWLSDFRVEFL-RSELEIPGQYDGGKPLPEYHAKITGFDERVKVMAI	3739
CANARY	HKEPGNLKECSPWMSDFKAEFL-RSELEVPQYDGGKPLPEYHAKISGFDERISVMESL	3740
OSTRICH	HKEPGNLKECSPWMSDFKAEFL-RNEIEVPGQYDGGKPLPEYHVRIISGFDERIKVMESM	3710
TURTLE	QKEPGNLKECSPWMSDFKAEFL-RNELEIPGQYDGGKSKPLPEYHAKISGFDERIKVMESI	3748
ALLIGATOR	QKEPGNLKEYSPWLSDFKAEFW-RNELEIPGQYDGGKPLPEYHAKISGFDERIKVMESL	3707
SOFTCORAL	KKFVGNLKDYSPWLANFQTSQE-TIQLEIPGQYDGGKSKPLPEYHVKIVAGFGEKVKAMSSL	3750
STONYCORAL	TPPPGNLKEYSPWLSRFQSNF-THTLEIPGQYKGGKTKPLPEYHVKIVGFDEKVVQLPSI	3776
ACORN_WORM	MSAPGNLREYSPWLSDFQPINY-EKLEIPGQYKGRSKPLPEYHVKIAGFDEKVKVMSL	3761
LANCELET	CYAPGLLKDYCPWLSDFNPLDY-DRELEIPGQYTGKVKPLMQYHAKIAGFDQRVKVMSL	3807
SEA_URCHIN	KDDPGNLKEYSPWTFATQTLR--GDELEIPGQYDGGKSKPLPAYHVKIAGFDETVLTLSSSL	3778
STARFISH	RDPPGNLKEYSTWFSDFQQLSY-DRELEIPGQYGGKSKPLPEYHVKIAGFDEQVKVLSM	3797
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TERMITE	RLPLQVTIFGSDAKEHQYLKVFGEGLRQDQRIEQLFNLMNKILDQDPTCRHRN--LSITT	3663
SHRIMP	RVPMRIIRGDDKEEYKFLVKGEDLRDQRMQMFVTLMNSIYARSPLCTKASSVPSLDT	3747
SCORPION	TKPRCLTIRGNDQKDYKFLVKSGEDLRQDSRIEQLFDVMNDIYQCNAIQFNK--LKLET	3776
ALVINELLA	RKPKRIVIRGNDQKEYPFLVKGEDLRDQRIQQLFGLMNEIFSHASKCHQYN--LQLRT	3711
CAPITELLA	RMPKSIVIRGNDKEEYKFLVKGEDLRDQRVQVFNLMNEIYANDANCHARR--LQLKT	3767
SPONGE	RKPKRLTIIGDDTREYMFVKGEDLRDQRIEQLFETMNVKLSDDPICSQRR--LNLRT	3829
OYSTER	RKPKRITIRGNDEREYHYLVKGGEDLRDQRIEQLFVLMNQALSDPACQQRN--LKIKT	3783
SNAIL	RRPKRITIRGNDKDYHYLVKGGEDLRDQRIEQLFVLMNVKLEKDPVCKARR--LVLKT	3786
TRICHOPLAX	RKPLRLTVQGDDEEYKFLVKGEDLRDQRIEQLFCVMNEILAQDSICSQQD--LRLRT	3795
SEA_ANEMONE	RKPKRVTIRGDDDERDHMFLVKGEDLRDQRIEQLFCMMNEVMSDPAACSQRN--LRLRT	3782
PRIAPULA	RLPKRITIRGHDENEYMFLVKGEDLRDQRIEQLFDIMNRSLDADAACRQRA--LRLRT	3813
ESHARK	RKPKRLIRGNDKEEYKFLVKGEDLRDQRIEQLFEVMNIIILSRDAACSQRS--LQLKT	3805
STERLET	RKPKRLIMRNDEREYKFLVKGEDLRDQRIEQLFDVMNIIILSRDATACSQRN--LQLKT	3815
COELACANTH	RKPKRLIQGNDEREHPFLVKGEDLRDQRIEQLFEVMNIIILSQDAACSQRN--LQLKT	3806
HUMAN	RRPKRIIRGHDEREHPFLVKGEDLRDQRIEQLFQVMNGILAQDSACSQRA--LQLRT	3790
CAECILIAN	RKPKRIIILGNDEEYKFLVKGEDLRDQRIQQLFDVMNIIILSQDAACSQRN--MQIKT	3809
PLATYPUS	RKPKRIIRGHDEREYKFLVKGEDLRDQRIEQLFDIMNIIILSQDAACSQRN--MQLKT	3797
CANARY	RKPKRITIRGSDEREYKFLVKGEDLRDQRIEQLFDVMNIIILSQDATACSQRN--MQLKT	3798
OSTRICH	RKPKRITIRGSDEREYKFLVKGEDLRDQRIEQLFDVMNIIILSQDAACSQRN--MQLKT	3768
TURTLE	RKPKRINIRGSDEREHPFLVKGEDLRDQRIEQLFDVMNIIILSQDAACSQRN--MQIKT	3806
ALLIGATOR	RKPKRIIRGSDEREYKFLVKGEDLRDQRIEQLFDVMNIIILSQDASACSQRN--MQIKT	3765
SOFTCORAL	RAPKRITILGNDEREHTFLVKGEDLRDQRIQQLFGLMNDVMRDDAACQQRN--LSLKT	3808
STONYCORAL	RKPKCLIRGDDKEDHMFLVKGEDLRDQRIEQLFGLMNDIMANDSACSQRG--LRLRT	3834
ACORN_WORM	RKPKRLTIRGNDKEHNFVKGEDLRDQRIEQLFGIMNDILALDAACSQRS--LKLVT	3819
LANCELET	RKPKRVTIRGDDDERDHMFLVKGEDLRDQRIQQLFDIMNDILTLPACSQRQ--LRIRT	3865
SEA_URCHIN	RKPKCITIRGNDMDYKFLVKGEDLRDQRIEQLFCIMNSILAQDAACSQRG--LTLTT	3836
STARFISH	RKPKRIVIRGNDHEHYSFLVKGEDLRDQRIEQLFRIMNSILEQDSTCSQQG--LQLVT	3855
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Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

TERMITE	YQVVPPLSSHLGIIQWVDGTEALKGLMLGVLDKNEKESYK-----KSCEEHCKWISKPCN	3717
SHRIMP	YQVPIPLSRVGIQWVDSTQPLKDFINDSYRENETKCYGE-----ARALY-----	3792
SCORPION	YQVIPLETTKIGLIEWVDNTNVLGSLFKDAMDKEKESFR----ESDPKMTFYKFLLSKTN	3832
ALVINELLA	YQVIPMTTRIGLIEWMKNKTKLKEILYETFTKEEK---EFFISPNGPRYDYAKWMGVPIR	3768
CAPITELLA	FQVIPMTPRLGMIEWLKNNSCTLKDFLRQGCSDVSWEQIQNKLPNPNANLLCQWIGDSSN	3827
SPONGE	YSVIPVTPRVGLIEWVRNMTPLKDFIQLSDPEKKSIPA-----ASKMNQKWLEQKFG	3881
OYSTER	YQVIPMTRVGLIEWMNDTIPLKEFLICNLTEQEAKFVS-----GNLHNSWIMKLSK	3835
SNAIL	YQVIPMNTRVGLIEWMSNTIPLKEFLNAMTEKERTAYF---GENGPSQLHYKWLPLKLPK	3843
TRICHOPLAX	YQVIPITQRLGLIEWMKNITLKEFLVTDAMEDHEKQHYL--SSQNSPHQLYSKWLKGFSG	3853
SEA_ANEMONE	YQVIPMTQRVGLIEWLKNKTKPLKELHIAATESEKQAMV--VRRKTKNMLDL-----	3832
PRIAPULA	YAVVPMSTRGLLEWVPRTKPLKQLLQEAMTQQQYDAYY--SYSMNPVEHFNKWAATALT	3871
ESHARK	YQVIPMSTRGLIEWLDNTCTLKDFLSSNITTEETQSRRQ----QEVLPKYREWLOKMG	3860
STERLET	YQVIPMTARIGLIEWLENTCTLKEFLFDRMTEEERKHCK-----RPAESYMEWLSKVAG	3869
COELACANTH	YQVIPMTRIGLIEWLENTCTLKEFLSNAMTEEERTNYETLSPKKGPKAQNEWLTKMAG	3866
HUMAN	YSVVPMTSRLGLIEWLENTVTLKDLLLNTMSQEEKAAYL--SDPRAPPCEYKDWLTKMSG	3848
CAECILIAN	YQVIPMTRRLGLIEWLEATNTLKDFLYNSMSEAEQENCS--S---TTKHYKDWIQKMG	3863
PLATYPUS	YQVIPMTRRLGLIEWLENTCTLKEFLKSMSEGEKAAYE--SNPKGPVHEYSWLYKMSK	3855
CANARY	YQVIPMTRRLGLIKWLENTCTLKEFLKNSMSEEDINYY---SPRGPRTATYSEWLSRMGG	3855
OSTRICH	YQVIPMTRRLGLIKWLENTCTLKEFLKNSMSEEDFNYS---SKKGPRTATYNEWLSKMG	3825
TURTLE	YKVIPMTRRLGLIEWLENTCTLKNFLMESMSEEEKDDYH---SRKGPRTATYSDWLSKMG	3863
ALLIGATOR	YQVIPMTRRLGLIEWLPNTCTLKNFLHSNMSEEEKADYC---SEKGPLFAYNEWLSKMG	3822
SOFTCORAL	YKVIPMTRIGLIEWLENTVTLKEFLRNGLSETENETFD--TI----GYKHNKWIVEKFP	3862
STONYCORAL	YQVIPMTPRVGLIEWMNNKTKPLKGVLSAMTKAENDHYI--GP-NGAGACYRNWIDKFKG	3891
ACORN_WORM	YEVIPMTPRIGLIEWVDHCLPLKVFVSEAMTKNERSHYA--NT---RLDHTTWVDMVK	3873
LANCELET	YQVIPMTRVGLIEWMONTTPLAGFLENAMTTREQEAFV--HQ-RLPLIDFDAYVHRLGG	3922
SEA_URCHIN	YQVVPMTPRGLIEWVKRTTTLKDFITRSMTEAEHKVYT--SRTTGPVALFTTWLQKFCQ	3894
STARFISH	YEVIPMTPRLGMIEWAQNTTTLKEFLHLAMTEQEGNAYN--SR-HGPRYQHSEWVDKYAK	3912
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TERMITE	P-----QCSFYEKYGEAHMKYSPEETSAEFRKKNVMIIPWDIRRALQRLSVSPESYFILR	3772
SHRIMP	-----GKNENYTVAKKAKRDRVIKAYEEVVKIPWDLRRGLVVRMSSTEGFFSLR	3843
SCORPION	S-----RDKSIPLLYENIYKI--ADTEVNKKFTECINMIIPWDLRRAFLKFSSSLAEFVILR	3887
ALVINELLA	D-----IGKPKPYQVSYSKNTRSDAITNFKRENLPVWNLARRAYQTMVAVSPAEAFVFLK	3822
CAPITELLA	T-----RQMIENYRKYQKYSRNETLNAFKKREAMVPWDLRKSQKCLASSPESYFVLR	3881
SPONGE	G-----SNYVNWYEMKYLKKADEVKKEYRRIVSAVPWDLRRSLISLASTSEFLLLR	3935
OYSTER	D-----PRDVQQGYMQMYLKYNMTETRRELQKKNIPWDLRRAFHKMSVSPAEFHVLR	3890
SNAIL	K-----TDWGLIYGQVYQNYSKTETMKEFRIKESKVPWDLRRAQLHLSVSPAEFHFVR	3897
TRICHOPLAX	A-----GGPVYMYQSMYRKAKRSEVENHFKFRENVPWDLRRRGFVALSASSAEYMLLR	3907
SEA_ANEMONE	-----TLRILFDIIISREANRDTSESEFKKQAQVPWDLRRRAFQQLAASPEAYLTLR	3885
PRIAPULA	ASESKRAASHVKLYARTFVQCSKSDTVRSFRERESMVPDRLRQAFRLRSASPFAFLALR	3931
ESHARK	R-----KDMFLRYPYMYLKSARTEVTAFRTHEQAI PGDLRRRAFIKMSVTPAEFLALR	3914
STERLET	K-----EKGI AQYITMYKTAKRTEVTRAFRNVHEHVPEDLLRRAFMKMSVTPAEFLSLR	3923
COELACANTH	G-----SVGPQRYGSMYKRASRTEVMAFRSVESLVSRLRRRAFTKMSVSPAEFLTLR	3920
HUMAN	K-----HDVGAYMLMYKGANRTEVTVSFRKRESKVPADLLKRAFVRMSVSPAEFLALR	3901
CAECILIAN	C-----DNISRYEYMYRRASYTEVVAFKARENLPVGDLLRRRAFTKMSVTPAEFLTLR	3916
PLATYPUS	K-----QDFGAYMLMYKHASRTEAVTAFNRNENRVPGDLLRRRAFVKMSVTRPEAFALR	3908
CANARY	K-----AQGISRYHAMRYNASRTEAVTSFKSRESSVPEDLLRRRAFVKMSVSPAEFLALR	3909
OSTRICH	K-----AQGVPRYHVMYRNANRTEVTVMSFKSRESSVPEDLLRRRAFVKMSVSPAEFLSLR	3879
TURTLE	K-----ENGIARYKTMYSRANRTEVTVLSFRNRETSVPGDLLRRRAFVKMSVSPAEFLSLR	3917
ALLIGATOR	G-----KIEDFARYMPMYKRASRTEVTVMSFRNRENVPEDLLRRRAFVKMSVSPAEFLSLR	3877
SOFTCORAL	V---NGNKHIINNYYPMFKKASREVIERKPRELQNLMPHDALRRSFMRLASSPFAFLTLR	3919
STONYCORAL	D-----PRNPSRFYGEFMFKKANRTEVTSFTQKQALVPWDLRRRAFQLAVSPAEFFILR	3946
ACORN_WORM	HV---GDRTSHCVRYGELYKVASRTEILKKFQDLHTQVPWDALRRAFQRLSSSPFAFLTLR	3931
LANCELET	TV---K-NDPWGKVGSLYQKASRTDVTLAFRQVQSKVTWIMRRGYLQMSVSPAEFLTLR	3979
SEA_URCHIN	T---D-G-NITKLFTEAYKKANETETIKAFREREAKLPWDLRRRFQMSVSPAEFLTLR	3949
STARFISH	G---N-QSNHGVRVYGAVYRHANYTDTVKCFRSWEALVPWDLRRRAFIQLSASPFAFLTLR	3968
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Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

TERMITE	QSFACSYAVLCTIAHWLLGIGDRHLSNLLVSVKDGRCVGIIDFGSAFGTAT--QFLPVPELM	3830
SHRIMP	SAFAVSYAALCISQWLLGIGDRHCSNSLVSLKTGRVIGIDFGHHFESAV--QFLPVPELM	3901
SCORPION	YNFITSHAVLCISQWLLGIGDRHTGNFLVSTTTGIEVGIIDFGHAFGTAT--QFLPIPELV	3945
ALVINELLA	TNFTTSHAQLCVCHYILGIGDRHLSNFMVDLQSGRMIGIDFGYAFGSAT--QFLPIPELM	3880
CAPITELLA	GNCATSHALNCISAYIMGIGDRHLSNHMVDLNGKMIADFGHAFGSAT--QFLDIPELI	3939
SPONGE	CTFIQSLSVINICQYILGIGDRHLSNFMVDMETGQLVGIIDFGHAFHSAT--QFLPLPELM	3993
OYSTER	CKCASTHALISICQYVLLGIGDRHLSNFMINLKNEMVGIIDFGHAFGSAT--QFLPIPELI	3948
SNAIL	CEMLTSHAVLCICHYLLGIGDRHLSNFMVNGRTGHHVGIIDFGHAFGSAT--QFIPVPELM	3955
TRICHOPLAX	SHFARTHATVSIICHYLLGIGDRHLSNFMIDRLTGGMIGIDFGHAFGSAT--QFLPLPELM	3965
SEA_ANEMONE	THFARTHACICICQYVLLGIGDRHLSNFLVDMRTGGLIGIDFGHSFGSAT--QFLPVPELV	3943
PRIAPULA	THFIKSHATLSVCHYVVGVDGRHLSNFMVSEQEDGGMVGIIDFGHAFGHSHPRCCLPIPELM	3991
ESHARK	SHFASSHALMCISHWILGIGDRHLSNFMVNLETGGMVGIDFGHAFGSAT--QFLPVPELM	3972
STERLET	SHFTCSHALMCVSHWILGIGDRHLSNFMINMETGGMVGIDFGHAFGSAT--QFLPVPELM	3981
COELACANTH	SHFASSHALMCISHWILGIGDRHLSNFMINMETGGMVGIDFGHAFGSAT--QFLPVPELM	3978
HUMAN	SHFASSHALICISHWILGIGDRHLNFMVAMETGGVIGIDFGHAFGSAT--QFLPVPELM	3959
CAECILIAN	SHFASSHALICISHWILGIGDRHLSNFMINMETGGMVGIDFGHAFGSAT--QFLPVPELM	3974
PLATYPUS	SHFARSHALLCVSHWILGIGDRHLSNFMINLETGGMVGIDFGHAFGSAT--QFLPVPELM	3966
CANARY	SHFASSHALMCISHWILGIGDRHLSNFMINKETGGMVGIDFGYAFGAAT--QFLSVPELM	3967
OSTRICH	SHFASSHALMCISHWILGIGDRHLSNFMINKETGGMVGIDFGHAFGSAT--QFLPVPELM	3937
TURTLE	SHFASSHALMCISHWILGIGDRHLSNFMINMETGGMVGIDFGHAFGSAT--QFLQVPELM	3975
ALLIGATOR	SHFTSSHALICISHWILGIGDRHLSNFMINTETGGIIGIDFGYAFGSAT--QMLPVPELM	3935
SOFTCORAL	AYFARTYGCMTICHYILGIGDRHLSNSMVDLQGRVIGIDFGHAFGSAT--QFLPLPELM	3977
STONYCORAL	SHFASSHACLICQYILGIGDRHLSNFLVDMETGGMIGIDFGHAFGSAT--QFQPLPELM	4004
ACORN_WORM	GHFATSHALLCICQYILGIGDRHLSNFMISLDTGAMVGIDFGHAFGSAT--ELLPVPELM	3989
LANCELET	SHFTTTHATLCAQYVLLGIGDRHLGNFMIDLESGGMVGIDFGHAFGSAT--QHLPVPELM	4037
SEA_URCHIN	AHFARSHAVLCICQYILGIGDRHLSNFLVSLKETGGMVGIDFGHSFGSAT--QFLPIPELI	4007
STARFISH	SHFARSHAVICICQYILGIGDRHLSNFLISLKTGGMIGIDFGHAFGSAT--QFLPVPELM	4026

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G(I)GDRHXXN IDFG T3950

Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

TERMITE	PFRLTPHIVSLLQPLE--ETGLFRETMIHCLRTRLRNNYDMLLATMEVVFVQEPSIDWLEFA	3888
SHRIMP	PFRLSPQIVNVFQPIG--QVGLMKEIMVSALGALQESRHVLTAVLEAFVKEPTKDWLDFV	3959
SCORPION	PFRLTNQYLNLMPLK--EKGVIEATMISALSALRDNADILLNTMDIFIKEPTVNWQENA	4003
ALVINELLA	PFRLTCQLRNLMPLR--EKGLFESTMIHVLRALRDNQDI IINTMDVFIKEPSLDWKQNA	3938
CAPITELLA	PFRLTRQLRNLLLPLR--EKGVIEGTMVHSLRALRQHKQELISTMDVFIKEPSLDWQNA	3997
SPONGE	PFRLTPQFVNLLLPHK--VSGQLRSCMIHTLRALRHSPDLLNTMDVFIKEPSLEWESNA	4051
OYSTER	PFRLTRQLRNLMPLQ--VHGLMESTMIHTLRALRNNCDLLNTMDIFVKEPSVDLWNA	4006
SNAIL	VFRLTRQIVNLGLPFK--VKGLLENTMIHVLHALRQNHDLNLLSTMDVVFVKEVSLDWLQFA	4013
TRICHOPLAX	PFRLTRQMLNLMPLR--ENGQLKCSMVHTLRALRNKPDLLVNTMDVFIKEPSLDWQNA	4023
SEA_ANEMONE	PFRLTRQFTNLLLPLK--ESGLVRNTMIHVMRALRGNHELLNNTMDVVFVKEPSLDWQNA	4001
PRIAPULA	PVRLTRQFLQLLLPHQQRRLLYQTMVHTLRALRDNHRLNLLNTLDVFIKEPSIDWKATA	4051
ESHARK	PFRLTRQILNLMPLK--ESGLIRSIMVHGLRALRDPDLLSTMDIFVKEPSLDWKNLE	4030
STERLET	PFRLTRQFLNLMPLR--ESGLIYSVMVHSLRAYRADPDLLINTMDVVFVKEPSLDWKNFE	4039
COELACANTH	PFRLTSQFLNLMPLK--EQGLLYSVMVHALRAYRANPDLLNNTMDVVFVKEPSLDWKNFE	4036
HUMAN	PFRLTRQFINLMPLK--ETGLMYSIMVHALRAYRSDPGLLNTMDVVFVKEPSFDWKNFE	4017
CAECILIAN	PFRLTRQFVQMLPMK--ESGLIESVMVHALRAYRTPDLLITMDVVFVKEPCLDWNFM	4032
PLATYPUS	PFRLTRQILNLMSPMK--ESGLVYSVMVHALHAFRTDPDLLNTMDVVFVKEPSLDWKNFE	4024
CANARY	PFRLTRQFVNLMMPVK--EWGLIYSVMVHALRAYRSDPDLISTMDVVFVKEPSLDWKNFE	4025
OSTRICH	PFRLTRQFVNLMMPVK--EWGLIYSVMVHALRAYRADPDLLISTMDVVFVKEPSLDWKNFE	3995
TURTLE	PFRLTRQFINLMPLK--ESGLIYSVMVHSLRAYRTEPDLLVSTMDVVFVKEPSLDWQNA	4033
ALLIGATOR	PFRLTRQFINLMPLK--ESGLIYSIMTHALRAYRKDPDLLINTMDVVFVKEPSLDWKNFE	3993
SOFTCORAL	PFRLTRQICNMEPLR--VSGQLQSTMVYTRALRNNHEILLNTMDVVFVKEPSLDWQNA	4035
STONYCORAL	PFRLTQQFVNLMPLK--KSGTLQSVMIHTLRALRNSHDLNLLNTMDVFIQEPSLDWQVYA	4062
ACORN_WORM	PIRLTRQIVNLMPLK--EDGLILSTMVHGLRALRNNPDLLNNTMDVVFVKEPHLDWQKRA	4047
LANCELET	PFRLTRQMLNLLLPLK--ESGLLQSTMVHVLRALRSPNVLLINTMDVFIKEPHLDWKNFA	4095
SEA_URCHIN	PFRLTRQFINLMPLK--IDGVLQSTMVHTLRALRQNHELLVNTMDVVFVKEPSLDWKNFA	4065
STARFISH	PFRLTRQIVNLMPLK--KEGILQSSMVHTLRALRQNHELLINTMDVFIKEPSLDWKTNA	4084
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TERMITE	SRHESLNKK-----SHEESQTWYPQKLDLAKLKEGANPVTI	3926
SHRIMP	QKQEGDT-----QDSKVELFSSKRIELLNDKLSDINPAYI	3994
SCORPION	LKQKRIIGKVDENVSDINIPGNTESDDPNHSECFNWPQKRI LFAKRKLEGINPCYI	4063
ALVINELLA	MRELNQMQSCDENHED-IGIRCTVAVVICPELMTDPHWYPKAKVAFACRKLNGHNPAAH	3997
CAPITELLA	KKEIQAMSNRKEDT-----SKLTLD SQWFPKEKVNIVRQKLEGSNPSHV	4041
SPONGE	KKQALAQ-----KINTDDNTWYPKEKVNICRKLKLGFNSSHL	4088
OYSTER	EKQNMENKVE-----VSPEDVQWYPKEKIEYVKRKLKRGDNPVCI	4046
SNAIL	ERQMRGGMGP-----KDADEDMRWYPKQKIETAARKLKGDNPSYI	4053
TRICHOPLAX	NRQNAKQGL-----KTESDDFSWYPREKVTFAKRKLKGANPAFV	4062
SEA_ANEMONE	RKQAEQDQME-----IGMYEDLTWYPREKVLTAQRKLKGANPAFV	4042
PRIAPULA	ERLADKDIHSN-----ESDQEQVQEWYPKQTI GVARSKLIGANPAHI	4094
ESHARK	LKQMKKGGTW-----NKDVNTREIHWYPMQKVRYARRKLEGANPAAI	4072
STERLET	LKQMKKAGSW-----SEAVNTNEINWYPMQKVNFAARRKLEGANPAVI	4081
COELACANTH	LKQLKKGGSW-----TKEVNTKEVNWYPVQKVKCGRQKLEGVNPIVI	4078
HUMAN	QKMLKKGGSW-----IQEINVAEKNWYPQKICYAKRKLKGANPAVI	4059
CAECILIAN	LKQLKKGQGW-----TKKVNTAEKNWYAVQKVNCAARRKLAGTNPAAI	4074
PLATYPUS	TKMLKKGQGW-----TRAVNTADTNWYPLQKI SYAKRKLKGTNPAAI	4066
CANARY	QRQLKKGQGW-----IKEINTSEVNWYPLQKVNYVRRKLTGANPAII	4067
OSTRICH	QRQLKKGQGW-----IQEINTSEVNWYPLQKVSYVVKRKLKGTGNPGRI	4037
TURTLE	LKQLKKGQGW-----SKEVNTAEINWYPLQKVNCAAKRKLKGANPAVL	4075
ALLIGATOR	LRLKKGQGW-----LKEVNTAEVNWYPLQKVNCAKVRKLAGSNPAAI	4035
SOFTCORAL	RKQAEKQKLN-----LNDMTDLAWYPKEKINSAKRKLKGENPAEI	4075
STONYCORAL	RKQAKTQGIN-----EEEQKADWYPKQKVQSAWRKLEGFNPAYV	4101
ACORN_WORM	KSDASKYGDA-----AEDANEMIERYAKDRINNARRKLQGANPCHI	4088
LANCELET	AKQMDKG-----M-----VGEDDDLDISWYPREKIKFAAKKLQGVNPTHI	4136
SEA_URCHIN	VKQADYQKLS-----EDSREDISWYPKKKIKFAKMLQGVNSTYI	4105
STARFISH	SKQAKAQKDAGRVLEG-Q-----SDPDGNSLDESWYPREKVNFAQKLEGANPSDI	4134
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KINASE

Supplementary Figure 2: CLUSTAL OMEGA DNA-PKcs METAZOA VERTEBRATE INVERTEBRATE

TERMITE	TTEELKAGFKDSK----YLAKFLECVKGH--NSVRSQMPSYQLLP ^{EE} QVDSLLDQATDYN	3980
SHRIMP	TLWAVSQN--KFVAKQKAYENLKQAVL ^{GDRGESV} RASVGERGLSTH ^{QQ} VDILLEQATDPN	4052
SCORPION	TKEELRLGHSNKP----IFQRLTDVCL ^{GDRK-SL} RQNLPKNGLSVK ^{QQ} VKSLIDQATDSG	4118
ALVINELLA	TRDELVQGHKGT----YCCKAAKVVL ^{GDP} EHDIRAKLPPKCLTVE ^{EE} QVACLINQATDGN	4053
CAPITELLA	MRAELALGQLGSY----LKYFVIVLM ^{GDKQADIR} ARLPADGLSSEE ^{QV} AALLNLATDPN	4096
SPONGE	MLIDL ^{EHGF} KNKP----EFKYLKILL ^{GDSSTNLR} ARVGRKCD ^{SVE} DQVCLIDHATDSN	4144
OYSTER	SREELKLGHSKPP----AFPALERV ^{LQGDKRENVR} AQLPASGLTVE ^{QQ} VAAALIDQATDPN	4102
SNAIL	TRDELRI ^{GHLRNQ} ----ALKDFEKVAL ^{GVDQDNIR} ARLKEKGLTE ^{EQ} VAAALIDQATDPN	4109
TRICHOPLAX	TRDELRLCHHL-----SILESFAL ^{GDKQYNER} ARMPADNLSVE ^{DQ} VTC ^{LI} DQATDPN	4114
SEA_ANEMONE	TRQEL ^{ELGH} RRRS----WFRNLQSACL ^{GDRRHNVRA} QKEENELTSE ^{EA} QVCLIDQATD ^{VN}	4098
PRIAPULA	TKAELALGHRKHE----ALKQMTNVVL ^{GDRS^{DL}RA} QLPPEGLTVE ^{QQ} VQCII ^{EQ} ATEPS	4150
ESHARK	TRDELQ ^{LGHETTE} ----AYKSYVAVAM ^{GDK} EHNIRARVPEDGLSVE ^{IQ} VCLIDQATDPN	4128
STERLET	TSEELRLG ^F EKSP----AYQSI ^I AVAQ ^{GE} KEHNVRAREAPQLSVE ^{TQ} VECLIDQATDPN	4137
COELACANTH	TCNEL ^{QLGHEKLS} ----AYQSYLAVVK ^{GDPDHNVR} AREVKEDLPVET ^{QV} ACLIDQATDPN	4134
HUMAN	TCDEL^{LLGHEKAP}----AFRDYVAVAR^{GSKDHNIR}AQEPE^{SGLSE}ET^{QV}KCLMDQATDPN	4115
CAECILIAN	TCDEL ^{ELGHEKSV} ----AYKEMKAVAM ^{GDKTHNVRA} REPDKGLTE ^{EQ} VKCLLDQATDPN	4130
PLATYPUS	TCDELRLG ^{HEKVP} ----AFGDYISVAR ^{GSKDHNVR} ARQPEGLSE ^{EQ} VQCLIDQATDPN	4122
CANARY	TCDELRLG ^H ERSP----AYNDFAAVAR ^{GNSNHDIR} AKEPEDGLSE ^{ET} QVRC ^{LI} DQATDPN	4123
OSTRICH	TCDELRLG ^{HEKSP} ----FFSDFVAVAR ^{GNAAHNTR} AKEPEDGLSE ^{ET} QVCLIDQATDPN	4093
TURTLE	TCDELRLG ^{HEKSP} ----AYKEYVAVAR ^{GSRDHNIR} AKEPEDGLSE ^{EQ} VRC ^{LI} DQATDPN	4131
ALLIGATOR	TCEELRLG ^{HEKSL} ----AYRDYVAVAR ^{GTRDQNI} RAKEPEDGLTE ^{EQ} VKCLIDQATDPN	4091
SOFTCORAL	MKQDL ^{ESGHKAG} ----YYEMLSVLL ^{GDKQHNR} ARHYV--NTVEN ^{QV} ACLIDQATDPN	4129
STONYCORAL	MRDDL ^{QLGHSKQS} ----WYQMESVCL ^{GDRNANVR} AREPESGLSVE ^{SQ} VSC ^{LI} DQATDAN	4157
ACORN_WORM	TRDELKMN ^{MNI} KK---HYCTGYIDVCM ^{GDKKYSM} TREPATGLSVE ^{EK} QVACLVDQ ^{AI} DPN	4145
LANCELET	TKAEL ^{QLGHK} NLP----WFKSFCLVAM ^{GDDGK^{DV}RA} QKPAEGLSVE ^{DQ} VACLIDQATDPN	4192
SEA_URCHIN	TKAEL ^{EMGPHSKDARDAPFLKAL} KSTC ^{GGNTE^{SK}RA} QSKSKGLSVE ^{DQ} VACLIDQATDPN	4165
STARFISH	TQRELALG ^{HSRNP} ----AFSAI ^{KEVVK} GDRSQNIRASSPKSGLSVE ^{TQ} VECLIDQATDPN	4190
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TERMITE	ILGKTWQGWEPWM	3993
SHRIMP	ILGRSWIGWDPFL	4065
SCORPION	ILSRIYFGWDPWF	4131
ALVINELLA	ILSRVFCGWEPWM	4066
CAPITELLA	ILGRTFAGWEPWV	4109
SPONGE	VLGRTYGGWEAWV	4157
OYSTER	IVGRVWGGWEPWM	4115
SNAIL	ILGRAWGGWEPWL	4122
TRICHOPLAX	ILGRTWQGWEPWM	4127
SEA_ANEMONE	ILGRAWEGWEAWV	4111
PRIAPULA	LLGRTWVGGWEPWM	4163
ESHARK	ILGRVWEGWEPWM	4141
STERLET	ILGRVWVWGESWV	4150
COELACANTH	ILGRVWEGWEPWM	4147
HUMAN	ILGRTWEGWEPWM	4128
CAECILIAN	ILGRVWEGWEPWM	4143
PLATYPUS	ILGRTWIGWEPWM	4135
CANARY	ILGRVWEGWEPWM	4136
OSTRICH	ILGRAWEGWEPWM	4106
TURTLE	LLGRVWEGWEPWM	4144
ALLIGATOR	ILGRVWAGWESWM	4104
SOFTCORAL	ILGRTYHGWEPWV	4142
STONYCORAL	ILGRTWQGWEPWV	4170
ACORN_WORM	ILGRAYEGWEAWV	4158
LANCELET	ILGRTWQGWQSFM	4205
SEA_URCHIN	ILGKTYQGWEPWV	4178
STARFISH	ILGRVYAGWEAWM	4203
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