Supplementary Figure 1. Alignment of DNA-PKcs from selected jawed vertebrates.
Full-length DNA-PKcs sequences from selected jawed vertebrates (panel A and Supplementary Table 1), were aligned using Clustal Omega using default settings (1). The percent identity from the percent identical matrix feature is shown in panel A. Panel B shows the full sequence alignment. The human sequence is highlighted in yellow. Identical amino acids are indicated by the asterisks (*) and shown in blue/bold font. Highly conserved amino acids are indicated by the double dots (:) and shown in blue. Similar amino acids are shown in purple, indicated by single dots (.). Identified DNA-PKcs phosphorylation sites referenced from humans are highlighted in green**.** The catalytic amino acids DXXXXN and DFG are in red/bold font.
See also, Figure 3.

A. Percent identity with human DNA-PKcs from Clustal Omega.

SEQUENCE	% ID
HUMAN	100
MOUSE	79.3
TASDEVIL (Tasmanian Devil)	76.76
PLATYPUS	75.02
TURTLE	71.88
ALLIGATOR	70.21
OSTRICH	69.71
GECKO	68.56
CANARY	67.87
CAECIL (amphibian)	67.78
SNAKE	66.5
LATIMERIA (coelacanth)	65.32
STERLET (fish)	64.8
XENOPUS	64.31
BAMBOO (Banded Bamboo Shark, bshark)	62.27
MILII (Elephant shark, eshark)	62.14
GAR (fish)	61.77
DANIO	58.42

Panel B: Clustal Omega alignment of DNA-PKcs/PRKDC in selected jawed vertebrates.

```
CLUSTAL O(1.2.4) multiple sequence alignment

DANIO           ------------------MAADTSTVGGIQGYLLKLHSSLEDTVSTNVAIVCHDIIGDLGQ  43
MILII           ------------------MAGPRGAAADTLSAFSKLHHLLSLSDVKSAAAESHSAVGSISR  43
BAMBOO          ------------MADGMRRHGAGVGLEVERRLQQLEQLLSAQDSRSAAVESHSIVANLTH  48
XENOPUS         MLLAGAGGSSGDGQDGVASGPAESAAGILGRLHQLHGLLSLE-SGVGAEGAHSLLHNLAE  59
STERLET         --------------MAQPGSCSVGAGGIQGNLHKLHSFLNATDAKSAAVESHNLIGNLGQ  46
GAR             --------------------MAGSGGGIQGYLQKLHSLCGAGETKQTALECHSVIGDLGQ  40
LATIMERIA       --------------MAEEGGSPSAVEGVSGYLLKIHSSLTVTDTKSAAIEISNIFGNLRQ  46
CAECIL          --------------MSVPGVGGDSAVGVQGSLLRLHASLSSKDPGLEAPVAQSLIRSLGE  46
SNAKE           ------------MASSL-VVP---GGGLQGFLLQLHDALRSSDASSAALRGCSLIRSVAE  44
CANARY          ------------------------MAGVQQCLLQLHRCLQPGDAGGSALHGYSLLRSLAE  36
OSTRICH         ------------------------------------MCS--------------ERKDVQA  10
GECKO           ------------MAISLPVA----GGGLQGLLLQLHGTLQSPDPASAALHGHSLIRSMAE  44
TURTLE          ------------MAAALPVGG---GGGIQGSLHQLSCALQDPDPGTAALRGYHLIRGVGE  45
ALLIGATOR       ------------------------------------------------------MAALV  5
PLATYPUS        --------------------MAGSVPGPQGSLLRLQRFLEAEDAGVSAVAAYQLIRGLGQ  40
TASDEVIL        -------------------MSGAGGGGLQGSLLQLQELLSGGDPGSAALAAYHLIRAVGQ  41
HUMAN           --------------------MAGSGAGVRCSLLRLQETLSAADRCGAALAGHQLIRGLGQ  40
MOUSE           --------------------MAEEGTGVRCWLLQLQEFLSAADRCSAAGASYQLIRSLGQ  40
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N-TERMINAL UNIT

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DANIO           ECMITK-NENELVLQTSLLFAKEEGLLSFLRRSLSTEKLGTTGVEILRETRVEIMNFLGA  102
MILII           DFRCSSSSDSQLALQSSMVFSKDTGLLVFLRKSLRFEE--------FRDSREDVLKLLSE  95
BAMBOO          DLLH-NTHESRLALHSSLVFSKDEGLLIFLRKSLSNEE--------FRDCREEVLKLITA  99
XENOPUS         ECLVSALGSSALDLNTSLIFSKEFGLLAFVRKSLSSDE--------FKDCREEALKFLYT  111
STERLET         ECMVSK-NENELVLQTSLIFSKENGLLAFVRKSLNIED--------FRDTREEALKLLTT  97
GAR             ECLVVR-NENELVLRSSLLFSKEDGLLSFLRKSLSSED--------FRDVREEVLKLLST  91
LATIMERIA       ECLVTS-DENELALHISLIFSKEIGLLIFLRKSLSSEE--------FRDNREEILKFLTA  97
CAECIL          ECVTSS-GDSVLALQTSLIFSKEHGLLAFIHKSLGIEE--------FRDCREETLKFLCI  97
SNAKE           SCVTSS-GDDILALQISLVFSKENGLLSFIYKSLSVED--------FRECREEALKFILA  95
CANARY          TCLASL-ASGEQALHLSLVFSQEYGLLVFIHRSLTIEE--------FRDCREEALKFLCV  87
OSTRICH         DCVF----ALPAALHISLVFSQEYGLLVFIHKSLGIEE--------FRDCREEALKFLCA  58
GECKO           TCVTSS-GDVARALQTSLVFSKEDGLLAFIHKSLSTEE--------FRECREEILKFLCA  95
TURTLE          ACVTST-GDGARALQTSLVFSKDNGLLVFVRKSLSMEE--------FRECREEALKFLCA  96
ALLIGATOR       PVVIRT-GDSAQALQSSLVFSKDQGLLVFIRKSLSIEE--------FRDCREEALKFLCT  56
PLATYPUS        ECVLSA-GPAVQALHTSLVFSKEFGLPVFIRKSLDIEE--------FRDCREEALKFLCI  91
TASDEVIL        EGVLCT-SPAVLALQTSLIFSKEFGLLVFIRESLSIEE--------FRDCREEALKFLCI  92
HUMAN           ECVLSS-SPAVLALQTSLVFSRDFGLLVFVRKSLNSIE--------FRECREEILKFLCI  91
MOUSE           ECVLST-SSAVQALQISLVFSRDFGLLVFIRKSLSIED--------FRDCREEALKFLCV  91
                             *. *::*::: **  *: .**   .        ::: * : ::::
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N-TERMINAL UNIT

Supplementary Figure 1. DNA-PKcs, jawed vertebrates

```
DANIO          FLQRMSATVRGWEKNYAVELKDTCIVVYTKDKSAKCRNPALDLLIKILYLTKDSSITQNL 162
MILII          VVERIGEAVG----RYACDIKGTCVVVYTKEKAAKCKAAALDLLITLLHSKLSSSCLQQF 151
BAMBOO         FVEKIKETVG----PYALDIKDVCLVIYTKEKAAKCKVAALDLLLVLLHSK---VCLQEF 152
XENOPUS        FLEKIGSNVQ----PYAMDIKTLCVIVYTKDRAAKCKIPSLELLIKLLQLLKNSIIIEEF 167
STERLET        FLDRIAHKVNGWEKNYACDIKDTCLVVYTKDRAAKCKVSALELLIKLLHITS-PCLLQEF 156
GAR            FLQRITQSVKGWERNYAVDIKETCLVVYTKDKAAKCRVPALSLLIQLLHGTKSSGVAQDF 151
LATIMERIA      FVEKIGQKLN----PYACNVKLILFPVFFFF-----FIFIFFTYLQLLQSTKSPHCIEEF 148
CAECIL         FLEKIGQKVQ----PYACDIKNTCVVVYTKEKAAKCKVPALELLIKVLQILKNSYEIEEL 153
SNAKE          FVEKIGPKIQ----PYAQDVKRICVTAYTKDRSAKCGIPALELLIKLLQKLQSSYAMVDM 151
CANARY         FMEKVGDKIH----PYACNIKQTCLSVYIKERTAKCKISALELLIKLLHTLQRSCLMEEM 143
OSTRICH        FLEKIGEKVH----PYACNVKQTCISVYTKERAAKCKIPALELLIKLLQNLRRSCLMEEM 114
GECKO          FLEKIGEKIH----LYAHDVKRTCIIVYTKDKSAKCRIPALELLIKLLQNVRSACVMEDM 151
TURTLE         FLEKIGQQVH----PYAHDIKQTCISVYTKEKAAKCKIPALELLIKLLQNLRSSFLMEEL 152
ALLIGATOR      FLEKIGQGVH----PYACDIKQTCISVYTKDKMAKCKIPALELLIKLLQNVQCSSLMGEL 112
PLATYPUS       FLEKIGQKIE----PYSYDIKSVCISVYSKDRAAKCKIPALELLIKLLQTLRSSRLMEEL 147
TASDEVIL       FLEKIGQKIE----PYSLGIKSVCTSVYTKDKAAKCKIPALELLIELLKTLRSSRYMEEF 148
HUMAN          FLEKMGQKIA----PYSVEIKNTCTSVYTKDRAAKCKIPALDLLIKLLQTFRSSRLMDEF 147
MOUSE          FLEKIDQKVM----HYSLDIKNTCTSVYTKDRTAKCKIPALDLLIKLLQILRSTRLMDEF 147
               .::::   :      *:  :*      :            :   : :*          ::
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N-TERMINAL UNIT

```
DANIO          RIGDMFNKFYGELCQKHKIPDTVLGCIYELLGVLGEVHPSEMVNNSDKLYKAYLGELKGQ 222
MILII          KIGELFNKFYGDLSQKSKFPDTVLEKVYELLGVLAEVQPTEMLHNSEKLFCAYLNELRVQ 211
BAMBOO         KIGDMFNKFYGELAQKSKLPDTVLEKVYELLGVLAEVQPTEMLDNSEKLYRAYLNELKIQ 212
XENOPUS        KIGEIFNKFYGELATKSKLSDTVLEKVYELLGILGEVQPCEMTYNSEKLFKAFLGELKAQ 227
STERLET        KVGDMFNKFYGDLAQKSKIPDTVLEKIYELLGVLGEVQPSDMLNNSEKLYRAYLSELKSQ 216
GAR            RVGDMFNKFYGELSQKSRIPDTVLGNIYELLGVLAEVQPSDMTDNSEKLYRAYLGELKSQ 211
LATIMERIA      KVSEMFNKFYGELAQRSKLPDTVLEKVYELLGVLGEVQPSEMLHNSEKLFRAFLGELKTQ 208
CAECIL         KVKEIFNKFYSELGVKSKVPDTVLEKVYELLGVLGEVQPSDMLDNSEKLFRAYLGELKKQ 213
SNAKE          KVGEIFNKFYGEIAIKSKVPDTVLEKIYELLGVLGEVQPSEMIDNSEKLFRAYLLELKVQ 211
CANARY         KVGEIFNKFYEELAARSRIPDTVLEKIYELLGVLGEVQPSDMINNSEKLFRAYLRELKTQ 203
OSTRICH        KVGEIFNKFYGELATRSKVPDTVLEKIYELLGVLGEVQPSDMINNSEKLFRAYLGELKTQ 174
GECKO          KVGEIFNKFYGELAVKSKVPDTVLERIYELLGVLGEVQPSDMLENSEKLFRAYLGELKTQ 211
TURTLE         KVGEIFNKFYGELAARSKVPDTVLEKLYELLGVLGEVQPSDMVDNSEKLFRAFLGELKTQ 212
ALLIGATOR      KVGEIFNKFYGELAGKSRVPDTVLEKIYELLGVLGEVQPSDMLDNSEKLFRAYLGELKTQ 172
PLATYPUS       KVGGIFNKFYEELALKTKITDTVLEKIYELLGVLGEVHPSEMLCNSEKLFRAYLGELKMQ 207
TASDEVIL       QLGELFSKFYGELALKTKIADTVLEKIYELLGVLGEVHPSVMVHNSEKLFRAFLGELKTQ 208
HUMAN          KIGELFSKFYGELALKKKIPDTVLEKVYELLGLLGEVHPSEMINNAENLFRAFLGELKTQ 207
MOUSE          KIGELFNKFYGELASKSKLPDTVLEKVYELLGVLGEVHPSEMINHSENLFRAFLGELKTQ 207
               ::  :*.*** ::  : :. ****  :******:*.**:*  *  ::::*: *:* **: *
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N-TERMINAL UNIT

Supplementary Figure 1. DNA-PKcs, jawed vertebrates

```
DANIO          MTSTTKEPKLPVVAGCLKGIAALMVNFTKSVEEDPAASKEIFDYALKAISPQTDIKRYAV 282
MILII          MTSATREPKFLVVSGCLRGLTALMINFTKSMEEDPKASKDIFDYALKAINPQIDLKRYAV 271
BAMBOO         MTSATRQPKFLVVSGCLRGLIALMVNFTKSIEEDPRTSKEIFDCAVKAINLKIDIKRYAV 272
XENOPUS        MNSSTRNPKFPVIAGCLKGLSALMINFTKTMEEDPRTSKEIFDYTVKAISPQVEMKRYAV 287
STERLET        MTSATREPKLPVVAGCLKGLTALMINFTKSMDEDPKSSKEIFDFALKAISPQTEFKRYAV 276
GAR            MTSTTREPKLPLVAGCLKGLTALLVNFTKSMSEDPKTSKEIFDYALKSISPQTEFKRYAV 271
LATIMERIA      MRSTTKEPKLSVVAGCLRGLTALMINFTKSVDEDPKTSKEIFDYAVMAISPQVDLKRYAV 268
CAECIL         MTSTTREPKLSVVAGCLKGLTSLMINFTKSMDEDPKVSKEIFDYSVKAISPQVELKRYAV 273
SNAKE          MTSATRQTKFPIVAGCLKGLTALMYNFTKSMDEDPRTSKEIFDFAVKAISPKIDLKRYAV 271
CANARY         MTSATRGPKLPLVAGCLRGLVALMYNFTKSVDEDPQTAKEIFDFAMKAINPQVDQKRYAV 263
OSTRICH        MTSTTRVPKLPIVAGCLRGLAALMYNFTKSEDEDPQTSKEIFDFAMKAIRPQIDQKRYAV 234
GECKO          MTSSTREPKFPVVAGCLKGLTALMYNFTKSMDEDPQTSKEIFDFAVKAINPQVDLKRYAV 271
TURTLE         MTSATREPKLPVVAGCLKGLTALMYNFTKSMDEDPHTSKEIFDFAVKAINPQVDLKRYAV 272
ALLIGATOR      MTSATREPKLPVVAGCLKGLTALLYNFTKSMEEDPRTSKEVFDFSVKAINPQVDLKRYAV 232
PLATYPUS       MTSSTREPKLPVVAGCLKGLSALMCNFTKSMDEDPQTSKEIFDFAVKAISPQVDLKRYAV 267
TASDEVIL       MTSTTREPKLPVVAGCLKGLSSLMYNFTKSMDEDPQMSKEIFDFALKAISPQVDLKRYAV 268
HUMAN          MTSAVREPKLPVLAGCLKGLSSLLCNFTKSMEEDPQTSREIFNFVLKAIRPQIDLKRYAV 267
MOUSE          MTSTVREPKFPVLAGCLKGLSSLLCNFTKSMEEDPQTSKEIFGFTFKAIRPQIEMKRYAV 267
               * *:.:  *: :::***:*: :*: ****: .***  ::::*.  . :*  : : *****
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N-TERMINAL UNIT

```
DANIO          IFAGLKLFAKHSSQFGSCLMDHYISIFDVMSKHCGHINAELKKSSYTALESFLKQVATLV 342
MILII          PLAGLRLFTLHSSQFGTCLMDNYRTVFEKMKKSCGHTNSEMKKASYSALESFLKQVAIQV 331
BAMBOO         PLAGLRLFTLHANQFKTCLLDSYQVLFETMSKWCGHTNIEMKKAGYAALESFLKEIALQV 332
XENOPUS        PSAGLNLLALHASQFSSYLMDDYQSLFEVISKWCGHTNGEMKKLAFAALDSFLKQIAHLV 347
STERLET        LLAGLRLFAKHAGQFSSCLMDNYRSLYEVMSKWCGHTNIEMKKAGYHALEAFLKQVALLV 336
GAR            LFAGLKLFARHAEQFSSCLIDNYRSIFEVMSKWCGHTNAELKRAGHSALESFLKQVAVLV 331
LATIMERIA      PLAGLRMFALHANQFNTCLMDNYRSLFETMSKCCGHANGELKRAGYAALENFLKQVAAMV 328
CAECIL         PLAGLHMLAIHASQFGSCLMDNYRSLYEVMSKWCGHTNADLKKAGHLALESFLKQIASIV 333
SNAKE          PLAGLHLFSKHAEQFSTCLLDNYVSLFHTMAKWCGHQNAELKKAGHSALDSFLKQVSSMV 331
CANARY         PLAGLQLFIWHSAQFGALLLDNYVSLYEVMCKWCGHTHPELKKASYSALDSFLKQISLMV 323
OSTRICH        QLAGLQLFGRHAAQFGTFLLDSYVSLFETMCKWCGHTNQELKKAGHSALDSFLKQISLMV 294
GECKO          PLAGLHLFSVHAVQFSTCLLDNYVSLFEVMSKWCGHQNAELRKVSNSALDAFLKQVSEMV 331
TURTLE         PLAGLHLFSMHAAQFGTFLLDNYISLFEVLSKWCGHTNAELKKGGHSALDSFLRQISLMV 332
ALLIGATOR      PLAGLRMFGLHAAQFGTCLLDNYVMLFEVMSKWCGHTNVDLKKAGHSALDSVLKQISLMV 292
PLATYPUS       PLAGLHLFTVHASQFGTNLLDNYVYLFEVMAKWCGHTNGELKKVAHSALDSFLKQISLMV 327
TASDEVIL       PLAGLRLFTLHASQFSTCLLDNYISLFEIMSKWCGHTNGELKKIAHSALDSFLKQVSLMV 328
HUMAN          PSAGLRLFALHASQFSTCLLDNYVSLFEVLLKWCAHTNVELKKAALSALESFLKQVSNMV 327
MOUSE          PLAGLRLLTLHASQFTACLLDNYITLFEVLSKWCSHTNVELKKAAHSALESFLRQISFTV 327
                 ***.::  *: ** : *:* *  ::. : * *.* : :::: .  **: .*::::  *
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N-TERMINAL UNIT

Supplementary Figure 1. DNA-PKcs, jawed vertebrates

```
DANIO          AENIELHKSKLKFFMQKFCAIIRTMDSTNKELSIAIRGYGLFAAPCKVVCPQDVDLMYTE 402
MILII          AENAHLHKDKLEYIMQQFYDIIRTPESSMKELSIAIRGYGLFAAPCKAVNSNDVDFMYIE 391
BAMBOO         AEDAHLHKDKLQYFMQQFYSIIRTMESSTKELSIAIRGYGLFAAPCKAVDSHHVDFMYTE 392
XENOPUS        ASDAETHKNKLHFFMEQFYEIIRKMDSSNKELSIAIRGYGLFAAPCKAVNAKNVDLMYIE 407
STERLET        AENAELHKSKLEFFMRQFYTVIRTLDSSTKELSIAIRGYGLFAAPCKAVCLGDVDFMYTE 396
GAR            AENAELHKSKLKFFMQQFCSIIKTTDSTNKELSIAIRGYGLFAAPCKAVCPQDVDFMYTE 391
LATIMERIA      AENAELHKNKLEYFMKQFYGIIRTLDSSNKELSIAIRGYGLFAAPCKAVCPEDVDLMYTE 388
CAECIL         THDAETHKSKLQFFMDQFYRIIRKLDSSNKELSIAIRGYGLFAAPCKVINAKDVDFMYIE 393
SNAKE          AKDVEMHKSKLRFFMEEFYGIIRNMDASNKELSIAIRGYGLFAAPCKVINPKDVDFMYVE 391
CANARY         AKDAELHKSKLRFFMEQFYGTIRRMDSSSKELSIAIRGYGLFASPCKAIHPEDVDNMYVE 383
OSTRICH        AKDAELHKSKLQFFMDQFYGIIRRMDSSNRELSIAIHGYGLFAAPCKAIRSKDVDYMYVE 354
GECKO          AKDAEMHKSKLNYFMKQFYSIIRKMDSSNKELSIAIRGYGLFAAPCKAINSKDVDFMYVE 391
TURTLE         AKDAEMHKSKLQFFMEKFYDIIRKMDSSNKELSIAIRGYGLFAAPCKAINSKDVDFMYVE 392
ALLIGATOR      AKDAEMHKSKLKFFMEQFYSIIRKMDSSNKELSIAIRGYGLFAAPCKAINSKDVDIMYIE 352
PLATYPUS       AKDVELHRSKLQYFMEQFYEIIRKIDSTNKELSIAIRGYGLFAAPCKVINPNDVDIMYIE 387
TASDEVIL       AKDAEAHTSTLRYFTEQFYGIIRNVDSSSKELSIAIRGYGMFAGPCKSINAKDVDFMYIE 388
HUMAN          AKNAEMHKNKLQYFMEQFYGIIRNVDSNNKELSIAIRGYGLFAGPCKVINAKDVDFMYVE 387
MOUSE          AEDAELHKSRLKYFMEQFYGIIRNTDSNNKELAIAIRGYGLFAGPCKVINAKDVDFMYVE 387
               : : . * . *.::  :*   *:  ::. :**:***:***:**.*** :   .** ** *
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N-TERMINAL UNIT

```
DANIO          LIQRCKQMYLTESDRDDDNVYQLPSFLDSIASVLVHLDRIPEVYTPVLERLLVVQMDSFP 462
MILII          LIQRCKQMYLTEADTEDDNVYQLPSFLDSIASVIFHLDKIPGVYTPVLERLLVVQIDSFP 451
BAMBOO         LIQRCKQMYLTEADTEDDNIYQLPSFLDSIASVIFHMDKIPDIYTSVLERLLVVQIDSFP 452
XENOPUS        LIQRCKQMYLTEADTEEDNVYQLPNFLQSVASVILHMDSIPEVYTPILERLLVVQIDSFP 467
STERLET        LIQRCKQMYLTETDTEDDNVYQLPSFLDSIASVIFHLDRIPEVYTPVLERLLVVQIDSFP 456
GAR            LIQRCKQMYLTETDTEDDNVYQLPSFLDSIASVLFHLDRIPEVYTPVLERLLVVQIDSFP 451
LATIMERIA      LIQRCKQMYLTETDTEDDNVYQLPSFLQSIASVLFHIDRIPEVYTPVLERLLVVQIDSFA 448
CAECIL         LIQRCKQMYLTEAETEDDNMYQLPHFLQSIASVIVHMDSIPEVYTPVLERLLVVQIDSFS 453
SNAKE          LLQRCKQMYLTEAETIDDHVYQLPSFLQSIASVIFHLDTIPEIYTPVLERLMIVQIDSFS 451
CANARY         LLQRCKQMFLTEAETIDDHLYQLPSFLQSIASVIFHIDKVPEVYTPVLEHLVVLQINSFP 443
OSTRICH        LLQRCKQMYLTEAETVDDHIYQLPSFLQSIASVIFHLDTIPEVYTPVLERLVVVQIDTFP 414
GECKO          LLQRCKQMYLTEAETMDDHVYQLPSFLQSIASVIFHLDTIPEVYSPVLERLIVVQIDSFP 451
TURTLE         LLQRCKQMFLTEAETADEHVYQLPSFLQSIASVIFHIDTIPEVYTPVLERLIVVQIDSFP 452
ALLIGATOR      LLQRCKQMYLTEAETADDNVYQLPSCLQSIASVIFHLDTLPEVYTPVLEHLIVMQIDSFP 412
PLATYPUS       LIQRCKQMFLTEAETIDDHLFQLPSFLQSIASVLLHLDKVPEVYTPVLERLLVVQIDSFP 447
TASDEVIL       LIQRCKQMFLTETDTIDDHMYQLPSFLQSIASILLHLDTVPEVYTPVLERLIVVQIDNFP 448
HUMAN          LIQRCKQMFLTQTDTGDDRVYQMPSFLQSVASVLLYLDTVPEVYTPVLEHLVVMQIDSFP 447
MOUSE          LIQRCKQMFLTHADASEDHVYQMPSFLQSIASVLLYLDTVPEVYTPVLEHLMVVQIDSFP 447
               *:******:**.::  ::.::*:*  *:*:**::.::* :* :*: :**:*:::*::.*
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N-TERMINAL UNIT

Supplementary Figure 1. DNA-PKcs, jawed vertebrates

```
DANIO          QYSQRMQHATCRSIVKVFVAMAVRGPVLWSFTSSVVHQGLIRVCSKPVLQSDERGVSSGV 522
MILII          LYSARMQPICCRSIVKVFVALAGKGPVLWNFISTVVHQGLIRVCSKPVLLPGEGTGRSES 511
BAMBOO         LYSVRMQPVCCHSIIKLFIALAGKGPVLWSFISTVVHQGLIRVCSKPVLLPGEEMTKAEP 512
XENOPUS        QYSLKMQSSCCKAVLKVFLSLAGKGPVLWSLISTVVHQGLIRVCSKPVVLAQDG--KEGS 525
STERLET        QYSQRMQPVCCRSILKVFIALAGKGPVLWSFISTVVHQGLIRVCSKPVVLTGEEGG---Q 513
GAR            QYSQRMQPACCRAIVKVFVAMAGKGPALWSFISTVVHQGVIRVCSKPVLLTEEEGAAQGA 511
LATIMERIA      QYSQKMQPTCCKSIVKVFLALAGKGPVLWSFISTVVHQGLIRVCSKPVPLSTEGIGKGGL 508
CAECIL         QYSVKMQSVCCRSIIKVFLALAGKGPVLWNFISTVVHQGLIRVCSKPVTLGKEGSGKGSP 513
SNAKE          QYSARMQTACCRSIVKVFLALAAKGPVLWSFMSTVVHQGLIRICSKPLVFSMDFGGKNIS 511
CANARY         QYTEKMQPVCCRSIIKVFLSLSGKGPVLWSFISTVVHQGLIRIFSKPITFSKDFSVKETS 503
OSTRICH        QYSEKMQSVCCRSIVKVFLALTGKGPILWSFISTVVHQGLIRIFSKPITFSKEYFGKKTS 474
GECKO          QYSIKMQSTCHKSIVKVFLALASKGPVLWSIMSTVVHQGLIRVCSKPLAFLRENSGTGVS 511
TURTLE         QYSVKMQSACCKSIVKVFLALAGKGPVLWSFISTVVHQGLVRVCSKPITFSREIFGKEVS 512
ALLIGATOR      RYSEKMQPVCCRSIVKVFLALAGKGPVLWNFISTVVHQGLIRVCSKPIVFSREFDGKGAS 472
PLATYPUS       QYSIKMQSACCKAIVKIFLALAGKGPVLWNFISTVVHQGLIRVCSKPVPFLKEAYGRDAS 507
TASDEVIL       QYSIKMQTICCRAIIKVFLALAEKGPILWNFISTVVHQGLIRVCSKPVILQKEAFGKEVS 508
HUMAN          QYSPKMQLVCCRAIVKVFLALAAKGPVLRNCISTVVHQGLIRICSKPVVLPKGP----ES 503
MOUSE          QYSPKMQLVCCKAIIKLFLALSEKGPVHWNCISAVVHQGLIRICSKPVVLQKDV----ES 503
                *: :**    ::::*:*:::: :**   .  *:*****::*: ***:
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N-TERMINAL UNIT

```
DANIO          -----SQSEDSTLVRSGKWKVPSSKDYLELFKGLLDCENLKDTGFVDGAPAAKNYNLRDL 577
MILII          --GL-QQQSASEVMWTGKWRVPSYKDYLDLFRSLLNCGKMKEFGLV-DTLQMINLPLQSL 567
BAMBOO         WSSA-QQSLSNGNMGTGKWRVPSYKDYLELFRSLLDCGRMKESGLIYETFQMFDSPLKSL 571
XENOPUS        EAE---TAAATGEVRAGKWKVPTYKDYLDLFRNLLRCDQLKDSIFSDEIFSTVNSPLQSL 582
STERLET        GGG---QPVEKGQVHTGKWKVPSYRDYLDLFRNLLECDKMKDTGFVDGAFDVRSSSLHSL 570
GAR            EGG---RSAGAGQVRTGKWKVPSYRDYLDLFRSLLDCDLMKDFGFLEGVFESQSAPLQSL 568
LATIMERIA      QSEEEADPAAPGEVRTGKWKVPSYKDYLDLFRNLLECDKLKQSALVDETFGVVNSPLQSL 568
CAECIL         GSE---EPPVAEEVRIGKWKVPTYKDYLDLFRSLLDCDKMKESIFSDEVF-SVNSPLQSL 569
SNAKE          KSE---EYDSSGEVRTGKWKVPTYKDYLDLFRTLLGCDTMKNILLADEVCLTEYSPLQSL 568
CANARY         GTE---EAFEAGEVGTQRSKLPTYKDYLYLFRSLLSCDTMKESVFEDANFLTEKAQLQSL 560
OSTRICH        GSE---ESPAAGEAGAGKWKVPTYKDYLYLFRSLLNCDTMKESVLEDENFLAANSALKSL 531
GECKO          ASE---EHPASGEVRSGKWKVPTYKDYLDLFRSLLSCDTMKDSLLADETCLMANSPLQSL 568
TURTLE         KLE---ESTTAGEVRTGKWKVPTYKDYLDLFRSLLNCDTMKESVLADETFLIANSPLLSL 569
ALLIGATOR      KSE---EPPAVGEVRTGKWKVPTYRDYLDLFRSLLNCDAMKESVFADENFLTVNSPLQSL 529
PLATYPUS       ESD---DSSAFGEVRVGRWKVPTYKDYLDLFRSLLNCDEMKDSQL-DETFLIVNSPLQSL 563
TASDEVIL       ESE---EYPSSGEVKTGKWKVPTCKDYLDLFRNLLSCDQMKDSLLADETFLLVNSPLQSL 565
HUMAN          ESE---DHRASGEVRTGKWKVPTYKDYVDLFRHLLSSDQMMDSILADEAFFSVNSSSESL 560
MOUSE          RSD---NRSASEEVRTGRWKVPTYKDYVDLFQHLLGCDQMEDFILGDETFLFVNSSLKSL 560
                           : ::*: :**: **: ** .  : :  :             .*
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N-TERMINAL UNIT

Supplementary Figure 1. DNA-PKcs, jawed vertebrates

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DANIO          NRHLYDALVQSVMKIVEKLDLSVQKVSAADEVQ-SD-ASAGIVLSSDPTANLMPNKPKDF  635
MILII          NRLLYDEFIKSILKIIEKLDLSVEKQNQREEEGSGDVSNGNVIPTSDPAADLQPVKPKDF  627
BAMBOO         NRLLYDEFIKSVLKIIEKLDLSVDKQSQNEEGGSGDVNSSIVIPTTDPSANLQPTKPKDF  631
XENOPUS        NRLLYDELMKSILKIIEKLDLSLQKQDTGQEDD-GGINNLLINATSDPAGNLYATKPKDF  641
STERLET        NRLLYDELIKSILKIIEKLDLSVQKQSADEQEGRSDASSSMLIPSSDPAANLQPSKPKDF  630
GAR            NRLLYDELVKSILKIIEKLDLSVQKQNPDELE-ESDVSSGVVIPSSDPTAHLLPSKPKDF  627
LATIMERIA      NRLLYDELIKSILKIIEKLDLNVQKQKVGDQEGETDPSSTIIIPTSDPAANLQPSKPKDF  628
CAECIL         NRLLYDELIKSVLKIIEKLDLTVEKQSVGEQQDASDEDSALVIPTSDPAANLQPTKPKDF  629
SNAKE          NHMLYDELIKSVIKIIDKLDLTVQKQNINEEKDGSEGDAHLAIPTSDPAANLQPSKPKDY  628
CANARY         SRVLYDELIKSVLKIIEKLDLTVQKLDISEQ-DGNAGDSALVGPSSDPASNLQPTKPIDF  619
OSTRICH        SRLLYDELLKSVLKIIEKLDLTVQKLNVNEQ-DEDETDSALVVPTSDPASNLQPAKPTDF  590
GECKO          SRLLYDELIKSILKIIEKLELTVQKQNVNDAKDANEADADLTIPTSDPAANLHPTKPKDF  628
TURTLE         NRLLYDELIKSILKIIEKLDLTVQKLNVSEQ-DENEAGSDLVVPTSDPASNLQPTKPKDF  628
ALLIGATOR      NRLLYDELIKSILKIIEKLDLTVQKLTFSEQ-AESESGDVMIIPSSDPASNLQPAKPTDF  588
PLATYPUS       NHLLYDELIKSVLKIVEKLDLNVEKQNTGEK-DESEVSNLWVIPTSDPVANLHPSKPKDF  622
TASDEVIL       NRLLYDELIKSILKIVEKLDLKLEKQNVGNQEDESEASGVWVIPTSDPTANLHPAKPKDF  625
HUMAN          NHLLYDEFVKSVLKIVEKLDLTLEIQTVGEQENGDEAPGVWMIPTSDPAANLHPAKPKDF  620
MOUSE          NHLLYDEFIRSVLKIVEKLDLTLEKQTVGEQEDGST-ADVWVIPTSDPAANLHPAKPSDF  619
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```
DANIO          IAFINLVDFCSELLPSRNPEYFAQWMHPLCHELILQSIRFPLVSGFYKLLSLSMGIAKKT  695
MILII          TAFVNLVQFSTELLLERHEEFFDQWVYRFGYELILRSTQFPLVSGFYKLLSATMKIAKKI  687
BAMBOO         TALFNLVEFCGEL-LEKHTDFFEHWVYRFGHELILRSTQFPLVSGFYKLLSVTMKIARKI  690
XENOPUS        TAFVNLVEFCSEILPKEHIEYFESWVYVFGYELVLQSTRLPLISGFYKLLSVVMKNAKKS  701
STERLET        TAFVNLVEFCSELLMKEHVDFFEQWVYGLGHELILQSTRFPLVSGFYKLLSVSMKIAKRI  690
GAR            TAFINLVEFCSELLLKKHVEFFEQWVYPLGHEIILQSTRFPLVSGFYKLLSVAMKIAKKI  687
LATIMERIA      TAFINLVEFCRELLPEKHVEFFEPWMYGFGHEVILQSTRLPLVSGFYKLLSVSMKIARKI  688
CAECIL         TAFVNLVEFCREILPEKHIEFFEIWVYTFGYELILQSTRLPLISGFYKLLSVAMKNAKRT  689
SNAKE          SAFINLVEFCREILPDKHIKYFEPWMYSFGYELIIQATHLPFISGFYKLLSIAMKIAKKT  688
CANARY         IAFINLVEFCREILPEKHVEYFHPWVYSFGYELIVHSTRLPLISGFYKLLSVTMKIAKRI  679
OSTRICH        IAFINLVEFCREILPEKHVEYFNPWVYSFGYELIIHSTRLPLISGFYKLLSVAMKIAKKI  650
GECKO          TAFINLVEFCREILPEKHIEYFEPWVYSFGYELIIQSTRSPFISGFYKLLSIAMKIAKKI  688
TURTLE         IAFVNLVEFCREILPEKHVEFFEPWMYSFGYELIVQSTRLPLISGFYKLLSVAMKIAKKI  688
ALLIGATOR      IAFINLVEFCREILPKKHLEYFKQWVYSFGYELIIQSTRLPLISGFYKLLSVVMKIVKKI  648
PLATYPUS       TAFINLVEFCRDILPEKHVQFFEPWVYSFGYELILQSTRLPLISGFYKLLSIAIRNAKKM  682
TASDEVIL       TAFINLVEFCREILPEKHIQYFEPWIYSFGYELILQSTRLPLISGFYKLLAIAIRNAKKL  685
HUMAN          SAFINLVEFCREILPEKQAEFFEPWVYSFSYELILQSTRLPLISGFYKLLSITVRNAKKI  680
MOUSE          SALINLVEFCREILPRKHVGFFEPWVYSFAYELILQSTRLPLISGFYKLLSIAVKNARKI  679
                *:.***:*. ::    .:  :*  *:: : :*:::::: : *::********:  :  .::
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Supplementary Figure 1. DNA-PKcs, jawed vertebrates

```
DANIO          QYFQDVKQCP-KQVGGSTMENACFSLLAKFGKE--------VCVRMKQYKDELLAACLMF  746
MILII          NYFKGVSTNTWKQCHTDPEKCACFALFGKFGKE--------VTIRMKQYKDELLVSCLNF  739
BAMBOO         KYFEGVNPKTRKQCPKNPEKFACFALFGKFGKE--------VAIRMKQYKDELLASCLTF  742
XENOPUS        RYFEGFTSKIYKKAPEDPERLSCFALFAKFGKE--------VSSKIRQFKDELLASCLTF  753
STERLET        KYFQGVSPRSCKTSPEDPDKYACFALFAKFGKEVSTILGKEVSVRMKQYKDELLASCLTF  750
GAR            KYFKGVSPKSFQPNPQDPEKYACFALFAKFGKE--------VSVRMKQYKDELLASCLTF  739
LATIMERIA      KYFEGVSSKSCKQNSLDPEKYACFALFAKFGKE--------VCARMKQYKDELLASCLGF  740
CAECIL         KYFEGVSPKSHKKCPKDPERFACFALFAKFGKE--------VSAKMKQYKDELLASCLIF  741
SNAKE          KYFAGVSPESTKKYPEDPERSSCFALFSKFGKE--------VTTKMKQYKDELLASCLTF  740
CANARY         KYFEDISPRSLRRCPEDPEKSSCFALFVKFGKE--------VAAKMKQYKDELLASCLIF  731
OSTRICH        KYFEGVSPKSLRKCPEDPEKSSCFALFLKFGKE--------VTAKMKQYKDELLASCLSF  702
GECKO          KYFEGVAPKSKKKCPENPEKSSCFALFAKFGKE--------VTAKMKQYKDELLASCLIF  740
TURTLE         KYFEGVSPKSYQKCPDDPEKSSCFALFAKFGKE--------VTAKMKQYKDELLASCLTF  740
ALLIGATOR      KYFEDVSPGTQKKYPEDPEKSSCFALFAKFGKE--------VAARMKQYKDELLASCLTF  700
PLATYPUS       KYFEGVSPRSLKKSPEDPEKYSCFALFAKFGKE--------VAVKMKQYKDELLASCLTF  734
TASDEVIL       RYFEGLSPKSHKKSPEDPEKYSCFALFAKFGKE--------VSIKMKQYKDELLASCLNF  737
HUMAN          KYFEGVSPKSLKHSPEDPEKYSCFALFVKFGKE--------VAVKMKQYKDELLASCLTF  732
MOUSE          KYFEGISPKSLKHSPEDTEKYSCFALFAKFGKE--------VSVKMKQYKDELLASCLTF  731
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```
DANIO          ILSLHPGMVALDIKAYIPALQAALRLGLSHAPLATAALDALESWSSFIPAAILQPHYTDI  806
MILII          VLSLPHDIIELDIKAYIPALQAAFKLGLSHTPLADAGLDALEDWSAHIPKHIIQPHYKDI  799
BAMBOO         VLSLPYDIIELDIKTFIPALQTAFKLGLSHIPLADAGLDALEHWSTRISKHVIEPYYKDI  802
XENOPUS        VLHLPHDIIMMDIKAYIPALQTAFKLGLSCPPLADVGLNALQYWSTNIPSDILKPYYKDI  813
STERLET        VLSLPHDIVALDIKAYIPALQNSFKLGLSHTPLANTGLYALENWSQFIPKYVMQPHYKDI  810
GAR            VLSLHHDIVALDIKAYVPALQTALKLGLSHTPLASAALDALEEWSSRISQPLIQPLYRDV  799
LATIMERIA      ILSLPHTIVELDVKAYIPALQMAFKLGLSYTPLADSGLDALEEWSNRIPKWVLQPYYKEI  800
CAECIL         ILSLPHDIIMLDIKAYIPALQTAFKLGLSYSPLADAGLDALEDWSAYIPQYVIQPHYSEI  801
SNAKE          VLSLPYNIIMLDIKAYIPALQNAFKLGLSYTPMADVALDALEDWSSYIPRNIIQPYYKDI  800
CANARY         LLSLPHDIIMLDIKAYIPALQNAFKLGLSCTPMADLGLDALEDWSAHIPRHMMQPYYKDV  791
OSTRICH        LLSLPPDIIMLDIKAYIPALQNAFKLGLSCIPMADLGLDALEDWSAHIPKHIMQPYYKDV  762
GECKO          VLSLPHDIIMLDIKAYIPALQNAFKLGLSYTPMAEVALDALEDWSAHIPRYTMQPYYKDI  800
TURTLE         VLSLPHDIIMLDIKAYIPALQNAFKLGLSYTPMADEGLDALEDWSAYIPKHIMQPYYKDV  800
ALLIGATOR      VLSLPHDIIMLDIKAYVPALQNAFKLGLSYTPMADVALSALEDWSSHIPKNIMQPYYKDV  760
PLATYPUS       VLCLPHDIIMLDIKAYIPALQMAFKLGLSYPPLADVGLNALEEWSIYIPRHVIQPYYKDI  794
TASDEVIL       VLCLPHDIIELDIKAYVPALQMAFKLGLSYTPLAEVGLNALEEWSLYIPKHTIQPYYKDI  797
HUMAN          LLSLPHNIIELDVRAYVPALQMAFKLGLSYTPLAEVGLNALEEWSIYIDRHVMQPYYKDI  792
MOUSE          VLSLPHDIIELDVRAYVPALQMAFKLGLSHMPLAEIGLHALKEWSVHIDKSILQPYYKDI  791
               :* *   :: :*::::::**** :::****  *:*  .* **: **  *    ::* * ::
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N-TERMINAL UNIT

Supplementary Figure 1. DNA-PKcs, jawed vertebrates

```
DANIO          LPHLDGYLKTTSSSEKDDSNMEVTFVSTGSSKGYGQVLLRLLKKSKRFSLGDESPIAAVR 866
MILII          LPHLDGYLKTAAF-NEAQNNWEGMNINNPSRKGGSKVLFHHTKKSKEFLVSEDSAITAVR 858
BAMBOO         LPHLDGYLKTAAS-NEFESNWEMMSMNT-SSKGGNKVLIRRLKNARDLSMSEETPAAAVK 860
XENOPUS        IPLLDGYLTNLSSTNESLSTLDMVRISRSLHKGFNKQLIQQLKRMKTLSVKEESSLTAVR 873
STERLET        LPYLDGFLKTTASNDEEQNNWEVMSLSRSTEKGYGRVLMRLLKKAKRFSLTEDSPTALVR 870
GAR            LPCLDGYLKTAASNGSDQNTWEVMCLSSGAEKGYGRVLLRLLKRTKHLSMAEDSPSAVVR 859
LATIMERIA      LPCLDGYLKTSISAGDTPSSWEVLRLSRASQKGDHKVLIRLLKKAKAVSLNEDSSLGAVR 860
CAECIL         LPYLDGYLKTASSADEYQNSWEVMRLSRAAQKGFNRFLVQRLKKTKTLSLDQDVSLASIR 861
SNAKE          VPCLDSYLKTSASTDESQNNLEVKKLSKAIQKGMNKVVIQHLKKSKNLELEADPSLEAVR 860
CANARY         LPLLDGYLKSSTSTVESQNNWEVRKLSQAAQKGRNKVVIQRIRRAKTLSVDNSPSLQAVR 851
OSTRICH        LPLLDGYLKNSASTVEPQDNWEVRKISRAAQKGFNKVVIQHLRRAKTSL-VGDPSLEAVR 821
GECKO          LPCLDGYLKTSTSTDDSQNNWEVKKLSQAVQKGSNKVVIQRLKKAKSLALEEDHSLEAIR 860
TURTLE         LPLFDGYLKTTGSADESQNNWEVRKLSRAAQKGFNKVVIQRLKKAKTLSLEDNLSLEAVR 860
ALLIGATOR      LPLLDGYLKTATSPDEFQNNWEVKKLSQAVQKGFNKVVIQRLRKAKALSLNEDLSLEAMR 820
PLATYPUS       LPCLDSYLKTTALSDETKNNMEVTMLSRATQKGFNKVVVRHLKKAKATAPVEDLSLESVR 854
TASDEVIL       LPCLDSYLKTTALSDDNKDNEEVTVLSRAAQKGFNKVVIKHLKKSKTILSDAEMSLEAVR 857
HUMAN          LPCLDGYLKTSALSDETKNNWEVSALSRAAQKGFNKVVLKHLKKTKNLSSNEAISLEEIR 852
MOUSE          LPCLDGYLNTSTLSDETKSHWGLSALSRAAQKGFNRHVVKHLKRTRNSSPDEALSLEEIR 851
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```
DANIO          RRVVRLLGHLGGQLNRSLVTAVSAEDMMKRFVAWDCEKRLSFAVPFKDMKPVIYLDSFLP 926
MILII          RRIVRLLGSLGGQNNRSLVTAVSAEEMMKRCIAWVTEKPLSFAVPFMDMKPIIYLDSFIP 918
BAMBOO         KRVVRLLGSLGGQINRSLVAATSSEEMMKKCVAWVAERPLSFAVPFADMKPVIYLDSFLP 920
XENOPUS        NRVVRILGSLGGQINRSLVTAASTEEMIKRHVSWDTEKRLRFDVPFKDLKPVIYLDMFLP 933
STERLET        RRVVRLLGHLGGQINRSLVTATSAEEMMKKFVAWDSEKRLNFAVPFADMKPVIYLDTFLP 930
GAR            RRVVRLLGHLGGQLNRSLVTAASAEEMMKKFVAWDSEKRLTFAVPFADMKPVIYLDAFLP 919
LATIMERIA      GRVVRVLGSLGGQVNRSLVTAASSEEMMKKFVSWDTEKRLSFAVPFADMKPVIYLDSFLP 920
CAECIL         NRVVQILGSLGGQINQSLVTASCAEEMMKKYVSWDTEKRLSFAVPFVDMKPIIYLDSFLP 921
SNAKE          ARVVRLLGTLGGQINRHLITGTSAEEKMKKFVSWDIEKHLNFAVPFVDMKPIIYLDLFLP 920
CANARY         TRVARLLGSLGGQINHNLITATSAEEMMKKCVSWDTEKHLSFAVPFADMKPVIYLDLFLP 911
OSTRICH        TRVARLLGSLGGQINHNLITATSAEEMMKKCVSWDTEKRLSFAVPFADMKPVIYLDLFLP 881
GECKO          MRVACLLGSLGGQINRNLVTAASAEERMKKFVSWDTEKHLSFAVPFADMKPVIYLDVFLP 920
TURTLE         TRVVRLLGSLGGQINRNLLTAASTEEMMKKFVSWDTEKHLSFAVPFADMKPVIYLDLFLP 920
ALLIGATOR      SRVVQLLGSLGGQVNRSLVTAASEEEMMKKFVSWDSEKHLNFAVPFVDMKPVIYLDIFLP 880
PLATYPUS       TRVVRLLGSLGGQINRNIVTAASADEMMKKCVAWDTEKRLSFAVPFAEMKPVIYLDVFLP 914
TASDEVIL       AQVIRVLGSLGGQINRNLVTAASSDEIMKKCLAWDSEKKLSFAVPFAEMKPVIYLDVFLP 917
HUMAN          IRVVQMLGSLGGQINKNLLTVTSSDEMMKSYVAWDREKRLSFAVPFREMKPVIFLDVFLP 912
MOUSE          IKVVQILGSLGGQINKSLVTATS-GERMKKYVAWDAERRLSFAVPFREMKPVIYLDVFLP 910
                ::  :** **** *: ::: .  : :*  ::*  *: * * *** ::**:*:** *:*
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N-TERMINAL UNIT | **FOREHEAD**

Supplementary Figure 1. DNA-PKcs, jawed vertebrates

```
DANIO          RVTELALSSSDRQTKVAACELLHSLVIYMVGKGAQMTEDD-KSAPPMYNLHRKVFPVLLR  985
MILII          RISELALSASDRQTKVAACELLHSVVAYTLGKGSQISEGQ---QETLYKLNRQLFPVLLR  975
BAMBOO         RITELALSASDRQTKVAACELLHSVVAYMLGKGSQIAEGQ---QETMYKLNRHLYPVLLR  977
XENOPUS        HITELALSTSDRQTKVAACELLHSIVAFMLGKATQMPDDKKTGSSPMYKIYKRTFPVLLR  993
STERLET        RITELALSTNDRQTKVAACELLHSVVVFMLGKGSQIPEGE-KSTPPMYRLYKRIFPVLLR  989
GAR            RITELALSTSDRQTKVAACELLHSVVVCMLGKGSQIPEGE-KSSPPMYKLHKRIFPVLLQ  978
LATIMERIA      RIAELALSSSDRQTKVAACELLHSVVVYMLGKGSQIPERC-GGVPPMYRLYKRIFPVLLR  979
CAECIL         RVTELALSTSDRQTKVAACELLHSMVVYMLGKASQMPEKD-QSLPPMYQLYKRTFPVLLR  980
SNAKE          RVTELALCASDRQTKVAACELLHSIVMFMLGKAAQIPEGH-KNSPPLFHLYKRMFPVLLR  979
CANARY         HVTELALSASDRQTKVAACELLHGIVTYMLGKASQMPEGC-QGPPPMYHLHKRVFPVLLR  970
OSTRICH        RVTELALSASDRQAKVAACELLHSIVAYMLGKASQMPEGC-QGPPPMYQLYKRIFPVLLR  940
GECKO          RVTELALSASDRQTKVAACELLHSMVMYVLGKAAQIPEGQ-EVSQPMSHLYKRTFPILLR  979
TURTLE         RVTELALSASDRQTKVAACELLHSIVMYMLGTASQMPDGP-PGSPPMYQLYKRMFPVLLR  979
ALLIGATOR      RVTELALSASDRQTKVAACELLHGLVMFMLGKASQMPEGR-QGSSPMYQLYKRTFPVLLC  939
PLATYPUS       RITELALSASDRQTKVAACEVLHSIVMFMLGKASQIPEGN-QGSPPMYQLYKRTFPVLLR  973
TASDEVIL       RVTELALSSSDRQTKIAACELLHSMVMFMLGKASQIPEGK-LGPPPMYQLYKKTFPVLFR  976
HUMAN          RVTELALTASDRQTKVAACELLHSMVMFMLGKATQMPEGG-QGAPPMYQLYKRTFPVLLR  971
MOUSE          RVTELALSASDRQTKVAACELLHSMVMFMLGRATQMPEG--QGLPPMYQLYKHTFPVLLQ  968
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FOREHEAD

```
DANIO          LACDVDQVTRQLFEPLVMQLIHWFTNNRKFESQDTVAVLEAILDGIVDPLDSTLRDFSGT 1045
MILII          LGCDVDTVTRQLFEPLVLQLIHWFTSNRKFESRDTVAMLEAILDGIVDPVDSTLRDFCGQ 1035
BAMBOO         LGCDVDKVTNQLFEPLVMQLIHWFTNNRKFESRDTVALLEAILDGIVDPVDSTLRDFCGN 1037
XENOPUS        LACDVDKVTEQLYKPLVMSLIHWFTNNKKFESQDTVALLEAILTGIVDPVDSTLRDFCGQ 1053
STERLET        LACDVDQVTRQLYEPLVMQLIHWFTNNTKFESQDTVAMLEAILDGVVDPVDSTLRDFCGQ 1049
GAR            LACDVDQVTRQLYEPLVMQLIHWFTNNRKFESQDTVAILEAILDGIVDPVDSTLRDFCGQ 1038
LATIMERIA      LACDVDQVTRQLYEPLVMQLIHWFTNNKKFESQDTVAMLEAIMDGIVDPIDSTLRDFCGL 1039
CAECIL         LACDVDQVTRQLYEPLVMGLIHWFTNNKKFESQDTVALLEAILDGIVDPVDSTLRDFCGH 1040
SNAKE          LACDVDQVTRQLYGTLVMELIHWFTNNKKFESQDTVTLLEAILDGIVDPVDSTLRDFCGQ 1039
CANARY         LACDIDQVARQLYEPLVMQLIHWFTNNKKFESQDTVAFLEAMLSGIVDPVDSTLRDFCGQ 1030
OSTRICH        LACDVDQVTRQLYEPLVMQLIHWFTNNKKFESQDTVAFLEAILGGITDPVDSTLRDFCGQ 1000
GECKO          LACDVDQVTRQLYEPLVMQLIHWFTTNKKFESQDTVTLLEAILDGIVDPVDSPLRDFCGR 1039
TURTLE         LACDVDQVTRQLYKLLVMELIHWFTNNKKFESQDTVALLEAILDGIVDPVDSSLRDFCGQ 1039
ALLIGATOR      LACDVDQVTRQLYEPLVMQLIHWFTNNKKFESQDTVALLEAILDGIVDPVDSTLRDFCGQ 999
PLATYPUS       LACDVDQVTRQLYEPLVMQLIHWFTNNKKFESQDTVALLETILDGIVDPVDSTLRDFCGQ 1033
TASDEVIL       LACDVDQVTRQLYEPLVMQLIHWFTNNKKFESQDTMTLLETILDGIVDPVDSTLRDFCGQ 1036
HUMAN          LACDVDQVTRQLYEPLVMQLIHWFTNNKKFESQDTVALLEAILDGIVDPVDSTLRDFCGR 1031
MOUSE          LACDVDQVTRQLYEPLVMQLIHWLTNNKKFESQDTVALLEAILDGIVDPVDSTLRDFCGR 1028
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FOREHEAD

Supplementary Figure 1. DNA-PKcs, jawed vertebrates

```
DANIO          CIQEFVKWSIKQTTPKQQEKSPANMKSLFKRIYSLALHPSVFKRLGAALAFNSMYRQFRE 1105
MILII          CVREFLKWSIKQTTPEQQAKSPANTKSLFKRLYSLALHPNTFKRLGAALAFNSLYREFRQ 1095
BAMBOO         CVREFLKWSIKQTTPEQQQKSPVNTKSLFKRLYSLALHPNTFKRLGAALAFNSLYREFRE 1097
XENOPUS        CIQEFLRWSIKQTTPDQQAKSPVNTTSLFKRLYSLALHPNAFKRLGAALAFNNIYRDFRE 1113
STERLET        CVQEFLMWSIKQTTPKQQEKSPANTKSLFKRLYSLALHPNVFKRLGAALSFNSIYRQFRE 1109
GAR            CIQEFLKWSIKQTTPKQQEKSPANTKSLFKRLYSLALHPNVFKRLGAALAFNNIYKQFRE 1098
LATIMERIA      CIQEFLKWSIKQTTPKQQESTPANTKSLFKRLYSYALHPGAFKRLGAALAFNNLYKEFRE 1099
CAECIL         CIREFLKWSIKQKTPQQMEKSPVNTKSLFKRLYSLALHPNAFKRLGAALAFNNIYREFRE 1100
SNAKE          CVHEFLKWSIKQTTPQQQEKSPVNTKSLFKRLYSLALHPNAFKRLGASLAFNNIYQEFRE 1099
CANARY         CIREFLKWSIKQTTPRQQEESPANTKSLFKRLYSLALHPSAFKRLGAALAFNSIYREFRE 1090
OSTRICH        CVREFLKWSIKQTTPKQQEKSPVNTKSLFKRLYSLALHPSAFKRLGAALAFNSIYREFRE 1060
GECKO          CVREFLKWSIKQTTPQQQERSPVNTKSLFKRLYSFALHPNAFKRLGAALAFNSIYREFRE 1099
TURTLE         CVREFMKWSIKQTTPQQQEKSPVNTKSLFKRLYSLALHPNALKRLGAALAFNNIYREFRE 1099
ALLIGATOR      CIREFMKWSIKQTTPQQQEKSPVNTKSLFKRLYSLALHPNAFKRLGAALAFNNIYREFRE 1059
PLATYPUS       CVREFLKWSIKQTTPEQQEKSPVNTKSLFKRLYSFALHPNPFKRLGAALAFNNIYREFRE 1093
TASDEVIL       CVREFLKWSIKQTTPQQQEKSPVNTKSLFKRLYSFALHPNAFKRLGAALAFNNIYREFRE 1096
HUMAN          CIREFLKWSIKQITPQQQEKSPVNTKSLFKRLYSLALHPNAFKRLGASLAFNNIYREFRE 1091
MOUSE          CVQEFLKWSIKQTTPQQQEKSPVNSKSLFKRLYSLALHPNAFKRLGAALAFNHIYKEFRE 1088
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FOREHEAD

```
DANIO          ESSLVEQFVFEVLVVFVESLALAHFDEKSVGTVQQCCSSLDHLKRIIKHKADSLN--INS 1163
MILII          ESALVDQFIFEVLVVYVESLALAHADDNSLGTVQQCCDAIDHLNRIIKQKASALN--KPI 1153
BAMBOO         ESALVEQFVFEVLVVYVESLALAHADDKSLGTIQQCCDCINHLKRIIKQKAHELN--KPV 1155
XENOPUS        ETALVENFVFEVLVIYMESLALSHADEKSLGTTQQCSDAVDHLKRIIIRKAASLN--KAT 1171
STERLET        ESTLVDQFIFELLVIFVESLALAHTDEKSLGTLQQCSDAIDHLKRIIKQKAASLNAEKTS 1169
GAR            ESSLVDMFVFEALVIFVESLALAHSDEKSLGTLQQCSGAIDHLKRIIKHKAATLN--KSS 1156
LATIMERIA      ESALVDKFVFETLVVYMESLALAHMDEKSLGTVQQCCDAIDHLKRIIEQKAPSLN--KAA 1157
CAECIL         ENALVDQFVFEILVVYLESLALSHQDEKSLGTVQQCCDAIDHLKRIIIHKAPSLN--KTL 1158
SNAKE          ENALVDQFVFEALVVYLESLALTHGDEKSLGTIQQCCDAIDHLKRIIKHKASTLN--QKS 1157
CANARY         ENSLVEQFVFEALVVFLESLALAHTDEKSLGTAQQCCDAINHLKRIIKHKAPSLN--KEG 1148
OSTRICH        ENSLVEQFVFEALVVFLESLALTHADEKSLGTTQQCCDTINHLKRIIKHKAPSLN--RAG 1118
GECKO          ENALVDQFVFEALVLYLESLALTHGDEKSLGTTQQCCDAVDHLKRIIKHKASTLN--KES 1157
TURTLE         ENSLVEQFVFEVLVVYLESLALTHTDEKSLGTVQQCCDAIDHLKRIIKHKASSLN--KAE 1157
ALLIGATOR      ENSLVEQFAFEALIVFIESLALTHTDEKSLGTTQQCCDAIDHLKRIIKHKAPSLN--KAE 1117
PLATYPUS       EDSLVDQFTFEALVIFLESLALTHADEKSLGTIQQCCDAIDHLKRIIEKKHISFN--EEK 1151
TASDEVIL       EEALVEQFVFEALVIYMESLALTHADEKSLGTIQQCCDAIDHLTRIIEKKHITLN--KPK 1154
HUMAN          EESLVEQFVFEALVIYMESLALAHADEKSLGTIQQCCDAIDHLCRIIEKKHVSLN--KAK 1149
MOUSE          EGSLVEQFVFEALVTYMESLALAHEDEKSLGTVQQCCDAIDHLRRIIEKKHVSLN--KAK 1146
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FOREHEAD

Supplementary Figure 1. DNA-PKcs, jawed vertebrates

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DANIO          KRRIPRGFPADQ-SVCLSNVVLWLLTQCGRPQTECRHKSMELFFEFVPLLPGNSSPAMWL 1222
MILII          KGRVPRGFPPDQ-PVSLKEVVMWLLTQCGRPQTECRHKCMVLFYELVPLLPGNKTPSCWL 1212
BAMBOO         KRRVPRGFPADQ-MVCLTDVVMWLLTQCGRPQTECRHKCMELFYEFVPILPGARTASLWL 1214
XENOPUS        KRRIPRGFPQGN-TVCLFDIVLWLLEQCGRPQTECRHKAMQLFFEFVPLLPGNKPLTAWL 1230
STERLET        RRRVPRGFPPDK-PVCLLDVIMWLLVQCGRPQTECRHKCMELFYEFVPLLPDNKSPASWL 1228
GAR            RRRVPRGFPPDK-PVSLTDVVMWLLVQCGRPQTECRHKCMELFYEFVPLLPGGKNPAVWL 1215
LATIMERIA      TRRVPRGFSPDK-VFCLSDVVMWLLVQCGRPQTACGHKAMELFYEFVPLLPGKKSPAAWL 1216
CAECIL         KRRLPRGFPSTKSSFCLSDLVPWLLGQCGRPQTECRHKAIDLFCKFIPLLPGNKSPSSWL 1218
SNAKE          TRRLPRGFPS-R-SICLEDVVMWLLRQCGQPQTECRHKVMELLFEFVPLLPGNPSPSSWL 1215
CANARY         KRRVPRGFPPTK-SVCLEDIVMWLLVQCGRPQTECRHKAMELFYEFVPLLPGNKSPSSWL 1207
OSTRICH        ERRVPRGFPATK-TVCLLDIVMWLLVQCGRPETECRHKSMELFYEFVPLLPGNKSPSSWL 1177
GECKO          QRRLPRGFPPAK-SICLEDIVMWLFLQCGRPQTECRHKAMELFFEFIPLLPGSKSPSLWL 1216
TURTLE         KRRIPRGFPNAK-SVCLLDLVMWLLVQCGRPQTECRHKSMELFYEFVPLLPGNQSPSLWL 1216
ALLIGATOR      KRRLPRGFQPAE-SLCLLDIVMWLMMQCGRPQTECRHKSMELFYEFVPLLPGNKSPSSWL 1176
PLATYPUS       NRRLPRGFPNAR-SVRLLDLVYWLLGQCGRPQTECRHKSIELFYKFVPLLPGNKSPASWL 1210
TASDEVIL       KRRLPRGFPPVQ-TLCLLDLVKWLLAQCGRPQTECRHKSIELFYKFVPLLPGNRSPSCWL 1213
HUMAN          KRRLPRGFPPSA-SLCLLDLVKWLLAHCGRPQTECRHKSIELFYKFVPLLPGNRSPNLWL 1208
MOUSE          KRRLPQGFPPLT-SLCLLDLVEWLLAHCGRPQTECRHKSMELFYKFVPLLPGNKSPSLWL 1205
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FOREHEAD

```
DANIO          DEQLKQRGPGFLISCLEGGG--------LLSQPTLREIEAPFSIRGTLQWMDLLLAALDC 1274
MILII          ADVLKERGVSFLIGKFESAGSDHAKCSGIIYQPTLKDLQEPFSVRAALQWMDMLLAALDC 1272
BAMBOO         EEILKRNGVSFLVNKFEGAGSDHDNCSGIICHPTLQALKEPFSVRAALQWMDMLLAALDC 1274
XENOPUS        DDQVEKEGIIFLINRFEGAGHSDGMHTGIFNIPALHDLHEPFSMHAVLQWLDMLLAALDC 1290
STERLET        DDILKKQGVAFLISRFESAGREDGGCSGILSQTTLHDLQEPFSLRAVLQWMDMLLAALDC 1288
GAR            EDILKDEGEGFLIRRFEGAGRCDGDSSGLLSQATLRDLQGSFSVRAALQWMDLLLAALDC 1275
LATIMERIA      DEVLKKQGVSFLIQKFEGGGNTDDRLSGILSQPTLCDLQEPFSLRAVVQWMDMLLAALDC 1276
CAECIL         NDHLKEEGISFIISRFEGGGSDGDHQSGLIAQPTLCDLKEPFSLRAVVQWMDMFLAALDC 1278
SNAKE          GDVLQKEGIYFLIKKFEGGGCEGENVSGILSHPTLYELQGSFSLQAVVQWMDMLLAALDC 1275
CANARY         ADTLKKRTVTFLINKFEGGGTDAKSPSGILSQPTLHGMQEPFSLQAVMQWMDMFLAALDC 1267
OSTRICH        ADVLKEKGCSFLINKFEGGGRDADSPSGIFSRPTLHGIQEPFSLRTVMQWMDMFLAALDC 1237
GECKO          DDILRKQEISFLIKKFEGGGDEGKSVSGILSHPTLSGLQDNFSLRAVVQWMDMLLAALDC 1276
TURTLE         GDLLKKQGISFLINKFEGGGNDGDNLSGILSQPTLCDMQEPFSLRAVVQWMDMFLAALDC 1276
ALLIGATOR      GDVLKKQDSSFLINKFEGGGNQDDNLSGILSYPTLHHLQEPFSVRAVVQWMDMLLAALDC 1236
PLATYPUS       NDILKEEGVSFLISRFEGAGTGNDHLSGILVWPTLLDLEGPFSLRAVLQWMDMLLASLEC 1270
TASDEVIL       TDILKKEDISFLINRFEGAGNASEHLSGILAQPTLFDLQGPFTLRAVVQWMDMLLAALEC 1273
HUMAN          KDVLKEEGVSFLINTFEGGGC--GQPSGILAQPTLLYLRGPFSLQATLCWLDLLLAALEC 1266
MOUSE          KDLIKKKGISFLINTFEGGASSSDQPAGILAQPTLVYLQGPISLRGVLQWLDLLLAALEC 1265
                : :. .   *::  :*...        ::   :*  :.  :::: .: *:*::**:*:*
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FOREHEAD

Supplementary Figure 1. DNA-PKcs, jawed vertebrates

```
DANIO          YNTFTNLRCLQLQRILGTCE-KSSFLPAVHFFLTELSMQDIQAARACFRLGNAGQSHFSP 1333
MILII          YNTFVRLAMVKPSELLGTSQ-ETGFMKAMNFFLKTLARHDITAAEECFTLGVKGVL-FSP 1330
BAMBOO         YNTFIGLHLVKPSKIMGTSE-NSSFLKALNFFLTNLARHDVTAAEESFAYGIKGIL-FSP 1332
XENOPUS        YNTFIGMRFLKANTVLGKNAEKSSFLKAAFFFITSLSMENIKAAEQCMGSKS--S-VFSP 1347
STERLET        YNTFIGLHLVKPHEVLGAKV-QSGFLKAIEFFITELAVQDISAAELCFSVGPKGAL-FSP 1346
GAR            YNTFIGLHFVKPQQILGTQE-KSSFLKAIGFFIAELTMQDISAAERCFSSGSEGSL-FSP 1333
LATIMERIA      YNTFIELRMINPREIFGTTS-VSGFLRAVEFFLTRLATQDITAAEQCFTAGSKDTM-FSP 1334
CAECIL         YNTFIWMRAIKPNEILSTTT-QSSFLRTCEFFLQKLCLHDITAAEQCFRTGPSGNI-ASP 1336
SNAKE          YNTFIEPGMIKPSEIFASNT-GSSFLKSLEFFLGKIALYNISGAEQCFSSASKGDMLLSP 1334
CANARY         YNTFFELQMIKPDEVLGVNE-SSLFLKAVQFFLDTIALHDIHAAEQCFDSSSKGSM-FSP 1325
OSTRICH        YNTFFELRMIKPHEILGVNE-RSSFLKAVRFFLETIALHDIQAAEQCFDCGLKGSV-FSP 1295
GECKO          YNTFIEQGMIKPNEIVATNT-ESSFMTSVEFFLEKLALKDVSGAEQCFNTASKGNI-FSP 1334
TURTLE         YNTFIEQGMIKPNEILGTKM-RSSFLRAVEFFLKTIVLHDISAAERCFDTGSKGNM-FSP 1334
ALLIGATOR      YNTFIEQRMFKPENVLGTN---SSFLRAVEFFLETIALHDIHAAEQCFYTKSKDNV-FSP 1292
PLATYPUS       YNTFIEEKTVKAHEILGTQA-KSSFLRAISFFLERIAFHDITAAEQCFGTGSKGSM-FSP 1328
TASDEVIL       YNTFIEERAIKAQEILGTKA-KSSFLKAVGFFLENIALHDIRAAEKCFGTGIKGNV-FSP 1331
HUMAN          YNTFIGERTVGALQVLGTEA-QSSLLKAVAFFLESIAMHDIIAAEKCFGTGAAGNR-TSP 1324
MOUSE          YNTFIEKETVQGQEVLGAEV-QSSLLKSVAFFLESIATHSARAVEQRFGSGAPGPP--SL 1322
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FOREHEAD | M-HEAT/CIRCULAR CRADLE

```
DANIO          RETEQYNYSKCSIIVRMLEFSTMVLQKCPQDLWKLMEKDVFNSSLFTLVVLAVCEPSSIG 1393
MILII          RERFEYNYCKCTIIVRIMEFACLILEGLQQDCWKVLEKDLLNSDLFELIAMVVIDPTSIG 1390
BAMBOO         RERFDYNFNKCTIIVRIMEFVSMVLEDCQQDFLKMLEKYLLNSTLFELVATVVIDPPSIG 1392
XENOPUS        HEIEAYNYSKCTIIVRIMEFITMFIDICQQDSLKILENSVFNEPMWELIAITVCDPSSIG 1407
STERLET        KERFDYNYSKGTIIVRMMEFVSMVLENCQPEFWKLLEQNILNPTFFELITTTVCDPSSIG 1406
GAR            RERFDYNYCKGTIIVRLMEFVTMVLDKCSQDLWKVLERDILHLTFFELIATTVCEPSSIG 1393
LATIMERIA      RERFDYSYSKCTIIVRILTFVSMVLEKCQPDLWKVLEKDLLTPALLELTVRTVCEPASIG 1394
CAECIL         QERFDYNYSKCTIIVRIMEFVSMILENCQQDFWRLLEKDLLNNNLVELTVLTVCDPSSIG 1396
SNAKE          HERFEYNYSKCTIIVRIMVFGSMILETHQQHVWKLLEKELLNENLIKLVVKTICDPESVG 1394
CANARY         QERDKYNYSKCTIIVRILEFVTVILEMCQQDFWKLLEKELLNASFIELVVMTVCDPSHVG 1385
OSTRICH        QEREVYNYSKCTIIVRSMEFVTMVLESCQQDFWKLLEKELLNASFIELLVMTVCDPSHVG 1355
GECKO          QEKEDYNYSKCTIIVRIMVFVSMILETCQQDFWKLLERELLNKNLIELTVRTVCDPKSIG 1394
TURTLE         QEREEYNYSKCTIIVRIMAFVSMILETCQQDFWKLLEKELLNANLIELLVRIVCDPANIG 1394
ALLIGATOR      QEREEYSYSKCTIVVRIIRFVSMILETCQQDFWKLLEKELLNLNLIELLVVTVCDPSAVG 1352
PLATYPUS       QEREEYNYSKCTIIVRIMEFATMLLNTYQ-DTWKLLEKDLLNATFMELVVEIVCDPSSIG 1387
TASDEVIL       QEREEYNYSKCTIVVRIMEFSSMLLNTCQ-DVWKLLEKDLLNAYFMELLVKTLCDPSSIG 1390
HUMAN          QEGERYNYSKCTVVVRIMEFTTTLLNTSP-EGWKLLKKDLCNTHLMRVLVQTLCEPASIG 1383
MOUSE          HEEEKYNYSKCTVLVRIMEFTTTLLIASP-EDCKLLEKDLCNTNLMQVLVKMICEPMSLG 1381
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M-HEAT/CIRCULAR CRADLE

Supplementary Figure 1. DNA-PKcs, jawed vertebrates

```
DANIO          FNMADLEVMTHLPEVCFPLLKALASAPYRTQLESCIRMRITKQSVEELCAIDLYETDTRN 1453
MILII          FNMADVQVMKNLPNVCVKLLNAVMKSPFKETLVDSVRKRITAQSIEALCNVDLYSPGART 1450
BAMBOO         FNMADVQVMKGLPDICVRLMKAALRSPYQESLECSMKKRLKSQSIEDLCNVDLYSQ---S 1449
XENOPUS        FNTADVEVINNLPNICIKLMKALGNTSYRSSLEVSLKKRVTLQSIEELCSVDLYDPGARF 1467
STERLET        FNMADVEVMKNLPDICVRLLKALAKSPYKGQLEISMKRRISYKSVEELCGVDLCNVDARS 1466
GAR            FNMADMEVMTNLPEVCVHILKALLKSPYKTQLEQSIRRRVSQQNVEQLCAVDLYGSEARS 1453
LATIMERIA      FNTADVQVMKNLPEICVRLLKALMKSPYKDTLEASIRKRITARSIKELCSVDLYNPDARL 1454
CAECIL         FNVADVQVMKNLPDVCIKLLKGLMKSPFKNDLEFSIKKRITSESIKDLCDVDLYNQDARH 1456
SNAKE          FNIADVQVMENLPSICVRLVKALMKTPYNESLENSIKEIITMKSIEELCTVDLYNPEARL 1454
CANARY         FNTADVQVMKKLPDISVRLMKALMKSPYQESLKLCLKERITPQSLEDLCSVDLFNSEARL 1445
OSTRICH        FNTADVQVMKNLPDISVRLMKALMKSPYKESLKLSLKERLTPQSLEDLCSVDLFNSDARF 1415
GECKO          FNTADVQVMEKLPDICVRLIKALMRSPYKESLVTSMKKVITPESIEEFYGVELYNPDSRL 1454
TURTLE         FNTADVQVMKNLPDVSVRLIKALMKSPYKESLELSIKDRITSQSIEELCSVELYNPDARF 1454
ALLIGATOR      FNTADVQVMKNLPDNTVRLMKALAKTPYKSSLELSIKKRITSHSIQELCSVDLYDPDARF 1412
PLATYPUS       FNVADVQVMSNLPDVCVSVMKALKKSPYKDALEGNIKKRVTAQSIEELCTVDLYKPDARF 1447
TASDEVIL       FNIADVQVMNNLPNVCVNLLKALKKSPYKESLEINIKKRITPQSIEVICAVNLYNSDARF 1450
HUMAN          FNIGDVQVMAHLPDVCVNLMKALKMSPYKDILETHLREKITAQSIEELCAVNLYGPDAQV 1443
MOUSE          FNIGDVQVMNHLPSICVNLLKALRKSPYRDMLETHLKEKVTVQSVEELCSINLCSSGARQ 1441
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M-HEAT/CIRCULAR CRADLE

```
DANIO          SHASMNLLLSACRQLHQSGLLNSVLHSQDASYGCSLGSKLLTSVYKSIAPGTDRKSLPSM 1513
MILII          DHAGLRSILSACQQLHKADLLNSAIDCEAGSLSSSLSLKLLSVVYKGIAPGDERKSLPSI 1510
BAMBOO         DHAKLNSILLACKQLHKAGLLNSVLKCQIGSIVPPLNLKLLSTVYKGIAPGDERKSLPTM 1509
XENOPUS        NRVKLGSVLSACKQLYKAEFFNSIVPEQVGGQ--RFGSKLLSVVYKGIAPTNERKSLPSL 1525
STERLET        DRARLVFVLSACKQLHKAGLLNSALQSQAASFGLSLGSKLLSVVYKGIAPGDERKSLPSM 1526
GAR            EHARLALVLSACKQLHRAGLLNSTLQSQAASFGLSLGSKLLSVVYKGIAPGDEKKSLPSM 1513
LATIMERIA      DHIRLGSILSACKQLYDAGLLNSAVQYQSGDFNLQLGSTLLSVVYKGIAPGDERKSLPSI 1514
CAECIL         YHARIGSILSACKQLHKAGLLNSVLQSQTAGLQFTVGSKLLSVVYKGIAPGDERKSLPSL 1516
SNAKE          DHVRYIAILSACRQLHKAGVLHCILQSKGADLQFETGSKLILVVYKGIAPGDEGRSLPSL 1514
CANARY         DQVRFGAVLSACKQLQKSGLLHSVLHGQDEGSHFSVGSKLLSVVYKGIAPGGERMSLPCL 1505
OSTRICH        DQVKYSAILSACKQLQKAGLLHSVLHNQDEVPHFSLGCKLLSVIYKGIAPGAERLCLPSL 1475
GECKO          DHVRLGAILSACKQLHRVGLLHCTLQSQGVGLHCEAGSKLLLVIYKGIAPGDERKSLPSL 1514
TURTLE         DHVRLSSILSACRQLHKAGLLHSTLQSQGSGLHFTVGSKLLSVVYKSIAPGDERKSLPSL 1514
ALLIGATOR      DRVRISSILSACKQLHKAGVLHSVLQSQGSGLHFTVGSQLLSVVYKGIAPGDERKCLPSL 1472
PLATYPUS       DRPRLASILSACKQLQRAGLLHAAVHPQASHLQRPGSTKLLSVVYKGIAPGDERQSLPSL 1507
TASDEVIL       DRANLASLLSACKQLHKAGLLHSTVESQATDLPHPIGTKLLSVVYKGIAPGDERTALPSL 1510
HUMAN          DRSRLAAVVSACKQLHRAGLLHNILPSQSTDLHHSVGTELLSLVYKGIAPGDERQCLPSL 1503
MOUSE          ERSKLLSILSACKQLHKAGFSHVISPSQSTALNHSVGMRLLSLVYKGIVPAEERQCLQSL 1501
                :     :: **:**    . :     :         .  *:  :**.*.*  :  .*  :
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M-HEAT/CIRCULAR CRADLE

Supplementary Figure 1. DNA-PKcs, jawed vertebrates

```
DANIO          DVGSRKLADRLVQLSFCLGDQSEQTVGLLLNTITLSVPLSGSLNPHFLSFSHGEYFYSLF 1573
MILII          DVSSKQLADGLLQLSFSLGGQCEELVSLLLNTMELSVPLSGATQKNFITFSHGEYFYSLF 1570
BAMBOO         DVSSKMLADGLLQLSFSLGGQCEELVSLLLNTVELSVPLSGASQRHFISFSHGEYFYNLF 1569
XENOPUS        DISSKRLAEGLLELAFMFGGQCEELVSLLLNTVILSVPLPGTSQRNIINFSHGGYFYTLF 1585
STERLET        DVSSRKLADGLLQLAFSLGGQCKELVDLLLNSIMLSVPLSDTSQKNFITFSHGEYFYSLF 1586
GAR            DVSSRRLADGLLQLAFSLGGQSEQLVSLLLNTIMLSVPLSGTSDKNFISFSHGEYFYSLF 1573
LATIMERIA      DISSKRLADGLLQLAFSFGLQSGELVCLLLNRVTLSVPLSGTSQRNFITFFHGEYFYNLF 1574
CAECIL         DISSKRLADGLLQLAFDLGGQCDELVSLLLNTVKLSVPLSGTSQRNIISFSHGEYFYSLF 1576
SNAKE          DIGSKRLAEGLLHLAFAFGVRCTELVSLLLNTLMLFVPLSGAAQESLINFSHGEYFYSLF 1574
CANARY         DLSRKRLADSLLQLAFAIDEQCEELVSLLLNTVVLSVPLSEASQNQLMNFSHGQYFYSLF 1565
OSTRICH        DISKKRLADGLLQLAFAIDGQCEELVSLLLNTVVLTVPLLGASRKNLVNFSHGEYFYSLF 1535
GECKO          DMSSKRLAEGLLQLAFAFGVQCKELVSLLLNSLMLSVPLSGVSQRNLISFSHGEYFYSLF 1574
TURTLE         DISSKRLADGLLQLAFAFGGQCEELVSLLLNTMMLSVPLSGTSQRSLISFSHGEYFYSLF 1574
ALLIGATOR      DISSKRLADGLLQLAFAFGCQSEELVSLMLNTAMLSVPLSEAAPRNLLSFCHGEYFYNLF 1532
PLATYPUS       EISSKQLASGLLELAFAFGGLCEELVSLLLNTVVLSVPLAGTSQRNLISFSHGEYFYNLF 1567
TASDEVIL       EISSKRLASGLLELAFAFGGLCEELVNLLLNTVVLSVPLSGTCQKNLINFSHGEYFYSLF 1570
HUMAN          DLSCKQLASGLLELAFAFGGLCERLVSLLLNPAVLSTASLGSSQGSVIHFSHGEYFYSLF 1563
MOUSE          DPSCKSLANGLLELAFGFGGLCDHLVSLLLNSAMLSTQYLGSSQR-NISFSHGEYFYSLF 1560
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M-HEAT/CIRCULAR CRADLE

```
DANIO          QTSLNTELLRSVDRSVPLLLSSANQNPSMVSVLLNGMLDHSFRERSVRKSQGSQLAEQVL 1633
MILII          SETINAELLKSLKSAVTQLMRSASENPKMVSTVLNGMLDQSFRDHTVRKTQGVLLVSAVL 1630
BAMBOO         PETINSELLRNLNSAVAQLMTSARENPKMVSAVLNGMLDHSFRDHTVRKKQGIYLVSAVL 1629
XENOPUS        AETINTELLNNLDTIVVELMKSSLEDPKMVSCVLNGMLDQSFRQRTIRKQQGVKLVNAVL 1645
STERLET        QETINSELLKNLDTTVAQLMKSAAENPKMVSMVLNGMLDQSFRERSVRKTQGSQLVGGVL 1646
GAR            QQTINIELLGSLDSTVPQLMSLAAENPKMVSAVLNGMLDQSFRDRSVRESQGRQLVKRVT 1633
LATIMERIA      METTNSELLRNLSTAVSQLMNSAAENPKMVGAILNGLLDQSFRNRTVRKQQGSQLVDTVL 1634
CAECIL         SETINTELLKNLNTAILQLMKSSVDNPRMVGTILNGMLDQCFRDRTVRKQQGVKMVIAVL 1636
SNAKE          LEIINRELLKNLEIAVLELMKSALDSPKMVSTVLNGMLDQSFKDRATCKQQGVKLVAAIL 1634
CANARY         SETINQQLLKNLDVFIVRLMKSSISNPQMVGSILNGMLDQSFRDRAVRKQQGAKLVTAVL 1625
OSTRICH        SETINEQLLKNLDVIILQLMESSVSNPQMVGSILNGMLDQSFRERTIRKQQGVKLVTAVL 1595
GECKO          SDTINRELLKNLDVAVLHLLKSSLDSPKMVGTILNGMLDQSFRDRAVHKQQGVKLVNAIL 1634
TURTLE         SETINQELLKDLDVAILQLMKSSVDSPKMVGTILNGMLDQSFRERAVRKQQGIKLVTAVL 1634
ALLIGATOR      SETINHELLKNLDVAILQLMKSAVDNPRMVGTILNGMLDQSFRERTVRKQQGMKLVTAVL 1592
PLATYPUS       SATINTELLKNIDTAVLELMKSSVDNAKMVGTILNGMLDQSFRDRIVRKQQGEKLVDAIL 1627
TASDEVIL       SEVINTELLKNLDTAILELMKSSVDNAKMVGAILNGMLDQSFRDRAVRKQQGMKLVATIL 1630
HUMAN          SETINTELLKNLDLAVLELMQSSVDNTKMVSAVLNGMLDQSFRERANQKHQGLKLATTIL 1623
MOUSE          SEVINSELLKNLDIAVSRLMESSSDNPKMVSTVLNGMLDTSFRDRAVQKHQGLKLATAIL 1620
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M-HEAT/CIRCULAR CRADLE

Supplementary Figure 1. DNA-PKcs, jawed vertebrates

```
DANIO          KGWDLLRPWWDGPAATPESKTSVLSLLAKVLQIDSSVCSNTSHPAFNAVFTTFTALLTDV 1693
MILII          TNWTRLESWWSENS-SAESKMAVLTLLSKVLQIDSSVSFSSNHEAFAMVFHTYTTILTDS 1689
BAMBOO         SNWAKLDSWWSVKS-SPESKMAVLTLLSKVLQIDSSVSFGNSHDAFSMVFQTYTTILTDS 1688
XENOPUS        ENWRRLDSWWYKDS-PSESKMAVLTLLAKVLQIDSSVCFDINHSAFAEVFKTYTSILTDQ 1704
STERLET        GSWTSLQSWWASSS-SAESKMAALTLLSKVLQIDSSVSFNTSHLAFAVVFSTYTTLVTDS 1705
GAR            QAWSSLGSWWSSPASTSESKMATLTLLSKVLQIDSSVCFNVNHEAFEAVFTTYTALITDS 1693
LATIMERIA      QNWTKLSSWWIRSS-SPESKMAALTLLSKVLQIDSSVSFNPNHAAFPAVFNTYTTLLTDQ 1693
CAECIL         QNWKKLDSWWDKNS-APESKMAVLTLLAKVLQIDSSVSSNAHHEAFSAVFNTYTSILTDQ 1695
SNAKE          KNWGHLDHWWAKDA-SPESKMSVLTLLAKVLQIDSSVSFT-HHEAFPNVFNTYTCLLMDQ 1692
CANARY         RNWEKLDGWWAKGS-SAESKMALLTLLAKVLQIDSSVSFNTNHEAFTAVFNTYTSLLTDQ 1684
OSTRICH        RNWKRLDSWWAKGS-APESKMAVLTLLAKVLQIDSAVSFNTNHEAFTAVFSTYTSLLIDQ 1654
GECKO          KNWVHLDNWRTRDS-APESKMAVLTLLAKVLQIDSSVSFSTQHEAFSDVFNTYTSLLTDQ 1693
TURTLE         RNWMRLDSWWAKDS-APESKMAVLTLLAKVLQIDSSVSFNTNHEAFSAVFNTYTSLLIDR 1693
ALLIGATOR      RNWMRLDTWWAKDS-APESKMAVLTLLAKVLQVDSSVSFNTKHEAFFAVFNTYTSLLVDQ 1651
PLATYPUS       QNWKRLDTWWAEDS-TPESKIAVLTLLAKVLQIDSSVSSNTNHAAFSAVFNAYTSLLIDK 1686
TASDEVIL       QNWKKLDTWWAKDS-VPESKMAVLTLMAKILQIDSSVSFSINHGAFLDVFTTYTSLLDDP 1689
HUMAN          QHWKKCDSWWAKDS-PLETKMAVLALLAKILQIDSSVSFNTSHGSFPEVFTTYISLLADT 1682
MOUSE          QNWRKCDSWWAPDS-APESKTTVLSLLAKMLQIDSALSFDTNHSSFSEIFTTYASLLADT 1679
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M-HEAT/CIRCULAR CRADLE

```
DANIO          SMPLNLKSQALIMLPFFTALPSMPLEELRRALESLVATHFPMQSDEFPRGSLQCNNYMDC 1753
MILII          TLALNLKSQAMIILPFFAHLPEENLAVLRHALDQFVAAHFPMKSDEFPKGTLKYNNYVDA 1749
BAMBOO         TLALNLKTKAVIILPFFTQLPEENLVTLKNALNHFIASHFPMKSDEFPKGTLRYNNYVDC 1748
XENOPUS        KLGLNLKSQAIIILPFFTKLTGEKLTELKNTLDQFVASNFPMKSDEFPKGTLKFNNYVDC 1764
STERLET        TLPLNLKSQALIILPFFTNLLGSTLADLHNALEVLVASHFPMQSDEFPKGTLRYNNYIDS 1765
GAR            ALPLNLKNHGLIILPFFTNLPESTLAELQRALEMLVASHFPISSDEFPKGTLRYNNYVDT 1753
LATIMERIA      TLALNLKSQAVIVLPFFTNLPEDHLADLKNALDQLVAFNFPMKSDEFPKGTLKYNNYVDC 1753
CAECIL         KLGLNLKSQAIIILPFFTNLTGDSLNDLKNALDQLVAFNFPLKSDEFPKGTLKYNNYVDC 1755
SNAKE          KLGLHLKSQAIIILPFFTELVGEGLHKLKHALDQLVAYNFPLTSDEFPKGTLKYNNYVDC 1752
CANARY         NLGLNLKGQAVIILPFFTNLTGEKLNDLKNALDQLVAFNFPMRSDEFPKGTLKHNNYVDC 1744
OSTRICH        NLDLNLKSQAMIILPFFTNLTGEKLNDLKNALDQLIAFNFPMRSDEFPKGTLKHNNYVDC 1714
GECKO          NLGLNLKSQAVIILPFFTNLVGERLVDLKNVLDQFVAFNFPLRSNEFPKGTLRYNNFVDC 1753
TURTLE         NLGLNLKSQAVIILPFFTNLTGDRISELKNALDQLVAFNFPMKSDEFPKGTLRYNNYVDC 1753
ALLIGATOR      NLGLNLKSQAVVILPFFTNLTGERLKELKDALDQLVAFNFPMKSDEFPKGTLRYNNYVDC 1711
PLATYPUS       KLGLNLKSQAVLILPFFTNLTGDRLNDLKNALEQFVAFNFPMNSDEFPKGTLRYNNYVDC 1746
TASDEVIL       KLGLNLKGQALIILPFFTNLTGERLEDLKLALEKLVASNFPMTSHEFVQGTLKYNNYVDC 1749
HUMAN          KLDLHLKGQAVTLLPFFTSLTGGSLEELRRVLEQLIVAHFPMQSREFPPGTPRFNNYVDC 1742
MOUSE          KLGLHLKGQAIILLPFFTSLREGSLENLKHILEKLIVCNFPMKSDEFPPDSLKYNNYVDC 1739
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M-HEAT/CIRCULAR CRADLE

Supplementary Figure 1. DNA-PKcs, jawed vertebrates

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DANIO          IRKFLEALQLSQSPLLLKLMARVLCRDKKHIMEELFQACFQKIAHQSYLGKQVLLLSSTY 1813
MILII          IKKLLDALELSQSPMLLKLMIAILCRDSRHVMEEGFQVCFQRLAKTGSCEKQVALLEAVY 1809
BAMBOO         VKKLLDALELSQSPLLLQILTEVLCRDNRHVMEEAFQICFQNIAKRGTCEKQVALLEAAY 1808
XENOPUS        IKKFLDALELSQSPMLLQLMTEILCRDERHFMEELFQSSFKKVIKRSSCDTQVILLNTLH 1824
STERLET        IKKFLDALELSQSPMLLKLMTGILCRDNKHVMEELFQTCFKRIARRGSCEKQVSLLDTVY 1825
GAR            IKKFLDALELSQNPMLLKLMAEILCRDKKHVTEELFQACFKRIARRSGCERQVVLLETVY 1813
LATIMERIA      IKKFLDALELSQSPMLLRLMTEILCRDSKHCLEELFLRCFKKIVRRGSCDRQVTLLDTVY 1813
CAECIL         VKKFLDALELSQSTMLLKLMTEILCRDTKHFMEELFLTSFKRIARRGNCDKQVALLETVH 1815
SNAKE          VKKFLDALELSQNSTLLELMTEILCRDNKHIMEELFEINLKRIAKRGSCERQVLLLDTVH 1812
CANARY         TKKFLDALELSQSPMLLQLMTEILCRDNRHFMEDLFQASFKRISRRSPTDKQVLLLDTVH 1804
OSTRICH        TKKFLDALELSQSPMLLQLMTEVLCRDHRHFMEGLFQASFKRISRRSNSDRQVVLLDTVH 1774
GECKO          TKKFLDALELSQSPMLLQLMTEILCRDHRHIMEEQFEISFIRIARRGSCYKQVVLLDTVH 1813
TURTLE         TKKFLDALELSQSPMLLQLMTEILCRDHRHFMEDLFQTSFKRISRRSSYEKQVVLLDTVH 1813
ALLIGATOR      TKKFLDALELSQSPLLLQLMTEILCRDHRHCMEDLFQTSFKRVIKRSDCNKQVVLLDTVY 1771
PLATYPUS       TKKFLDALELSQSPMLLQLMTEILCRDQRHFMEELFQMSFKRIARRSGSAKQVALLEAVH 1806
TASDEVIL       TKKFLDALELSQSPMLLQFMTEILCRDQRHVIEELFQTTFQRISKRSSATQVALLDTVH 1809
HUMAN          MKKFLDALELSQSPMLLELMTEVLCREQQHVMEELFQSSFRRIARRGSCVTQVGLLESVY 1802
MOUSE          MKKFLDALELSQSPMLFQLMTDILCREQRHIMEELFQTTFKRIARQSPCVTQLNLLESVY 1799
                :*:*:**:***.  *:.::  :***: :*  *  *   : .: : .    *: **.: :
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M-HEAT/CIRCULAR CRADLE

```
DANIO          QSFQAKEVPSNFMLMGLIDRVLLPLASHCSPQALSQFFISNIADIMTTLQTRFTKSVESV 1873
MILII          GMFENEGGLSNIARQSVMDRSLLTLITHCSLDALKEFISKIIKDAMGILQSRFTKTSESS 1869
BAMBOO         EMFRNEEMLPNATRQFAMDRSLLTLIGHCSPDALREFFCKIVKDAMEILQSRFTKTNESS 1868
XENOPUS        NMFKSESLMLNGTLQSLIDRCLLTLLWNCSLDAMISFFTNIISLAMDTLKSRFTKVPEAA 1884
STERLET        QMFQNDELHSNTARQAVLDRSLLTLTLHCSSDALKEFFCTTVGDIMGTLQARFTKSSEST 1885
GAR            EMFQAGELASGAMRQAVLDRVLLTLVLHCSSDALRGFFCKTIASVMETLQARFTKLNEAM 1873
LATIMERIA      KMFQDEGLLSNTTRQAIMDRTFLTIMLNCSIDALKEFLCKNILDVMGTLQARFTKSNESA 1873
CAECIL         DMFKTENLWSNTTRQTIVDKSLLILIWHCSLDALKEFFCKIIIHTMDTLKGRFTKSNELA 1875
SNAKE          QMFQSETLHSNITRQAYVDRCLLILLLHCSLDALKEFLSKIIIEAMDTLKSRFTKSNETS 1872
CANARY         KMFQSEELLSNAARQAFVDRSLLTLLWHCSLDALRVFFGKIIVEAMDTLNSRFTKSHEHT 1864
OSTRICH        KMFQSEDLRSNVTRQAFVDRSLLTLLLHCSLDALREFFGTIIVQAMDTLNSRFTKSNEST 1834
GECKO          KMFQSETLLSSATRQAYVDRSLLTLLLHCSTDALDDFFCKIIVEAMDSLTSRFTKSNETM 1873
TURTLE         KMFQSEALLSNATRQAFVDRSFLTLLLHCSLDALKDFFSKIVLEAMDTLKTRFTKSNESA 1873
ALLIGATOR      KMFQSESLLSNVTRQAFLDRSLLTLLLYCSLDALKEFFSKIVVEAMDTLKSRFTKSNETV 1831
PLATYPUS       GMFLRDDHLSSTTRQAFVDRSLLTLLLHCSLDALKEFFYRIIVGAMDMLKSRFTKSNEST 1866
TASDEVIL       RMFQKDD-LSNIPRLACVDRCLLTLLWHCSLAALREFFSSIIVEALDVLKSRFTKLSEST 1868
HUMAN          EMFRKDDPRLSFTRQSFVDRSLLTLLWHCSLDALREFFSTIVVDAIDVLKSRFTKLNEST 1862
MOUSE          TMFRKADLPSNVTRQAFVDRSLLTLLWHCDLDTLKEFFSRIVVDAIDVLKSRFTKLNEFT 1859
                 *       .      :*: :* :   *.  ::  *:   :   :  *  ****  *
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M-HEAT/CIRCULAR CRADLE

NUC194

Supplementary Figure 1. DNA-PKcs, jawed vertebrates

```
DANIO          FESQIMMKIGCCKLLEVLYSRLPKEEVYSKNSAINQAFCGTGC-AEGNEL-SKNLLKSCF 1931
MILII          FDNQLTRKIGCYKLLEVTYIRLPKDDIYSEDSKINRAFHSSSN-MEGNKLLSKSLLKLCY 1928
BAMBOO         FDNQLTKKIGCYKLFEVMYTRLPKNDVYTDGSKIIQAFHSAGN-IEGNKL-SKTLLKSCY 1926
XENOPUS        FDSQITKKWGYYKMLEVQYSRLSKDEIYST---VNNAYHVSSK-PEGNEL-TKALIKLCY 1939
STERLET        FETQLTKKNGCYKLLEVLYSRLPKEDVYSKESLINQAFCRPNK-AEGNEL-SKSLLKSCF 1943
GAR            FEGQLIKKNGCYKLLEVLYSRLPKEEVYSKESKINQGFCGPSRAAEGNEL-SKTLLKSCF 1932
LATIMERIA      FDTQVTKKTGCYKLLEVMCSRLPKDDIYSEQSRINQAFHGSCS-AQRNGL-SKTLLKLCY 1931
CAECIL         FDAQIMMKMSYYKMLEVMYSRLTKEDIYSKGSRINQAFHGSSN-AEGNEL-TKILVKSCY 1933
SNAKE          FETQLIKKISYYKILEVMYSRLSKEDVHSKDSRINQVFQRSTH-VEGNEL-TKLLIKSCY 1930
CANARY         FDTQVTKKMGYYKLLEVMYVRLSKEEVYSKDSKINQAYRGSMS-VEGNEL-TKTLIKSCY 1922
OSTRICH        FDTQVTKKTGYYKVLEVMYVRLSKEDVYSKDSKINQAYCGSIS-VEGNEL-TKTLIKSCY 1892
GECKO          FDTQLTKKMSYYKILEVMYSRLSKEDVYSKDSRINQAFLRSTC-VEGNEL-TKTLIKSCY 1931
TURTLE         FDTQVTKKMGYYKILEVMYSRLSKEDIYSKDSRINQAYQGSTN-VEGNEL-TKTLIKSCY 1931
ALLIGATOR      FNTQVIKKMGYYKILEVLYSRVSKEDVHSKDSQINQAYQGTTN-VEGNEL-TKMLIKSCY 1889
PLATYPUS       FDTQVTKKLGYYKMLEMMYSRLPKDDVHSKESRINRAFHGSSV-IEGNEL-TKTLIKSCY 1924
TASDEVIL       FDTQVTKKLGYYKMLEVLYSRLPKDDVHSKESRINQVFHGSSI-VEGNEL-TKTLIKLCY 1926
HUMAN          FDTQITKKMGYYKILDVMYSRLPKDDVHAKESKINQVFHGSCI-TEGNEL-TKTLIKLCY 1920
MOUSE          FDTQITKKMCYYKMLAVMYSRLLKDDVHSKEAKINQAFHGSRV-AEGNEL-TKTLLKLCH 1917
               *: *:  *    *:: :   *: *::::::    : . :       : * * :* *:* *.
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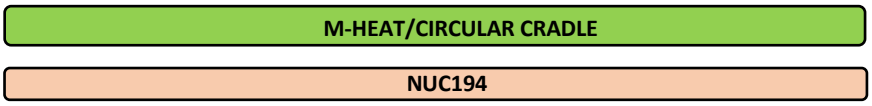


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DANIO          EAFTENMTGEMVLLELRRQFHCAAYNCAIALISCSFNETKFYQGFLFTEKPDKNQFIFDN 1991
MILII          DAFTENMTGEKQLLEKRRQYHCAAYNCIMAVVTCIFTEAKFYQGFLFSEKAEKNIFIFEN 1988
BAMBOO         DTVTENMTGETQLLEKRRQYHCAAYNCMIAILCCIFTEAKFYQGFLFSEKPEKNIFILEN 1986
XENOPUS        DTFTENMCGETQLLEKRRQYHCAAYNCAISLISCVFSELKFYQGFLFTEKKEKNLLIFEN 1999
STERLET        DTFTENMAGETQLLEKRRKYHCAAYNCAITVISCSFNETKFYQGFLFSEKPEKNQFIFEN 2003
GAR            EAYTENMAGETQLLEERRQYHCAAYNCAIAVISCSFNETKFYQGFLFTEKPEKNQFIFEN 1992
LATIMERIA      DEFTENMAGETQLLEKRRQYHCAAYNCAIAVISCIFTESKFYQGFLFSEKPEKSLYILEN 1991
CAECIL         DSFSENMAGETQLFEKRRQYHCAAYNCAIAVISRAFTDAKFYQGFLFTEKTEKNLLIFEN 1993
SNAKE          DAFTENMSGETQLLENRRQFHCAAYNCAIAVISCVFNENKFYHGFLFTEKPDKNLLIFEN 1990
CANARY         DAFTENMAGESQLLEKRRQYHCAAYNCAIAVISCVFTESKFYQGFLFSEKSEKNLLIFEN 1982
OSTRICH        DAFTENMAGESQLLEKRRQYHCAAYNCAIAVISCVFTESKFYQGFLFTEKTEKNLLIFEN 1952
GECKO          DAFTENMTGETQLLEKRRQYHCAAYNCAIAVISCVFNESKFYQGFLFTEKPDKNLLIFEN 1991
TURTLE         DAFTENMAGESQLLEKRRQYHCAAYNCAIAVISCVFTESKFYQGFLFTEKPEKNLFIFEN 1991
ALLIGATOR      DAFTENMAGESHLLGKRREYHCAAYNCAIAVISCVFTESKFYQGFLFTEKPEKNLLIFEN 1949
PLATYPUS       DAFTENMAGETQLLEKRRQYHCAAYNCAIAVISCVFNETKFYQGFLFTEKPEKNLFIFEN 1984
TASDEVIL       DAFTENMAGETQLLEKRRLYHCAAYNCAIAILCRVFSEMKFYQGFLFTEKPEKNLFILEN 1986
HUMAN          DAFTENMAGENQLLERRRLYHCAAYNCAISVICCVFNELKFYQGFLFSEKPEKNLLIFEN 1980
MOUSE          DAFTENMVGESQLLEKRRLYHCAAYNCAISLISCVFNELKFYQGFLFNEKPEKNLFIFEN 1977
               :  :*** **  *:  ** :******* ::::   *.: ***:****.** :*.  *::*
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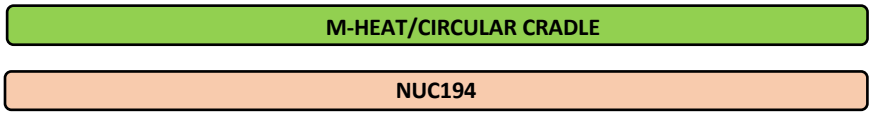

Supplementary Figure 1. DNA-PKcs, jawed vertebrates

```
DANIO          LIDSQRVYNFPIEIDVPIERKKKYVMIRKEVSG---ENGDAPVYLSSQSYMADSSLSEEM 2048
MILII          LIEAHRTYNFPVEIEVPLEKKRRFISIRKEAREAGDGDSGEPQYLSSQSYMADSSLSEEM 2048
BAMBOO         LIDSQRAYNFPVEIEVPVEKKRRYFAIRKEARESAEGDSDEPHYLSSQSYMVDSSLSEEM 2046
XENOPUS        LIDLQRNYTFPIEVEVPMERKKKYFAIRKEARDASSTESDEPSYLSSQSYMADSSLIEEM 2059
STERLET        LIDAKHTYSFPVEIEVPLERKKKYVAIRKEARQGGEGDSDEPHYLSSQSYMADSSLSEEM 2063
GAR            IIDAQQTYRFPVEIEVALERKAKYVAIRKEAREAGDRDAEEPHYLSSQSYMADSSLSEEM 2052
LATIMERIA      LIDMKCSYNFPIEIEVPIEKKRKYVAIRKEARGSTIGDLDEPQYMSSQSYMADSSLSEEM 2051
CAECIL         LIDLQRCYTFPVEVEVPLERKKKYVAIRQEARNTANGESDAPHYLSSQSYMADSSLREEM 2053
SNAKE          LLDLQHRYSFPIEIEVPLEKKKRYITIRKEARQTMSGDSAEPRYLASASYMVDSSLSEEM 2050
CANARY         LIDLKREYTFPVEIEVPLERKKRYIAIRKEARDAGNSSQDEPKYLASSSYMMDSSLSEEM 2042
OSTRICH        LIDLKRQYSFPVEVEVPLERKKRYIAIRKEARDSGNGNEDEPKYLPSASYMMDSSLSEEM 2012
GECKO          LLDLQHRYSFPIEVEVPLERKKRYIAIRKDAREAMSVDSAEPHYLASASYMADSSLSEEM 2051
TURTLE         LLDLKHRYSFPVEVEVPMERKKRYITIRKEARDAVNRDSDEPQYLPSASYMVDSSLSEEM 2051
ALLIGATOR      LIDLKHQYSFPVEIEVPMERKKRYIAIRKEARDTVNGGPDEPQYLPSASYMVDSSLSEEM 2009
PLATYPUS       LIDLKRCYTFPVEIEVPMERKKKYIAIRKEARDSVNDNSDEPHYLSSLSSMADSSLSEEI 2044
TASDEVIL       LIDLKHCYTFPVEVEVPMERKKRYIAIRKEARDAANGDSEGPHYLSSLSYMADSSLSEEM 2046
HUMAN          LIDLKRRYNFPVEVEVPMERKKKYIEIRKEAREAANGDSDGPSYMSSLSYLADSTLSEEM 2040
MOUSE          LIDLKRCYTFPIEVEVPMERKKKYIEIRKEARDAANGASGSPHYMSSLSYLTDSSLSEEM 2037
               ::: :  * **:*::* :*:* ::. **::.          * *: * * : **:* **:
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M-HEAT/CIRCULAR CRADLE

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```
DANIO          SQFDFSTGVQSFSYNSQNPSGVSSSSRMRE-RKEVLSQDETVELEMDELNQHECMANMTA 2107
MILII          SQFDFSTGVQSFSYNSQDPRGHAVRSRRKEQAELSVVQSDIMELEMDELNQHECMPAMIA 2108
BAMBOO         SQFDFSTGVQSFSYSSQDPKVSVLRTRKTEWTESNIMLNDIVELEMDEMNQHECMATMTA 2106
XENOPUS        SQFDFSTGVQSFSYSSQSKMLSQSASRKKEQITEGKTFDDVMEFEMDELNQHECMAAMTG 2119
STERLET        SQFDFSTGVQSFSYSSQDPSARAARGRRRE-RVESLVQDDVVELEMDELNQHECMASMTA 2122
GAR            SQFDFSTGVQSFSYGSQDPSTRPMPSRRRD-GAEAALQDDVVVLEMDELNQHECMASMTV 2111
LATIMERIA      SQFDFSTGVQSFSYSSQNRAAAVVHSRRKE-RTESVVQDDVMEFEMDELNQHECMAAMTA 2110
CAECIL         SQFDFSTGVQSFSYSSQDPTAAQFHSRKRE-HPEFTVQEDVMEFEMDELNQHECMAAMTG 2112
SNAKE          SQFDFSTGIQSFSRSSEDPTSSGSHIRKKE-ITDTVVPGDMMELEMDELNQHECMTSMTT 2109
CANARY         SQFDFSTGVQGFSYSSQDVTASSTRFRRKE-PTEYKVLNDEMELEMDEFNQHECMASMTS 2101
OSTRICH        SQFDFSTGVQGFSYSSQDVTASSPRFRRKE-PTEYMALDDDTELEMDELNQHECMASMTT 2071
GECKO          SQFDFSTGVQSFSYNSQDPTASASHFRRKE-PTESMGLGDIMELEMDELNQHECMASMTT 2110
TURTLE         SQFDFSTGVQSFSYNSQDPTASSIHFRRKE-PTESMDPDDLMELEMDELNQHECMASMTT 2110
ALLIGATOR      SQFDFSTGVQSFSYNTQDPTATSARFRRKE-STESMVLDDEMELEMDELNQHECMTAMTT 2068
PLATYPUS       SQFDFSTGVQSYSYSSQDVKSTGYHFKRRE-YRDPVTQSDVLELEMDELNQHECMATMTA 2103
TASDEVIL       SQFDFSTGVQSYSYSTQDSKATVVHFRRRE-RIDSMVQDDVMELEMDELNQHECMTTMTA 2105
HUMAN          SQFDFSTGVQSYSYSSQDPRPATGRFRRRE-QRDPTVHDDVLELEMDELNRHECMAPLTA 2099
MOUSE          SQFDFSTGVQSYSYSSQDRKPTTGHFQRRE-HQDSMTQDDIMELEMDELNQHECMAPMIA 2096
               ********:*.:* .::.        :  :          :   :****:*:****  :
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M-HEAT/CIRCULAR CRADLE

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Supplementary Figure 1. DNA-PKcs, jawed vertebrates

```
DANIO          LLRHMQRNNITPKVEEGVRPSDLPPWMKFLQGKLDNPSTPLNIRLFIAKLIINTEEIFRP 2167
MILII          LINHMQRNNITPQVEEGKTPQELPPWMKFLHGKLGNSSIPLNIRLFIAKLIVNSEEVFRP 2168
BAMBOO         LIKHMQKTNITPKVEEGKTPHELPPWMKFLHGKLGNSATPLNIRLFVAKLIVNTEEIFQP 2166
XENOPUS        LIKHMNRSEITPKVDEDASPQELPSWMKFLHVKLGNTSTPLNIRLFIAKLIVNTEEVFRP 2179
STERLET        LLNHMQRNNITPKVDEGTVPADLPPWMKFVHGKFGNASTHLNIKLFIAKLIINTEEVFRP 2182
GAR            LINHMQRNNITPEVEEGTVPSDLPPWMKFLQGKLGNPSTQLNIRLFIAKLIVNKEEVFRP 2171
LATIMERIA      LINHMQRNKITPQVEEESGPVELPPWMKFLSHKLANPATPLNIRLFIAKLVINTEEVFRP 2170
CAECIL         LIKYMQKTQITPKVEEGTVPQDLPPWMKFLHGKLGNTSTPLNIRLFIAKLIANTEDVFRP 2172
SNAKE          LLKHMHRNNITPVVEKDTNSPELPPWMKFLHNKLGNSTVPLNIRLFVAKLIVNTEEVFQP 2169
CANARY         LIKHMERNQITPKVEEGTVPADLPLWMKFLHGKLGNPSVPLNIRLFIAKLIVNTEDVFRP 2161
OSTRICH        LIKHMQRNQITPKVEDGTVPVDLPLWMKFLHGKLGNPSVPLNIRLFIAKLIANTEDVFRP 2131
GECKO          LIKHMHRNNITPTVEKGAVLPDLPPWMKFLHSKLGNPSVPLNIRLFVAKLIVNTEEVFQP 2170
TURTLE         LIKHMQRNQITPKVDEGIVPRDLPPWMKFIHGKLGNPSMPLNIRLFLAKLIVNTEEVFRP 2170
ALLIGATOR      LIKHMQRNQITPQVDEGAVSVALPPWMKFLHSKLGNPSVPLNIRLFLAKLIVNTEEVFRP 2128
PLATYPUS       LIKHMQNNQITPKVEEGSGSTNLPPWMKFLHGKLANPLGALNIRLFLAKLIANTEEVFRP 2163
TASDEVIL       LIKHMQRNHITPHVKEGSEPPSLPPWMKFLHNKLENPSTPLNIRLFLAKLIINTEEVFRP 2165
HUMAN          LVKHMHRSLGPPQGEEDSVPRDLPSWMKFLHGKLGNPIVPLNIRLFLAKLVINTEEVFRP 2159
MOUSE          LIKHMQRNVIAPKGEEGSIPKDLPPWMKFLHDKLGNASVSLNICLFLAKLVINTEEVFRP 2156
               *:.:*...   *  ..      ** ****:  *: *    *** **:***: *.*::*:*
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M-HEAT/CIRCULAR CRADLE

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```
DANIO          YAKHWLGPLMQLVVSSSNGGEGIHFMVVDIVVTVLSWASVASPKGNTRDEVLVNRLLGFL 2227
MILII          YAKEWLGPLLQLVVSGNNGGDGIHYMVVEIVVTVLSWTSVATPKGNMKDEILANRLLEFL 2228
BAMBOO         YAKEWLGPLLQLVVSGNNGGDGIHYMVVEIVVTVLSWISVATPKGDLKNEILANRLLEFL 2226
XENOPUS        YARFWIGPILQLIVSGNNGGTGIHYMVVETLVTILSWSSIATPNGQAKEEILANRLLEFL 2239
STERLET        YARHWLGPLLQLVVSGNNGGEGIHYMVVEIVVTVLSWTSLASPKGNTRDEILANRLLEFL 2242
GAR            YAKHWLWPLLQLVVSGNNGGEGIHFMVVEIVVTVLSWASVATPKGDTKDEVLANRLLEFL 2231
LATIMERIA      YAKHWLGPFLQLVVSGNNGGEGIHYMVVDIVVTVLSWANIAAPKGNTRDEILANRLLEFL 2230
CAECIL         YAKQWLGPLLQLVVSGNNGGDGIHYMVVEIVVTVLSWANVATPAGLAKDEILANRLLEFL 2232
SNAKE          YAKWWLGPLLQLVVSGDNGGEGIHYMVVEIVVTLLSWTNVATPKGNIKDEVLANRLLEFL 2229
CANARY         YAKHWLGPLLQLVVSGNNGGEGIHYMVVEIVVTILSWTSVATPKGNIKDEILANRLLEFL 2221
OSTRICH        YAKQWLGPLLQLVVSGNNGGEGIHYMVVEIVVTLLSWTSVATPKGNIKDEILANRLLEFL 2191
GECKO          YAKQFLGPLLQLIVSGDNGGEGIHYMVVEIVVTLLSWTSIATPKENIKDEILANRLLEYL 2230
TURTLE         YARQWLGPLLQLVVSRDNGGEGIHYMVVEIVVTLLSWTSVAAPKGNIKDEILANRLLEFL 2230
ALLIGATOR      YARHWLGPLLQLVVSRDNGGEGIHYMVVEIVVTLLSWTSVASPKGNVKDEILANRLLEFL 2188
PLATYPUS       YARHWLGPLLQLVVSGENGGEGIHYMVVEIVATVLSWTSIATPTGVTKDELLANRLLEFL 2223
TASDEVIL       YAKHWLNPLLQLVVSENNGGEGIHYMVVEIVVVVLSWTSIATPKGVPKDELLANRLLQFL 2225
HUMAN          YAKHWLSPLLQLAASENNGGEGIHYMVVEIVATILSWTGLATPTGVPKDEVLANRLLNFL 2219
MOUSE          YAKHWLSPLLQLAVCEN-NREGIHYMMVEIVATILSWTGLATPTGVPKDEVLANRLLRFL 2215
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M-HEAT/CIRCULAR CRADLE

NUC194

Supplementary Figure 1. DNA-PKcs, jawed vertebrates

```
DANIO          FKNCFHSKRAVFRHNLEIIRTVVECWKDCLTIPYDLIYERFAGTDPNSKDNSVGIQLLGI 2287
MILII          MKNSFHEKTAVFRHNLEIIKTVVECWKDCLSVPYSLIFSRFSSTDPNSKDNSVGIQLLGI 2288
BAMBOO         MKNCFHEKRVVFRHNLEIIKTVVECWKDCLSIPYSLIFDRFAGRDPNTKDNSVGIQLLGI 2286
XENOPUS        MKNVFHEKRAVFRHNLEIIKTVLECWKECLSIPYRLIYEGFSGTDPNTKDNSVGIQLLGL 2299
STERLET        MKNAFYDKRAVFRHNLEIIKTVIECWKDCLAVPYSLIFDRFSGKDPNSKNNSVGIQLLGI 2302
GAR            MRNAFHEKRAVFRHNLEIIKTVVECWKDSLMVPYSLIFDRFAGSDPNSKDNSVGIQLLGI 2291
LATIMERIA      MKNTYHEKRAVFRHNLEIIKTVVECWKDCLAVPYSLLYQRFSGKDPNTKDNTVGIQLLGI 2290
CAECIL         VTHSFHEKRAVFRHNLEIIKTVVECWKDCLSIPYRLIFERFSNGNTNSKDNSVGIQLLGL 2292
SNAKE          MKNVFHQKRAVFRHNLEIIKTVIECWKDCLSIPYRIIFQLFS-GDPNTKDNSVGIQLLGI 2288
CANARY         MKNAFHPKRAVFRHNLEIIKTVIECWKDCLSIPYSLIFQRFSSGDPDTKDNSVGIQLLGI 2281
OSTRICH        MKNAFHPKRAVFRHNLEIIKTVIECWKNCLSIPYSLIFEKFSGGDPNTKDNSVGIQLLGI 2251
GECKO          MKNAFHQKRAVFRHNLEIIKTVVECWKDCLSIPYRIIFERFSGGDPNTKDNSVGIQLLGI 2290
TURTLE         MKNVFHQKRAVFRHNLEIIKTVVECWKDCLSIPYRLIFEQFSGGDPNTKDNSVGIQLLGI 2290
ALLIGATOR      MKNTFHQKRAVFRHNLEIIKTVVECWKDCLTVPYRLIFEQFSGGDPDTKDNSVGIQLLGI 2248
PLATYPUS       MKHVFHQKRAVFRHNLEIIKTVVECWKDCLSIPYRLIFEKFATGDPNTKDNSVGIQLLGI 2283
TASDEVIL       MKHVFHPKRAVFRHNLEIIKTVVECWKDCLSIPYRIIFEKFSNRDPNSKDNSVGIQLLGI 2285
HUMAN          MKHVFHPKRAVFRHNLEIIKTLVECWKDCLSIPYRLIFEKFSGKDPNSKDNSVGIQLLGI 2279
MOUSE          MKHVFHPKRAVFRHNLEIIKTLVECWKECLSIPYRLIFEKFSHKDPNSKDNSVGIQLLGI 2275
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M-HEAT/CIRCULAR CRADLE

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DANIO          VMANNLPPYDAACGIEHDRYFQSLANNLSFIRYKEVYSAAAEVIGLILNYMTERENQIEG 2347
MILII          VLANNLSPYVPKCEIGYERYFQRLVYNISLTRYKEVYAAAAEVLGLVLHYFAENEKQVDG 2348
BAMBOO         VLANNLPPYDCKCEIDSERFFQRLVHNISLTRYKEVYAAAAEVLGLVLQYLAG--KPMDC 2344
XENOPUS        ALANNFSPLDPKCGIDPERYFQSLANNLGLTRFKEVYIAAAEVIGLVLRYIVQNEKRTEA 2359
STERLET        VLANNLPPYDPKCGIDSESYFQALATNISFGRFKDIYAAAAEVIGLIMQYLAKNEKQLEG 2362
GAR            VLANNLPPYDPSCGIEHERYFKSLANNISFVRYKDIHVAAAEVIGLVMQYMAEKEKQSEG 2351
LATIMERIA      ILANNLPPHDPTCSIDMESYVKALANNLSFTRYKEVYAAAAEVLGLVLQYRAEKEKELGG 2350
CAECIL         ILANNLPPYDPKCGIDVERYFQALANNIALTKYKDIYLAAAEVLGLALHYVAEKEKTLEG 2352
SNAKE          VLANNLPPYDPKCEIDSIRYFQALSNNIALIRYKEVYVAAAEVLGLILQYIAEKENTFEG 2348
CANARY         VLANNLPPFDPKCEIDRVRYFQALTSNMGLLKYREVYAAAAEVLGLALQYIAERENILED 2341
OSTRICH        VLANDLPPFDPKCEIDRVRYFQALISNMGLLKYKEVYAAAAEVLGLALRYVAERENILED 2311
GECKO          VLANNLPPYDPKCEIDNVRYFQALANNMALVRYKEVYAAAAEVLGLVLQYIAEKENIYES 2350
TURTLE         VLANNLSPYDPKCEIDSVRYFQDLANNMSLIRYKEVYAAAAEVLGLILQYMAEKENIFEG 2350
ALLIGATOR      VLANNLPPYDPKCEIDSTRYFQALVNNMALLKYKEVYAAAAEVLGLTLRYIAEKENITEG 2308
PLATYPUS       VLANNLPPYDPKCGIDSARYFQALANNLSLVKYKEVYAAAAEVLGLTLQYVSEKETMLED 2343
TASDEVIL       IMANNLPPYDSKSGIESTRYFQALVNNMSFIKYKEVYAAAAEVLGLILQYIAKKENVLED 2345
HUMAN          VMANDLPPYDPQCGIQSSEYFQALVNNMSFVRYKEVYAAAAEVLGLILRYVMERKNILEE 2339
MOUSE          VIANNLPPYDPNCDITSAMYFEALVNNMSFVKYKEVYAAAAEVLGLILQYITERKHVIAE 2335
                :**:: *    . *    :.: *  *:.: :::::: *****:** :.*
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M-HEAT/CIRCULAR CRADLE

Supplementary Figure 1. DNA-PKcs, jawed vertebrates

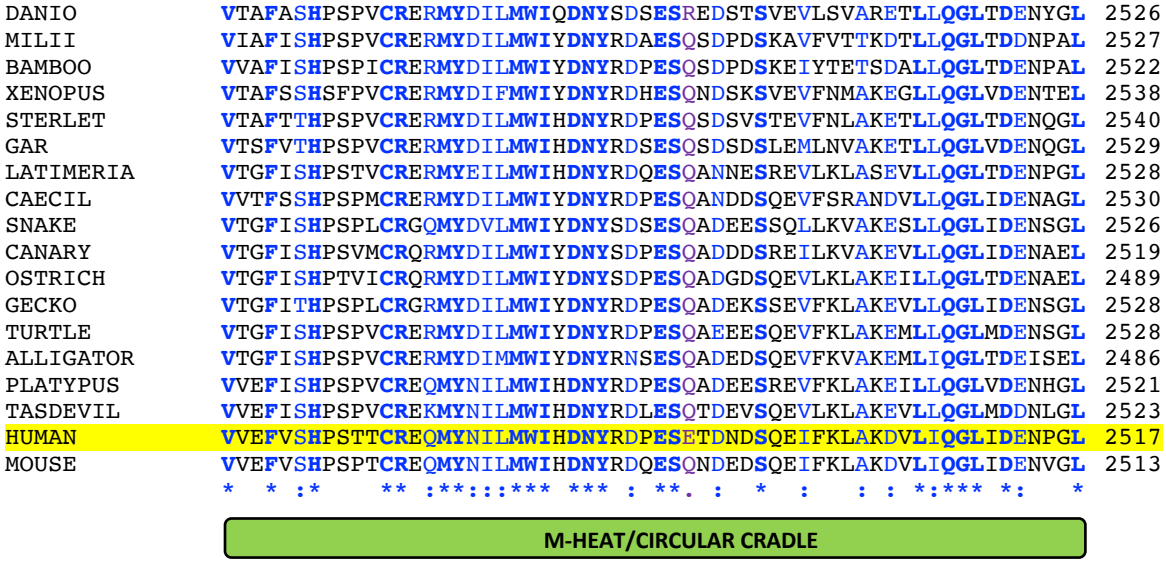
```
DANIO          TLFNITVTKLMDLRKKEVDDKFIVCLSKVSKHFPPLVD-RFINPVFYLLPKLHGMLKTHC 2406
MILII          LVHDLIAKELKQLQ-QSKEDKFIVCLSKIVKNYPPFADRRFLNQVFYLLPKLHGVLKTHC 2407
BAMBOO         AVHDLVVKELQQLQ-NTKEDKFIVCLSKIVKHFPPFAD-RFMNAVFFLMPKLYGILKTHC 2402
XENOPUS        PVFDYVVKELKRHQTNNKEDKFIMCLNKVVKNFPPFAD-RFMTIVLFLLPKLHGVLKTQC 2418
STERLET        PIFDFTVKELKHLQ-NTKEDKFVECLSKVVKNFPPLVD-RFLNAVLFLLPKLHGVLKTHC 2420
GAR            PIFDFTAHHLKKLQ-NEKEDKFVVCLSKVVKHFPPFMD-RFVNAVFFLLPKMHGVLKTHC 2409
LATIMERIA      PIIDSVVRELKQLQ-SIKEDKFIVCLSKIVKNFALLAD-RFMSVVFFLLPKLHGVLKTHC 2408
CAECIL         PLFDCVIKELKQHQ-NAKEDKFIMCLNKVVKNFSPLAD-RFMTVVLFLLPKLHGVLKTYC 2410
SNAKE          PIYDMVIKQLKLHQ-NTRDDKFIVCLNQITKNFPPLAD-RFMSFVFFLLPKLHGVMKTHC 2406
CANARY         PVYDCVIKQLKHHQ-NTQHDKFIQCLNKVVKNFPPLAD-RFMNAVFFLIPKLHGVMKTYC 2399
OSTRICH        PAYDCVIKQLKHHQ-NTQQDKFIQCLSKVVKSFPPLAD-RFMSAVFFLIPKLHGVMKTHC 2369
GECKO          PVFDIIIKQLKQHQ-NTREDKFIICLNKLAKNFPPLAD-RFMNTVFFLIPKLHGVMKTYC 2408
TURTLE         PVYDCVIKRIEQHQ-STKEDKFIVCLNKVAKNFPPLAD-RFMNAVFFLIPKLHGVLKTYC 2408
ALLIGATOR      PIYDCVVKQLKQHQ-NTKEDKFILCLNKVVKTFPPVAD-RFINAVFFLLPKLHGVLKTSC 2366
PLATYPUS       SICELIVKQLKQHQ-NSREDKFIVCLNKAVKNFPPLAD-RFLNAVFFLLPKLHGVMKTFC 2401
TASDEVIL       SVFELVVKQLKQHQ-NTKEDKFIVCLNKAVKTFPPLAD-RFMNAVFFLLPKFHGVMKTLC 2403
HUMAN          SLCELVAKQLKQHQ-NTMEDKFIVCLNKVTKSFPPLAD-RFMNAVFFLLPKFHGVLKTLC 2397
MOUSE          LVCELVIKQLKQHQ-NTMEDKFIVCLNKIAKGFPPLAD-RFLNALFFLLPKFHGVMKTLC 2393
                  :    .:   : .  .***: **.:  * :  . * **:. :::*:**::*::** *
```

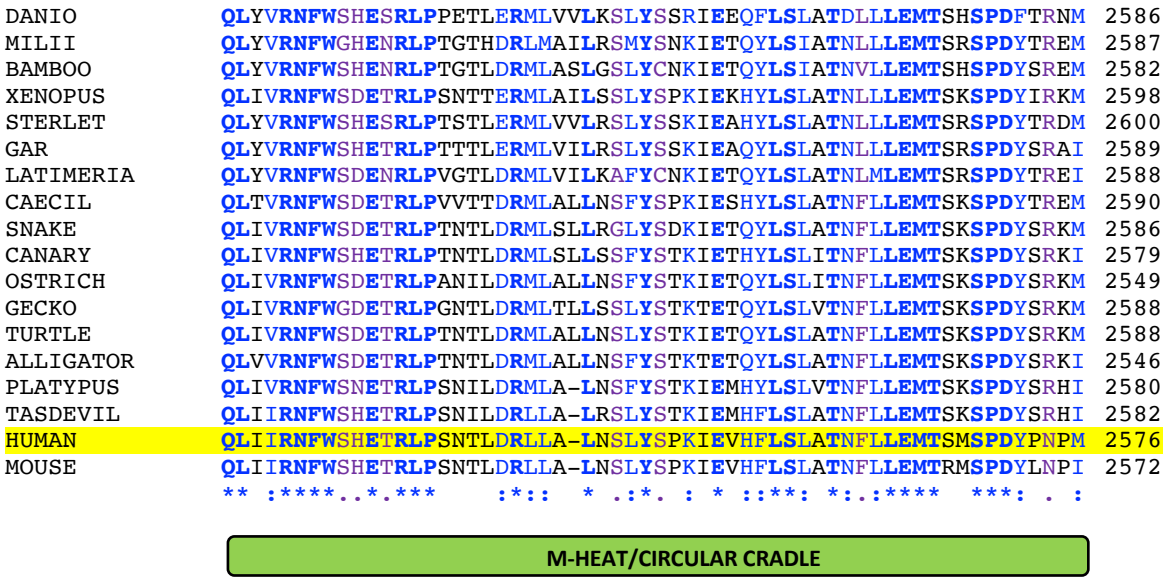
M-HEAT/CIRCULAR CRADLE

```
DANIO          LECVLSRADVIPEIFLHLKTKGLSQIMSHKDEGRQRVCLDIIHKILACLKPEELKEILGA 2466
MILII          LEVVMHRAETIIDIFQELKNKNFVQIMSYSDEERQRICLDIVYKIIAKLKAEEVKVFLVP 2467
BAMBOO         LEVVMYRAEEIPDIHIQLKSKDFTQIMSHRDEDRQRVCLDIIYRIKAKLKSAELKELLRS 2462
XENOPUS        LEIIMHRAEDIPDLFIELKNKDFCQIMNNRDDERQRVCLDIIYKILSKLTPAELHEFLIP 2478
STERLET        MEILMSRAEEVTDIYLQLKSKDFAQIMSHRDEMRQRVCLDIVHKILAKLKPVELKELLIS 2480
GAR            LECILSRAEEIPDVYLQLKSKDFSQVMSHRDEARQRVCLDIIHKIMAKLKPVEMREMLGA 2469
LATIMERIA      LEVVMSRAEEIPDIFLQLKSKDFIQLMNHRDDARQRVCLDIVYKIMFKLKPVEMKEFLVA 2468
CAECIL         LEVVMCRAEEIPDLYIQLKSKDFNQIMSHRDDDRQKVCLDIIYKMLPKLKPMELGELLNT 2470
SNAKE          LEVVMCRAQEIPDMYLELKSKEFIQVMCHRDDERQRICLNIVYKMLPKLKPAEVLELLPS 2466
CANARY         LEVIMCRAEEVPDLHLQLKSKDFIQIMNHRDDERQRVCLDIVHKMLSKLKPLELKELLPG 2459
OSTRICH        LEVIMCRAEEITDLHLQLKSKDFLQIMNHRDDERQRVCLDIVYKMLPKLKPLELKELLPG 2429
GECKO          LEVVMGRAHGIPSLYLELKSKDFTQIMSHRDDERQTVCLDIVYKMLAKLTPAEVQELLPT 2468
TURTLE         LEVVMYRAEEITDLYLQLKSKDFIQVMSHRDDERQRVCLDIVYKMLPKLKPLELRELLPG 2468
ALLIGATOR      LEVVMCRAEEITDLYLQLKSKDFMQVMNRRDDERQRVCLDIIYKMLSKLKPLELRELLPG 2426
PLATYPUS       LEVVLCRAEEITDLYLQLKSKDFAQVMRHRDDERQRVCLDIIYKMLAKLKPGELRELLNV 2461
TASDEVIL       LEVVLCRAEEIHDLYLQLKSKDFIQIMRHRDDERQKVCLDIIYTMLAKLKPVELQELLNC 2463
HUMAN          LEVVLCRVEGMTELYFQLKSKDFVQVMRHRDDERQKVCLDIIYKMMPKLKPVELRELLNP 2457
MOUSE          LEVVLCRAEEITGLYLQLKSKDFLQVMRHRDDERQKVCLDIVYKMVAKLKPIELRELLNP 2453
               :* :: *.. :  :. .**.* : *:*   *: ** :**:*:: :   *.  *:  :*
```

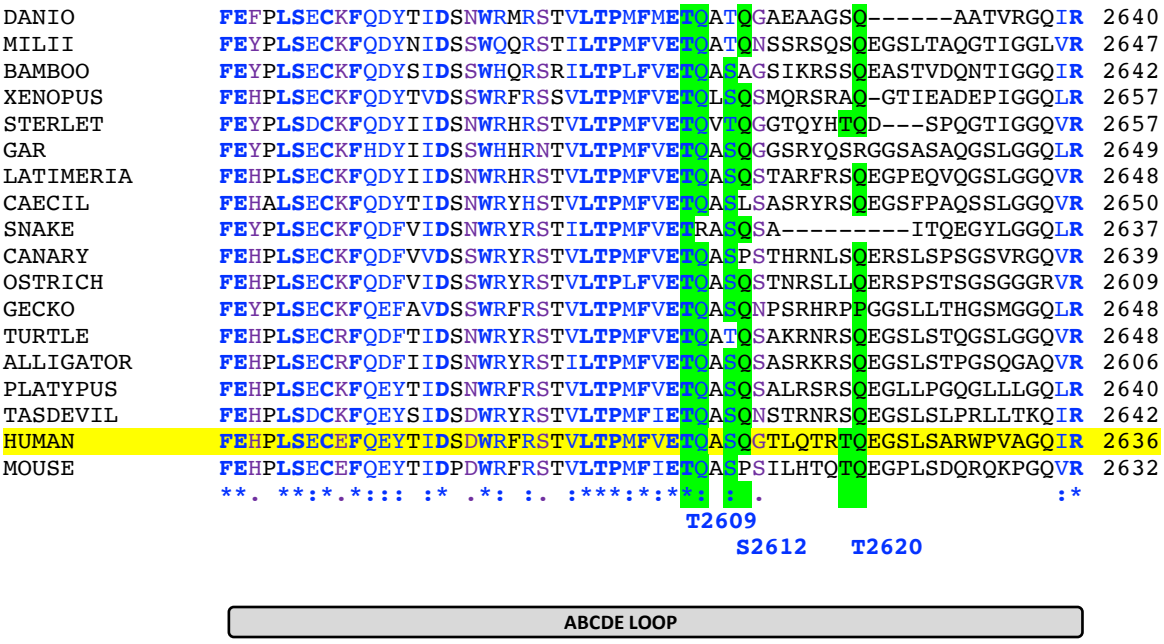
M-HEAT/CIRCULAR CRADLE

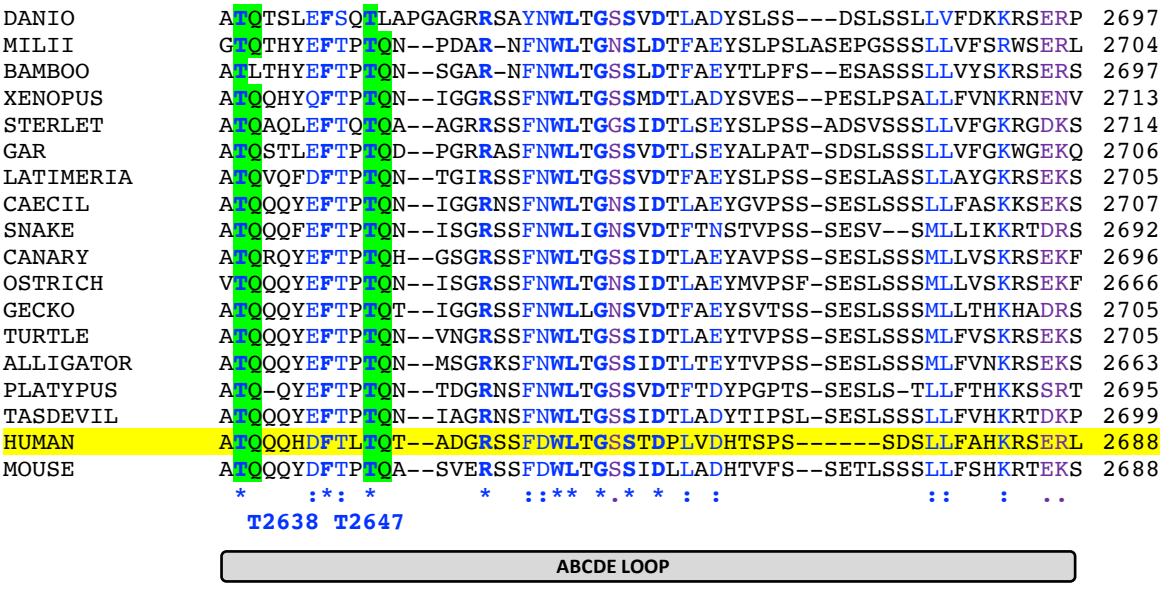
Supplementary Figure 1. DNA-PKcs, jawed vertebrates





Supplementary Figure 1. DNA-PKcs, jawed vertebrates





Supplementary Figure 1. DNA-PKcs, jawed vertebrates

```
DANIO          Q-----AAWRAVGAGFGSKRLTATSDDTDSRTAAERERRADILRLRRRFLKDKEKESIKF 2752
MILII          HR----PAKKPVGPDFGKKRLALPGDEVDSKTKGIVDQRADILRLRRRFLKDREKVSLIF 2760
BAMBOO         QK----P-MKPVGPDFGQKRLAIPGDEVDAKTKAVADQRADILRLRRRFLKDRQKENLIF 2752
XENOPUS        RR----VPLKPLGPNFGMRRLGLPGDVTDSKTK-SMEDRSDILRLRRRFLKDREKLSLIY 2768
STERLET        QQ----AARKPVGSDFGKKRLGLPGDEVDSRTK-VKDQRADILRLRRRFLKDQEKVSLIY 2769
GAR            QQQQQRGPKKPVGADFGKKRLALPGDEVDSRKKAVNDQRADILRLRRRFLKDQEKVSLQF 2766
LATIMERIA      QR----AAMKPVGPDFGKRRLALPGDEVDSRTK-VADQRLDILRLRRRFLKDQEKVSLIY 2760
CAECIL         RR----TSLKPLGPNFGKKRLGLPGDEVDSKAK-GIDDRSDILRLRRRFLKDQGQISKIF 2762
SNAKE          YK----TAFKPLSPNFGKKRQGLPGDEVDNKSK-DTDEHTEILRLRRRFLKDKEKLSLIY 2747
CANARY         KQ----ATFKPVGPDFGKKRLGLPGDEVDSKTK-GIEERAEILRLRRRFLKDQDKLSLIY 2751
OSTRICH        KQ----SAFKPVGPDFGKKRLGLPGDEVDSKIK-GIDERAEILKLRRRFLKDQEKLSLIY 2721
GECKO          QR----AAFKPLGPNFGEKRLGLPGDEVDSKTK-GIDERAEILRLRRRFLKDQEKLSLIY 2760
TURTLE         QR----ATLKPLGPNFGKKRLGLPGDEVDSKAK-GIDERAEILRLRRRFLKDQEKLSLIY 2760
ALLIGATOR      QR----GTLKPVGPNFGKKKLGLPGDEVDSTTK-DINERAEILRLRRRFLKDQEKLSVIY 2718
PLATYPUS       QK----AGFKPLGPNFGKKRVGLPGDEVDSKTK-GIEERTEILRLRRRFLKDQEKLSLIF 2750
TASDEVIL       QR----AAWKSVGPNFGKKRLGLPGDEVDNKTK-GIDERAEILRLRRRFLKDQEKLSLIY 2754
HUMAN          QR----APLKSVGPDFGKKRLGLPGDEVDNKVK-GAAGRTDLLRLRRRFMRDQEKLSLMY 2743
MOUSE          QR----MSCKSVGPDFGTKKLGLPDDEVDNQVKSGTPSQADILRLRRRFLKDREKLSLLY 2744
                         : :. .** ::    .* .*         : ::*:*****::*: : .  :
```

ABCDE LOOP

```
DANIO          AKKEIHSQRTERERRADLKIRQDAQVTLYRSYRVGDLPDIQIQFSSLIAPLQALAQRDAT 2812
MILII          AKRGIREQRAEQKIKTEKRMERDAKVTLYRSYRFGDLPDIQIKYSSLIAPLQALAQKDHS 2820
BAMBOO         ARKSIQEKHLAKEMKTEQLKKRDAQVTLYRCYRVGDLPDIQIKFSSLIAPLQAVAQKDHS 2812
XENOPUS        ARKGTAEQKREKAIKIEQKMKQDAQITLYRNYRQGELPDIQISYSNLIAPLQALAQRDPT 2828
STERLET        AKKGVREQKQAKENVAEQKLKREAQVTLYRSYRQGDLPDIQIQHSSLIAPLQALAQRDPT 2829
GAR            ARKGIQAQRQEKERAAEQTLRREAQVTLYRRYRHGDLPDIQIPYSSLIVPLQALAQRDST 2826
LATIMERIA      ARKGVQIQKEEQKMKAELKMKQDAQVTLYRRYRQGDLPDIQIHYSSLIAPLQALAQRDPT 2820
CAECIL         VRKGVAEQKREKEITAERKMKRDSEVTLYRSYRHGDLPDIQIAYSNLIAPLQAVAQRDPT 2822
SNAKE          ARKGVAEQKQEKEIKTQLKIKHDAQITLYRKYRQGDLPDIQIEYSSLITPLQAVAQKDPT 2807
CANARY         ARKSLAEQKREKEIKSELKMKYDAQVTLYRSYRVGDLPDIQIEYCSLIAPLQGLAQKDPT 2811
OSTRICH        ARKGVAEQKREKEMKSELKMKHDGQVILYRSYRVGDLPDIQIEYSSLIAPLQGLAQKDAT 2781
GECKO          ARKGVAELKQEKELKTELKMKHDAQVTLYRRYRQGDLPDIQIEYSSLITPLQGLAQRDST 2820
TURTLE         ARKGVAEQKREKEIKSELKMKHDAQVTLYRSYRQGDLPDIQIEYSSLITPLQGVAQRDPP 2820
ALLIGATOR      ARKGVAEQKREKEIKTELTMKRDAQVTLYRSYRQGDLPDIQIEYSSLITPLQGVAQRDPT 2778
PLATYPUS       AKKGVVEQKREKEIKSELKMKHDAQITLYRSYRQGDLPDIQIEHSSLITPLQAVAQRDPT 2810
TASDEVIL       ARKGVVEQKREKEMKNELKMKHDAQVTLYRSYRQGDLPDIQIEYSSLINPLQAVAQRDPV 2814
HUMAN          ARKGVAEQKREKEIKSELKMKQDAQVVLYRSYRHGDLPDIQIKHSSLITPLQAVAQRDPI 2803
MOUSE          AKRGLMEQKLEKDIKSEFKMKQDAQVVLYRSYRHGDLPDIQIQHSGLITPLQAVAQKDPI 2804
               .::     :  :    :   . :.:: *** ** *:****** ...** ***.:**:*
```

ABCDE LOOP

Supplementary Figure 1. DNA-PKcs, jawed vertebrates

```
DANIO          LAKQLFSSLFAGVLVEMERLKSNKETADILKELVQTLNAFLNKSTVYFPPFISCIQDMSY 2872
MILII          LAKQLFSALFSGILEEVHKSKTA-ETKDISKQLVENFNYLLKATTLNFPPFVACIQDMSC 2879
BAMBOO         LAKQLFSSLFSGILEEVRKSKTAAEMSGIGKELLKHFTFLLNTTTLCFPPFVTCIQDMSC 2872
XENOPUS        MAKLLFSSLFSGILTDTAS------DISVTDKLLKQFNSFLSNSLSYFPPFIACVQDMCY 2882
STERLET        LAKQLFSSLFSGILIEMEKSKSQSEKKRITEEILGDMNNFLSKTTVYFPPFVTCVQDMSY 2889
GAR            LAKQLLSTLFCGILAQMEGSKNEAEKRRITEELLQDMNHFLNKSTLYFPPFVTCVQDMSY 2886
LATIMERIA      LAKQLFSNLFTGILTEMEKSRSDSERKTILLELLGNFNGFLSNTTVYFPPFVTCIQDMSY 2880
CAECIL         LAKQLFSSLFFGIMKEMDKLKSSSEMKDITQKLLADFNRFLNITTSYFPPFVACIQDMSY 2882
SNAKE          LAKQLFSSLFSGILEQMKKSKPLAERNNIIQQLLHDFNHFLTTSVLYFPPFIACILEMTY 2867
CANARY         FAKQLFSSLFSGIFHEVKKSKHPSEKNAIVQKLLNDFNNFLSMSLSYFPPFIACIQEMSY 2871
OSTRICH        FAKQLFSSLFTGILREVEKSKTPSEKKIIIQQLLKDFNQFLSMSMSYFPPFIACIQEMSY 2841
GECKO          LAKVLFSSLFAGILEEMRKSKSQSEKNSIIQQLVQDFNCFLTTSVLYFPPFIACVQEMSY 2880
TURTLE         LAKQLFSSLFTGILKEMNKFKNPSEKNCITQELLQNFNRFLSMTVSYFPPFIACIQEMSY 2880
ALLIGATOR      LAKQLFSSLFTGILKEMENSKSPLEKTHIVQKLLQNFNDFLSISVSYFPPFISCIQEMSY 2838
PLATYPUS       LAKQLFSSLFAGILKEIDKFKSQSEKRNITLKLLQDFNHFLSSTVSFFPPFISCIQEMSF 2870
TASDEVIL       LAKQLFGSLFAGILKEMDKFKSPSEKKSITEKLLLDFNYFLSSTMLFFPPFISCIQEMSY 2874
HUMAN          IAKQLFSSLFSGILKEMDKFKTLSEKNNITQKLLQDFNRFLNTTFSFFPPFVSCIQDISC 2863
MOUSE          IAKQLFSSLFSGILKEMNKFKTTSEKNIITQNLLQDFNRFLNTTFLFFPPFVSCIQEISC 2864
               :** *:. ** *:: :            :  ::: :. :*. :   ****::*: ::
```

FAT

```
DANIO          HHKALLGVEPSLVSATCLASLQQPMGILLLEESLLHGAGASEEPPLKRARG---KRELPP 2929
MILII          QHKDLLGLDSTSVRSTSLASLQQPMGILLLEKSLIHSTTN-EEPPTKKARG---RQELPP 2935
BAMBOO         KHPDLLNLDPSIVSSTALVSLQQPMGIMLLELSLMHLSLP-EEPPAKRSRG---RTQLPP 2928
XENOPUS        QHDELLHLNPANISTSCLASLQQPLGILLLEKGLLHMKVP-DEPPAKKMRKEKEKAEIPP 2941
STERLET        RHKELLNIEPSSVSSSCLASLQQPMGILLMEESLIKGLVP-EEPPAKRARG---RRELPP 2945
GAR            QYKELLKVDPSAVSSSCLASLQQPMGILLLEESLIRGSVP-DEPPSKRARG---HRELPP 2942
LATIMERIA      QHAELLNLDPASVSASCLASLQQPMGVLLLEQGLIQLLAA-EEPPAKRARG---RKELPP 2936
CAECIL         HHTELLNLDPSNVSTSCLASLQQPVGILLLERSLMSLVDT-EEPPRKKMRG---KTELSP 2938
SNAKE          LHEELLDLNCYSVSTSCLASLQQPMGILLLEQALVHLFPVEQQPPSKRMRG---KTELSP 2924
CANARY         QHRELLELDSANVSTSCLASLQQPMGILLLERALMALSPA-EEPPSKRMRG---RTELPP 2927
OSTRICH        QHRELLELDSANVSTSCLASLQQPVGILLLEHALISLSPA-EEPPSKRVCG---RAELPP 2897
GECKO          QHKELLDLNPSSVSTSCLASLQQSVGILLLEQALVHLSSEEEEPPAKRMRG---KTDLSP 2937
TURTLE         QHRELLDLDSATVSTSCLASLQQPVGILLLEQALTRLSSE-EEPLSKRMRG---RAALSP 2936
ALLIGATOR      QHKELLDIDSTSVSTSCLASLQQPVGILLLEQALIHLSTI-EEPPAKRMCG---RTELSP 2894
PLATYPUS       QHTELLNLDANCVSTSCLASLQQPVGILLLEQALIRLGPP-EEPSSKKRRG---KPQLPP 2926
TASDEVIL       QHSELLSLDSTTVSTSCLVSLQQPVGILLLEKALIHLTPA-EEPPSKRMRG---KPQLSP 2930
HUMAN          QHAALLSLDPAAVSAGCLASLQQPVGIRLLEEALLRLLPA--ELPAKRVRG---KARLPP 2918
MOUSE          QHPDFLTLDPASVRVGCLASLQQPGGIRLLEEALLRLMPK--EPPTKRVRG---KTCLPP 2919
                :  :* ::   :   .*.****  *: *:* .*       :   *:      :  : *
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FAT

Supplementary Figure 1. DNA-PKcs, jawed vertebrates

```
DANIO          DT--ERWIHLAKLYRSLGDYDVVRGIFSGKIGTKSITFTALQAEAKSDYAEAVKLYNEAL 2987
MILII          DTDVARWIELATLYRSLGDYDVLRGIFSEKIGTKPLTHTALLAEAKSDYAEAVRLYDQAL 2995
BAMBOO         DT--ARWVELAKLYRSLGDYDVLRGIFSEKIGTKSTTQKALLAEAKSDYAEAVQLYDQAL 2986
XENOPUS        DI--VRWIELAKLYRSIGDYDVLRGIFSGKIGAKSITQCALNAEAKSDYAKAAKLYDEAL 2999
STERLET        DT--ARWIHLAKLYRSLGDYDVLRGIFSGKIGAKSITSMALQAEAKSDYAEAVKLYNEAL 3003
GAR            DT--ERWIHLAKLYRSLGDYDVLRGIFSGKIGAKPVTSLALQAEAKNDYSQAVKLYNEAL 3000
LATIMERIA      DT--IRWLELAKLYRSLGDYDVLRGIFSGMIGTKQVTQKALLAEAKSDYSEAVRLYDEAL 2994
CAECIL         DV--VRWIELAKLYRSLGDYDVLRGIFSGKIGTKPHTKDALLAEAKSDYATAAKLYDEAL 2996
SNAKE          DV--TRWIELARLYRSVGDYDVLRGIFSGKIGTNEITHNALLAEAKSDYAEAAKLYDKAL 2982
CANARY         DV--IRWIELAKLYRSLGDYDALRGIFSGKIGTKEITQKALLAEARNDYAEAAQYYDKAL 2985
OSTRICH        DV--IRWIELAKLYRSLGDSDVLRGIFSGKIGTKEITQKALLAEARSDYATAAKHYDEAL 2955
GECKO          DV--IRWIELAKLYRSVGDYDVLRGIFSGRIGTKEVTQKALLAEANSDYAEAAKQYDEAL 2995
TURTLE         DV--IRWIELAKLYRSVGDYDVLRGIFSGKIGTKEITQNALLAEARSDYAEAAKQYDEAL 2994
ALLIGATOR      DV--IRWIELAKLYRSVGDYDVLRGIFSGRIGTKEITQKALLAEAKSDYVEAVKQYDEAL 2952
PLATYPUS       DV--VRWIELAKLYRSVGEYDVLRGIFSGEIGTKHVTQIALLAESKSDYSEAAKQYNEAL 2984
TASDEVIL       DV--IKWIELAKLYRSIGEYDVLRGIFSGEIKTKPVTQNALLAEAKNDYSEAAKQYNEAL 2988
HUMAN          DV--LRWVELAKLYRSIGEYDVLRGIFTSEIGTKQITQSALLAEARSDYSEAAKQYDEAL 2976
MOUSE          DV--LRWMELAKLYRSIGEYDVLRGIFSSELGTTQDTQNALLAEARSDYCQAAKLYDEAL 2977
               *    :*:.** ****:*: *.:****:  : :.  *  ** **:..**  *.: *::**
```

FAT

```
DANIO          NKEDWDDGEPTITEKDFWEIAALEAYNHLTEWKSLEYCATVNIDDSSPIRLDRMWTETFY 3047
MILII          NTEEWMDGNPMETEKDFWEIAALECYNHLTEWKALEYCSTVNIDDKTPADIENIWSDTFY 3055
BAMBOO         NTEEWVDGNPTDAEKDFWDIAALECYSHLTEWKSLEYCSTVNISDKTPVDLEDIWTDPFY 3046
XENOPUS        T-ETFSDGDPTDAEKDFWELASLECYNHLTEWKPLEYCSTVNIDTGKPPDLNKMWSDPFY 3058
STERLET        NTEEWTDGEPAEAEKDLWEIAALESYSHLTEWKSLQYCSTVNIDDSSPADLEKIWGDPFY 3063
GAR            NTEEWMDEGPTDTEKDFWEIAALECYNHLSEWKSLQYCATVNIGDSSPVDLEKMWSDPFY 3060
LATIMERIA      NVEEWPDGEPTEAEKDFWELAALECYSHLTEWKALEYCSTVNIDDKTPADLENIWNDPFY 3054
CAECIL         NMPDWSNDEPTEAEKDFWEVAALECYNRLTEWKPLEYCSTVNIDDSKPADLNKIWNDPFY 3056
SNAKE          SIQDWPGDEPTEAEKDFWKIASLECYNHLTEWKSLEYRLTVNIDNGQPADLNKIWSDPFY 3042
CANARY         SQEDWQDGEPTEAEKDFWELASLECYDHLTMWKSLEYCATVNIDSGKPPDLSKTWNDPFF 3045
OSTRICH        SKEDWQDGEPTEAEKDFWELASLECYDHLTEWKSLEYCATVNIDSGQPPDLNKTWNDPYY 3015
GECKO          SKQDWPDEEPIEAEKDFWEFASLECYDHLTEWKSLEYCSTVNIDDKQPPDLNKTWSNPFY 3055
TURTLE         SKQDWPDGEPTEAEKDFWELASLECYNHLTEWKSLEYCSTVNIDSGQPPDLNKTWSDPFY 3054
ALLIGATOR      SKQDWSDGEPSEAERDFWELASLECYDHLTEWKSLEYCSTLNIDSEQPADLNKTWSDPFF 3012
PLATYPUS       NMQHWEDGEPSEAEKDFWELAVLECYNHLTEWKSLEYCSTVNIDSESPPDLNKIWNDPFY 3044
TASDEVIL       NTQEWLEGDPTEAEKDFWELAALECYNHLTEWKSLEYCSTINVDSENPPDLSKMWSEPFY 3048
HUMAN          NKQDWVDGEPTEAEKDFWELASLDCYNHLAEWKSLEYCSTASIDSENPPDLNKIWSEPFY 3036
MOUSE          NKLEWVDGEPTEAEKEFWELASLDCYNNLSKWKELEYCSTVNIVSENSLDLSKMWSEPFY 3037
               .   :    *  :*:::*..* *:.*..*: ** *:*  * .:       :.  * : ::
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FAT

Supplementary Figure 1. DNA-PKcs, jawed vertebrates

```
DANIO          VETYLQYMMRSMLKQLQMGETNQDLLSFVDAAMKTEEHKIIMETHYSQELSLLYILQEDY 3107
MILII          QETYLSYMIRSKVKLLQSGEVDQSLLTFVDRAMKVEQRKAVIETYYSQELSLLYILQDDV 3115
BAMBOO         MEAYLPHMMRSKVKLLQLGENDQSLLTFVDNAMKVDQRKTVIETRYSQELSLLYILQDDF 3106
XENOPUS        QETYLPYMIRSKLKMLLGGNNDQTLLTFVDEAMKVEQRKVLMETFYSQELSLLYILQDDF 3118
STERLET        QEAYLPYVMRSSVKLLQLGEPDQSLLTFVDNAMKVEERKSIIETSYSQELSLLYILQGDF 3123
GAR            QEAYLPYVVRGMVKQLQLGGQDQSLLTFVDNAMKVEERKSVMETNYSQELSLLYILQDDY 3120
LATIMERIA      QETYLPYLMRSKVKLLLLGQGDQSLLTFIDNAMKVEERKALLETHYSQELSLLYILQDDF 3114
CAECIL         QETYLPYMIRSKVKLLLQGKDDQSLLTFIDNAMKVEQRKALLETNYNQELSLLYILQDDF 3116
SNAKE          QEAYLPYVIRSKLKLLFHGGSDQSLLTFIDEAMKAEEKKALIEMYYSQELSLLYILQDDF 3102
CANARY         QETYLPYIIRSKLKLLLSGENDQTLLTFIDEAMKTEQKKAIIEMHYSQELSLLYILQDDF 3105
OSTRICH        QETYLPYIIRSKLKLLLNGENDQTLLTFIDEAMKTEQKKAIIEMRYSQELSLLYILQDDF 3075
GECKO          QETYLPYIIRSKLKLLLHGGDDQSLLTFIDEAMKTEQKKALIEMYYSQELSLLYILQDDF 3115
TURTLE         QETYLPYIIRSKLKLLLHGGNDQSLLTFIDEAMKIEQRKALIEMYYSQELSLLYILQDDF 3114
ALLIGATOR      QETYLPYIIRSKLKLLLHGGSDQSLLTFIDEAMKIEQRKALIEMHYSQELSLLYILQDDF 3072
PLATYPUS       QETYLPYMIRGKLKLLLQGGSDQSLLTFMDEAMKKEKQKTLIETHYSQELSLLYILQDDF 3104
TASDEVIL       QETYLPYMIRSKLKLLLQGASDQSLLTFIDEAMKKEPQKTLIEVHYSQELSLLYILQDDF 3108
HUMAN          QETYLPYMIRSKLKLLLQGEADQSLLTFIDKAMHGELQKAILELHYSQELSLLYLLQDDV 3096
MOUSE          QETYLPYVIRSKLKLLLQGEGNQSLLTFVDEAMNKELQKTVLELQYSQELSLLYILQDDI 3097
                *:** :::*. :* *  *  :* **:*:* **: : :* ::*  *.*******:** *
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FAT

```
DANIO          DRAKYYANNCMQVFMQNYSSIDPLLNRSRLTVLQSVQALTEIQDFLNYITGDV---SVNS 3164
MILII          DRAKYYINNCMEVFMQNYSSIDTLLHQSRLTKLQSLQAVTEMQDFLHFISKEYNFISEVP 3175
BAMBOO         DRAKYYVNNSIQSFMQNYSSIDPLLHRSRLTKLQSLQTLTEIQDFLHFITKGSNLTSEVP 3166
XENOPUS        DRAKYYINNGIQVFMQNYSSIDCLLYQSRLTKLQSVQALTETQDFISFIRKPGNVSS-SS 3177
STERLET        DRAKYYVNNCMQVFMQNYSSIDTLLPGSRLTKLQSVQALTEIQDFLNFMTKDV---SQTS 3180
GAR            DRAKFYINNSMQVFIQNYSSNIDALLYGSRLAKLQSVQALTEIQDFLYFITKDV---STAS 3177
LATIMERIA      DRAKYYVGNCMQVFMQNYSSIDTLQHKSRLTKLQSVQALTEMQDFLGFISKPDHLNSRAS 3174
CAECIL         DRAKYYIDNGIQVFMQSHSSIDTLLNKSRLTKLQSVQALTETKDFIHFISKPSNLTSQTS 3176
SNAKE          DRARYYVKNAMQVFMQNYSSNIDSLLFNSRMIKLQSVQALTEIQDFINFMSKESSLTFQAS 3162
CANARY         DRAKYYISNGMQIFMQSYSSIDSLLYQSRITKLQSVQALTEIQDFINFMTKRSNLASEAS 3165
OSTRICH        DRAKYYISNGLQIFMQSYSSTDTLLHQSRMTKLQSVQTLTEIQDFIHFMTKTSNLASQAS 3135
GECKO          DRAKYYISNAMQVFMQNYSSIDSVLHQSRLTKLQSIQTLTEIQGFVNFISRSGNIASQAS 3175
TURTLE         DRARYYISSGMQAFMQNYSSIDTLLHQSRLTKLQSVQALTEIQEFINFISKPSSLASQVS 3174
ALLIGATOR      DRARYYISNGMQVFMQNYSSIDALLHQSRLTKLQSVQALTEIQDFINFMREPSNLASQAS 3132
PLATYPUS       DRAKYYIDYCIQIFMQNYSNIDALLLQSRLTKLQSVQALTEIQDFTNFISRPSNLSSQAS 3164
TASDEVIL       DRAKYYIENSIQVFMQNYSSIDALLHQSRLTKLQSVQALIEIQDFVNFMSKQGNLSSQAP 3168
HUMAN          DRAKYYIQNGIQSFMQNYSSIDVLLHQSRLTKLQSVQALTEIQEFISFISKQGNLSSQVP 3156
MOUSE          DRATYYIKNGIQIFMQNYSSIDVLLYRSRLAKLQSVQTLAEIEEFLSFICKHGDLSSLGP 3157
               *** :*    :: *:*.:*. * :   **:  ***:*:: * : *  ::
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FAT

Supplementary Figure 1. DNA-PKcs, jawed vertebrates

```
DANIO          LKFMIRRWTSHYPDAKLDPMNVWDDIITSRCFFLDKILKRLKST---PENSMEVDGADQG  3221
MILII          LRKLLRTWTGRYPDAKMDPMSIWDDVITNRCFFLDKIQERLVSV--QADESMEVDREGEV  3233
BAMBOO         LRKLVRTWIGRYPESKLDPMSVWDDVITNRCFFLDKIKERLSLL--QADDSMEVDDEGA-  3223
XENOPUS        LRKLFQGWMKRYPDSKMDPMNIWDDIISNRCFFLDKIQDVAVGHPQLVDESMEVDDLADG  3237
STERLET        LKSLIRIWTDRYPDAKMDPMNVWDDIITTRCFFLDKIAGKLTNS--EADNSMEVDGGEDT  3238
GAR            LKTLIRTWTHRYPDDRMDPMNVWDDVITNRCFFLDKISEKLVSS--VAGDSMEVEEDGDK  3235
LATIMERIA      LRRLLRNWSDRYPDAKMDPVNIWDDIITNRCFFLDKIQEHLCKV--PADESMEVDGEGDA  3232
CAECIL         LKRLLRIWSSRYPDSKMDPMNVWDDIITNRCFFLDKIREKLPHF--QADDSMEVDGGGDA  3234
SNAKE          LKRLLNIWRSRYPDTKMDPMNIWDDIITNRCFFLDKIQEKFSST--HLDDSMELDGDAT-  3219
CANARY         LKRLLRTWTSRYPDAKMDPMNIWDDIITNRCFFLDKLQEKLPSD--QANDSMEVDGEYSA  3223
OSTRICH        LKRLLRIWTSRYPDAKMDPMNIWDDIITNRCFFLDKLQEKLPRD--QANDSMEVDEKDDI  3193
GECKO          LKRLISIWMSRYPDSKMDPMNIWDDIITNRCFFLNKIQERLPNT--HLEDSMEVDGGGDA  3233
TURTLE         LKRLLRIWRSRYPDDKMDPMNIWDDIITNRCFFLGKIQEKLPNI--QADDSMEVDGRGDV  3232
ALLIGATOR      LKRLLRIWTSRYPDAKMDPMNIWDDIITNRCFFLDKIQEKLLNV--QADDSMEVVEAGDI  3190
PLATYPUS       LKRLLRIWTNRYPDAKMDPMNIWDDIITNRCFFLSKIQEKLAGL--QADDSMEMDGGGDT  3222
TASDEVIL       LKRLLRIWTNRYPDAKMDPMNIWDDIITNRCFFLNKIQEKLNCL--QLDDSMEVEGDGHF  3226
HUMAN          LKRLLNTWTNRYPDAKMDPMNIWDDIITNRCFFLSKIEEKLTPL--PEDNSMNVDQDGDP  3214
MOUSE          LRRLLKTWTSRYPDVVTDPMHIWDDIITNRCFFLSKIEERLTAP--SGDHSMSVDEDEES  3215
               *: :.  *  :**:   **: :***:*:.*****.*:           .**.:
                                                              3205
```

FAT

```
DANIO          --------SGEELGVLVKTCKFNMKLQMADSAWKQNNFPVASKLLKELHRHAKIDDARLL  3273
MILII          ETRMEVDKEEEDINMAIRSCKFNMKLKMAESGTKQNNFAVAMKLLKELHKESKARDDWAV  3293
BAMBOO         ETQMDIDKEEDDITMLIRSCKFNMKLKMLESARKQNNFSVSTKLLKELHKESNIRIDWRV  3283
XENOPUS        NEAMEVDR-QEDIAVMINKCRFTMKMKMVDSARKQNNFSVAMKLLKDLHRESKTNEDWSV  3296
STERLET        GVKMEVDE-PEDVGSMIRGCKFSMKLMMADSARKQNNFSVATKLLKELHRESKNQEDWLV  3297
GAR            EIKTEAGE-WEDPDFLIKDCKISMRLKMAESARKQRNFSVAAKLLKALHKECKARSHWNL  3294
LATIMERIA      SPRMDVDE-EPNISAMVQSCKFNMKLKMAESARKQNNFSVATKLLKELHRESKSREECLT  3291
CAECIL         SDRMELGGEEEDITSMIKSCKFNMKLKMVESARKQNNFSVAMKLLKDLHRESKTRDDWSV  3294
SNAKE          -FSMEIDNENQDTHTMIKNCKFAMKMKMIECARKQNSFSVALKLLKDLHGDSKTCEDWRV  3278
CANARY         GDQMEVDQQGENIHSMIKSCKFNMKMKMIESARKQNSFAVAKKLLKDLRKEARWREDWLV  3283
OSTRICH        GDQMEADQQGEDISSMIRSCKFNMKMKMIESARKQNSFSVAKKLLKYLHREAKTREDWLV  3253
GECKO          NDNIEGGNEKEDIHSMIRNCKFSMKMKMIESARKQNSFSVAIKLLKDLHRDSKTREDWLV  3293
TURTLE         GDKMETDMQEEDIHSMIRSCKFNMKMKMIESARKQNSFSVAMKLLKDLHRESKTREDWLL  3292
ALLIGATOR      GDEMEVDQQEDNIHSMIRSCKFNLKMKMIESARKQNSFAVAKKLLKDLKRESKTRDSWLV  3250
PLATYPUS       TDRMELEKQEDDIYSMIESCKFSMKMKMIESARSQNNFRVAMKLLKDLHRESKTKDDWLV  3282
TASDEVIL       IDKVEVEKQEEDIYSMIRSCKFSMKMKMIESARKQNNFSVAMKLLKDLHRESKTREDWLV  3286
HUMAN          SDRMEVQEQEEDISSLIRSCKFSMKMKMIDSARKQNNFSLAMKLLKELHKESKTRDDWLV  3274
MOUSE          IDR-EVYEPKEDVRCMLQSCRFTMKMKMIESAWKQSNFSLSMKLLKEMHKESKTREIWRV  3274
                          :    :. *:: ::: * :.. .* .* :: **** :: ...
```

FAT

Supplementary Figure 1. DNA-PKcs, jawed vertebrates

```
DANIO          RWVHSFSRFTHKRIARLGPSEKINALLKTVPLLK-DAERQSEALSARMLRDQRILLGTTY 3332
MILII          KWTHTYSRLSHRRSQRQARPEQVVTVLKSIPLLV-EINVDYLNTHTRILRDQNTLLGSSY 3352
BAMBOO         RWIQSYSRFSHKRSRSMKRAEQIVTVMKTIPLLG-EIDVGNLNIQRHAFRDQNTLLGTTY 3342
XENOPUS        KWIHSYSRYSHSRSRDLTCSEQILTALKTIPLLE-ESKTEYLTKNTKACRYQNMLLGDTY 3355
STERLET        RWVHSFSRFSHTRSHTQSSSEQILTVLKTIPLLE-ERKIDYTKATTRIVRDQNILLGTTY 3356
GAR            RWAHGFCRFKHLYSQAQDSAEQILNVLKTVDVLE-DSKTDPEKETAQNFRNQKLLLGTTY 3353
LATIMERIA      RWVHSYSRFGHSRSQSQSCPERIQTVMKTISLLE-ESKADYLNKNTRALRDQNILLGTTY 3350
CAECIL         RWIHSYCHYTHSRSQSQTSPDQVLSVIKTVSLLE-ETKADYLRENTREFRNQNLLLGTTY 3353
SNAKE          KWNHSYCCFSHSRSRSQSNAEQILTVLKTVFLLD-EIKLSSVSNNAITFRNQNLLLGTTF 3337
CANARY         RWNYAYCRFTHSSSRNLSCPERVLSVLKTISLLE-DTKSDYLSKNIMAFRNQNLLLGTTY 3342
OSTRICH        RWNYAYCRFTHSCSRNQSCPEQVCSVLKTISLLE-DTKSDYLSKKVTAFRNQNLLLGTTY 3312
GECKO          RWNHSYCRFSHSRSRSQSNPEQILTVLKTVSLLD-EASSGTLSKDRLAFRNQNLLLGTTF 3352
TURTLE         RWNHSYCRFSHSRSQSQNSPEQMLTVLKTISLLD-ESKSDYLSKNIVAFRNQNLLLGTTY 3351
ALLIGATOR      RWNHSYCHVSHSSCQTQSSPQQILTVLKTVSLLD-ENVPDHLSKNIEILRNQNLLLGTTY 3309
PLATYPUS       RWNHNYCRCSHSQSQSQSSPEKILTVLKTVSLL-DDNLSSYLSKNIVASRNQKLLLGTTY 3341
TASDEVIL       KWNHSYCRFSHSRCQIQSSSEQILTVLKTVSLLADENLSSYQSRNSLAFRNQNILLGITY 3346
HUMAN          SWVQSYCRLSHCRSRSQGCSEQVLTVLKTVSLLDENNVSSYLSKNILAFRDQNILLGTTY 3334
MOUSE          QWLHSYSQLNHCRSHTQSPREQVLNTLKTITLLDESDISNYLNKNIQASCDQSILLGTTC 3334
                *   :.   *         :::   :*:: :*  .              *  *** :
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```
DANIO          DLMAGAADRSPFALETLGEEKVQKILQLSQAS--SIAQVVEGLQIQALELLRSAACKAEE 3390
MILII          CILADALNKEPTCLQRIKEDQAERVIEHSGSSSEEIQEVVIGLHRKTLHYLERAVRKAEE 3412
BAMBOO         YIMANALNKDPSCLQYIEEERAKNVKKLSGATSDNPVQVSIGLYRKAHEYLQSAVKKAEE 3402
XENOPUS        RIMADAVCKEPDCLYKIEDGKAGKVKDLS----ESPENVVGGLYRKSLHYFTNAVRKATE 3411
STERLET        HIMANALTRDGLALEHIGEDKAGKVLDLLGTTSDNLEQVVVGLHRKALQHLQNAVKKAEE 3416
GAR            HIMASAVSRDPSVLEKIGPEKAGRVLKLSGASSSNPQQVTAGFHKRALGLMQSAVKKVED 3413
LATIMERIA      NIIANALNKTPTSLQDIGEEKARKIQDLSGAQSDHPEQIVISLYRKALSYLQTAAKKAEE 3410
CAECIL         SIIANALCKDPRCLQRIDKNKADKVLQLSGTMSENPDEVAASLFKKSFHYLDSAVKKAEE 3413
SNAKE          HIMANALSKERSCLNQIGEEKARKVFMLSEERSDNVEKVIAGLNKRAFLCFSGAVKKAEE 3397
CANARY         QIMANALSQDPRCLEQIEKEKARKISLISGESLENPKKVLAGLNKKAFQCFSCAVRKTEE 3402
OSTRICH        RIMADALSHDPRCLEQIEEEKARKVSVLSGESLESPEKVLAGLNKRAFQCFSSAVRKSEE 3372
GECKO          HIMANALSKDPRCLEQIVEEKARKVLVLSGEKTDDIGKVIAGLNTRAFQCFSSAVRKAEE 3412
TURTLE         HILASALSKDPGCLEKIEEEKARKVVMLSGERPENSEKVIAGLNKKAFQYFSTAVRKAEE 3411
ALLIGATOR      RIMAVALSKDPRCLVELEEDKVRKVSMLSGEKPDSPEKVIASLNKQAFQYFSNAVRKAEE 3369
PLATYPUS       RIMANALSKEPASLEQIERNKARKVMELSGASFDNVQKVIAGLHRRAFQYLTHAVRKAEE 3401
TASDEVIL       NIIANALSNEPTCLAQIEESKAKKVLELSGASSEDAEMVIGGLHKKAFECLFKAARRAED 3406
HUMAN          RIIANALSSEPACLAEIEEDKARRILELSGSSSEDSEKVIAGLYQRAFQHLSEAVQAAEE 3394
MOUSE          RIMADALSREPACLSDLEENKVNSILTLSGSNAENTETVITGLYQRAFHHLSKAVQSAEE 3394
                ::* *       *  :   :.  :             :  .:  ::   :  *.    :
```

FAT

Supplementary Figure 1. DNA-PKcs, jawed vertebrates

```
DANIO          EEQSFSQQHVNTHGIVEAYMTMANFCDRRLRESEQKEEAI-SSKLQSLPEHVVKMMLKAL 3449
MILII          EVQSLAGEHVDIAGVIEAYVNLANFCDRCLREKEESATAINFSEQQTFPACVVEKILKAM 3472
BAMBOO         EVQSLSEEHVDTVGVIKAYMTLANFCDRCLREEEESENINNFPELQTYPASVVENMLKAL 3462
XENOPUS        EEQSHSTDQIDVRGIIKAYMTLVDFCDSHLRKVEEESAVMDRADYQNFPEIMVEKMIKAL 3471
STERLET        ELQSRSTEHIDIPGAIEAYMTLVNFCDKRLREEEESAEVSTFSELPTFPAVVVDTMLKAL 3476
GAR            EVQSRSADHVDTAGAIEAHMTLANFCDKRLREEEENDQVSEFSELPTFPAIVVEQVLKAL 3473
LATIMERIA      QVQSRSTEHIDVAGVIEAYMTLVDFCDKRLREVEESAEVSHFSELQTFPAVVVENLLRAL 3470
CAECIL         EVQSRAMENVDTTGVIKAYMTLVDFCDTHLLKKEDTTAVIDHSHLQQFPTIVVEKMIKSL 3473
SNAKE          EVQSMSFDHIDISGIIDAYMTLANFCDSHLRKEEQNSADVNNEDLQIFPAIVVEKVIKAL 3457
CANARY         EVQSSSVDHVDMVGVVDAYLTLISFCDQYLRREEEGLLEINTVDLQQFPAIVVEKMIKAL 3462
OSTRICH        EVQSHSMEHVDVAGVIDSYMTLVGFCDQHLRREEEGLLEINTADLQLFPAIVVEKMIKAL 3432
GECKO          EIQSLSFDHINTKSIIDAYMILANFCDTHLRKKEEGSADINAVDLQMFPAIVVEKVIKAL 3472
TURTLE         EVQSHSMEHVDLTGVIDAYMILVDFCDKHLRKEEEGSSDVSALDLQTFPAIVVEKMIKAL 3471
ALLIGATOR      EMQSRTMEHVNLTGVIDAYLTLVDFCDKHLHKEREGLSDISAVDLQTFPTIVVEKMIKAL 3429
PLATYPUS       EEQSHSSEHVDTGGVIDTYMTLVDFCDKHLRNEEEGTSVIDAVVLQAYPALVVEKMMKAL 3461
TASDEVIL       EVQSHTTEHVDIAGVIDAYMTLVDFCDRHLRKEEESTSVIHTVELQTYPALVVDKMLKAL 3466
HUMAN          EAQPPSWSCGPAAGVIDAYMTLADFCDQQLRKEEENASVIDSAELQAYPALVVEKMLKAL 3454
MOUSE          ETQLSCWGHEAAAERAHAYMTLVGFCDQQLRKVEESASQKTSAEMEAYPALVVEKMLRAL 3454
               : *             .::: : .***  * . .:            *  :*. :::::
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```
DANIO          KLSSEEARLKFPRLLQLVEVYPAETLDLMVREVVSVPCWLLIGWISQMMALLDKPQATAV 3509
MILII          KYNSKEARLKFPRLLQIVKLYSAETLDLMKKEVSSVPCWQFIGWINQMMAELDKKEAVVV 3532
BAMBOO         QYNSREARLRFPRLLQIVELYPVETQDVMTRGVSTIPCWQFIGWINQMMASLDKKEACVI 3522
XENOPUS        KLNSSEARLKFPRMLQIIEQYPSETLDLMARENCTVPCWQFIGWISQMMAMLDKKESIAV 3531
STERLET        KLNSKEARLKFPRLLQIIELYPAETLDLMAKEVSSVPCWQLIGWISQMMALLDKEEAVAV 3536
GAR            KLNSSEARLKFPRLLQIVELYSAETLDLMIKEMSSVPCWQLIGWISQMMALLDKKEAVAV 3533
LATIMERIA      KLNSREARLKFPRLLQIVELYPAETLDLMAKMGGSVPCWQFIGWISQMMALLDKKEAVAV 3530
CAECIL         KLNSKDARLKFPRLLQIVELYPAETLDLMTREVSSVPCWQFIGWISQMMAMLDKKEAVAV 3533
SNAKE          KLNSNEARLKFPRLLQIVEKYPEKILRLMAQEISSVPCWQFIGWISQLMAMLDKNEAPAV 3517
CANARY         KLNSREARLRFPRLLQIIERYPAETLGLVTQELSSVPCWQFIGWISQMMALLDKDEAVAV 3522
OSTRICH        KLNSREARLRFPRLLQIIERYPAETLGLVTRELSSVPCWQFIGWISQMMALLDKDEAIAV 3492
GECKO          KLDSKEARLKFPRLLQIVEKYPTETLGLMAQEISSVPCWQFIGWISQLMAMLDKEEALAV 3532
TURTLE         KLNSRDARLKFPRLLQIIERYPAETLGLMAREISSVPCWQFIGWISQLMAVLDKEEAVAV 3531
ALLIGATOR      KLNSREARLKFPRLLQIIERYPAETLSLMAQEISTVPCWQFIGWISQMMAVLDKDEAVAV 3489
PLATYPUS       KLNSREARLKFPRLLQIIERYPEETLDLMTQEISSIPCWQFIGWISQMMAVLDKEEAVAV 3521
TASDEVIL       KLNSKEARLKFPRLLQILERYPEETLNLMIKEMSSIPCWQFIGWISQMMALLDKEEAVAV 3526
HUMAN          KLNSNEARLKFPRLLQIIERYPEETLSLMTKEISSVPCWQFISWISHMVALLDKDQAVAV 3514
MOUSE          KLNSSEARLKFPRLLQIIEQYSEETLNIMTKEISSIPCWQFIGWISHMMALLDKEEAIAV 3514
               : .* :***:***:**::: *  :   :: :   ::*** :*.**.:::* *** :: .:
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FAT

Supplementary Figure 1. DNA-PKcs, jawed vertebrates

```
DANIO        QHVIEEIAECYPQALIYPYMISSENYTFEESASGQRNREFVEKLESLLDKGGVIQGFVDA 3569
MILII        QHIIEEIADSYPQAIVYPLMISSESYTFEQTARGNTNKEFVERLKNKLDKGGMVEVFINS 3592
BAMBOO       QPIIEKIADSYPQAIVYPFKISSENYTFEPSANGNKNKEFVERLKTKLDKGGVVESFIHS 3582
XENOPUS      QHIIEEIAENYPQALVYPFMVSGESYNFEDTVVGHKNREYVNRIKSKLDKDNVAQDFIRA 3591
STERLET      QHVIKEIAEYYPQAILYPFMISSENYVFEDSATGHRNKEFVARLKSQLDKGGVVKNFIDA 3596
GAR          QHVIQGLAESYPQAVVYPFMISSETYQFEDSATGHRNKEFVTRLKDQLDKGGVVKDFVEA 3593
LATIMERIA    QHIVEKIAESYPQAIVYNFMISSESYSFEESPKGKKNKEFVARLKSELDKGAVVEDFIHA 3590
CAECIL       QHIIEDIADAYPEALVYPFMISSENYSFEDTATGHKNREFMLRIKSKLDKGGMVQDFIQS 3593
SNAKE        QHTVEEIASSYPQAIVYPFMISSESFSFPETAIGHKNKEFVKRVKSKLYEGGVIQDFAHS 3577
CANARY       QHTVEEIANTYPQALVYPFMISSESYCFKDTAAGCKNKEFVERIKNKLDRGGVVQDFVHS 3582
OSTRICH      QHTVEEIANTYPQAIIYPFMISSESYSFKDTVTGCKNKEFVERIKKKLDRGGVVQDFVHS 3552
GECKO        QYTVEEIANSYPQAIVYPFMISSESFSFQDTIIGHKNKEFVARVKSKLDREGVVQEFVQA 3592
TURTLE       QHTVEEIANSYPQAIVYPFLISSENYSFKDTATGHKNKEFVARIKSKLDRGGVIQDFVHA 3591
ALLIGATOR    HHTVEEIAHNYPQAIIFPFMISSENYSFKDTATGHKNKEFVTRIKSKLDRGGVIQDFVQA 3549
PLATYPUS     QHTIEEIADNYPQAIVYPFMISSENYSFKDTSAGHKNKEFVTRIKSKLDKGGVVQDFIQA 3581
TASDEVIL     QHTVAEIADNYPQAIVYPFMISSENYSFKDTSAGHKKEFVLRIKSKLDQGGVVQDFINA 3586
HUMAN        QHSVEEITDNYPQAIVYPFIISSESYSFKDTSTGHKNKEFVARIKSKLDQGGVIQDFINA 3574
MOUSE        QHTVEEIADNYPQAIIYPFIISSESYSFKNTSSGHNNKAFVERIKSKLDHGEVIHSFINA 3574
             :  :  ::  **:*:::   :*.*.: *  :  *  :: :: :::  * .  : . *  :

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```
DANIO        LQQLSNPEMLFKDWWDEVKNQLDKPNLDKKKMKLQY--MTELLGDAKSPRFGSYRRKFIQ 3627
MILII        LEQLSNPDMLFKDWVDNFRSKLEKKE-NKTQLKNLYSEMYSNLANAGAPGIGAFRRRFVT 3651
BAMBOO       LEQFSNPDLLFKDWANDFKTELEKKVKDKKLLKNMYDEMYSNLASLQFPGIGAFRTRYVQ 3642
XENOPUS      LEQLSNPPMIFQDWWEDVSNELSKPNVNKNKIKELYKEMYTNLGNPKDHFMGAFRRRFCE 3651
STERLET      LQQLTNPEMLFKDWVEDVKKELEKPKTDKKLLKNMYEEMYSALGNPRCQGIGAFRKKFAQ 3656
GAR          LQQLSNPEMLFKDWLEDARNTLSKPKTDKKDAKKMYEEIISVLGNAKAAGIGRFRKKFVE 3653
LATIMERIA    LEQLTNSDMIFKDWVDDVRNELDKPQRNKANLKRMYEEMYANLGNLRAPGLGSFRSNFVK 3650
CAECIL       LEQLSNPDMIFKDWIEDMKNELAKSQRNKNNIKKLYEEMYMNLGNLKAPGIGEFRRRFVQ 3653
SNAKE        LEQLSNPAMLFKDWIGDVQNELGKTKKNTNNIQQLYDGMYQNLGNLEAPGLGWYRKQFIK 3637
CANARY       LEQLSNPVMIFKDWAEDVRNELSKPQRNKKKLKEMYERMYKNLGNLESPGLGMMRKRFIQ 3642
OSTRICH      LEQLSNPMMLFKDWTEDVRNELVKTQRNKNKLQDMYERMYRNLGNLEAPGLGLLRRRFIQ 3612
GECKO        LEQLSNPVMLFKDWTDDMKNELGKTKRNKENILKLYDGMYQNLGNVHASGLGLFRKRFIE 3652
TURTLE       LEQLSNPVMLFKDWVEDVKNELGKTQRNKNNLKEMYEGMYRNLGDLQAPGLGLFRKRFVQ 3651
ALLIGATOR    LEQLSNPEMLFKDWVDAVRNELGKAQKNKAKLKEMYEGMYGNLGNLQASGLGLFRRRFIQ 3609
PLATYPUS     LEQLSNPEMLFKDWVEDIKIELTKTPINKNNLKRMYEGMYKTLGNLKAPGLGAFRKRFIQ 3641
TASDEVIL     LEQLSNPELLFKDWVDDVRGILMQTPVNKKKLEKMYEEMYAILGTLEVPGIGAFRKKFIQ 3646
HUMAN        LDQLSNPELLFKDWSNDVRAELAKTPVNKKNIEKMYERMYAALGDPKAPGLGAFRRKFIQ 3634
MOUSE        LDQLSNPDLLFKDWVSDTKDELGKNPVNKKNIEKLYERMYAALGDLRAPGLGPFRRRFIQ 3634
             *:*::*  ::*:**       * :   :.      *  :   *.      :*  * .:

                          FAT                  KINASE
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Supplementary Figure 1. DNA-PKcs, jawed vertebrates

```
DANIO          KFSKEVE---KLLGAGGSKLYERRKDKDFLQQVDRMVQSM------RGFQKEPGNMKEYS 3678
MILII          GFKKKID---QHFGKDGLLLLNMN-LKAFNVAVGQIMET--------QKPEPPGNLKEYS 3699
BAMBOO         VFKKAFD---QYYGKEGSRLLDMN-IKIFDEATKKILETV-----CKKQQAPPGNLKEYS 3693
XENOPUS        KYTKDFD---KAFGPEGSKLLNIK-CDGFNKTVGPLITKM------KEQQKEPGNLKEYS 3701
STERLET        HFSKEFD---KTFGKGGAKLFDMK-HDAFRKASDSLWGSISEE---QKKEKEPGNLKEYS 3709
GAR            TYAKRIEEIVKELGKDGSKLWDKR-KD------EKFWQKLTTSIRSMDSIALPGNLKEYS 3706
LATIMERIA      AYGKEFE---RVYGKRGEKLLDMK-SSDFFKVSDQLLTSM------RKFQREPGNLKEYS 3700
CAECIL         AHAKDLD---THFGKGGSKLVDMK-EDAFAKTAYSLFNNM------RGSQPEPGNLKEYS 3703
SNAKE          EFGKELD---IHFGKGGSKLLGMN-ASVFIKVANSLSEKM------KKCEKEPGNLKECS 3687
CANARY         AFGKDLD---HHFGRGGSELLNMK-TSDFDAIANSLHSKM------IKTHKEPGNLKECS 3692
OSTRICH        AFGKDFD---HQFGKRGSKLLNMK-ASDFDAITSALLSKM------TKSHKEPGNLKECS 3662
GECKO          KFGKEFD---SHFGKRGSKLLDMK-ASGFNTIADSLLLKM------KECHQEPGNLKECS 3702
TURTLE         TFGKDFS---SHFGKGGSKLLDMK-ADDFNRIAFSLLSKM------KD-QKEPGNLKECS 3700
ALLIGATOR      AYGKEFD---TQFGKGGSKLLDMK-DNEFIKIVNALLAKM------RDGQKEPGNLKEYS 3659
PLATYPUS       AFGNEFD---HHFGKGGSKLLQMK-LSDFTSITNSLNSKM------KESSKPPGNLKECS 3691
TASDEVIL       TYGKEFD---RHFGKRGSKLLVMK-LSDFNNITTTLLNKM------REDSKPPGNLKECS 3696
HUMAN          TFGKEFD---KHFGKGGSKLLRMK-LSDFNDITNMLLLKM------NKDSKPPGNLKECS 3684
MOUSE          AFGKEFV---KSFGNGGSKLLTMK-VDDFCKITGSLLVRM------KKDSKLPGNLKEYS 3684
                . : .       *  *  *   .  .        :               ***:** *
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KINASE

```
DANIO          PWLSSFKAETLKNELEVPGQYDGKSKPLPEYHAKITGFDERVKVMTSIRRPKRIIIRGDD 3738
MILII          PWMSNFKPQFLGNELEIPGQYDGKCKPLPEYHAKITGFDERVKVMSSIRKPKRLIIRGND 3759
BAMBOO         PWMSEFKPEYLRNDLEIPGQYDGKSKPMPEYHAQITGFDERIKVMSSIRKPKRLIIRGND 3753
XENOPUS        PWMSEFKPEFLRNELEIPGQYSGRSKPMPEYHVKISGFDERVSVMASIRKPKRIIVRGND 3761
STERLET        PWMSNFKPEVLRNELEIPGQYDGKCKPLPEYHARITGFDERIKVMSSMRKPKRLIMRGND 3769
GAR            SWLSNFRPETLRNELEVPGQYDGRSKPLPEYHVKITGFDERVQSLRSIRKPKRLIIRGSD 3766
LATIMERIA      PWMSQFKPEFLRNELEIPGQYDGKSKPMPEYHAKITGFDERIKVMASIRKPKRLIIQGND 3760
CAECIL         PWMSNFKPEFLRHELEIPGQYNGRSKPLPEYHVKISGFNERVKVMSSIRKPKRIIILGND 3763
SNAKE          PWMSEFKPEFLRTELEIPGQYDGKGKPLPEYHAKISGFDERIKVMQSMRKPKRIVIRGND 3747
CANARY         PWMSEFKAEFLRSELEVPGQYDGKGKPLPEYHAKISGFDERISVMESLRKPKRITIRGSD 3752
OSTRICH        PWMSEFKAEFLRNEIEVPGQYDGKGKPLPEYHVRISGFDERIKVMESMRKPKRITIRGSD 3722
GECKO          PWMSEFKPEFLKHELEIPGQYDGKGKPLPEYHAKIAGFDERIKVMLSIRKPKRIIIRGSD 3762
TURTLE         PWMSDFKAEFMRNELEIPGQYDGKSKPLPEYHAKISGFDERIKVMESIRKPKRINIRGSD 3760
ALLIGATOR      PWLSEFKAEFWRNELEIPGQYDGKGKPLPEYHAKISGFDERIKVMESLRKPKRIIIRGSD 3719
PLATYPUS       PWLSDFRVEFLRSELEIPGQYDGKGKPLPEYHAKITGFDERVKVMASIRKPKRIIIRGHD 3751
TASDEVIL       PWMSNFKVEFLRNELEVPGQYDGRGKPLPEYHAKITGFDERVKVMASIRKPKRITIRGND 3756
HUMAN          PWMSDFKVEFLRNELEIPGQYDGRGKPLPEYHVRIAGFDERVTVMASLRRPKRIIIRGHD 3744
MOUSE          PWMSEFKAQFLKNELEIPGQYDGKSKPLPEYHVRISGFDERVKVMLSLRKPKRIVIRGHD 3744
                *:*.*: :    ::*:****.*: **:****.:*:**:**:  : *:*:***: : * *
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KINASE

Supplementary Figure 1. DNA-PKcs, jawed vertebrates

```
DANIO          ERDYPFLVKGGEDLRQDQRIEQLFGVMNMILSQDTACSQRSLALRTYQVIPITSRIGLIE 3798
MILII          EKEYPFLVKGGEDLRQDQRIEQLFEVMNIILSRDAACSQRSLQLKTYQVIPMTSRLGLIE 3819
BAMBOO         EKEYPFLVKGGEDLRQDQRIEQLFDIMNIILSRDAACSQRNLQLKTYQVIPMTSRLGLIE 3813
XENOPUS        EREYPFLVKGGEDLRQDQRIEQLFEIMNIILSQDAACSQRHMQLKTYQVIPMTTRIGLIE 3821
STERLET        EREYPFLVKGGEDLRQDQRIEQLFDVMNIILSRDATCSQRNLQLKTYQVIPMTARIGLIE 3829
GAR            ERDYPFLVKGGEDLRQDQRIEQLFGVMNIILSQDAACSQRNLGLRTYQVIPMTTRIGLIE 3826
LATIMERIA      EREHPFLVKGGEDLRQDQRIEQLFEVMNIILSQDAACSQRNLQLKTYQVIPMTTRIGLIE 3820
CAECIL         EKEYPFLVKGGEDLRQDQRIQQLFDVMNIILSQDAACSQRNMQIKTYQVIPMTTRLGLIE 3823
SNAKE          EREYPFLVKGGEDLRQDQRIEQLFEVMNNILSRDAACSQRNMQIKTYQVIPMTTRLGLIE 3807
CANARY         EREYPFLVKGGEDLRQDQRIEQLFDVMNIILSQDATCSQRNMQLKTYQVIPMTTRLGLIK 3812
OSTRICH        EQEYPFLVKGGEDLRQDQRIEQLFDVMNIILSQDAACSQRNMQLKTYQVIPMTTRLGLIK 3782
GECKO          EREYPFLVKGGEDLRQDQRIEQLFDVMNTVLLQDAACSQRSMQLKTYQVIPMTTRLGLIE 3822
TURTLE         EREHPFLVKGGEDLRQDQRIEELFDVMNIILSQDAACSQRNMQIKTYKVIPMTTRLGLIE 3820
ALLIGATOR      EREYPFLVKGGEDLRQDQRIEQLFDVMNIILSQDASCSQRNMQIKTYQVIPMTTRLGLIE 3779
PLATYPUS       EREYPFLVKGGEDLRQDQRIEQLLDIMNIILSQDAACSQRNMQLKTYQVIPMTTRLGVIE 3811
TASDEVIL       EKEYPFLVKGGEDLRQDQRIEQLFEVMNIILSQDAACSQRNMQLKTYHVIPMTTRLGLIE 3816
HUMAN          EREHPFLVKGGEDLRQDQRVEQLFQVMNGILAQDSACSQRALQLRTYSVVPMTSRLGLIE 3804
MOUSE          EKEYPFLVKGGEDLRQDQRIEQIFEVMNAILSQDAACSQRNMQLRTYRVVPMTSRLGLIE 3804
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```
DANIO          WMENTCTLKDFLSSRRTEQEQKT------ITRPNEFYDEWISKVAG-KVEGIRRYAELYK 3851
MILII          WLDNTCTLKDFLSSNITEETQSRRQ-----QEVLPKYREWLQKMAGRK-DMFLRYPTMYL 3873
BAMBOO         WLDNTCVVKDFLLSNMTEDEHKRPS-----P--KELFSEWLQRISGSKSDVTTLYGQMYM 3866
XENOPUS        WLENTCTLKEFILNTMTEDEAKIYNSKT-TNGPLYHYNAWLDKKEK--VGDARQHVTSYT 3878
STERLET        WLENTCTLKEFLFDRMTEEERKH------CKRPAESYMEWLSKVAG-KEKGIAQYITMYK 3882
GAR            WLENTCTLKDFLDSRRTEPEEKS------SPSPQDMYSAWLEKISR-RSKGQEQYHEVYK 3879
LATIMERIA      WLENTCTLKEFLSNAMTEEERTNYETLSPKKGPKAQYNEWLTKMAGG-SVGPQRYGSMYK 3879
CAECIL         WLEATNTLKDFLYNSMSEAEQENCS--S-T---TKHYKDWIQKMGR--CDNISRYEYMYR 3875
SNAKE          WLENTYTLKEFLLKNMSEQEKNCYN--S-SQGPFADYKDWLCKMGE--RNRIECYMTMFK 3862
CANARY         WLENTCTLKEFLKNSMSEEEDINYY--S-PRGPRATYSEWLSRMGG-KAQGISRYHAMYR 3868
OSTRICH        WLENTCTLKEFLKNSMSEEEDFNYS--S-KKGPRATYNEWLSKMGG-KAQGVPRYHVMYR 3838
GECKO          WLGNTCTLKEFLLQNMSEQEKNDYN--S-SKGPRADYNEWLSKMGD-RNAGLVNYVSMYK 3878
TURTLE         WLENTCTLKNFLMESMSEEEKDDYH--S-RKGPRIMYSDWLSKMAGK-ENGIARYKTMYS 3876
ALLIGATOR      WLPNTCTLKNFLHSNMSEEEKADYC--S-EKGPLFAYNEWLSKMAGGKIEDFARYMPMYK 3836
PLATYPUS       WLENTCTLKELILKSMSEGEKAAYE--SNPKGPVHEYSEWLYKMSK--KQDFGAYMLMYK 3867
TASDEVIL       WIENTCTLKELLLNNMSEEEKAAYE--SGPKAPQLEYSTWLTKITG--KQDISAYMLMYR 3872
HUMAN          WLENTVTLKDLLLNTMSQEEKAAYL--SDPRAPPCEYKDWLTKMSG--KHDVGAYMLMYK 3860
MOUSE          WIENTMTLKDLLLSNMSQEEKVANN--SDPKAPIRDYKDWLMKVSG--KSDAGAYVLMYS 3860
               *:  * .:*::: .  ::                  :  *: :          :   :
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KINASE

Supplementary Figure 1. DNA-PKcs, jawed vertebrates

```
DANIO          KAKRVDTVNNFRRIEQMVPDDLLKRAFVRMSTTPEAFLSLRSHFSSSHAVLCISHWILGI  3911
MILII          KASRTETVTAFRTHEQAIPGDLLRRAFIKMSTTPEAFLALRSHFASSHALMCISHWILGI  3933
BAMBOO         KASRTETVKAFRQCERAVPPDLLRRAFTKMSTTPEAFLALRSHFASSHALMCVSHWILGI  3926
XENOPUS        RCDRTNTVASFRERERALVPKDLLRRAFVKMSTTPEAFLSLRSHFARSHALLCVSHWIVGI  3938
STERLET        TAKRTETVRAFRNVEHHVPEDLLRRAFMKMSTTPEAFLSLRSHFTCSHALMCVSHWILGI  3942
GAR            KASRTETVANFQSIEKLVPQDLLRRAFIQLSTTPESFLSLRSHFASTHALICVSHWILGI  3939
LATIMERIA      RASRTETVMAFRSVESLVSRDLLRRAFTKMSTSPEAFLTLRSHFASSHALMCISHWILGI  3939
CAECIL         RASYTETVVAFKARENLVPGDLLRRAFTKMSTTPEAFLTLRSHFASSHALICISHWILGI  3935
SNAKE          RASRTETVMSFQHRENRVPEDLLRKAFVKMSTTPEALLSLRSHFASTHALLCISHWILGI  3922
CANARY         NASRTEAVTSFKSRESSVPEDLLRRAFVKMSTSPEAFLALRSHFASSHALMCISHWILGI  3928
OSTRICH        NANRTETVMSFKSRESSVPEDLLRRAFVKMSTAPEAFLSLRSHFASSHALMCISHWILGI  3898
GECKO          KASRIETVTSFQQRENLVPEDLLRRAFVKMSTTPEAFLSLRSHFASSHALMCISHWILGI  3938
TURTLE         RANRTETVLSFRNRETSVPGDLLRRAFVKMSTAPEAFLSLRSHFASSHALMCISHWILGI  3936
ALLIGATOR      RASRTETVMSFRNRENRVPEDLLRRAFVKMSTAPEAFLSLRSHFTSSHALICISHWILGI  3896
PLATYPUS       HASRTEAVTAFRNRENRVPGDLLRRAFVKMSTRPEAFLALRSHFARSHALLCVSHWILGI  3927
TASDEVIL       RANRTETITSFRNRESKVPADLLRRAFVKMSTTPEAFLALRSHFASSHALMCISHWILGI  3932
HUMAN          GANRTETVTSFRKRESKVPADLLKRAFVRMSTSPEAFLALRSHFASSHALICISHWILGI  3920
MOUSE          RANRTETVVAFRRRESQVPPDLLKRAFVKMSTSPEAFLALRSHFASSHALLCISHWLLGI  3920
                .. ::: *: * : ***::** ::** **::*:*****: :**::*:***::**
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```
DANIO          GDRHLSNFMINTETGGMIGIDFGHAFGSATQFLPVPELMPFRLTRQFINLMRPLAESGLI  3971
MILII          GDRHLSNFMVNLETGGMVGIDFGHAFGSATQFLPVPELMPFRLTRQILNLMLPMKESGLI  3993
BAMBOO         GDRHLSNFMINLETGGMVGIDFGHAFGSATQFLPVPELMPFRLTHQFLNLMLPMKESGLI  3986
XENOPUS        GDRHLSNFMINMETGGMIGIDFGHAFGTATQFLPVPELMPFRLTRQIVNLMLPMKDSGLF  3998
STERLET        GDRHLSNFMINMETGGMVGIDFGHAFGSATQFLPVPELMPFRLTRQFLNLMLPMRESGQI  4002
GAR            GDRHLSNFMVNMETGGMVGIDFGHAFGSATQFLTVPELMPFRFTRQFLNLMLPMGVSGLI  3999
LATIMERIA      GDRHLSNFMINMETGGMVGIDFGHAFGSATQFLPVPELMPFRLTSQFLNLMLPMKEQGLL  3999
CAECIL         GDRHLSNFMINMETGGMVGIDFGHAFGSATQFLPVPELMPFRLTRQFVQLMLPMKESGLI  3995
SNAKE          GDRHLSNFMISTETGGLVGIDFGYAFGSATQFLQLPELMPFRLTRQFVNLMLPMKESGLM  3982
CANARY         GDRHLSNFMINKETGGMVGIDFGYAFGAATQFLSVPELMPFRLTRQFVNLMMPVKEWGLI  3988
OSTRICH        GDRHLSNFMINKETGGMVGIDFGHAFGSATQFLPVPELMPFRLTRQFVNLMMPVKEWGLI  3958
GECKO          GDRHLSNFMVNMETGGMVGIDFGHAFGSATQFLPVPELMPFRLTRQFINLMLPMKETGLI  3998
TURTLE         GDRHLSNFMINMETGGMVGIDFGHAFGSATQFLQVPELMPFRLTRQFINLMLPMKESGLI  3996
ALLIGATOR      GDRHLSNFMINTETGGIIGIDFGYAFGSATQMLPVPELMPFRLTRQFINLMLPMKESGLI  3956
PLATYPUS       GDRHLSNFMINLETGGMVGIDFGHAFGSATQFLPVPELMPFRLTRQLINLMSPMKESGLV  3987
TASDEVIL       GDRHLSNFMINMETGGMIGIDFGHAFGSATQFLPVPELMPFRLTRQFINLMLPMKETGLI  3992
HUMAN          GDRHLNNFMVAMETGGVIGIDFGHAFGSATQFLPVPELMPFRLTRQFINLMLPMKETGLM  3980
MOUSE          GDRHLNNFMVAMETGGSVIGIDFGHAFGSATQFLPVPELMPFRLTRQFVSLMLPMKETGLM  3980
               *****.***:  ***.::*****:***:**:* :********:* *::.** *:   * .
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KINASE

T3950

Supplementary Figure 1. DNA-PKcs, jawed vertebrates

```
DANIO          QSVMVHSLRAFRAEPDLLLNTMDVFVKEPSLDWKNFELKQLKKGGTWTESVNTKEINWFP 4031
MILII          RSIMVHGLRAFRLDPDLLLSTMDIFVKEPSLDWKNLELKQMKKGGTWNKDVNTREIHWYP 4053
BAMBOO         YSTMVHGLRAFRLDPDLLLNTMDVFVKEPSLDWKNFELKQLKKEGSWSKDVNINEINWYP 4046
XENOPUS        DSVMVHSLRAYRSDPGLLVTTMDVFIKEPSLDWKNLELKQMKKGEWKKAVDVTSHNWHP 4058
STERLET        YSVMVHSLRAYRADPDLLLINTMDVFVKEPSLDWKNFELKQMKKAGSWSEAVNTNEINWYP 4062
GAR            SSVMAHALRAYRAEPDLLLNTMDVFVKEPSLDWKNFELKQLKKGGTWKETVNTKEIDWYP 4059
LATIMERIA      YSVMVHALRAYRANPDLLLNTMDVFVKEPSLDWKNFELKQLKKGGSWTKEVNTKEVNWYP 4059
CAECIL         ESVMVHALRAYRTDPSLLITTMDVFVKEPCLDWNNFMLKQLKKQGTWTKKVNTAEKNWYA 4055
SNAKE          YSVMVHSLRAYRINQDVLINTMDIFVKEPSLDWKNFELKQLRKGGTWTKEINTDEVNWYP 4042
CANARY         YSVMVHALRAYRSDPDLLISTMDVFVKEPSLDWKNFEQRQLKKGGTWIKEINTSEVNWYP 4048
OSTRICH        YSVMVHALRAYRADPDLLISTMDVFVKEPSLDWKNFEQRQLKKGGTWIQEINTSEVNWYP 4018
GECKO          YSVMVHSLKAYRVYPDLLINTMDIFVKEPSLDWKNFELKQLKKGGTWTKDINMDEVNWYP 4058
TURTLE         YSVMVHSLRAYRTEPDLLVSTMDVFVKEPSLDWQNFELKQLKKGGTWSKEVNTAEINWYP 4056
ALLIGATOR      YSIMTHALRAYRKDPDLLINTMDVFVKEPSLDWKNFELRLLKKGGTWLKEVNTCEVNWYP 4016
PLATYPUS       YSVMVHALHAFRTDPDLLLNTMDVFVKEPSLDWKNFETKMLKRGGTWTRAVNTADTNWYP 4047
TASDEVIL       YSVMVHALRAFRLDPGLLISTMDVFVKEPSLDWKNFEQKMLKKGGSWTREVNMTEMNWYP 4052
HUMAN          YSIMVHALRAFRSDPGLLTNTMDVFVKEPSFDWKNFEQKMLKKGGSWIQEINVAEKNWYP 4040
MOUSE          CTVMVHALRAFRSCAGLLTDTMEIFVKEPSFDWKSFEQTMLRKGGSWIQEINVTEKNWYP 4040
                : *.*.*:*:*   .:*  **::*:***.:**:.:    ::: * * . ::  . .*.

                KINASE
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```
DANIO          LQKVNFARRKLEGTNPSVITSEELCLGFEKMPEYKGLLAVARGEEQHNIRARLADKDLTV 4091
MILII          MQKVRYARRKLEGANPAAITRDELQLGHETTEAYKSYVAVAMGDKEHNIRARVPEDGLSV 4113
BAMBOO         RQKVNYAKRKLEGANPSAITRDELQLGHEKSKAYASYVAVAMGDKDHNVRARESEEGLSV 4106
XENOPUS        QQKIHCAKRKLDGANPCEITCEELRLGHESAPEYKDFIAVARGDKKHNRRTNEPPDGLTE 4118
STERLET        MQKVNFARRKLEGANPAVITSEELKLGFEKSPAYQSIIAVAQGEKEHNVRAREAPQGLSV 4122
GAR            RQKVQFAQRKLEGANPAAITSDELKLGFEKESWCRAALAMAQGEQGVNVRASQAAEGLAV 4119
LATIMERIA      VQKVKCGRQKLEGVNPIVITCNELQLGHEKLSAYQSYLAVVKGDPDHNVRAREVKEDLPV 4119
CAECIL         VQKVNCARRKLAGTNPAIITCDELELGHEKSVAYKEMKAVAMGDKTHNVRAREPKDGLTE 4115
SNAKE          LQKVKIARRKLAGANPAVITCDELRLGHEKSEAFREYVSVAQGSKQFNIRARQPQDGLAE 4102
CANARY         LQKVNYVRRKLTGANPAIITCDELRLGHERSPAYNDFAAVARGNSNHDIRAKEPEDGLSE 4108
OSTRICH        LQKVSYVKRKLTGCNPGRITCDELRLGHEKSPFFSDFVAVARGNAAHNTRAKEPEDGLSE 4078
GECKO          LQKVNFARRKLAGANPAVITSDELRLGHEKSSAYRYYVSVARGSKEHNIRAKEAEDGLSE 4118
TURTLE         LQKVNCAKRKLAGANPAVLTCDELRLGHEKSPAYKEYVAVAQGSRDHNIRAKEPEDGLSE 4116
ALLIGATOR      LQKVNCVKRKLAGSNPAAITCEELRLGHEKSLAYRDYVAVARGTRDQNIRAKEPEDGLTE 4076
PLATYPUS       LQKISYAKRKLTGTNPAIITCDELRLGHEKVPAFGDYISVARGSKDHNVRARQPEEGLSE 4107
TASDEVIL       LQKINYAKRKLAGANPAAITCDELHLGHEKVPAFECYVSVAQGNRDHNFRAQQPDDGLSE 4112
HUMAN          RQKICYAKRKLAGANPAVITCDELLLGHEKAPAFRDYVAVARGSKDHNIRAQEPESGLSE 4100
MOUSE          QHKIRYAKRKLAGANPAVITCDELYLGHEASSAFRSYTAVARGNRDYNIRAQEPESGLSE 4100
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Supplementary Figure 1. DNA-PKcs, jawed vertebrates

```
DANIO          EDQVDCLLDQATDPNILGRVWIGWEPWI        4119
MILII          EIQVDCLIDQATDPNILGRVWEGWEPWM        4141
BAMBOO         ECQVDCLIDQATDPNILGRVWIGWEAWM        4134
XENOPUS        ETQVQCLIDQATDPNILGRVWKGWEPWI        4146
STERLET        ETQVECLIDQATDPNILGRVWVGWESWV        4150
GAR            EIQVECLLDQATDPNILGRVYMGWEPWI        4147
LATIMERIA      ETQVACLIDQATDPNILGRVWEGWEPWM        4147
CAECIL         EIQVKCLLDQATDPNILGRVWEGWEPWM        4143
SNAKE          EIQVKCLIDQATDPNILGRTWEGWEPWM        4130
CANARY         ETQVRCLIDQATDPNILGRVWEGWEPWM        4136
OSTRICH        ETQVKCLIDQATDPNILGRAWEGWEPWM        4106
GECKO          EIQVKCLIDQATDSNILGRVWEGWEPWM        4146
TURTLE         EIQVRCLLDQATDPNLLGRVWEGWEPWM        4144
ALLIGATOR      ETQVKCLIDQATDPNILGRVWAGWESWM        4104
PLATYPUS       EQQVQCLIDQATDPNILGRTWIGWEPWM        4135
TASDEVIL       ETQVKCLMDQATDPNVLGRTWIGWEPWM        4140
HUMAN          ETQVKCLMDQATDPNILGRTWEGWEPWM        4128
MOUSE          ETQVKCLVDQATDPNILGRTWEGWEPWM        4128
               * ** **:***** *:***.: *** *:
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FATC

Reference Supplementary Figure 1.

1. **Sievers F, Wilm A, Dineen D, Gibson TJ, Karplus K, Li W, Lopez R, McWilliam H, Remmert M, Soding J, Thompson JD, Higgins DG.** 2011. Fast, scalable generation of high-quality protein multiple sequence alignments using Clustal Omega. Mol Syst Biol **7:**539.