BRCA genes: Conserved regions and the potential effect of missense changes

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Abstract

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Half of coding single-nucleotide polymorphisms in the human genome result in missense changes. Many are rare, weakly penetrant, or occur in genes for which functional assays are not available. Comparative analysis of protein sequences from multiple species is a practical method to predict their effects. Protein-truncating mutations in either of the breast cancer susceptibility genes, *BRCA1* or *BRCA2*, confer a 50-80% lifetime risk of breast cancer. While 34% of BRCA mutations reported in the Breast Cancer Information Core are missense changes, only 8% are known to be disease-associated. For BRCA1 30% of reported missense changes occur in exon 11, but none has been clearly identified as disease-associated. Initially, in a comparison of sequences from 57 eutherian mammal species, Melissa Fleming and I found seven "highly conserved regions" between amino acids 282 and 1103 and identified 38 missense changes as likely to disrupt gene function. In a second analysis, I hypothesized that using 37 ancestral sequences derived from the 57 GenBank sequences and including eight marsupial sequences would allow me to identify regions unique to mammals and refine my predictions of disease-associated missense changes. I identified 13 conserved regions, three of which appear to be unique to mammals, and 21 likely disease-associated missense changes. Recently the Ostrander and Malone Labs screened *BRCA1* and *BRCA2* from 1,628 women with breast cancer and 674 controls as part of the Women's Contraceptive and Reproductive Experiences (CARE) study. We identified 80 BRCA1 and 127 BRCA2 missense changes. Based on

alignments of full-length sequences from five eutherian mammals, I identified a proline to arginine change at BRCA2 amino acid 655 (P655R) that is likely to be disease-associated. P655R occurred in six out of 84 Jewish women with breast cancer, in zero out of 36 controls, and at a population frequency of 2% in 315 Jewish individuals. A 500-Mb, 12-SNP haplotype surrounding P655R appears to be unique to the Jewish population. Current studies use a combination of functional, structural, and evolutionary methods to determine the likelihood of missense changes in BRCA1 being associated with breast cancer, but the status of most missense changes still remains unclear.

Table of Contents

List of Abbreviations

a.a. – amino acid

AS – ancestral sequence

BIC – Breast Cancer Information Core

BRCA1 – breast cancer susceptibility gene 1

BRCA2 – breast cancer susceptibility gene 2

CARE – contraceptive and reproductive experiences

DHPLC – denaturing high-performance liquid chromatography

DSB – double-stranded break

GCD – Grantham chemical difference

indel – inframe insertion/deletion

nuc. - nucleotide

PCR – polymerase chain reaction

SIFT – sorting intolerant from tolerant

SNPs – single nucleotide polymorphisms

List of Figures

List of Tables

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Introduction

SNPs and disease

According to the Human Gene Mutation Database (HGMD; www.hgmd.org)[105], over half of the mutations known to cause disease are non-synonymous single nucleotide polymorphisms (nsSNPs or missense changes). Within the human genome approximately 500,000 SNPs occur in coding regions of genes, and half of these result in missense changes [20, 57, 77]. Twenty percent of missense changes are predicted to affect function [97, 111], but less than 20,000 are reported in the HGMD, which suggests that only half of the missense changes causing disease have been identified as such.

Various methods including linkage studies, functional analyses, protein structure, and phylogenetic methods have been used to assess the role of missense changes in diseases. For example, linkage studies have been able to identify missense changes in proteins associated with high-density lipoprotein cholesterol [19], Crohn's disease [48], Alzheimer's disease [32], and atherosclerosis [24]. Functional analyses and protein structural information have been useful for determining the effect of missense mutations in proteins associated with Werner syndrome [52], cystinuria, glycogen storage disease type Ib [8], and muscular dystrophy [80]. Unfortunately, these methods are not always informative. Linkage analyses are feasible for discovering missense changes that occur in large pedigrees or at a high population frequency and are highly penetrant. Functional analyses can only be done if the functions of the disease gene are well understood and can be easily tested, and protein structures are not always attainable, especially if the protein is large.

For missense changes whose function cannot be easily ascertained by the approaches described above, phylogenetic methods can be used. Predictions regarding the significance of particular missense changes can be strengthened by comparative evolutionary analysis to establish whether mutations occur in conserved regions [13, 21, 38, 55, 64, 66]. Comparative analyses may be particularly helpful in characterizing low-penetrance missense changes in functionally important regions. Mutations that are weakly penetrant can be present in non-affected individuals, which may lead to the incorrect conclusion that the mutation is neutral. Phylogenetic approaches can also determine whether certain residues have evolved more rapidly or slowly than predicted by neutral theory, reflecting the action of positive selection or purifying selection in particular species. According to the National Human Genome Research Institute (www.genome.gov), 2X-8X coverage of vertebrate genomes has been completed for 14 species, sequencing is in progress for 12 additional species, and white papers have been submitted for 13 more. The species with completed genomes cover 450-million years of evolution [56]. The great evolutionary diversity of sequenced genomes makes possible the identification of gene regions that have been conserved over vertebrate evolution and regions that have evolved separately within taxa. Comparative analysis is a practical tool for predicting functionally important regions of genes, and missense changes occurring in these regions may be important in disease susceptibility.

BRCA genes

The breast cancer susceptibility genes *BRCA1* [65] and *BRCA2* [117, 130] were identified ten years ago, but structural and functional information remains limited. Since their discovery, a large number of low frequency missense changes have been identified in sequences from individuals with breast cancer. As limited functional tests are available for these genes, a phylogenetic approach is ideal for differentiating missense changes in these genes that may be associated with breast cancer.

The *BRCA1* gene encodes a protein of 1,863 amino acids with 22 coding exons. Exon 11 encodes 60% of the protein. BRCA2 is also very large (3,418 a.a.; 27 exons) with exon 11 encoding over half of the protein. Both genes have highly polymorphic common SNPs noted throughout the coding regions. Known disease-associated mutations are also distributed throughout these genes. Protein-truncating mutations in BRCA1 and BRCA2 are associated with an increased cumulative lifetime risk of both breast (44-78%; 31-56%) and ovarian (18-54%; 2.4-19%) cancer [6].

BRCA1 and *BRCA2* genetic tests are common in the clinical setting. Observed mutations in the *BRCA* genes have been submitted voluntarily to an international database termed the Breast Cancer Information Core (BIC) [99, 114]. Mutations are compiled from linkage, population-based, case-control, and hospital-based studies [99, 114]. Of the 3,431 (1,538 BRCA1; 1,893 BRCA2) independent mutations reported in the BIC only half are known to affect function. Over 80% of functional mutations are protein-truncation mutations and as such, are expected to be disease-associated [99]. Over a thousand missense changes remain unclassified in the BIC.

Functional analyses have demonstrated roles for BRCA1 in double-stranded break (DSB) repair, cell cycle checkpoint control, and transcription (reviewed in [103, 126, 127, 135]). BRCA1 co-localizes with the DSB repair protein RAD51 at sites of DNA damage and is thought to regulate the generation of single-strand breaks in DNA. These data are supported by the observations that BRCA1-deficient cell lines have defects in DSB repair, and a RAD51 binding domain is present in exon 11. The C-terminal end of BRCA1 binds and activates the basal transcriptional machinery. Several proteins important in transcription including p53, STAT1, and c-Myc also bind exon 11. STAT1, which is required for interferon-gamma mediated apoptosis in human breast cancer cell lines [12, 120], will be discussed in more detail in Chapter 2. The N-terminal region has a zinc-binding RING-finger that binds to BARD1. Together BRCA1 and BARD1 are necessary for ubiquitination of target proteins. *BRCA1*-deficient mice have an embryonic lethal phenotype mostly likely because BRCA1 is required for activation of several genes required for the S-phase and G2/M-phase cell-cycle checkpoints.

While the functions of BRCA1 mentioned above have been studied, the precise structural and biochemical properties of this essential protein remain largely unknown. Functional and structural studies have focused on the N-terminal and C-terminal domains because these regions have obvious functional domains. Mutations in the N-terminal zinc RING finger domain (a.a. 1-109) are associated with hereditary breast cancer [121]. Missense mutations that target the zinc binding amino acids inhibit the ability of BARD1 to bind the RING domain [14]. A yeast assay, in which a reporter gene is fused to the C-terminal domain of BRCA1 (a.a. 1560-1863), has been developed to determine the effect of missense changes on BRCA1's ability to activate transcription [68, 125]. A small-colony phenotype in yeast expressing the BRCT domains (a.a. 1652-1863) can also be used to assay for missense changes that inhibit function [23]. Over 90% of missense changes known to be disease-associated occur in the N- and C-terminal domains, but these regions encompass only 13% of the entire protein. Functional assays using *BRCA1* deficient cell-lines and transgenic mice are being developed [58, 69], but these assays will likely be expensive and time consuming. The phylogenetic approach that Melissa Fleming and I develop in Chapters 1 and 2 is a practical alternative to functional assays.

BRCA2 also functions in repairing double-stranded DNA breaks [86, 98, 127, 133, 135]. BRCA2 binds to RAD51 through eight BRC repeats (within a.a. 990-2100), and BRCA2-deficient cell lines have chromosomal anomalies similar to RAD51-deficient cell lines. BRCA2 is thought to be required for RAD51-mediated homologous repair of DSBs (reviewed in [86]). Several studies use structural assays to determine the effect of missense changes on RAD51 binding [87, 133]. Wu et al. [131] developed *in vitro* functional assays to identify BRCA2 missense changes that prevent GFP localization to the nucleus of cells or result in cells that exhibit sensitivity to a cross-linking agent. As with BRCA1 functional assays, the straightforward assays are limited to the small portion of the BRCA2 for which the function is best understood.

Thirty-two percent of *BRCA1* mutations reported in the BIC result in missense changes, but only 6.4% are confirmed as either disease-associated or neutral polymorphisms. Thirty-five percent of *BRCA2* mutations result in missense changes with 10% classified as neutral polymorphisms or disease-associated variants. The effects of missense changes have been difficult to characterize not only because the function of the BRCA proteins are not yet fully understood [116, 127], but also because case-control [7, 28, 62, 75] and family studies are generally underpowered to draw conclusions [22, 59]. This lack of information represents a growing source of frustration to breast cancer patients and their health care providers.

Mutations in the breast cancer genes BRCA1 and BRCA2 are associated with breast and ovarian cancer, but most of these mutations are protein truncating. The precise role of BRCA1 and 2 in breast cancer is not completely understood; and therefore determining the effect of mutations that do not cause a truncation, for example missense changes, is difficult to determine. In my thesis I used comparative analysis as a means to predict the effect of missense changes in BRCA1 and 2. In Chapter 1, I aligned sequences of BRCA1 exon 11 from eutherian mammals. I used the alignment to identify amino acid regions and sites of evolutionary importance and predicted the effect of missense changes identified in women with breast cancer. In the second chapter, I expand the eutherian analysis to include marsupial mammals. By adding more divergent mammal species, I identified regions of conservation unique to mammals and eliminated sites that are conserved due to insufficient time for non-functionally important regions of the protein to diverge. Finally in chapter 3, I used the comparative methods I developed in sections 1 and 2 to predict the effect of missense changes in a large case-control study. While my predicted missense changes do not occur more often in cases than in controls, when I looked at the Jewish subset of women I identified one missense change stands out. I am still determining the exact role of the missense change in breast cancer among the Jewish population.

Chapter 1: Understanding missense mutations in the *BRCA1* gene: An evolutionary approach

Introduction

Exon 11 comprises over 60% of the BRCA1 protein and includes a number of putative protein-interaction domains [129]. Research using the BRCA1-Δ11 splice variant demonstrates that exon 11 is essential for BRCA1 function in genome stability, tumor suppression, spindle checkpoint, and at the G2-M cell cycle checkpoint [45, 128]. Although half of reported missense changes occur in exon 11, none has been clearly identified as disease-associated, and only seven are designated probable neutral polymorphisms (i.e., unlikely to be disease-associated). The difficulty in characterizing exon-11 mutations can be attributed to both the absence of functional assays for this region and the insufficient power of most case-control and family studies that underlie the BIC database [1, 25, 29, 36, 59, 62, 72, 89, 102].

Previous to this study, *BRCA1* comparative studies were based on alignments from some or all of the cloned sequences (chimpanzee, mouse, rat, dog, and chicken), which limited their ability to detect conserved [2, 83, 115] and evolving [49, 50] regions. In an alignment of human, dog, and mouse BRCA1, Szabo et al. [115] found that the N- and C-terminal ends were highly conserved (80% identity), while exon 11 had short stretches of conserved regions, but only 53% and 70% overall conservation between mouse and human and dog and human. Orelli et al. [83] found similar results when he looked at human, dog, mouse, rat, and chicken BRCA1. Overall there were nine conserved regions among vertebrates including the highly conserved end terminal regions. Only six short (8-10 a.a.) conserved regions occurred within exon 11. Huttley et al. [50] found six sites that show adaptive evolution in the chimpanzee and human lineages and not in other primates or mammals. These sites occur within the RAD51-binding domain and may have been important for the maintenance of genome stability in the human and chimpanzee lineages [50]. Portions of *BRCA1* exon 11 have also been used in phylogenetic studies aimed at understanding the relationships among higher mammalian taxa [4, 61, 118]. DNA sequences for exon 11, but not other regions of the gene, are now available for representatives of all 18 eutherian orders and a marsupial (metatherian). Melissa Fleming, a former post-doctoral fellow in the Ostrander Lab and I used a phylogenetic approach to identify 1) regions of exon 11 that are conserved in eutherian mammals, and 2) regions that have evolved under positive selection. Using this information, we here rank reported missense changes with a view to establishing priorities for functional and population studies.

Methods

Sequences

BRCA1 amino acid and nucleotide sequences were extracted from GenBank for 57 eutherian mammals, one marsupial, the chicken and frog (species names and accession numbers in Table 1.1). Amino-acid sequences were aligned using ClustalX version 1.81 [51]. The 57 mammalian nucleotide sequences were aligned to the amino-acid sequences using Codon Align, version 1.0 [42] and were adjusted by eye (Appendix A).

Analyses were based on sequences between human codons 282 and 1152 (76.4% of exon 11). Sequence data spanning this region are available for 53 eutherians and the marsupial, *Vombatus*. Codon numbers are based on the human sequence. Sequences for three other eutherian mammals start at codon 300 (*Lepus*), codon 316 (*Hystrix*), codon 285 (*Erinaceus*), and end at codon 1072 for a fourth (*Aplodontia*). Determination of levels of amino-acid conservation where there were missing data was based on taxa with sequence at these positions (see Appendix B for amino-acid alignment).

MrBayes version 2.01 [47] was used to construct a phylogenetic tree of *BRCA1* evolution using nucleotide sequences of 57 eutherian mammals, and *Vombatus* as an outgroup (Figure 1.1). We specified a general time-reversible model of sequence evolution and base frequencies were estimated. Among-site rate variation was calculated by an approximation to the continuous gamma model using four rate categories. Rates for each codon position were estimated separately and adjacent sites were assumed to have correlated rates. Markov chain Monte Carlo sampling was started from random trees for four simultaneous chains, uniform prior probability distributions for tree topologies and the rate matrix, and a dirichlet prior of 4.0 for base frequencies. The analysis was run twice, for 250,000 and 500,000 generations, and every 100 trees were saved. Stable likelihood estimates were achieved after approximately 50,000 generations, so the first 20% of saved trees were discarded as 'burn in' when generating a consensus tree with estimates of posterior probabilities for each clade.

Conserved regions

Homologous amino-acid sites were categorized as: 1) having a single residue in all species (fixed), 2) including conservative substitutions only (conservative sites), or 3) including non-conservative substitutions (non-conservative sites). Conservative sites were further described as including only 'strongly' or 'weakly' conserved amino-acid groups, defined by scores of > 0.5 and ≤ 0.5, respectively, in the Gonnet Pam 250 substitution matrix [40]. We identified 'conserved regions' of the gene using a sliding window of five amino acids. These were identified as portions of the alignment that began and ended with fixed or conservative sites and that were comprised of ≥80% of such sites. One-sample runs tests (two-tailed; [100]) were used to determine whether fixed or conservative residues were associated with one another. To reduce the impact of sequencing errors and species-specific polymorphisms, we compared levels of amino-acid conservation both among the species themselves and among sequences derived for their immediate ancestors (nodes just interior to terminal nodes; Figure 1.1). Ancestral sequences were calculated by Bayesian phylogenetic analysis in which clades of sister taxa were constrained on the 250,000-generation consensus tree. Because MrBayes allows a maximum of 31 constraints on a tree, we imposed constraints in two sets to include all ancestral nodes of interest while maintaining the topology of the tree in Figure 1.1.

Regions evolving under selection

Positively-selected sites were identified by running the Bayesian phylogenetic analysis as described above, but using codons as sites and varying omega according to the Nielsen and Yang [79] model of among-site rate variation. To identify residues and regions that may have been selected for new or modified functions specific to humans or primates, but not other lineages, we also used a reduced phylogeny of taxa derived from a previous study aimed at identifying positively selected clades in primates that included primates, flying lemur, mouse, and rat [50]. Lastly, we identified amino-acid substitutions that arose independently in the primate lineage leading to humans and classified the sites according to their degree of conservation in non-primate eutherians. Substitutions at fixed and conservative sites in non-primates were deemed most likely to affect function.

Missense changes

To determine which missense changes were most likely to affect protein function in humans, we compared the distribution of conserved sites and sites evolving under selection in the 57 eutherian species and in their immediate ancestors with that of missense changes reported in the BIC database. Non-conservative substitutions at fixed or conservative sites were assumed to have a greater potential impact on protein function than conservative substitutions at these sites. Conservative substitutions were considered most likely to affect function when they occurred at fixed residues. Predictions were derived using the Gonnet PAM250 matrix to identify missense changes involving non-conservative substitutions, and determine the extent to which sites in the *BRCA1* sequence were conserved across ancestral sequences (AS method). We also used another method, the program SIFT [76], which estimates the degree of conservation at sites as a continuous variable derived using information theory from the number of different amino acids observed at a homologous position. The associations of missense changes (conservative or non-conservative) with fixed or conservative amino-acid sites and with particular portions of BRCA1 were tested using Chi-square with correction for continuity [101].

Results

Phylogeny of BRCA1

Variation in sequence length among mammals resulted in an alignment of 940 codons for the 57 eutherian mammals and *Vombatus*. Insertions in a variety of taxa were removed from the analysis because they are phylogenetically uninformative (see Table 1.1). Three sites with amino-acid deletions in the primate lineage leading to humans were retained in the analysis, however, resulting in an 874-codon alignment between human codons 282-1152.

The topology of the phylogenetic tree of *BRCA1* (Figure 1.1) is well supported, with all but 7 of 54 (13%) clades resolved with posterior probabilities of greater than 0.90. The relationships of the African hominids (human, chimpanzee and gorilla) and of the orders Chiroptera, Perissodactyla/Cetartiodactyla and Pholidota/Carnivora were not resolved because the sequences were very similar.

Conserved regions

Only 24 (2.8%) of the 871 human amino-acid residues are fixed among eutherian mammals, whereas another 32 (3.7%) include only strongly and 43 (4.9%) only weakly conserved amino-acid groups (Figure 1.2 a). Fixed residues are not randomly distributed across exon 11; most occur near other fixed residues ($z = 5.56$, $P < 0.001$) or conservative sites ($z = 8.53$, $P < 0.001$). The majority of fixed (70.8%) residues were identified across codons 282 – 554 ($\chi^2 = 16.81$, d.f. = 1, $P < 0.001$), an interval that includes interacting domains for at least 15 different proteins or complexes (reviewed in [129]; Figure 1.2 b). Five conserved regions (amino-acid identity ≥ 80%) of 5-12 residues in length were identified in this portion of the exon. Another three residues occur in the two conserved regions encompassed by the RAD51-interacting domain (codons 758-1064). An eighth conserved region includes a single fixed residue and occurs at the 3' end of this portion of the gene in a region of unknown function (Figure 1.2). Twenty-one (87.5%) of the fixed residues are also fixed in *Vombatus*, 20 (83.3%) in *Gallus* and 14 (58.3%) in *Xenopus*. Amino-acid substitutions occur at fixed residues in two conserved regions in *Vombatus* (regions 2 and 5), three in *Gallus* (regions 1, 3, and 8), and all but region 7 in *Xenopus* (Figure 1.2). All conserved regions consisted of >70% (79.8 ± 1.7% mean ± SEM) fixed and conservative sites when *Gallus* and *Xenopus* sequences were included in the comparison.

In contrast, pairwise comparisons of fixed amino-acid conservation between humans and other eutherian species reveal high levels of amino-acid identity (Table 1.1). Between humans and other primates, pairwise conservation is 90.6 ± 4.0% on average. Conservation remains high between humans and other eutherian orders (69.8 ± 1.6% on average) but is lower between humans and *Vombatus* (41.5%). Overall conservation between humans and *Gallus* or *Xenopus* is lower still, 25.4% and 19.5% respectively; only small portions of these sequences could be aligned to the mammal sequences with any confidence and the *Xenopus* sequence was considerably shorter than others.

Conservation is also marked during the evolution of *BRCA1*. The human sequence has 80.5% amino-acid identity with the ancestral sequence calculated for the 57 eutherian mammals ('ancestral eutherian sequence'; Figure 1.2). The average level of amino-acid identity for all 57 eutherian mammals with the ancestral eutherian sequence is 77.3 ± 1.0%.

The discrepancy between simultaneous and pairwise estimates of amino-acid conservation in eutherians is due, in part, to the large number of sequences in the comparison. Approximately 18% of nonconserved residues are attributable to substitutions in ≤ 5 species including non-disease-associated polymorphisms and sequencing errors. Therefore, we maximized our ability to identify functionally important gene regions by deriving ancestral sequences for each pair of sister taxa on the phylogenetic tree (Figure 1.2 a) and comparing these 'ancestors' rather than the terminal taxa (the ancestral sequences, or AS, method). This approach reveals 167

(19.1%) residues as fixed among these ancestral sequences (Figure 1.2). The numbers of sites including only strongly and weakly conserved groups increases to 151 (17.3%) and 123 (13.8%), respectively.

Regions evolving under selection

Because previous studies have found positive selection in BRCA1 [49, 50], MrBayes was used to identify sites of positive selection in the dataset of 57 eutherian mammal sequences. Three sites had posterior probabilities of 0.5 or greater of being under positive selection in eutherian mammals: codons 801, 886, and 890 (Figure 1.2). All are included in the RAD51-interacting domain and show evolutionary change in the primate lineage leading to humans: codon 890 diverged in humans and the other two diverged in the haplorhine primates (monkeys and apes). These sites also showed evidence of evolutionary change in other eutherian lineages. No positively selected sites were detected in the analysis that included only primates, flying lemur, rat, and mouse.

There are 132 amino-acid sites in human BRCA1 that have clearly evolved since the divergence of primates from nonprimate eutherians suggesting that BRCA1 has evolved a function specific to primates. Overall, there was a trend toward more sites experiencing substitutions in the primate lineage leading to humans in the RAD51-interaction domain than elsewhere in this portion of exon 11 ($\chi^2 = 3.59$, 1 d.f., $P = 0.08$). Twenty-three substitutions in the primate lineage replaced a fixed amino acid with a conservative substitution (2) or replaced a site that was fixed or conservative with a non-conservative substitution (8 or 13, respectively; Table 1.2; Figure 1.2), suggesting functionally important changes in otherwise conserved residues. Three missense changes occur at three of these sites (Figure 1.2). The computer program SIFT [76] also identified these three residues as likely to affect function. G813 (also identified by the AS method) evolved in African hominids from glutamic acid, while N822 and P871 evolved in humans from threonine and leucine, respectively.

Missense changes

In the BIC, 139 missense changes are reported at 126 sites in this portion of *BRCA1*. These sites are randomly distributed across amino-acid sites that are fixed or conservative in the 57 eutherian mammals ($\chi^2 = 0.22$, 1 d.f., $p > 0.80$) and in their immediate ancestors ($\chi^2 = 0.12$, 1 d.f., $p > 0.90$). There is no difference in the distribution of conservative and non-conservative missense changes relative to fixed and conservative versus non-conservative sites in either the eutherian mammals ($\chi^2 = 0.52$, 1 d.f., $p > 0.90$) or the ancestral sequences ($\chi^2 = 0.12$, 1 d.f., $p > 0.70$).

Based on the level of amino-acid conservation observed, we identified 38 of the 139-missense changes as likely to affect protein function (Table 1.3). Three of these changes affect residues that are fixed in all 57 eutherian mammals (F461L, G462R and P514R) and another three are non-conservative substitutions affecting conservative sites in the phylogeny (E765G, R866C and E1060A). When ancestral sequences are compared, another 32 changes to fixed sites or non-conservative changes to conservative sites in eutherians are predicted to disrupt function (Table 1.3).

SIFT predicted that 36 of these 38 changes would affect protein function (Table 1.3). Two changes predicted to disrupt function using the AS method had SIFT scores of 0.05 and 0.08 (H476R and M1137T, respectively) and were predicted to be 'tolerated'. SIFT also predicted an additional 34 missense changes as likely to affect function.

In addition to the 38 changes above, another three missense changes are predicted to affect function because they affect residues that are rapidly evolving or have recently evolved in humans at sites that are fixed or conservative in other eutherian lineages (Table 1.2; Figure 1.2). Two of these occur at one of the sites under positive-selection, G890V and G890R. The third, S708Y, affects a site that was conservative in nonprimate ancestral sequences but had recently evolved a non-conservative substitution in haplorhine primates. Two other changes, K739I and

R841W, affect conservative sites that had been fixed in nonprimate ancestral sequences (Q in both) but had experienced conservative substitutions during human evolution and were already included in the 38 changes predicted to affect function.

To address the issue of potential rates of false positives and negatives using the AS method, I applied it to a well-studied protein with missense changes known to affect function: beta-globin. I used 15 diverse eutherian sequences from GenBank and 10 deleterious mutations from [119] (see Tables 1.4, 1.5; Figures 1.3, 1.4). The AS method correctly predicted that all 10 mutations would affect function: 6 nonconservative and 2 conservative changes at fixed sites and 2 nonconservative changes at conservative sites. In contrast, simply aligning the 15 eutherian sequences would have resulted in 1 false negative because of a nonconservative change in the hamster that was not retained in the ancestral sequence of the hamster, rat and mouse. SIFT also correctly assigned the 10 changes but with 'low confidence' because the median sequence conservation was too high.

Using the available sequence from human, dog, rat, mouse, *Gallus* and *Xenopus* (see Figure 1.5; Table 1.6, Melissa Fleming performed a similar comparison for 22 missense changes of known effect in *BRCA1* (RING domain and the two 3' BRCT domains according to the BIC and [125]). She did not apply the AS method because there were so few sequences from such divergent species. The 16 changes known to be detrimental were at 10 fixed sites in the six taxa and were correctly predicted to affect function. However, of six changes with no functional effect, two were correctly predicted to be tolerated (both conservative changes at a conservative site due to a single difference in either *Gallus* or *Xenopus*) but four occurred at fixed sites and were incorrectly predicted to be detrimental. Thus, the false positive rate for the BRCA1 RING and BRCT domains was 20% (4/20) and there were no false negatives.

Discussion

Phylogeny of BRCA1

The topology of the phylogenetic tree of *BRCA1* (Figure 1.1) is largely consistent with recent eutherian phylogenies derived from multiple genes and by multiple methods of phylogenetic inference [30, 61, 70, 71]. All these phylogenies maintain the same sister taxa relationships between species, support four major clades of eutherian mammals, and refute a basal position for rodents in the Eutheria. Clades observed to be poorly resolved (posterior probabilities < 0.70) or unresolved in this study are also poorly supported in other studies, including relationships among the African hominids [61], among the orders Chiroptera, Cetartiodactyla, Perrisodactyla, and Carnivora + Pholidota [30, 61, 70], and among the four major clades themselves [30, 61, 70].

Conserved regions

We identified eight regions in BRCA1 where amino-acid conservation (fixed and conservative residues) across eutherian mammals was ≥ 80%. By comparing the chicken BRCA1 with that of primates, dog, rat, and mouse, Orelli et al., identified 'conserved sequence motifs' by inspection that correspond to regions 3-8 described here [83]. In these six regions, we determined that 80.5% of fixed and conservative sites are maintained in *Gallus* and *Xenopus* as well, suggesting strong conservation of function across Mammalia, Aves, and Amphibia. Regions 1 and 2 have not been previously described as conserved, but 75% of fixed and conservative sites here are also found in *Gallus* and *Xenopus*.

Five of the conserved regions are at the 5' end of exon 11 (codons 282-554), which includes interacting sites for several proteins involved in transcription (Figure 1.2; reviewed in [129]). Conserved regions 6 and 7 are in the RAD51-interacting domain (codons 758-1064), which has a documented role in DNA double-stranded break (DSB) repair. The RAD50-interacting site (codons 341-748), also implicated in DSB repair, includes conserved regions 3-5. To our knowledge, conserved region 8 does not correspond to any functional region of BRCA1, although 5 of the 6 residues in this region that were fixed or conservative in eutherians were similarly conserved in *Gallus* and *Xenopus*.

Regions evolving under selection

In our analysis of 57 eutherian sequences, we detected positive selection at three sites in the RAD51-interacting domain either in humans or the primate lineage leading to humans (Figure 1.2). These are specifically in sites that evolved after the divergence of humans from African great apes (codon 890) and of the monkeys and apes (haplorhini) from other primates (codons 801, 886). Evolution at these three sites has also occurred in other taxa such as Rodentia, Chiroptera, Cetartiodactyla, and Afrotheria, suggesting that the selection pressures involved have not been unique to primates. Additional evidence for selection in the RAD51-interacting domain includes a trend toward more sites evolving there than in other portions of exon 11 in the primate lineage leading to humans and SIFT predictions of another three substitutions (at codons 813, 822 and 871) that evolved in humans and other primates as likely to affect function.

The RAD51-interacting domain has been previously identified as a putative site of positive selection. Hurst and Pal [49] used pairwise comparisons to detect differences in omega (rate of nonsynonymous over rate of synonymous substitution) between human and dog versus mouse and rat sequences and found high omegas at several sites between codons 204-306 and at codons 944 and 949. They attribute the former to purifying selection acting on silent sites rather than positive selection and suggest that the latter are consistent with the finding by Huttley et al. [50] of a peak in the nonsynonymous substitution rate around codon 900.

Current methods for detecting selection at the molecular level are best suited for detecting sites under continual selection pressure in multiple lineages [134]. Examples of molecular evolution under diversifying selection include rapid evolution of virus coat proteins [44, 78, 79] and of proteins involved in fertilization in response to sexual selection [112]. Why this type of strong selection should be occurring at the BRCA1 RAD51-interacting domain across a number of eutherian lineages, including humans, is not clear. The physical interaction between amino acids encoded by *BRCA1* exon 11 and the RAD51 gene, while apparently critical for an appropriate response to DNA damage [45], is not well understood although the preponderance of evidence points to the interaction being indirect [45, 126, 127].

Missense changes

The conserved regions, fixed sites, and evolving sites discussed above are evolutionarily important for BRCA1 exon 11. Missense changes occurring at evolutionarily important sites are likely to affect the function of the protein. To test this hypothesis we looked at human missense changes reported in the BIC.

We identified 38 of 139 BIC missense changes as affecting potentially functional residues in Exon 11 using the AS method. The SIFT program identified 36 of these 38 and an additional 34. SIFT identified more changes because it gives equal weight to substitutions in all taxa. In contrast, the AS method assumes that 1) substitutions not shared by sister taxa are likely to be sequencing errors or polymorphisms and 2) sites that have maintained non-conservative substitutions in even 1 pair of sister taxa are unlikely to affect function. The AS method correctly predicted the functional effects of > 85% of the known detrimental missense changes in beta-globin and the RING and BRCT domains of *BRCA1* confirming that this approach can identify high-priority mutations for further study.

The majority of these missense changes have been reported in the BIC only once, so the contribution to disease susceptibility is impossible to evaluate. The large number of changes predicted to disrupt function in this exon points to cancer susceptibility being influenced by multiple pathways, perhaps associated with the multiple proteins and complexes interacting in the region.

Another three missense changes considered to be high priority for further study affect sites under positive selection or that have recently evolved in the primate lineage leading to humans and therefore may also have functional consequences. Two non-conservative missense changes occur at a positively selected site (G890V, G890R). Three more occur at sites that evolved substitutions during the evolution of humans but were fixed or conservative in nonprimate ancestral sequences (Table 1.2; Figure 1.2). Two of these (K739I and R841W) affect sites that are also included among the 38 identified as likely to affect function by the AS method. Interestingly, R841W is the only missense change predicted to affect function for which there is a sufficiently high incidence (60 reports in BIC) to allow any preliminary evaluation of its role in cancer susceptibility [8, 27, 28, 88].

Conclusions

We identified 8 regions of very high amino-acid conservation in eutherian mammals that are also well conserved in the single representatives of Aves and Amphibia in which *BRCA1* has been cloned. Five of these regions, at the 5' end of Exon 11, overlap putative interaction domains for multiple proteins. Two other conserved regions are located at the 3' end, which is known to be involved in DSB repair. Possible interacting proteins are known for 7 of these regions, but the function of the eighth region is not known; its conservation even in Amphibia suggests that it is important. Evidence of positive selection acting on residues in the RAD51-interaction domain, both in humans and in other eutherian lineages, suggests that this region is undergoing adaptive evolution. Finally, consistent with our initial aim, we identified 41 missense changes likely to influence function and thereby contribute to cancer susceptibility. These sites are high priority for functional analyses.

This work is published as: Fleming, M.A., J.D. Potter, C.J. Ramirez, G.K. Ostrander, and E.A. Ostrander. 2003. Understanding missense mutations in the *BRCA1* gene: An evolutionary approach. *PNAS* 100(3):1151-1156. [35]

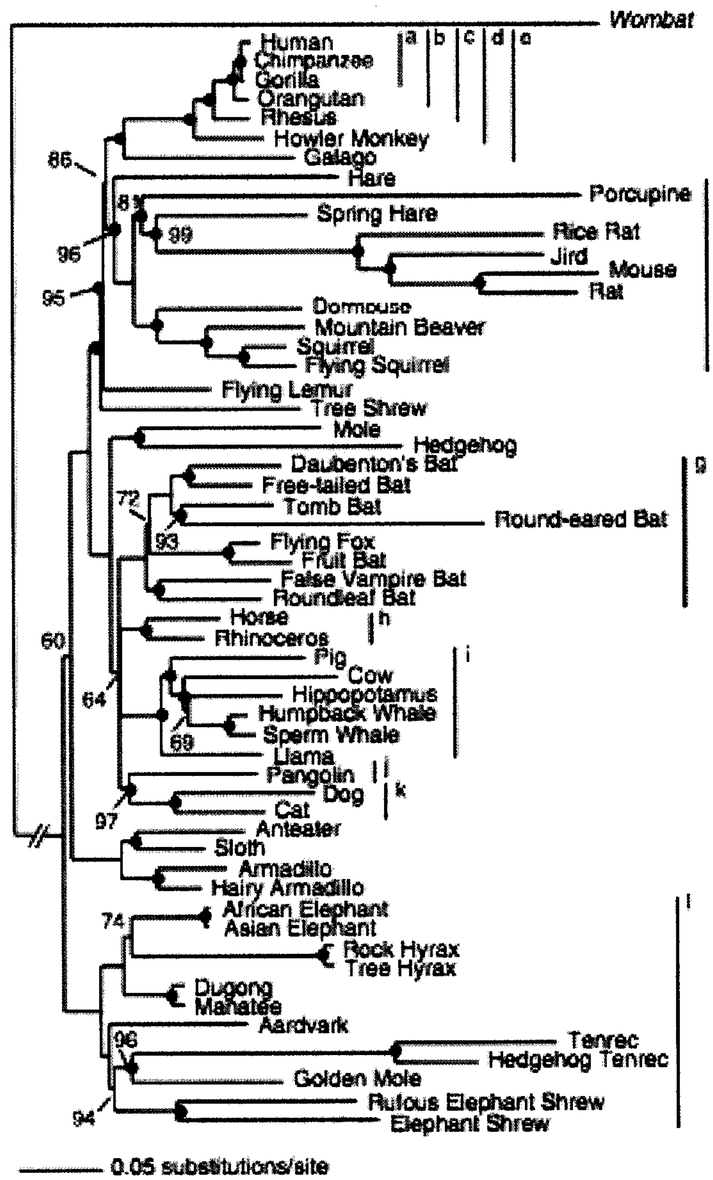
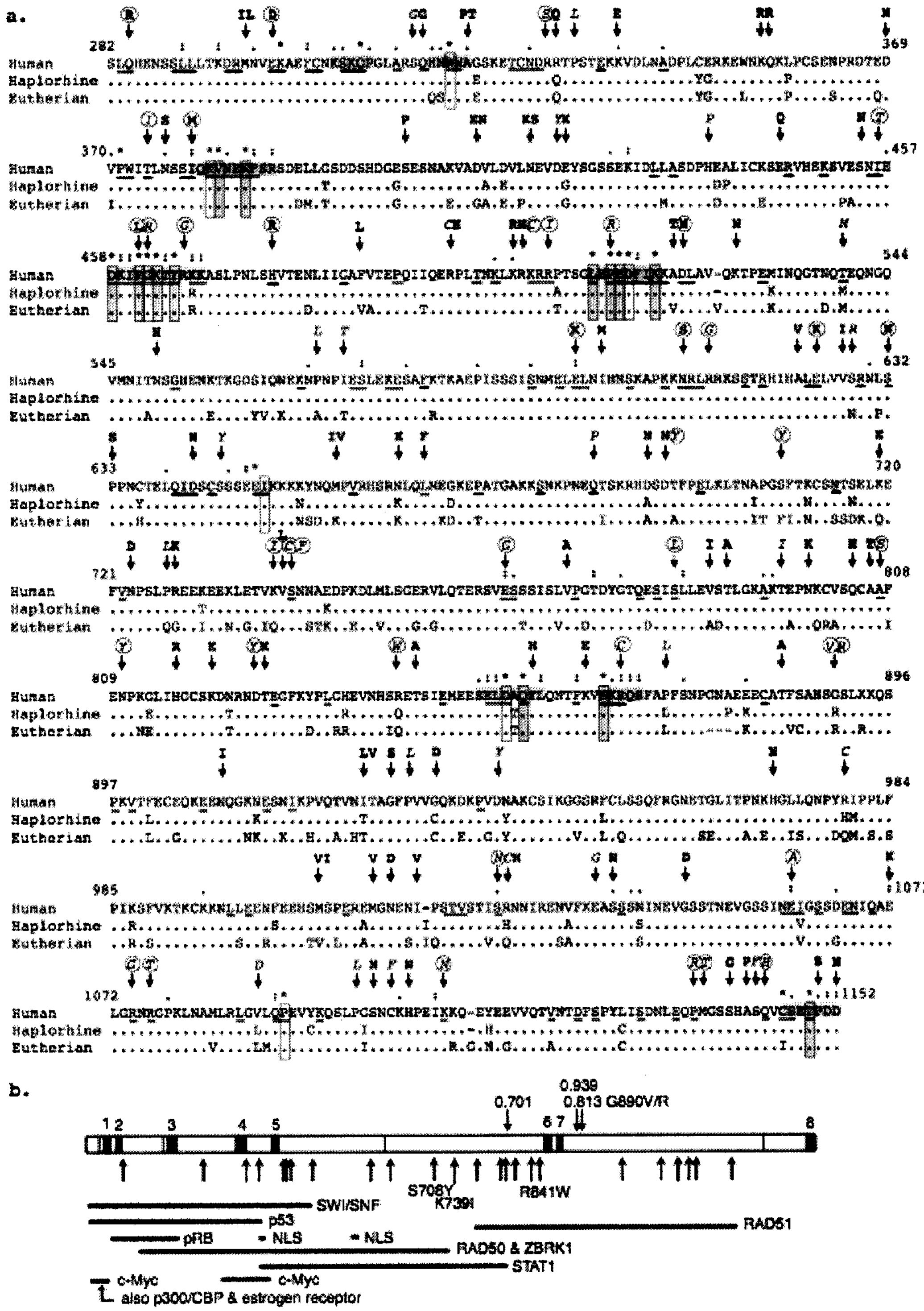


Figure 1.1 A phylogenetic tree of 2622 bp of *BRCA1* exon 11 derived by Bayesian inference. The numbers adjacent to internal nodes represent the posterior probability that a clade is correct based on a consensus of 4,000 trees with roughly equivalent likelihoods; unlabelled nodes represent posterior probabilities of 1.00. Filled circles indicate nodes where ancestral sequences were calculated. Taxonomic categories greater than species level for primates and other taxa referred to in the text are identified by lines and letters: a. African hominids, b. great apes, c. catarrhine primates (Old World monkeys and apes) , d. haplorhine primates (monkeys and apes), e. Primates, f. Rodentia, g. Chiroptera, h. Perissodactyla, i. Cetartiodactyla, j. Pholidota, k. Carnivora, and l. Afrotheria.

Figure 1.2 a. Alignment of BRCA1 amino acids 282-1152 for the human and ancestral sequences for haplorhine primates and eutherians derived from the phylogenetic tree in Figure 1.1. Residues identical to human sequence are shown as dots. Boxes highlight residues that are fixed in 57 eutherian mammals and *Gallus* (black outline) or in eutherians, *Gallus* and *Xenopus* (shaded gray, black outline). Markings above the alignment indicate the level of sequence conservation in all 57 eutherian mammals: '*' for fixed residues and ':' and '.' for sites that include conservative substitutions from only strongly conserved (> 0.5) or weakly conserved (≤ 0.5) amino-acid groups, respectively, based on the Gonnet PAM 250 matrix (34). Conservative (bold) and non-conservative (italics) missense changes that have been reported in humans are indicated by arrows; 41-circled changes are predicted to affect function. Residues underlined in the human sequence are fixed when only the sequences immediately ancestral to the 57 eutherian species are considered. Shading on the human sequence indicates highly conserved regions defined in the text.

b. Portion of *BRCA1* Exon 11 between human amino acids 282-1152 with the putative binding sites of several proteins (indicated by horizontal lines below) thought to interact with Exon 11. Highly conserved regions (>80%) shown in Figure 1.2 a are in black (numbered 1-8) along with 4 additional fixed residues (vertical black lines). Three positively selected sites with posterior probabilities > 0.5 are indicated by arrows above. Twenty-four sites that are fixed or conservative in non-primate eutherian ancestors that show conservative (for fixed sites) or non-conservative (for fixed or conservative sites) substitutions or deletions in primates are indicated by arrows below. Missense changes associated with these sites are in bold.



a.
Human
Haplorhine
Eutherian
b.
0.939
0.701
0.813 G890V/R
1 2
3
4
5
6 7
8
S706Y
K739I
R841W
SWI/SNF
p53
RAD51
pRB
NLS
NLS
RAD50 & ZBRK1
STAT1
c-Myc
c-Myc
also p300/CBP & estrogen receptor

Figure 1.3 Alignment of beta-globin amino acids 1-146 from the human with a) 14 eutherian species and b) eutherian ancestral sequences derived form the phylogenetic tree in Figure 1.4. Beta-globin nucleotide sequences were obtained from GenBank (Table 1.5) and aligned using ClustalX. The nucleotide sequences were translated to amino acid sequences and aligned manually in MacClade. Symbols above the alignment indicate whether the sites are fixed '*', or include amino-acid from strongly ':' or weakly '.' conserved groups, defined by scores of > 0.5 and < 0.5, respectively, in the Gonnet Pam 250 substitution matrix. Letters and arrows above the alignment indicate missense changes; symbols above missense changes indicate changes that were strongly or weakly conservative as described above. Ancestral sequences were inferred using MrBayes with the same parameters used to generate the phylogenetic tree in Figure 1.4.

a.

```
                                          R   E
               1                          ↑   ↑                 50
                      ::  :  :*.**. : **.*:*************:*: *****
Human           VHLTPEEKSAVTALWGKVNVDEVGGEALGRLLVVYPWTQRFFESFGDLST
Tarsier         VHLTAEEKAAVTALWGKVDVEDVGGEALGRLLVVYPWTQRFFDSFGDLST
Lemur           TLLSAEENAHVTSLWGKVDVEKVGGEALGRLLVVYPWTQRFFESFGDLSS
Bush_baby       VHLTPDEKNAVCALWGKVNVEEVGGEALGRLLVVYPWTQRFFDSFGDLSS
Hamster         VHLTDAEKALVTGLWGKVNADAVGAEALGRLLVVYPWTQRFFEHFGDLSL
Mouse           VHLTDAEKSAVSCLWAKVNPDEVGGEALGRLLVVYPWTQRYFDSFGDLSS
Rat             VHLTDAEKAAVNGLWGKVNPDDVGGEALGRLLVVYPWTQRYFDSFGDLSS
Rabbit          VHLSSEEKSAVTALWGKVNVEEVGGEALGRLLVVYPWTQRFFESFGDLSS
hare            VHLSGEEKSAVTALWGKVNVEEVGGETLGRLLVVYPWTQRFFESFGDLST
Elephant_Seal   VHLTAEEKSAVTSLWGKVKVDEVGGEALGRLLVVYPWTQRFFDSFGDLSS
Sheep           --LTAEEKAAVTGFWGKVKVDEVGAEALGRLLVVYPWTQRFFEHFGDLSN
Goat            -----PNKALITGFWSKVKVDEVGAEALGRLLVVYPWTQRFFEHFGDLSS
Cow             --LTAEEKAAVTAFWGKVKVDEVGGEALGRLLVVYPWTQRFFESFGDLST
Pig             VHLSAEEKEAVLGLWGKVNVDEVGGEALGRLLVVYPWTQRFFESFGDLSN
                                                               :
                         E                                     M
              51         ↑                                     ↑ 100
                . *::.*.:*:******: :* :*: :**:***:*: *******:*****
Human           PDAVMGNPKVKAHGKKVLGAFSDGLAHLDNLKGTFATLSELHCDKLHVDP
Tarsier         PAAVMSNAKVKAHGKKVLNAFSDGMAHLDNLKGTFAKLSELHCDKLHVDP
Lemur           PSAVMGNPKVKAHGKKVLSAFSEGLHHLDNLKGTFAQLSELHCDKLHVDP
Bush_baby       PSAVMGNPKVKAHGKKVLSAFSEGLNHLDNLKGTFAKLSELHCDKLHVDP
Hamster         PVAVMNNPQVKAHGKKVIHSFADGLKHLDNLKGAFSSLSELHCDKLHVDP
Mouse           ASAIMGNPKVKAHGKKVITAFNEGLKNLDNLKGTFASLSELHCDKLHVDP
Rat             ASAIMGNPKVKAHGKKVINAFNDGLKHLDNLKGTFAHLSELHCDKLHVDP
Rabbit          AHAVMSNPKVKAHGKKVLAAFSEGLNHLDNLKGTFAKLSELHCDKLHVDP
hare            ASAVMGNPKVKAHGKKVLAAFSEGLSHLDNLKGTFAKLSELHCDKLHVDP
Elephant_Seal   PNAIMSNPKVKAHGKKVLNSFSDGLKNLDNLKGTFAKLSELHCDQLHVDP
Sheep           ADAVMNNPKVKAHGKKVLDSFSNGMKHLDDLKGTFAQLSELHCDKLHVDP
Goat            ADAVLGNAKVNAHGKKVLDSFSNGVQHLDDLKGTFAELSELHCDKLHVDP
Cow             ADAVMNNPKVKAHGKKVLDSFSNGMKHLDDLKGTFAALSELHCDKLHVDP
Pig             ADAVMGNPKVKAHGKKVLQSFSDGLKHLDNLKGTFAKLSELHCDQLHVDP
                                         :
                     R   P   PD          R/P
             101     ↑   ↑   ↑↑           ↑                  146
                :** **** :: ** .  *: *.*  *. ::*******.****:**
Human           ENFRLLGNVLVCVLAHHFGKEFTPPVQAAYQKVVAGVANALAHKYH
Tarsier         ENFRLLGNVLVCVLAHHFGKEFTPQVQAAYQKVVAGVATALAHKYH
Lemur           QNFTLLGNVLVVVLAEHFGNAFSPAVQAAFQKVVAGVANALAHKYH
Bush_baby       ENFRLLGNVLVVVLAHHFGKDFTPQVQAAYQKVVAGVATALAHKYH
Hamster         ENFKLLGNMIIIVLIHDLGKDFTPSAQSAFHKVVAGVANALAHKYH
Mouse           ENFRLLGNAIVIVLGHHLGKDFTPAAQAAFQKVVAGVATALAHKYH
Rat             ENFRLLGNMIVIVLGHHLGKEFTPCAQAAFQKVVAGVASALAHKYH
Rabbit          ENFRLLGNVLVVVLSHHFGKEFTPQVQAAYQKVVAGVANALAHKYH
hare            ENFRLLGNVLVIVLSHHFGKEFTPQVQAAYQKVVAGVANALAHKYH
Elephant_Seal   ENFKLLGNVLVCVLARHFGKEFTPQMQGAFQKVVAGVANALAHKYH
Sheep           ENFRLLGNVLVVVLARHHGNEFTPVLQADFQKVVAGVANALAHKYH
Goat            ENFRLLGNVLVIVLARHFGKEFTPELQAEFQKVVAGVASALAHRYH
Cow             ENFKLLGNVLVVVLARNFGKEFTPVLQADFQKVVAGVANALAHRYH
Pig             ENFRLLGNVIVVVLARRLGHDFNPNVQAAFQKVVAGVANALAHKYH
```

b.

```
                                       R   E
           1                           ↑   ↑                 50
             ***:  **:***.:****: :***.***************:*: *****:
node1        VHLTAEEKAAVTALWGKVNVEEVGGEALGRLLVVYPWTQRFFESFGDLST
node2        VHLTAEEKAAVTALWGKVNVEEVGGEALGRLLVVYPWTQRFFESFGDLSS
node3        VHLSGEEKSAVTALWGKVNVEEVGGEALGRLLVVYPWTQRFFESFGDLSS
node4        VHLTDAEKAAVTGLWGKVNADEVGGEALGRLLVVYPWTQRFFDSFGDLSS
node5        VHLTDAEKAAVTGLWGKVNPDEVGGEALGRLLVVYPWTQRYFDSFGDLSS
node6        VHLTAEEKAAVTALWGKVNVDEVGGEALGRLLVVYPWTQRFFESFGDLSS
node7        --LTAEEKAAVTGFWGKVKVDEVGAEALGRLLVVYPWTQRFFEHFGDLST
node8        --LTAEEKAAVTAFWGKVKVDEVGGEALGRLLVVYPWTQRFFESFGDLST
node9        VHLTAEEKAAVTALWGKVNVDEVGGEALGRLLVVYPWTQRFFESFGDLST
node10       VHLTAEEKAAVTALWGKVNVEEVGGEALGRLLVVYPWTQRFFESFGDLSS
                                                            :
                      E                                     M
           51         ↑                                     ↑ 100
             . *:*.***********: :*.:*: ***:******:*************
node1        PAAVMGNPKVKAHGKKVLSAFSDGLAHLDNLKGTFAKLSELHCDKLHVDP
node2        PSAVMGNPKVKAHGKKVLSAFSEGLNHLDNLKGTFAKLSELHCDKLHVDP
node3        ASAVMGNPKVKAHGKKVLAAFSEGLNHLDNLKGTFAKLSELHCDKLHVDP
node4        ASAVMGNPKVKAHGKKVINAFNDGLKHLDNLKGTFANLSELHCDKLHVDP
node5        ASAIMGNPKVKAHGKKVINAFNDGLKHLDNLKGTFANLSELHCDKLHVDP
node6        PDAVMSNPKVKAHGKKVLNSFSDGLKHLDNLKGTFAKLSELHCDKLHVDP
node7        ADAVMNNPKVKAHGKKVLDSFSNGMKHLDDLKGTFAELSELHCDKLHVDP
node8        ADAVMNNPKVKAHGKKVLDSFSNGMKHLDDLKGTFAELSELHCDKLHVDP
node9        ADAVMSNPKVKAHGKKVLNSFSDGLKHLDNLKGTFAKLSELHCDKLHVDP
node10       PSAVMGNPKVKAHGKKVLSAFSDGLNHLDNLKGTFAKLSELHCDKLHVDP
                                      :
                  R   P   PD          R/P
          101     ↑   ↑   ↑↑           ↑                  146
             ********::* **.:*:******  ** :****************
node1        ENFRLLGNVLVCVLAHHFGKEFTPQVQAAYQKVVAGVANALAHKYH
node2        ENFRLLGNVLVVVLAHHFGKEFTPQVQAAYQKVVAGVANALAHKYH
node3        ENFRLLGNVLVVVLSHHFGKEFTPQVQAAYQKVVAGVANALAHKYH
node4        ENFRLLGNMIVIVLAHHLGKEFTPGAQAAFQKVVAGVANALAHKYH
node5        ENFRLLGNMIVIVLGHHLGKEFTPGAQAAFQKVVAGVANALAHKYH
node6        ENFRLLGNVLVVVLARHFGKEFTPQVQAAFQKVVAGVANALAHKYH
node7        ENFRLLGNVLVVVLARHFGKEFTPVLQADFQKVVAGVANALAHKYH
node8        ENFRLLGNVLVVVLARHFGKEFTPVLQADFQKVVAGVANALAHKYH
node9        ENFRLLGNVLVVVLARHFGKEFTPEVQAAFQKVVAGVANALAHKYH
node10       ENFRLLGNVLVVVLAHHFGKEFTPQVQAAFQKVVAGVANALAHKYH
```

Figure 1.3 (continued)

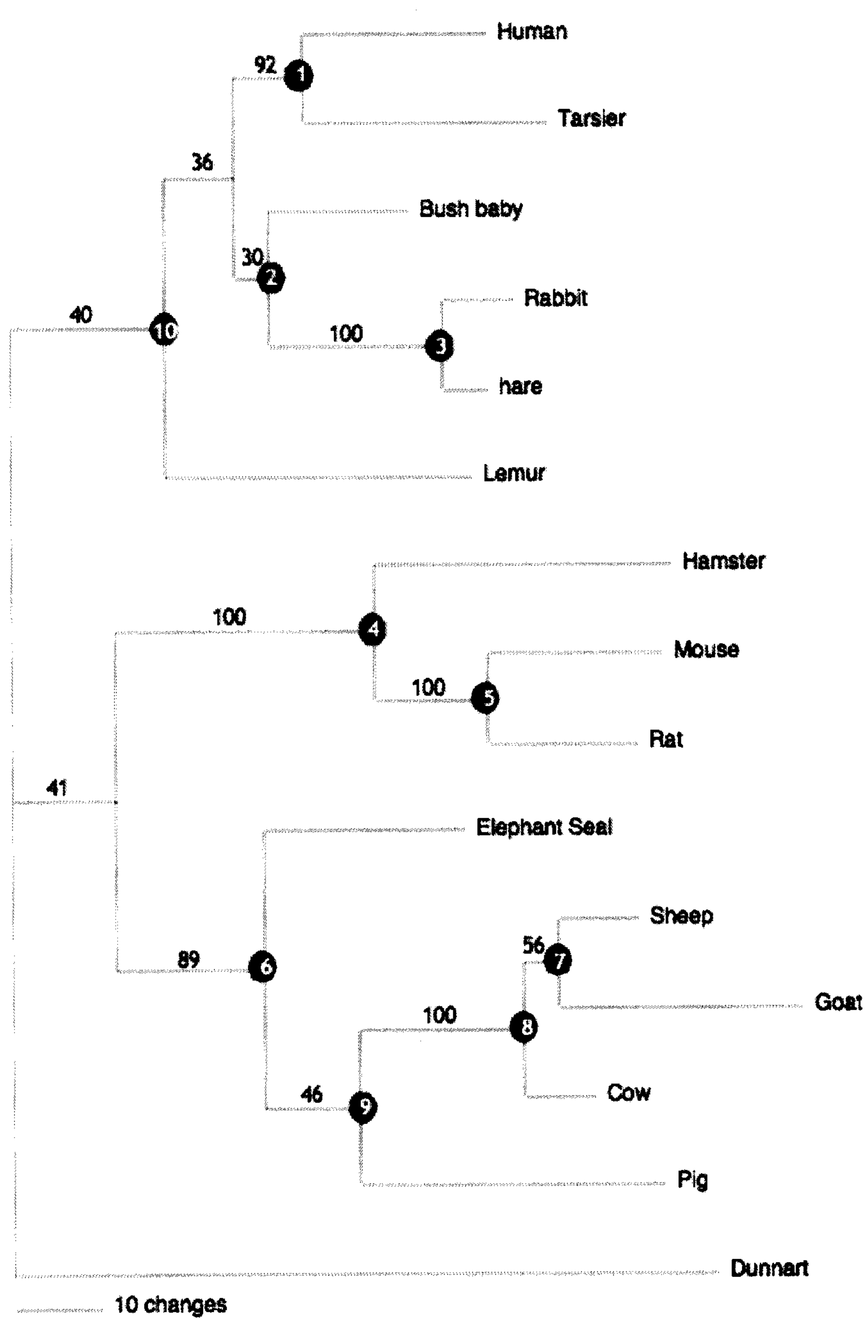


Figure 1.4 A phylogenetic tree of 441 bp of beta-globin derived by Bayesian inference using the same parameters as for BRCA1 exon 11 and run for 100,000 generations with a 'burn-in' of 200. The numbers adjacent to internal nodes represent the posterior probability that a clade is correct based on a consensus of 800 trees with roughly equivalent likelihood values. Clades with posterior probabilities of < 0.50 are not well supported and the relationships are unresolved. Many clades are poorly resolved because beta-globin sequences are too well conserved to allow taxa to be assigned to clades unambiguously. Filled circles indicate nodes (1-10) where ancestral sequences were calculated.

a. BRCA1 RING domain

```
                               RY    F  F              GRY GRY
                               |     |  |               |   |
                        24**:**:::****:*:***:**:***::** .::**   ****64
Homo                      CPICLELIKEPVSTKCDHIFCKFCMLKLL NQKKGPSQCPLC
Canis                     CPICLELIKEPVSTKCDHIFCKFCMLKLL-NQRKGPSQCPLC
Mus                       CPICLELIKEPVSTKCDHIFCKFCMLKLL-NQKKGPSQCPLC
Rattus                    CPICLELIKEPVSTQCDHIFCKFCMLKLL-NQKKGPSQCPLC
Gallus                    CPVCLDVIKEPVSTKCDHVFCRFCMFKLLSRKKKGVIQCPLC
Xenopus                   CPICLELMKEPVATKCDHIFCKFCMLQLLSKKKKGTVPCPLC
```

b. BRCA1 BRCT domains

```
                              :   ;                        :    :
                              M   S                        N   R WQ     E
                              |   |                        |   | |      |
                    1649 :*:*.***.  *   * :*:.. :  ::. *:: ****::*** *:********* ***1708
Homo                     RMSMVVSGLTPEEFMLVYKFARKHHITLTNLITEETTHVVMKTDAEFVCERTLKYFLGIA
Canis                    RISMVASGLTPKEFMLVHKFARKHHISLTNLISEETTHVIMKTDAEFVCERTLKYFLGIA
Mus                      DISMVVSGLTPKEVMTVQKFAEKYRLTLTDAITEETTHVIIKTDAEFVCERTLKYFLGIA
Rattus                   DISMVVSGLTPKEVMIVQKFAEKYRLALTDVITEETTHVIIKTDAEFVCERTLKYFLGIA
Gallus                   EMSIVASGLNQSEHLMVQKFARKTQSTFSNHITDGTTHVIMKTDEELVCERTLKYFLGIA
Xenopus                  NLSFVASGLNQCEMALVQRFSKTTQSILSSRITDSTTHVIMKTDAELVCERTLKYFQGIA

                           :                 .
                           RN                G   E
                           |                 |   |
                    1709. **:*** *: :*::* ::*.  .***:***:.* **:**:*:* .          :: .1764
Homo                     GGKWVVSYFWVTQSIKERKMLNEHDFEVRGDVVNGRNHQGPKRARESQDR-----KIFRG
Canis                    GGKWVVSYFWVTQSIKERKILDEHDFEVRGDVVNGRNHQGPKRARESQDRESQDRKIFRG
Mus                      GGKWIVSYSWVVRSIQERRLLNVHEFEVKGDVVTGRNHQGPRRSRESREK------LFKG
Rattus                   GGKWIVSYSWVIKSIQERKLLSVHEFEVKGDVVTGSNHQGPRRSRESQEK------LFEG
Gallus                   GRKWVVSYQWIIQSFKEGRILDEEHFEVKGDVINGRNHQGPKRARQSPAE-----KIFKD
Xenopus                  SRKWVVSYEWVVQSFREGQILDEYDFEVKGDVINGRNHRGPRRSRLGSDG-----LLLID

                              R
                              |
                    1765:::   .**:*. ..** ::  ***:***:    :.   .    :*:***.*  *  .  1823
Homo                     LEICCYGPFTNMPTDQLEWMVQLCGASVVKELSSFTLGTGVHPIVVVQPDAWTEDNGFHA
Canis                    LEICCYGPFTNMPTDQLEWMVHLCGASVVKEPSLFTLSKGTHPVVVVQPDAWTEDSGFHA
Mus                      LQVYCCEPFTNMPKDELERMLQLCGASVVKELPSLTHDTGAHLVVIVQPSAWTEDSNCPD
Rattus                   LQIYCCEPFTNMPKDELERMLQLCGASVVKELPLLTRDTGAHPIVLVQPSAWTEDNDCPD
Gallus                   FEICCCGPFTDMTTGHLEWIVELCGASVVKQLHLFTHKVNSTAVVVVQPDAWMEGTSYEA
Xenopus                  FEICFFGSFTDMTLDDLEWMVSECGATVVKKLQFFKKKHNVTSLVIVQPDASTEVRDYTE

                    1824* :   :  :*  :*::**:: :. :.:*:** 1855
Homo                     IGQMCEAPVVTREWVLDSVALYQCQELDTYLI
Canis                    IGQMCEAPVVTREWVLDSVALYQCQELDTYLI
Mus                      IGQLCKARLVMWDWVLDSLSSYRCRDLDAYLV
Rattus                   IGQLCKGRLVMWDWVLDSISVYRCRDLDAYLV
Gallus                   IQRKNNVAVVTREWVLDSVACFECQELDAYLV
Xenopus                  IRKKHKALVVTREWLMDSVATYRLQKFDAYLA
```

Figure 1.5 Alignments of BRCA1 a) RING and b) BRCT domains by ClustalX using available sequences from GenBank (accession numbers in Table 1.6). Symbols above the alignment indicate whether the sites are fixed ‘*’, or include amino-acid from strongly ‘:’ or weakly ‘.’ conserved groups, defined by scores of > 0.5 and < 0.5, respectively, in the Gonnet Pam 250 substitution matrix. Letters and vertical lines above the alignment indicate missense changes; their level of conservation is also indicated by ‘:’ or ‘.’

Table 1.1 GenBank accession numbers, taxonomic information, amino-acid identity with humans (871 amino acids; accession no. U14680), sequence length (between human AA 282-1152, including Ns), and amino-acid identity with estimated sequence for the ancestor of eutherian mammals for *BRCA1* sequences used in the study.

GenBank Accession Number	Order	Mean ± SEM % AA Identity in orders	Species	% AA Identity (species)	Sequence length (a.a.)	%AA Identity w/ eutherian ancestor
Eutheria						
AF019075	Primates	90.5 ± 4.0	Chimpanzee, *Pan troglodytes*	97.5	871	81.9
AF019076			Gorilla, *Gorilla gorilla*	97.9	871	82.1
AF019077			Orangutan, *Pongo pygmaeus*	96.2	871	82.1
AF019078			Rhesus Monkey, *Macaca mulatta*	92.3	870	81.3
AF019079			Red Howler Monkey, *Alouatta seniculus*	86.6	877	79.0
AF019080			Greater Galago, *Otolemur crassicaudatus*	72.7	871	77.5
AF019081	Dermoptera		Flying Lemur, *Cynocephalus variegatus*	75.8	874	84.4
AF284006	Scandentia		Large Tree Shrew, *Tupaia tana*	69.4	834	76.5
AF284005	Lagomorpha		Cape Hare, *Lepus capensis*	65.2	865	73.0
AF284004	Rodentia	63. 9 ± 2.6	Cape Porcupine, *Hystrix africaeaustralis*	55.7	820	60.5
AF332047			Spring Hare, *Pedetes capensis*	70.2	855	75.8
AF332045			Mountain Beaver, *Aplodontia rufa*	71.1	865	77.0
AF332044			Eastern Fox Squirrel, *Sciurus niger*	72.6	855	78.6
AF284003			Southern Flying Squirrel, *Glaucomys volans*	72.0	888	78.4
AF332046			Woodland Dormouse, *Graphiurus murinus*	72.8	863	79.1
AF332043			Coues' Rice Rat, *Oryzomys couesi*	56.4	835	60.4
AF332048			Shaw's Jird, *Meriones shawi*	57.6	834	62.1
MMU68174			House Mouse, *Mus musculus*	55.2	837	59.2
AF036760			Brown Rat, *Rattus norvegicus*	55.8	837	59.6
AF284007	Insectivora	66.1 ± 3.5	Eastern Mole, *Scalopus aquaticus*	69.6	872	76.2

Table 1.1 (continued)

GenBank Accession Number	Order	Mean ± SEM % AA Identity in orders	Species	% AA Identity (species)	Sequence length (a.a.)	%AA Identity w/ eutherian ancestor
AF284008			European Hedgehog, *Erinaceus europaeus*	62.6	851	69.2
AF203746	Chiroptera	69.7 ± 1.7	Daubenton's Bat, *Myotis daubentoni*	71.8	859	79.1
AF203747			Brazilian Free-tailed Bat, *Tadarida brasiliensis*	72.6	855	80.3
AF203748			Tomb Bat, *Taphozous sp.*	69.9	858	78.4
AF203745			Spix's Round-eared Bat, *Tonatia bidens*	57.9	850	65.0
AF203749			Greater False Vampire Bat, *Megaderma lyra*	71.3	865	79.9
AF203751			Solomons Flying Fox, *Pteropus rayneri*	72.4	859	81.5
AF203752			Roundleaf Bat, *Hipposideros commersoni*	70.7	872	80.5
AF203750			Short-nosed Fruit Bat, *Cynopterus sphinx*	70.7	864	78.6
AF284010	Perissodactyla	75.0 ± 0.5	Horse, *Equus caballus*	74.5	867	84.0
AF284011			Black Rhinoceros, *Diceros bicornis*	75.4	875	86.1
AF284009	Pholidota		Pangolin, *Manis sp.*	71.9	867	79.6
U50709	Carnivora	70.5 ± 2.3	Dog, *Canis familiaris*	68.2	875	76.0
AF284018			Cat, *Felis catus*	72.8	874	80.8
AF284014	Cetartiodactyla[1]	71.5 ± 1.0	Pig, *Sus scrofa*	70.8	871	79.1
AF284012			Llama, *Lama glama*	72.8	870	80.7
AF284013			Cow, *Bos taurus*	66.96	866	74.1
AF284015			Hippopotamus, *Hippopotamus amphibius*	71.4	859	80.4
AF284017			Humpback Whale, *Megaptera novaeangliae*	73.1	868	82.1
AF284016			Sperm Whale, *Physeter catodon*	73.8	870	81.8
AF284001	Xenarthra	72.0 ± 0.7	Southern Tamandua, *Tamandua tetradactyla*	71.8	870	83.0
AF284002			Three-toed Sloth, *Bradypus tridactylus*	71.6	866	84.4
AF283999			Nine-banded Armadillo, *Dasypus novemcinctus*	70.7	853	82.1

Table 1.1 (continued)

GenBank Accession Number	Order	Mean ± SEM % AA Identity in orders	Species	% AA Identity (species)	Sequence length (a.a.)	%AA Identity w/ eutherian ancestor
AF284000			Large Hairy Armadillo, *Chaetophractus villosus*	74.0	856	85.2
AF284021	Proboscidea	71.5 ± 0.1	African Elephant, *Loxodonta africana*	71.6	858	84.3
AF284022			Asiatic Elephant, *Elephas maximus*	71.4	858	84.0
AF284019	Sirenia	74.0 ± 0.1	Dugong, *Dugong dugon*	73.9	850	89.0
AF284020			West Indian Manatee, *Trichechus manatus*	74.1	857	88.7
AF284023	Hyracoidea	64.6 ± 0.1	Rock Hyrax, *Procavia capensis*	64.6	845	75.6
AF284024			Western Tree Hyrax, *Dendrohydrax dorsalis*	64.5	851	75.4
AF284030	Tubulidentata		Aardvark, *Orycteropus afer*	69.8	854	83.3
AF284026	Insectivora[2]	56.2 ± 1.1	Tailless Tenrec, *Tenrec ecaudatus*	54.4	840	61.4
AF284025			Lesser Hedgehog-tenrec, *Echinops telfairi*	57.9	834	64.5
AF284028	Macroscelidea	61.3 ± 1.3	Elephant Shrew, *Elephantulus rufescens*	62.5	826	71.5
AF284029			Elephant Shrew, *Rhynchocyon sp.*	60.0	861	71.0
AF284027	Insectivora[2]		Golden Mole, *Amblysomus hottentotus*	67.7	849	78.1
Marsupialia						
AF284031	Diprotodontia		Coarse-haired Wombat, *Vombatus ursinus*	41.5	861	
Aves						
AF355273		25.4	Chicken, *Gallus gallus*	25.4		
Amphibia						
AF416868		19.5	Frog, *Xenopus laevi*	19.5		

[1] Includes orders Cetacea and Artiodactyla
[2] Order Insectivora is paraphyletic

Table 1.2 Amino-acid substitutions (conservative and non-conservative) and a deletion that evolved in the primate lineage leading to human *BRCA1* and are predicted to be functionally important changes in otherwise conserved residues, and the three missense changes reported in BIC that affect these residues.

Site conservation in non-Primates[1]	Changes in primate lineage leading to humans	Substitution	Origin[2]	BIC missense changes
Fixed site	**Non-conservative**	S655Y	Haplorhine	
		S984F	***Haplorhine***	
	Conservative	R467K	***Human***	
		D537N	***Primate***	
		K564N	***Primate***	
		Q739K	***Haplorhine***	K739I
		T767S	***Haplorhine***	
		Q800K	***Primate***	
		Q841R	***African Hominids***	R841W
		V1061I	***Human***	
Conservative site	**Non-conservative**	E323G	***Catarrhine***	
		P416L	***Haplorhine***	
		T493I	Haplorhine	
		V525/526 –[3]	Haplorhine	
		K531M	Catarrhine	
		P631L	Haplorhine	
		F708S	Haplorhine	S708Y
		A797E	Haplorhine	
		E813G	African Hominids	
		D831Y	Haplorhine	
		G939V	Haplorhine	
		F1003S/F[4]	Haplorhine/ African Hominid	
		A1013E	Great Apes	
		Q1020P	Primates	

[1] Level of site conservation in non-primates is derived from ancestral sequences shown in Figure 1.1.
[2] The clade in which the substitution evolved, described in Figure 1.1.
[3] Indicates a gap in the sequence between residues numbered 525 and 526 in Primates.
[4] Indicates two substitutions during human evolution, the first occurred in Haplorhines and the second is a change back to the common eutherian amino acid in African Hominids.

Table 1.3 The 38 (of 139) missense changes reported in BIC that are predicted to affect function because they occur at sites that are fixed or conservative in eutherian ancestral sequences.

Type of missense change and amino-acid site	Missense change[1]	SIFT [2] score
Non-conservative changes at fixed sites	T374I	<0.01
	I456T	0.03
	G462R	<0.01
	R507I	0.01
	P514R	<0.01
	S741F	0.04
	E765G	<0.01
	S784L	0.02
	R866C (10)	<0.01
	E1060A	<0.01
	R1074G	0.03
	R1076T	<0.01
	P1136R	0.01
Non-conservative changes at conservative sites	R331S (3)	<0.01
	R466G	<0.05
	R504C	0.03
	R612G	0.01
	D695Y	0.03
	K739I	0.01
	N810Y (4)	<0.01
	D825Y	<0.05
	R841W (60)	<0.01
	M1137T	TOL (0.08)
Conservative changes at fixed sites	Q284R	0.01
	E300D	0.01
	I379M (10)	<0.01
	F461L (2)	<0.01
	H476R (3)	TOL (0.05)
	D522N	0.01
	E597K (4)	<0.01
	N609S	0.02
	E624K	0.01
	S632N	0.04
	S741C	<0.05
	A807S	0.01
	S1027N	0.03
	K1109N (2)	0.01
	Q1144H	0.01

[1]Missense changes affecting sites that were fixed in all 57 eutherian sequences and non-conservative changes affecting sites that were conservative in all 57 are in **bold**. Numbers in parentheses indicate the number of times (>1) that the missense change has been reported in the BIC.

[2]SIFT scores of < 0.05 indicate missense changes that are likely to affect function. TOL indicates substitutions predicted by SIFT to be 'tolerated' and is followed by a SIFT score when contrary to predictions based on eutherian ancestral sequences.

Table 1.4 GenBank accession numbers of 16 species used in the beta-globin analysis.

GenBank Accession #	Species
V00499	Human (*Homo sapien*)
J04429	Tarsier (*Tarsius syrichta*)
M15734	Lemur (*Eulemur macaco*)
M61740	Bush baby (*Otolemur crassicaudatus*)
V00878	Rabbit (*Oryctolagus cuniculus*)
Y00347	Hare (*Lepus europaeus*)
M73997	Elephant Seal (*Mirounga angustirostris*)
X14727	Sheep (*Ovis aries*)
M15389	Goat (*Capra hircus*)
X00376	Cow (*Bos taurus*)
X86791	Pig (*Sus scrofa*)
X57030	Hamster (*Cricetinae* sp.)
BC027434	Mouse (*Mus musculus*)
NM_033234	Rat (*Rattus norvegicus*)
Z69592	Dunnart (*Sminthopsis crassicaudata*)

Table 1.5. The distribution of ten deleterious missense changes in beta-globin [119] across nine amino acid sites that are either fixed or conservative in eutherian ancestral sequences indicated in Figure 1.4. All ten were correctly predicted to affect function by the ancestral sequences method. SIFT also predicted that these changes would affect function but the sequences were not diverse enough to do so with high confidence.

Missense change	Change conservation	Site conservation
L28R[1]	non-conservative	fixed
L32E	non-conservative	fixed
V60E	non-conservative	fixed
L106R	non-conservative	fixed
L114P	non-conservative	fixed
Q127P	non-conservative	fixed
V98M[1]	conservative	fixed
Q127R	conservative	fixed
L110P	non-conservative	conservative
A115D	non-conservative	conservative[2]

[1] L28R and V98M occur in *cis*

[2] This site was non-conservative in an alignment of 15 eutherian sequences because of a single histidine to aspartic acid change at amino acid 115 in the hamster.

Table 1.6 The 22 missense changes in the BRCA1 RING (a.a. 24-64) and BRCT (a.a. 1650-1855) domains and whether the change is a nonconservative or conservative one affecting an amino-acid site that is fixed or conservative in the alignment of the 6 taxa in Figure 1.5. Changes at a fixed site and non-conservative changes at conservative sites are predicted to affect function. Changes in parentheses were determined to have no affect on function in tests by Vallon-Christersson et al [125]. All other changes are reported to affect function in either the BIC or Vallon-Christersson et al [125].

Missense change	Conservation of amino-acid sites	
	Fixed	Conservative
Nonconservative	C39R/Y	
	C44F	
	C47F	
	C61G/R/Y	
	C64G/R/Y	
	C1697R	
	(R1699W)	
	A1708E	
	S1715R	
	G1738E	
	M1775R	
Conservative	(V1665M)	(A1669S)
	(D1692N)	(D1733G)
	(R1699Q)	
	S1715N	

Chapter 2: Marsupial BRCA1: Conserved regions in mammals and the potential effect of missense changes

Introduction

Occurrences of breast cancer have been reported in mammals besides humans, including primates, rodents, and carnivores [17, 43, 67, 124]. The correlation of BRCA1 mutations with breast cancer in humans suggests that these mutations may disrupt functions unique to mammary tissue and thus, to mammals in general. However, the comparison of eutherian mammals described in Chapter 1 did not identify any conserved regions that were not also conserved in birds and amphibians. To identify missense changes predicted to affect function, I minimized the loss of fixed and conservative sites due to species-specific neutral polymorphisms and sequencing errors by comparing 37 "ancestral sequences", i.e. sequences derived from the immediate ancestors of the 57 eutherian sequences (AS method). As validation for the use of the AS method, I looked at missense changes in the beta-globin protein. All of the missense changes known to affect function were correctly identified as such, and a false positive would have occurred if I had only used sequences from the terminal taxa. These data support the use of the AS method for comparative analyses of large numbers of closely related sequences. In Chapter 1 we did not use the ancestral sequences to identify the highly conserved regions, which could have prevented us from detecting other potentially functional regions.

The goal of this study was to determine whether there are other conserved regions of BRCA1 exon 11 specific to mammals. I performed a comparative analysis of ancestral eutherian sequences reported in Chapter 1 and sequences from five orders of marsupial mammals. The inclusion of marsupials makes the analysis more comprehensive of mammalian diversity, which should also refine my predictions of which missense changes are most likely to be disease-associated in humans. Marsupials are similar to eutherians in terms of mammary structure and development [33, 54, 123] and susceptibility to breast cancer [15, 16, 108], but the marsupial superorder of mammals diverged from eutherians much earlier than most eutherian orders diverged from one another ([56]; Table 2.1). Including the GenBank and four new marsupial sequences and the eutherian ancestral sequences that Melissa and I generated previously, this analysis encompasses 23 of 26 mammal orders and 130-170 million years of BRCA1 evolution.

Methods

BRCA1 sequencing and sequence alignment

I sequenced a portion of exon 11 that had not been previously sequenced from four marsupial species: tree kangaroo (*Dendrolagus matschiei*), red kangaroo (*Macropus rufus*), wallaroo (*Macropus robustus*), and Virginia opossum (*Didelphis virginiana*). DNA samples were extracted from liver tissue or lymphocyte nuclei from blood collected in Anticoagulant Acid Citrate Dextrose blood collection tubes (Becton Dickinson, Franklin Lakes, NJ) [10].

Partial exon 11 sequences for all marsupials were amplified using PCR. Degenerate primers 5'AGCAGCATCCAGAAGGTGAAYGARTGGTT3' and 5'YTTCTTGATAAARTCCTCAAGATGAAG3' were designed using CODEHOP [96] based on eutherian exon 11 sequences from GenBank. PCR amplification of BRCA1 nucleotides 846-3309 was performed in 12.0-μl reactions containing 100-ng genomic DNA, 25.6-mM $(NH_4)_2SO_4$, 107.2-mM TrisCl (pH 8.8), 0.016% Tween-20, 1.5-mM $MgCl_2$, 0.2-mM each of dNTP's, 0.25-units T4 Taq polymerase, 12.5-mM reverse primer, and 12.5-mM γP^{32} labeled forward primer. The forward primer was labeled with γP^{32}ATP in a 1.0 μl reaction of 12.5 mM forward primer, 0.3 units T4 PNK, and 1x T4 kinase reaction buffer (Roche, Indianapolis, IN). PCR reactions were performed in a Perkin Elmer (Boston, MA) 9600 thermocycler with the following cycling conditions: initial denaturation of 95°C for 1 minute, 35 cycles of 94°C for 30 seconds, 55°C for 30 seconds, and 72°C for 45 seconds, and a final extension of 72°C for 7 minutes.

Radiolabeled PCR products were separated on a 4% polyacrylamide gel and visualized using autoradiography. Bands of the expected size (500-600 nt.) for each of the marsupial species were cut from the gel, and the DNA was eluted in 50-100-μl sterile water for 15 min at room temperature.

A non-radioactive 50-μl PCR reaction was then performed using 5 μl of the radioactive PCR product described above to obtain material for DNA sequencing. Reactions included 25.6 mM $(NH_4)_2SO_4$, 107.2 mM TrisCl (pH 8.8), 0.016% Tween-20, 1.5 mM $MgCl_2$, 0.2 mM each of dNTP's, 0.5 units T4 Taq polymerase, 1.0 mM reverse primer and 1.0 mM forward primer. PCR reactions were carried out as described above with a 58°C annealing temperature.

The PCR product was quantified on a 1.0% agarose gel using a low mass DNA ladder (GIBCO BRL, Carlsbad, CA). Unincorporated PCR primers and dNTP's were neutralized prior to sequencing using 15-ng of product, 10-U of exonuclease I, and 1U of shrimp alkaline phosphatase with a 30 min incubation at 37°C and a 15 min deactivation at 80°C.

The enzyme treated PCR product was divided into two separate reactions for the forward and reverse primers used in the previous PCR amplifications. Sequencing reactions were carried out using the Big Dye Terminator Cycle Sequencing Ready Reaction kit (Applied Biosystems, Foster City, CA) according to manufacturer's instructions. Unincorporated dye terminators were removed from the sequencing product by filtration through Sephadex G-50 resin using Millipore Multiscreen HV plates. Samples were separated on the ABI PRISM 3700 DNA Analyzer (Foster City, CA), and the data were analyzed with the Applied Biosystems ABI PRISM 3700 Collection software, version 2.0. Chromatogram files were transferred to a Unix workstation and reanalyzed using the base-calling software Phred, version 0.000925 (www.phrap.org) and the assembly program Phrap, version 0.990329 (www.phrap.org) and viewed using the program Consed, version 11.0 (www.phrap.org).

I obtained partial exon 11 nucleotide sequences of four additional marsupial species plus red kangaroo, humans, and representatives of two other vertebrate classes, Amphibia (frog) and Aves (chicken) from GenBank (Table 2.2) and 37 eutherian ancestral sequences from Fleming *et al.* [35]. Nucleotide sequences were aligned using ClustalX, version 1.81 [51] and adjusted by eye in MacClade, version 4.03 [60]. Phylogenetic analyses were based on the nucleotide sequences and the levels of site conservation across taxa were determined using the amino acid translation. The alignment of ancestral eutherian, frog, and chicken sequences with marsupial sequences was also performed using ClustalX and based on amino acid translations (Appendices C, D, E).

Phylogenetic analysis of marsupial BRCA1 exon 11

All analyses were based on sequences that started at human codon 282 and ended at or before codon 1103. Determination of amino acid conservation levels where sequence was not available for all taxa was based on the sequence of the remaining taxa.

I derived a phylogenetic tree of marsupial sequences with the human sequence as an outgroup using maximum likelihood methods (Figure 2.4). Modeltest, version 3.04 [91] was used to determine the substitution model that best fits these data: a general time-reversible substitution model with invariant sites and a gamma distribution. Maximum likelihood analysis using a heuristic search with 10 repetitions was run using PAUP*[113]. Five hundred bootstrap replicates were run to assess support for the branches.

MrBayes, version 2.01 [46], a Bayesian analysis program, was used to find positively selected sites in marsupials. Residues at a site that are evolving more rapidly than predicted by neutral theory (i.e., posterior probability > 0.50), may demonstrate positive (diversifying) selection at that site. I generated a phylogenetic tree using the human as the outgroup and specifying a general time-reversible substitution model with estimated base frequencies. Codons were used as sites and adjacent sites were assumed to have correlated rates. Omega, the ratio of nonsynonymous to synonymous substitutions, was varied according to the Nielsen and Yang [79] model of among-site rate variation. Markov Chain Monte Carlo sampling was started from random trees for four simultaneous chains with uniform prior probability distributions for tree topologies and the rate matrix and a dirichlet prior of 4.0 for base frequencies. The analysis was run for 100,000 generations and trees were saved every 100 generations. Likelihood values converged around 20,000 generations so the first 200 trees were discarded as "burn in." The consensus tree was viewed in PAUP*, version 4.0 beta [113].

MrBayes, version 2.01 was also used to estimate the sequence of the ancestor of the eight marsupial sequences ("marsupial ancestor") for heuristic purposes in Figure 2.2. To determine the tree topology, an initial analysis was run using the above parameters except that rate variation for each codon position was estimated separately. The marsupial ancestor's sequence was generated by a second analysis, which was run with the clades constrained to maintain the same tree topology as the initial tree.

Conserved regions

Homologous amino acid sites were categorized according to the Gonnet Pam 250 substitution matrix [40]. Sites were labeled as fixed (having a single residue in all sequences), conservative (including conservative substitutions only), or nonconservative (including at least one nonconservative substitution). Conservative sites were further described as "weakly" or "strongly" conservative based on matrix values > 0 and ≤ 0.5 or values > 0.5 respectively. Two-tailed, one-sample Runs tests [100] were used to determine whether residues that were fixed or conservative were associated with one another or randomly distributed.

Regions of the protein with high levels of amino acid conservation across taxa ("highly conserved regions") were identified using a sliding window of five amino acids in length as described previously [35]. To compare percent conservation of regions between alignments (e.g., mammals alone versus mammals and chicken) I calculated the mean ± SD for the percent of fixed and conservative sites in each five amino acid window across the alignment. Windows that included sequence with conservation levels greater than two standard deviations from the mean were considered highly conserved.

Missense Changes

Missense changes reported in the BIC database between codons 282 and 1103 of BRCA1 were identified. The missense changes were designated conservative or nonconservative based on the Gonnet Pam 250 matrix. The association of missense changes (conservative or nonconservative) with fixed or conservative amino acid sites in the alignment of eight marsupial and 37 eutherian ancestral sequences was tested using Chi-square with correction for continuity ($P \leq 0.05$) [101].

Results

Phylogeny of marsupial BRCA1 exon 11

Marsupial sequences varied from 236 codons to 816 codons in length (Table 2.2) and extended over 843 amino acid sites that correspond to human BRCA1 amino acids 282-1103 (~76% of exon 11). The positions of the novel marsupial sequences on the phylogenetic tree with respect to the GenBank sequences from closely related species confirm that the sequences are *BRCA1* orthologs and not pseudogenes (Figures 2.1 and 2.2). The novel tree kangaroo, red kangaroo, and wallaroo sequences form a well-supported clade that also includes the only other representative of the diprotodont order in this analysis, the wombat. Similarly, the two New World marsupial sequences in the analysis, from the Virginia and silky shrew opossums, form a clade for which I observe strong support.

There is no evidence in marsupials that any sites in this region of BRCA1 exon 11 are evolving more rapidly than predicted by neutral theory. None of the marsupial BRCA1 exon 11 sites in the alignment of eight marsupial species had posterior probabilities ≥ 0.5 of being under positive selection. The average and highest posterior probabilities reported were 0.1738 and 0.2272, respectively.

Conserved regions

Based on pairwise analysis, there is an average of 43.1% (± 0.78% SE) amino acid identity between marsupial and human BRCA1 exon 11 sequences. When homologous amino acid sites were labeled as fixed, weakly or strongly conservative, or nonconservative based on the alignment of eight marsupial and 37 eutherian ancestral sequences, 67 (7.95%) of the 843 amino acid sites are fixed and an additional 189 (22.4%) are conservative. When all eight marsupial sequences were aligned with 37 eutherian ancestral, chicken, and frog sequences only 21 fixed sites remain. Fixed and conservative residues in mammalian exon 11 are not randomly distributed across the sequence; most are associated with other fixed ($Z=8.27$, $P<0.001$) or conservative sites ($Z=3.86$, $P<0.001$).

Thirteen highly conserved regions were identified among the eight marsupial and 37 eutherian ancestral sequences ("mammal alignment" boxed in Figure 2.3) between human amino acids 282-1103 following the criteria Melissa and I developed earlier [35]. Five of these (#1,2,3,5,12) expanded six of the conserved regions previously identified in an alignment of 57 eutherian mammal sequences [35]. A seventh region conserved in the eutherian alignment, adjacent to region #1 from this analysis, was not conserved in marsupials. Seven of the highly conserved regions in the mammal alignment (#4 and 6-11) were between codons 501-786. When chicken and frog sequences were included ("three-class alignment"), five regions (#2,3,5,12,13) were conserved among all three classes at ≥ 60% (shaded in Figure 2.3).

To determine the percent conservation levels not likely to occur by chance among the various amino acid sequences, I calculated the mean ± SD for the percent of fixed and conservative sites in each five amino acid window across the alignments. For the mammal alignment, the mean ± SD percent conservation is 30 ± 25%, supporting the selection of an ≥ 80 percent conservation criterion to define highly conserved regions in mammals (Figure 2.3). In the three-class alignment, the percent conservation is 13 ± 20% which includes five highly conserved regions previously identified using the ≥ 60% criterion (Figure 2.4). The remaining eight regions (#1, 4, 6, 7, 8, 9, 10 and 11) are also conserved to varying degrees in the chicken and frog sequences (Figure 2.4 b, c). Regions #4 and 11 are highly conserved in the chicken (21 ± 23%) but not the frog sequences (16 ± 22%), region #9 is conserved in the frog but not chicken sequences, and regions #1 and 10 are conserved in both, leaving conservation in three regions that may be considered mammal-specific (#6, 7 and 8; Figure 2.4 a-c).

To determine if eutherian mammals have lost any regions that are conserved among marsupials, chicken, and frog sequences, I calculated the mean ± SD in an alignment of eight marsupial sequences and frog and chicken sequences ("non-eutherian alignment"; Figure 2.4 d). The mean ± SD was 22 ± 25%, and I identified three additional conserved regions among the non-eutherian sequences (underlined in Figure 2.3).

Missense changes

To test the hypothesis that missense changes occurring at evolutionarily important sites are likely to affect the function of the protein, I looked at human missense changes reported in the BIC. There are 130 missense changes at 118 sites reported in the BIC database between amino acids 282 and 1103. Missense changes were designated conservative or nonconservative based on their effects in the human sequence. The missense changes are randomly distributed across the alignment of 45 mammalian sequences (χ^2=1.5, d.f. = 1, p>0.1). There is no difference in the distribution of conservative and nonconservative missense changes relative to fixed, conservative, or nonconservative sites (χ^2=1.03, d.f. = 1, p>0.1).

The distribution of missense changes was compared to that of fixed and conservative amino acid sites. Changes predicted to affect protein function were either 1) nonconservative missense changes at fixed or conservative sites or 2) conservative missense changes at fixed sites. Based on levels of site conservation in marsupials and eutherian ancestral sequences, 21 of the 130-missense changes are predicted to affect function (red in Figure 2.3). Eleven occur at ten sites that are fixed in the mammal sequences [35]. Three of the eleven are also at fixed sites in frog and chicken. The remaining ten are nonconservative changes that occur in sites that are conservative in mammals. Thirteen missense changes predicted to affect function in Fleming *et al.* [35] occur at sites that are not as well conserved in the marsupial sequences and thus are no longer predicted to be deleterious.

Half of the missense changes (11 of 21) predicted to affect function occur in highly conserved regions in the mammal alignment, and seven occur in highly conserved regions in the three-class alignment with four missense changes in region #3 alone (Figure 2.3). Another three changes occur in regions newly identified in this analysis (#4 and 11) that were also conserved in chicken but not frog (Figures 2.3, 2.4). Region #4 overlaps a nuclear localization site (NLS), and the eleventh missense change in a highly conserved region predicted to affect function occurs in region #8, which overlaps a second NLS that is conserved in mammals but not in chicken or frog (Figures 2.3 and 2.4). One missense change predicted to affect function occurs in at a fixed site in a region that is well conserved in non-eutherians, but not eutherian mammals.

Discussion

The addition of eight marsupial BRCA1 sequences to the 37 eutherian ancestral BRCA1 sequences [35] reduced the number of missense changes predicted to affect function due to changes in site conservation between human amino acids 282-1103 from 34 to 21 and expanded six highly conserved regions. Eleven additional conserved regions were identified: two conserved in all three classes, one in mammals and frog, two in mammals and chicken, three in non-eutherian species, and three only in mammals. Positively selected sites in BRCA1 exon 11 have been identified in previous studies using eutherian mammals [35 , 50]. Melissa and I [35] found three positively selected sites in the RAD51-interaction domain in eutherian BRCA1, but none was identified in marsupial BRCA1. This suggests that the RAD51 domain may serve a unique function in eutherians that has benefited from diversifying or relaxed selection of amino acids at specific sites.

The eutherian ancestral sequences allowed us to detect other highly conserved regions in mammals than those previously identified in the 57 eutherian sequences by eliminating substitutions that arose independently in single species and thus could not be distinguished from sequencing errors or species-specific neutral polymorphisms. Thirteen conserved regions were identified among eight marsupials and 37 eutherian ancestral exon 11 sequences, compared to the seven found among 57 eutherian sequences between amino acids 282-1103 [35]. Eight of the 13 were not identified in the eutherian alignment; however, all but one of the seven eutherian conserved regions are conserved in the mammal alignment. The addition of marsupials to the analysis does not change the five regions of conservation across eutherian mammals, birds, and amphibians [35] confirming the probable functional significance of these regions in all three classes.

Four (#1,2,3,5) of the eight regions conserved in all three classes (Figure 2.3) occur in the 5' portion of the sequence (amino acids 282-553) which overlaps several protein-interaction domains hypothesized to be involved in transcription (reviewed in [129]). Nine missense changes (six within these conserved regions) predicted to affect function also occur in this portion of exon 11. Amino acids in the 5' portion of the sequence may be more conserved due to the density of interaction domains. Another two conserved regions in the three-class alignment and five missense changes (one in a conserved region) predicted to affect function occur in the RAD51-interaction domain, which is implicated in double-strand break repair.

The putative STAT1 interaction domain (a.a. 502-802)[85] overlaps seven of the highly conserved regions in the mammal alignment not previously identified [35](4 and 6-11), which include the mammal-specific regions, and nine of the missense changes predicted to affect function. STAT1 is a member of a family of signal transducers and transcriptional activators and is required for response to interferon gamma which is involved in innate and adaptive immune response (reviewed in [11, 104]). Work in breast cancer cell lines demonstrates that STAT1 is required for interferon gamma mediated apoptosis [12, 120] and that BRCA1 sensitizes cells to interferon gamma mediated apoptosis [5]. Two of the conserved regions found in the non-eutherian alignment and three regions that were conserved in mammals and either frog or chicken also occur within the STAT1 interaction domain. This pattern of loss of regions highly conserved among some distantly related taxa but not others, is consistent with changes of function under different directional rather than disruptive (positive) selection pressures in the different classes and superorders. The concentration of apparently mammal-specific regions in the STAT1 interaction domain suggests that STAT1 may be important to mammary function and missense changes in this domain could be involved in breast cancer. Three missense changes, but only one predicted to affect function (R612G), are found in two of these mammal-specific regions (#6 and 8).

Regions 4 and 8 also perfectly overlap the two BRCA1 nuclear localization signals (NLSs; a.a 500-508 and 609-615) and three missense changes predicted to affect function occur in these regions (R504C, R507I and R612G). Aberrant localization of BRCA1 has been found in breast cancer cell lines with NLS mutations suggesting that localization to the nucleus is important to normal function of the protein [18]. Though studies have yet to show that BRCA1 is found in the nucleus of any non-mammalian species, the RING domain could perform a nuclear localization function. In mammals BARD1 interacts with the RING domain of BRCA1 and explains nuclear localization of BRCA1 exon 11 splice variants [31]. Efficient localization of BRCA1 to the nucleus through NLSs may be required for normal function in mammals; therefore mutations at these sites are likely to be associated with breast cancers and merit further examination.

Combined with functional and structural data, comparative analyses of proteins can provide an important resource for identifying functionally important regions of incompletely characterized proteins, like BRCA1. The inclusion of divergent marsupial mammal sequences reduced the number of missense changes predicted to affect function by almost 40% indicating a probable improvement over the predictions made in Chapter 1. Half of the missense chances predicted to affect function in this study occur in identified conserved regions, making them particularly good candidates for further studies of the relationship between missense changes and breast cancer. The remaining ten missense changes may have site-specific functions or occur in regions conserved under less stringent criteria. While this study shows that the STAT1 and NLS regions of BRCA1 exon 11 appear to be important to both mammalian and non-mammalian BRCA1 function, the sequencing of other exons in additional eutherian, marsupial, monotreme, and non-mammalian species may be useful for identifying other mammal-specific conserved regions and could be helpful in identifying regions evolving differently between mammals and non-mammals. While further evaluation is needed, the 21-missense changes prioritized for functional analyses will hopefully improve the efficiency of disease-associated BRCA1 mutational screening.

This work is published as: Ramirez, C.J., M.A. Fleming, G.K. Ostrander, J.D. Potter, E.A. Ostrander. 2004. Marsupial BRCA1: conserved regions in mammals and the potential effect of missense changes. *Oncogene* 23:1780-1788. [92]

Supporting research for comparative analysis methods in BRCA1

Since the publication of the work I describe in Chapters 1 and 2, comparative analysis methods have be used in several studies to predict the effect of missense changes found in BRCA1 sequences from individuals with breast cancer or a family history of breast cancer. For example, Abkevich et al. [3] found 314 distinct missense changes and eight indels in 20,000 full-length BRCA1 sequences from women screened by Myriad Genetic Laboratories. To determine the evolutionary conservation at an amino acid site in an alignment of human, chimpanzee, mouse, dog, chicken, frog, and pufferfish BRCA1 sequences, Avkevich et al. used the Grantham chemical difference

(GCD) matrix rather than a substitution matrix like the PAM Gonnet 250 matrix. In the Myriad dataset of unclassified missense changes, Abkevich et al. classified 40 missense changes as likely to be disease-associated because the changes occurred at fixed amino acid sites and an additional ten that occurred at conserved amino acid sites. Of the remaining missense changes, 92 were classified as probably neutral because the missense change was present in the alignment or occurred at a highly variable site. The average GCDs for the disease-associated and neutral predictions are similar to the average GCDs of known disease-associated and neutral variants, providing support for the predictions. Four missense changes in Avkevich et al. dataset overlap with the set of missense changes from the BRCA1 exon 11 alignments. I predicted that three of those would affect function, but one would not because the change occurred in the cow sequence. The use of the GCD matrix versus the PAM Gonnet 250 matrix does not appear to affect the predictions, while the diversity of the sequences is very important. Abkevich et al. [3] used highly divergent sequences and data from known deleterious missense changes to expand the Fleming et al. [35] and Ramirez et al. [92] analyses discussed in Chapters 1 and 2. As more BRCA1 full-length sequences are available the AS method will result in less false positives than the strict alignment method that current studies are forced to use due to limited numbers of full-length sequence.

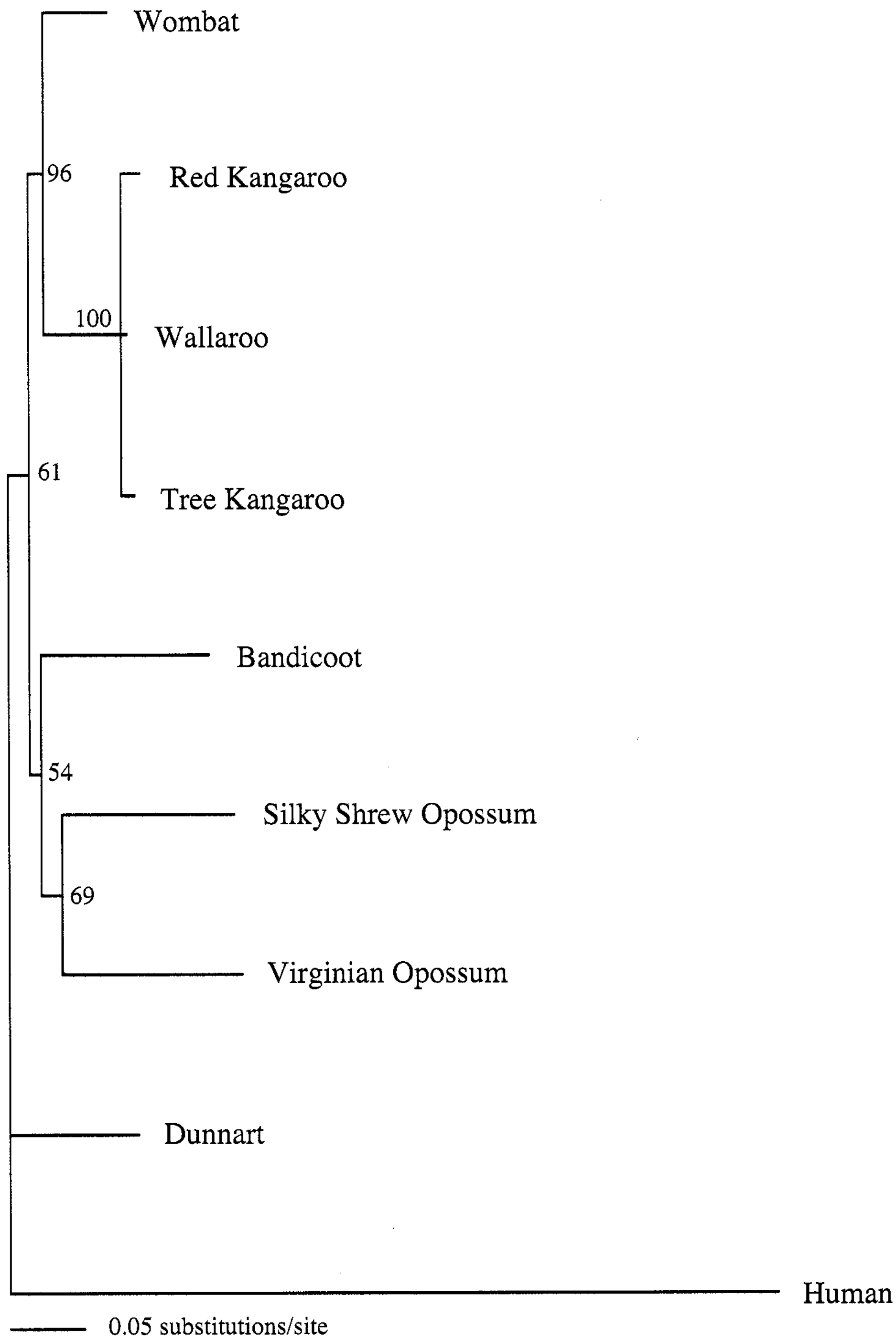


Figure 2.1 Maximum likelihood phylogenetic tree of 2,529 bp of *BRCA1* exon 11 marsupial sequences with the human sequence as the outgroup. The values adjacent to internal nodes represent the bootstrap support based on 500 trees. Nodes with no value have <50% bootstrap support and are collapsed.

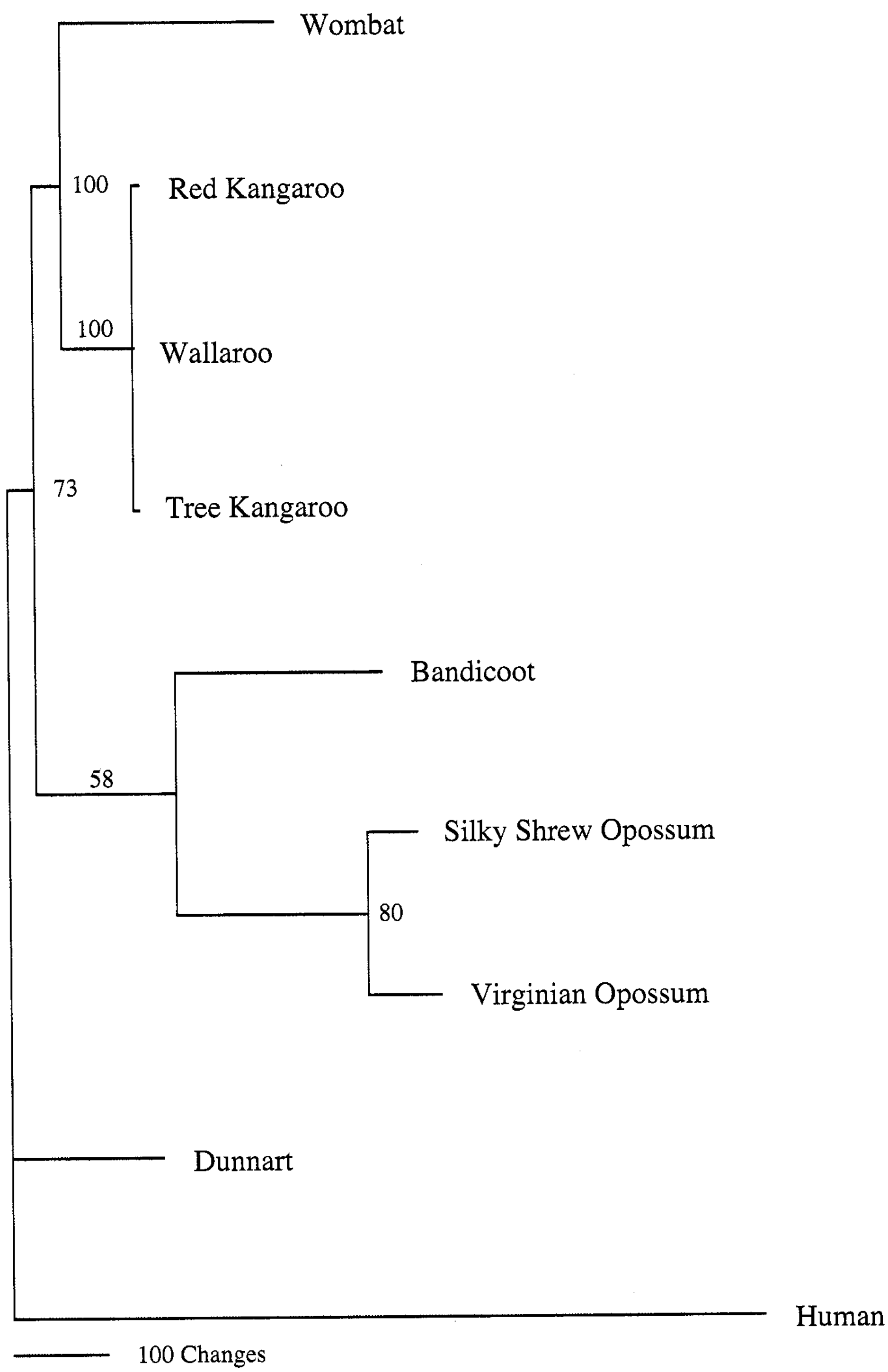
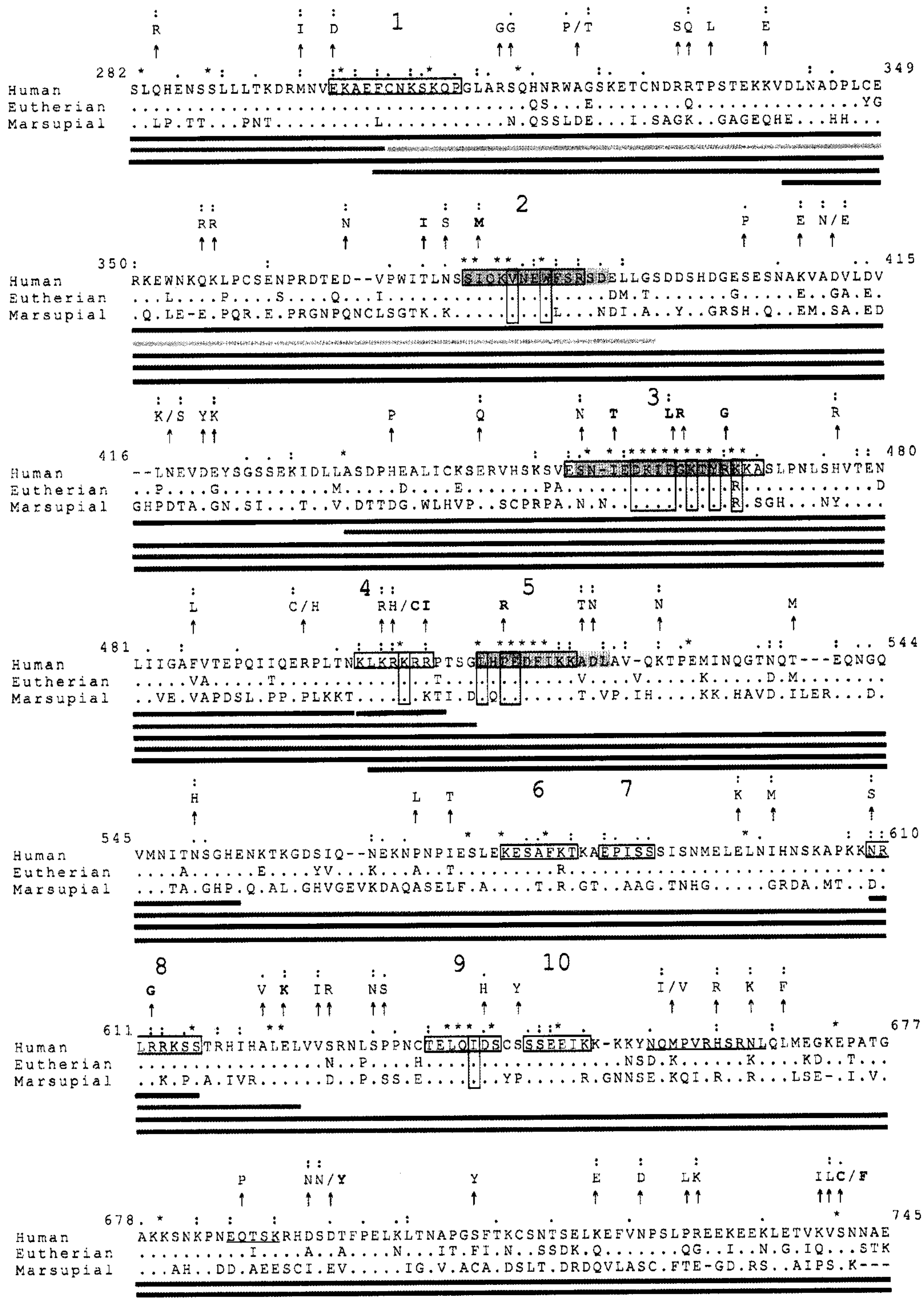


Figure 2.2 Bayesian phylogenetic tree of 2.529 bp of *BRCA1* exon 11 marsupial sequences with the human sequence as the outgroup. The values represent the posterior probability that the clade is reliable based on a consensus of 800 trees. Nodes with no value have <0.5 support and are collapsed.

Figure 2.3 Alignment of BRCA1 amino acids 282-1103 from human and the eutherian [35] and marsupial ancestors derived from Bayesian inference. Residues in the ancestor sequences identical to the human are represented by dots. Marks above the human residues represent identical (*), weakly conservative (.), and strongly conservative (:) sites in eight marsupial sequences and 37 eutherian ancestral sequences [35] based on the Gonnet PAM 250 matrix [40]. Boxed sites (vertical) represent amino acids that are fixed in 37 eutherian ancestral sequences, eight marsupial sequences, frog, and chicken sequences. In the human sequence, the shaded sequences show the five regions conserved ≥ 60% among 37 eutherian ancestral sequences, eight marsupial sequences, and frog and chicken sequences. Regions conserved among the eight marsupial and 37 eutherian ancestral sequences are outlined where conservation is ≥ 80% (numbered 1-13). Three regions conserved in marsupials, chicken and frog are underlined. Arrows above the human sequence show missense changes found in the BIC database. Marks above the missense change represent weakly (.) or strongly conserved (:) changes. The 21 changes in red are predicted to affect function. Colored lines below the alignment indicate the approximate locations of sites that have been identified as protein-interaction domains (reviewed in [129]: c-Myc (175-303 & 433-511) & p300/CBP (1-303) & estrogen receptor (1-300) ——, P53 (224-500) ——, SWI/SNF (260-553) ——, pRB (304-394) , VCP (303-625) ——, RAD 50 & ZBRK1(341-748) ——, STAT1 (502-802) ——, RAD 51 & Androgen receptor (758-1064) ——, and BRAP2 & Importin alpha (interact with NLS 500-508 & 609-615) ——.



282 SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQHNRWAGSKETCNDRRTPSTEKKVDLNADPLCE 349
Human
Eutherian
Marsupial
350 RKEWNKQKLPCSENPRDTED--VPWITLNSSIQKVNEWFSRSDELLGSDDSHDGESESNAKVADVLDV 415
416 --LNEVDEYSGSSEKIDLLASDPHEALICKSERVHSKSVESN-IEDKIFGKTYRKKASLPNLSHVTEN 480
481 LIIGAFVTEPQIIQERPLTNKLKRKRRPTSGLHPEDFIKKADLAV-QKTPEMINQGTNQT---EQNGQ 544
545 VMNITNSGHENKTKGDSIQ--NEKNPNPIESLEKESAFKTKAEPISSSISNMELELNIHNSKAPKKNR 610
611 LRRKSSTRHIHALELVVSRNLSPPNCTELQIDSCSSSEEIKK-KKYNQMPVRHSRNLQLMEGKEPATG 677
678 AKKSNKPNEQTSKRHDSDTFPELKLTNAPGSFTKCSNTSELKEFVNPSLPREEKEEKLETVKVSNNAE 745

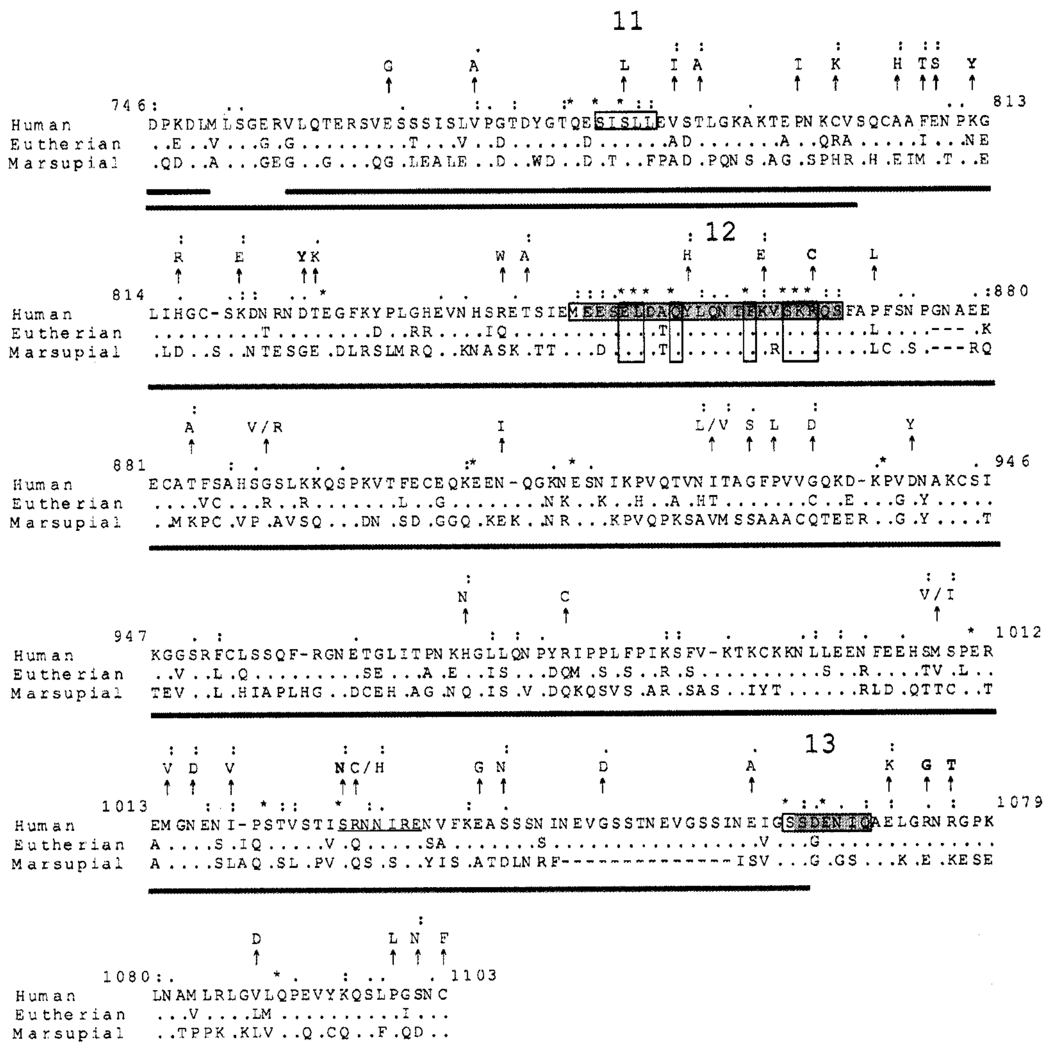


Figure 2.3 (continued)

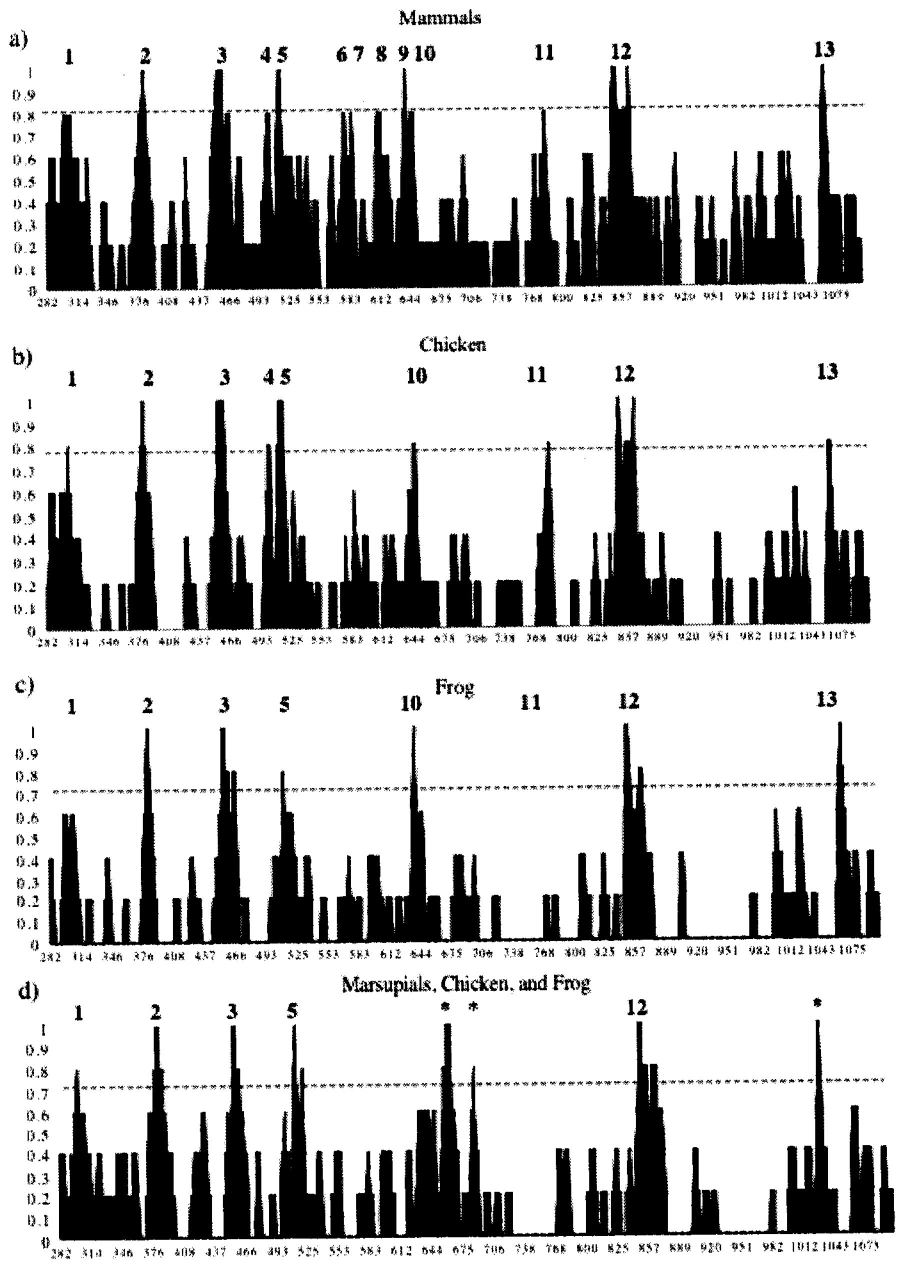


Figure 2.4 Results of sliding window analyses of the percent conservation across sites 282- 1103 of exon 11 within a sliding window of five amino acids for a) the alignment of 37 eutherian ancestral sequences and eight marsupial sequences, b) the alignment of the mammal and chicken sequences, c) the alignment of the mammal and frog sequences, and d) the alignment of the marsupial, frog, and chicken sequences. The dotted lines indicate the percent conservation that is two standard deviations above the mean value for each alignment. Values that exceed this line show a much higher percent conservation than would be expected by chance. Numbers above the lines indicate the approximate positions of highly conserved regions as defined by the criteria of Fleming *et al.* [35] and shown in Figure 1.

Table 2.1 Vertebrate clades used in this analysis and the dates of their last common ancestor with humans

Chordata	Mammalia	Eutheria - placentals Marsupalia - marsupials	5-130 Myr[a, b] 175 Myr
	Amniota	Aves - birds	310 Myr
	Tetrapoda	Anura - frogs	360 Myr

[a]approximate divergence dates relative to humans in million of years ago (31)

[b]eutherian dates given as a range from 57 species

Table 2.2 Information for BRCA1 sequences used in analyses

GenBank Accession Number	Mammalian Order	Species	Sequence Length (a.a.)	% AA identity with human	% AA Identity with marsupial ancestor	% AA identity with eutherian ancestor
AF284033	Diprotodontia	red kangaroo (*Macropus rufus*)	331	48.1	84.1	48.7
AY211953	Diprotodontia	red kangaroo (*Macropus rufus*)[a]	239	–	–	–
AY211954	Diprotodontia	tree kangaroo (*Dendrolagus matschiei*)	239	48.1	83.5	50.2
AY211955	Diprotodontia	wallaroo (*Macropus robustus*)	236	48.3	84.1	50.8
AF284031	Diprotodontia	coarse-haired wombat (*Vombatus ursinus*)	816	38.5	90.1	46.1
AF355795	Dasyuromorphia	brush-tailed phasogale (*Phascogale tapoatafa*)	792	40.0	80.3	43.2
AF355796	Peramelemophia	long-nosed bandicoot (*Echymipera kalubu*)	806	37.0	79.0	43.5
AY211956	Didelphimophia	Virginia opossum (*Didelphis virginiana*)	236	45.4	78.9	47.1
AF355794	Paucituberculata	silky shrew opossum (*Caenolestes fuliginosus*)	794	39.1	76.7	42.3
		Marsupial average:		**43.1 ±0.78**	**82.1±0.73**	**46.5±0.64**
U14680	Primate	human (*Homo sapiens*)	822	–	42.3	80.2
AF355273	—	chicken (*Gallus gallus*)	796[b]	21.1	24.9	23.3
AF416868	—	frog (*Xenopus laevi*)	627[b]	14.1	13.8	15.4

[a]Not used in analyses because 97.8% identical to longer red kangaroo sequence
[b]Exact length could not be determined because only small portions of these sequences could be aligned to the mammalian sequence

Chapter 3: Haplotype analysis of *BRCA2* in the Jewish population

Introduction

In Chapters 1 and 2 and in collaboration with Melissa Fleming, I developed a phylogenetic approach to identify regions of amino acid site conservation in BRCA1 exon 11 within mammal species. Currently there are no functional assays for missense changes in BRCA1 exon 11, and these likely disease-associated mutations have not been reported in large breast cancer families. In collaboration with Kathi Malone, the Ostrander Lab recently screened a large population of women with invasive breast cancer and controls with no incidence of breast cancer. In this chapter, I describe an analysis of the Contraceptive and Reproductive Experiences (CARE) case-control study [63] using the results of the evolutionary approach described in the preceding chapters.

In the largest population-based study to date of women ages 35-64 with breast cancer, Malone et al. [63] reported on the frequency and spectrum of *BRCA1* and *BRCA2* mutations. One thousand six hundred and twenty eight women with breast cancer and 674 women without breast cancer were screened for mutations in *BRCA1* and *BRCA2*. Previous to this study, case-control and family studies focused on younger Caucasian women and women with a family history of disease. Malone et al. [63] predicted that a large sample size, population-based design, wide age range, and inclusion of both African-American and Caucasian women would allow for a more complete depiction of the mutation frequency and spectrum within breast cancer cases in the general population than has been available from studies focused on high risk women.

In addition to analyzing missense changes likely to affect function in the complete dataset of CARE cases and controls, previous results identifying BRCA founder mutations in Ashkenazi Jewish women prompted me to focus on the Jewish subset of women in the CARE study. Missense changes in BRCA1 and BRCA2 are likely to be rare or weakly penetrant, and founder mutations have been identified in

Ashkenazi Jewish BRCA genes. Within the Caucasian set of women, the CARE study includes 101 individuals self-identified as Jewish. Approximately 90% of Jews in the United States are of Ashkenazi origin; therefore, all or nearly all of the Jewish women in the CARE dataset are likely to be of Ashkenazi Jewish descent [84].

The Ashkenazi Jewish population split from other Jewish populations approximated 2,000 years ago [73, 84]. During this time the Ashkenazi Jewish population remained reproductively isolated, which allowed the frequency of mutations previously present at low frequency within the Jewish population to increase in the smaller Ashkenazi population. Previous studies identified two *BRCA1* (185delAG and 5382insC) and one *BRCA2* (6174delT) mutation associated with breast and ovarian cancer in Ashkenazi Jews [22, 34, 74, 82, 109, 122]. Using a cohort of 5,318 Jewish individuals, Struewing et al. [110] determined the population frequency of these three mutations in the Jewish population in the Washington, D.C. area. The individuals were recruited from the general public without regard to cancer history and asked to complete a questionnaire, which included questions about their history of breast and ovarian cancer and their family's breast-ovarian cancer history. All individuals were genotyped for the three primary mutations, and approximately 2.3% carried one of the mutations. This study remains the largest population frequency study of these mutations in Jewish individuals unselected for cancer history. The New York Breast Cancer Study [53] also screened for the three founder mutations in Ashkenazi Jewish women. The New York cohort consisted of 1,008 index cases without regard to family history of breast and ovarian cancer. New York Breast Cancer Study found that 10.3% of the women had one of the three mutations. The high frequency of founder mutations in the New York cohort reflects the use of cases rather than individuals unselected from the population. Diez et al. [26] also identified the 185delAG BRCA1 mutation in Sephardic Jews on the same haplotype as the Ashkenazi deletion suggesting that the mutation originated in the Jewish population before the divergence of the two populations 2,000 years ago. The Sephardic population settled primarily in Spain and Portugal and has given rise to the Iraqi and

North African populations [73, 84]. In the United States, Sephardic Jews account for less than 10% of the Jewish population [84].

While the three primary Ashkenazi Jewish mutations have a frequency of more than 2% in the Ashkenazi Jewish population [81, 95, 109, 110], they do not account for all BRCA1- and BRCA2-linked breast cancer cases in Jewish women. In one study, Frank et al. [37] analyzed BRCA1 and BRCA2 in 10,000 individuals more than 90% of which were Caucasian. Within the cohort, 2,233 individuals had confirmed Ashkenazi Jewish ancestry. The three primary mutations were sequenced in 1,656 samples, and BRCA1/2 direct sequencing was performed on the remaining 577 samples and the 322 samples without a primary mutation. Over 60% (1392/2233) of these women had one of the three primary mutations. Frank et al. also identified 16 non-founder deleterious mutations and several missense changes of unknown significance. These results emphasize the importance of complete BRCA1 and BRCA2 mutational screening in Jewish women without one of the three primary Ashkenazi Jewish BRCA1 and BRCA2 mutations.

To identify missense changes likely to affect function, I aligned full-length BRCA1 and BRCA2 sequences from all species for which sequence was available. Missense changes were categorized based on amino acid site conservation and odds ratios were determined for missense changes predicted to be disease-associated. To identify founder-missense changes, I analyzed missense changes found in a sub-set of women in the CARE study that self-identified as Jewish and did not have an Ashkenazi Jewish founder mutation or any other mutation known to be disease-associated.

Methods

CARE Study population

This study was conducted within the NICHD Women's Contraceptive and Reproductive Experiences (CARE) population-based case-control study [1, 63]. The Cases were 4,575 Caucasian and African-American women aged 35-64 years that had been newly diagnosed with a primary invasive breast cancer. Four-thousand six hundred and eight-two control women without breast cancer were obtained using centralized random digit dialing and matched to case interview frequencies within strata of study center, race, and age group. A total of 9,257 women were interviewed. Interviews included questions on known breast cancer risk factors and family history of cancer.

Funding allowed collection of blood from 33% of all interviewed women. A stratified sampling scheme was used for blood collection in which all cases and controls with a first-degree family history of breast cancer plus a random sample of the remaining women without a first-degree family history were asked to donate a blood sample. One thousand six hundred and forty-four cases and 1,451 controls provided a sample, but only 1,628 case samples and 674 control samples had valid results in one or both genes.

Statistical analysis

Proportions of mutation carriers and 95% confidence intervals were calculated among cases and controls in the study and stratified according to their age at onset of disease, race, and family history of breast or ovarian cancer. All analyses were weighted to correct for sampling from a larger population dataset. Details of the statistical analysis can be found in Malone et al. [63].

Alignments

Sequences for human (*Homo sapiens*), dog (*Canis familiaris*), cow (*Bos taurus*), and mouse (*Mus musculus*) were obtained from the UCSC Genome Browser, cat sequence (*Felis catus;* AB107955) was obtained from GenBank, and opossum sequences (*Monodelphis domestica*) were obtained from The Broad Institute. Full-length BRCA1 amino acid sequences from human, dog, cow, and mouse were aligned using the ClustalX alignment program (Appendix F) and sites were categorized as conservative or nonconservative as described in Chapters 1 and 2. A separate alignment included the opossum BRCA1 sequence (Appendix G). Two BRCA2 alignments were made using full-length sequence from human, dog, cat, and mouse and human, dog, cat, mouse, and opossum (Appendices H, I).

Missense Changes

Missense changes identified in the CARE study were designated conservative or nonconservative changes based on the Gonnet Pam 250 matrix. Non-conservative missense changes that occurred at fixed or conservative amino acid sites based on their respective alignments were predicted to affect function, and grouped (1. full-length BRCA1, 2. BRCA1 exon 11, and 3. full-length BRCA2) to increase the number of individuals analyzed. Statistical methods are described in detail above. The groups of likely disease-associated mutations from each alignment were analyzed separately and the odds ratios and 95% confidence intervals were determined for each group. Initially the dataset was not stratified. Subsequently, the data was stratified by age at disease onset, ethnicity, and family history in a second analysis.

Population Frequency Analysis

Larry Brody's lab at the National Institutes of Health (NIH) genotyped the BRCA2 P655R missense change in 315 Jewish men and women previously screened for Tay-Sachs disease or other genetic diseases common in the Jewish population. I evaluated whether the population frequency of P655R in Ashkenazi versus Sephardic Jewish populations were different using the chi-square test with correction for continuity ($P \leq 0.05$) [101].

Also in collaboration with Larry Brody (NIH) we sequenced P655R in 1,000 arbitrarily chosen individuals from a previous dataset of 5,318 Jewish men and women from the Washington, D.C. area. While they were not selected based on cancer status or a family history of cancer, the individuals voluntarily participated knowing they were participating in a BRCA genotyping study. A full description of the population study group is described in [110]. Follow up information on cancer status is not available for these individuals, but they were asked to complete a survey upon participation in the study, which inquired about their history and their family history of breast and ovarian cancers [110].

Haplotype Analysis

SNPs were obtained from the International HapMap Project Database (www.hapmap.org). I used the program Haploview [9] to identify a twelve SNP haplotype block surrounding a 500 kb region of *BRCA2*. Primer sequences and PCR conditions are listed in Table 3.2. Primers were developed using Primer3 (http://frodo.wi.mit.edu/cgi-bin/primer3/primer3_www.cgi). Amplification was carried out in 10.0 μl reactions with 6.0 ng of template DNA, 0.1 μM of forward and reverse primers, 1.0 mM each of dNTPs, 1.5 mM MgCl2 or 2.5 mM $MgCl_2$, and 2.5 U of Taq DNA Polymerase (Roche, Indianapolis, IN). Touchdown reactions started with an initial denature of 95°C for 1 minute followed by 7 cycles of 96°C for 20 seconds, 70-64, 68-62, 66-60, or 66-58 (dropping 1°C each cycle) for 20 seconds, and 72°C for 45 seconds, then 28 cycles of 96°C for 30 seconds, final annealing temperature of the touchdown for 30 seconds, and 72°C for 45 seconds. Samples were quantified and sequenced as described in Chapter 2. Haplotypes were determined using the program PHASE [106, 107].

Results

CARE Results

Within the 1,628 cases and 674 controls in the CARE study, we observed known disease-associated *BRCA1* mutations in 2.4% of cases and .04% of controls, and 2.2% of cases and 0.4% of controls for *BRCA2*. Combined, *BRCA* mutations were identified in 4.6% of cases and 0.4% of controls. In this study there are 68 unique disease-associated mutations and 207 unclassified missense changes and inframe deletions or insertions (indels) [63]. The occurrences of each of the missense change and indel variants were too small in the sample set to identify variants that occurred significantly more often in cases than controls (Table 3.1).

Five-percent of the study participants self-identified as Jewish (84 cases; 36 controls). We observed the 185delAG in 12 cases (seven of whom reported Jewish religion), the 5382insC in eight cases (three of whom reported Jewish religion), and the 6174delT in two cases (both reported Jewish religion). We also noted the 6174delT in one control that reported her religion as Jewish. Overall, ten percent of the Jewish cases carried a *BRCA1* mutation and one percent carried a *BRCA2* mutation.

Missense Changes Predicted to be Disease-Associated

I identified six groups of missense changes likely to affect function (Table 3.3 a, b, c). Only non-conservative changes at conserved or fixed sites were predicted to affect function because the five eutherian sequences from which full-length protein sequence was available did not provide comprehensive coverage of eutherian mammal diversity. I used the alignment of 36 eutherian ancestral sequences from my previous analysis of BRCA1 exon 11 to classify missense changes in exon 11 separately. Non-conservative missense changes at sites that are conserved or fixed in all 36 ancestral sequences are highly likely to be disease-associated. If a group contains missense changes that are truly disease-associated, more CARE cases than controls should have these missense changes despite their low frequency overall. Based on the BRCA1 eutherian alignment, 17 nonconservative missense changes occurred in amino acid sites considered conserved by the Gonnet Pam 250 matrix (Tables 3.3 a, b) whereas 14 nonconservative missense changes occurred based on the mammalian alignment and seven with the exon 11 alignment. Based on the BRCA2 eutherian and mammalian alignments, 31 and 14 nonconservative missense changes, respectively, occurred in conservative sites (Table 3.3 c). However, none of the groups of missense changes was significantly associated with cases more often than controls when the data were stratified by age at onset of disease or family history of breast cancer.

When the data were stratified by ethnicity, a proline to arginine change at amino acid site 655 (P655R) of BRCA2 occurred in six self-identified Caucasian-non-Hispanic Jewish cases. A proline in an amino acid sequence results in a structural change from a beta-sheet to an alpha-helix or vice versa. The substitution of an arginine, which has a long side chain, for a proline, which causes a "bend", is likely to cause a disruption in the protein structure. P655R was found in six out of 84 Jewish cases but not in any of the 36 Jewish controls. This variant was not identified in any other women in the dataset and all individuals with P655R also have the IVS26+84G/A intron variant. Additionally, IVS26+84G/A occurred in one Caucasian case that did not self-identify as belonging to the Jewish religion. Because neither of these variants occurred in controls, an odds ratio could not be determined. None of the groups of missense changes were statistically associated with cases in self-identified African Americans or non-Jewish Caucasians.

Jewish Population Frequency of P655R

To compare the frequency of P655R in the CARE study to the frequency in the general Jewish population, I genotyped Ashkenazi and Sephardic Jewish individuals unselected for breast cancer history. In collaboration with Larry Brody at the National Institute of Health, P655R was genotyped in a Jewish population dataset of 315 individuals (Table 3.4). Two hundred-eighteen Ashkenazi Jewish individuals were homozygous for the common allele, seven heterozygous, and two homozygous for P655R. Out of 88 Sephardic Jews, 86 individuals were homozygous for the common allele, two were heterozygous, and none were homozygous for P655R. The population frequencies are 0.024 within Ashkenazi Jews, 0.014 within Sephardic Jews. Neither frequency is significantly different (χ^2=1.4, d.f. = 1, p>0.1) from the frequency in the overall Jewish dataset (0.021).

Jewish P655R Haplotype

Mutations within a reproductively isolated population are often associated with a population-specific haplotype. To identify a Jewish haplotype associated with the P655R variant, six Jewish cases with the P655R missense change, one non-Jewish case without P655R but with IVS26+86G/A, and eight Jewish controls without the P655R missense change were genotyped for 12 SNPs. The SNPs are located in a 500-Mb region of human chromosome 13 surrounding and within the BRCA2 gene. The program PHASE predicted 17 haplotypes with haplotype 16 specific to five of the six Jewish individuals in the CARE dataset (Figure 3.1). One individual (2060) is predicted to have haplotype 17 instead of 16. Haplotypes 16 and 17 differ at SNP 11 (Figure 3.1), but PHASE predicted the phase at SNP 11 in individual 2060 with only a 0.59 probability.

Discussion

Missense Changes Predicted to be Disease-Associated

One reason for the lack of significant odds ratios for missense changes in the CARE study is that the groups of likely disease-associated mutations are a mixture of highly penetrant mutations, weakly penetrant mutations, and neutral polymorphisms. If disease-associated missense changes are weakly penetrant, the large number of neutral polymorphisms will dilute the evidence for a disease-associated mutation. To reduce the number of neutral polymorphisms, I analyzed a the Caucasian, Jewish sub-set of the CARE dataset. The CARE dataset was over-sampled for African American women. The African American women had more BRCA polymorphisms than the Caucasian women[63]; these variants are unlikely to be disease-associated.

Population specific mutations in *BRCA1* and *BRCA2* have been identified in Ashkenazi Jewish families with breast cancer, which prompted me to focus on the Jewish subset of the CARE study. The BRCA2 P655R variant is interesting because it occurred in six self-identified Jewish cases and none of the 36 Jewish controls. It was not identified in any other women in the dataset and was always found with the IVS26+84G/A intron variant. While IVS26+84G/A is not reported in the BIC, P655R is reported 107 times in Ashkenazi Jewish breast cancer cases without any other deleterious mutation and once in a woman with a deleterious mutation in BRCA2 (Lawrence Brody, personal communication). P655R appears to occur at a higher frequency in Ashkenazi Jewish individuals with breast cancer than in non-Ashkenazi Jewish with breast cancer.

Jewish Population Frequency of P655R

In a set of Jewish individuals unselected for breast cancer history, P655R occurred at a frequency of 2.1%. The presence of homozygotes in the population makes P655R likely to be weakly penetrant if at all disease causing because BRCA2-null mice die early in embryogenesis [41]. The BRCA1 185delAG and BRCA2 6174delT mutations occur on an Ashkenazi-specific haplotype at frequencies of about 1%. The Ashkenazi haplotypes have not been identified in individuals of non-Ashkenazi Jewish ancestry except for in two Sephardic Jewish women [26]. The BRCA1 5382insC mutation is also commonly associated with breast cancer in Ashkenazi Jewish women but occurs at a frequency of approximately 0.5% and is not limited to Ashkenazi Jewish ancestry. P655R is the first variant in the *BRCA* genes to occur in both Ashkenazi and Sephardic Jews at a high frequency (2% and 1% respectively) and is likely to be an ancient variant that first occurred in the Jewish population over 1000 years ago when the Ashkenazi and Sephardic populations split.

Within the Jewish subset of the CARE study, P655R occurs at a frequency of 2.5%, which is slightly higher than the 2.1% described above. In a separate population of 1,000 Jewish individuals from the Washington, D.C. area, P655R occurs at a population frequency of approximately 5%. Individuals in the D.C. population are more likely to have a breast or ovarian cancer history than the general Jewish population because the individuals' participation was voluntary, which could explain the high frequency of P655R. Information regarding cancer history in the D.C. individuals will become available after SNP genotyping on chromosome 13 is completed.

Jewish P655R Haplotypes

Extending the haplotype surrounding P655R would allow me to determine the age of the variant. The Ostrander Lab is in the process of sequencing eight more SNPs surrounding a 1-Mb region of BRCA2 in the Jewish cases and controls from the CARE study to determine the extent of the haplotype, and to determine whether sample 2060 has haplotype 16 or 17. Larry Brody's lab is sequencing the IVS26+84G/A intron variant in 1,315 Jewish individuals. If the individuals with the P655R variant also have the IVS26+84G/A variant, they are likely to have the same haplotype as the six cases in the CARE study. If not, there is more than one haplotype in the Jewish population. One haplotype may be in linkage disequilibrium with an unknown disease-associated mutation while the other is not. After a P655R haplotype has been established in the six women from the CARE study, SNP sequencing will be done in the additional Jewish individuals with P655R (Table 3.3) to determine if they have the same haplotype, the age of the haplotype [93, 94], and whether it can be associated with breast cancer incidence. While P655R may not cause breast cancer, it may be a useful marker for breast cancer in Jewish women.

Conclusions

In this analysis, I was able to identify a single missense change from a set of 207 BRCA missense changes and indels that appears to be segregating with breast cancer in Jewish individuals. While I may have missed some disease-associated variants, the high incident of variants in the CARE controls suggests that many of the missense changes and indels are neutral or weakly penetrant polymorphisms. While neither case-control studies nor comparative analyses alone are likely to resolve the status of all BRCA missense changes, combined, these methods can elucidate disease-associated variants that would otherwise be hidden within the more common neutral variants.

This work is under preparation for publication.

Haplotype

1	212211111111	2
2	212211111112	1
3	212211111221	1
4	212211112112	1
5	212212112221	2
6	212212211221	1
7	212212212221	1
8	211111211111	1
9	211112211111	1
10	2222111111**1**2	3
11	222211121111	1
12	111111111111	2
13	111111111112	1
14	111112111112	4
15	111112211112	2
16	111121121111	5
17	1111211211**2**1	1
Total chromosomes		30

Individual Haplotypes

	2919: (1,5)
	2929: (5,6)
	2939: (2,7)
	2953: (8,10)
	2978: (13,14)
	3002: (14,15)
	3032: (12,14)
	3109: (14,15)
cases	973: (4,16)
cases	1127: (1,16)
cases	2060: (10,17)
cases	2256: (3,16)
cases	2350: (10,16)
cases	2515: (9,16)
WNJ case	1073: (11,12)

Figure 3.1 Seventeen haplotypes predicted by the PHASE program for 30 Jewish chromosomes
The 17 predicted haplotypes are in the box on the left. A '1' represents the higher frequency SNP and a '2' represents the lower frequency SNP. The number of times the haplotype occurred in the 30 chromosomes is listed in the last row. In the box on the right sample numbers for eight Jewish controls, six Jewish cases with the P655R and IVS26+84G/A variants boxed in red), and one non-Jewish White (NJW) case with the IVS26+84G/A variant, but not the P655R variant are listed with their predicted haplotypes in parenthesis. Haplotype 16 is common to five out of the six Jewish cases. The eleventh SNPs in haplotypes 10 and 17 are highlighted in red because sample 2060 (a Jewish case) is predicted to have these haplotypes. Haplotype 17 varies from haplotype 16 at the eleventh site.

Table 3.1 Missense changes and indels found in the CARE study and their frequencies

Table 3.1 a. BRCA1

Mutation	Occurrences[1]	Frequency[1]
A1708V	1	0.002
A622V	1	0.002
C1372Y	1	0.002
D1344G	1	0.002
D214G	1	0.002
D232N	1	0.002
D369N	1	0.002
D695Y	1	0.002
E1071K	1	0.002
E1250K	1	0.002
E597K	1	0.002
F461L	1	0.002
F486L	1	0.002
G1201S	1	0.002
H239Q	1	0.002
H476R	4	0.007
I1824N	1	0.002
I379M	2	0.004
I925L	1	0.002
I925V	1	0.002
K1109N	1	0.002
K339E	1	0.002
K739E	1	0.002
K820E	40	0.071
L1564P	4	0.007
L246V	1	0.002
M1008I	4	0.007
M1008V	6	0.011
M1628T	2	0.004
M1652I	48	0.085
M1689R	1	0.002
M1783T	3	0.005
M658I	1	0.002
M658V	1	0.002
N1236K	1	0.002
N550H	1	0.002
N723D	3	0.005
N810Y	1	0.002
P1238L	2	0.004
P142H	1	0.002
P1491T	1	0.002
P1502L	1	0.002

Table 3.1 b. (continued)

Mutation	Occurrences[1]	Frequency[1]
D596H	4	0.004
D806H	1	0.001
D935N	6	0.007
D946G	1	0.001
E1250G	1	0.001
E1382del	1	0.001
E1879K	2	0.002
E1928K	1	0.001
E238Q	1	0.001
E2571G	1	0.001
E2856A	13	0.015
E394A	1	0.001
E462G	1	0.001
E674G	1	0.001
E808D	1	0.001
F1524V	1	0.001
F2058Y	1	0.001
G2274V	2	0.002
G2748S	1	0.001
G2816D	1	0.001
G3212R	3	0.003
H1561N	14	0.016
H2074N	8	0.009
H2116R	12	0.013
H2440R	31	0.035
I1364L	4	0.004
I1583V	1	0.001
I1724V	1	0.001
I2285V	1	0.001
I2490T	19	0.021
I3363V	2	0.002
I3412V	149	0.168
I449T	1	0.001
I505T	7	0.008
K115E	1	0.001
K1286del	3	0.003
K1690N	1	0.001
K2008N	1	0.001
K2339N	21	0.024
K2950N	2	0.002
K3257R	1	0.001
K607T	1	0.001

Table 3.1 a. (continued)

Mutation	Occurrences[1]	Frequency[1]
P1614S	2	0.004
P514R	1	0.002
Q1200H	7	0.012
Q1331H	1	0.002
Q1395R	1	0.002
Q1537R	1	0.002
Q356R	195	0.345
Q804H	1	0.002
R1203Q	1	0.002
R1347G	24	0.042
R1645T	2	0.004
R1699W	1	0.002
R496C	1	0.002
R496H	4	0.007
R504H	1	0.002
R841W	8	0.014
R866C	1	0.002
S1040N	68	0.120
S1101N	1	0.002
S1140G	55	0.097
S1512I	8	0.014
S1542C	1	0.002
S1613C	1	0.002
S186Y	14	0.025
S308G	1	0.002
S316G	1	0.002
S616del	1	0.002
S784L	1	0.002
S844N	1	0.002
T1561I	2	0.004
T1720A	1	0.002
T826K	2	0.004
V1116L	1	0.002
V1181I	1	0.002
V1534M	2	0.004
V162L	1	0.002
Y130F	1	0.002
Y179C	1	0.002
Total :	566	

Table 3.1 b. (continued)

Mutation	Occurrences[1]	Frequency[1]
K960N	1	0.001
L1019V	1	0.001
L1357R	1	0.001
L1904V	2	0.002
L2106P	1	0.001
L2587F	1	0.001
L3135F	1	0.001
L929S	10	0.011
M3118T	1	0.001
N108H	1	0.001
N1758del	1	0.001
N1880K	12	0.013
N2348H	1	0.001
N289H	139	0.156
N319T	1	0.001
N56T	1	0.001
N900D	1	0.001
N987I	6	0.007
N991D	160	0.180
P2187L	1	0.001
P3280S	1	0.001
P59A	6	0.007
P655R	6	0.007
Q1396R	5	0.006
Q1452R	1	0.001
Q1509H	1	0.001
Q2384K	7	0.008
Q2561R	1	0.001
Q347R	4	0.004
Q713L	1	0.001
Q853R	1	0.001
R2034C	19	0.021
R2108C	1	0.001
R2108H	14	0.016
R2336H	1	0.001
R2502C	4	0.004
R2502L	1	0.001
S1733F	4	0.004
S2247G	1	0.001
S270A	1	0.001

Table 3.1 Table b. BRCA2

Mutation	Occurrences[1]	Frequency[1]
A1586T	1	0.001
A2466V	91	0.102
A248T	2	0.002
A2717S	18	0.020
A3029T	1	0.001
A487E	3	0.003
A565V	2	0.002
A938E	1	0.001
C1290Y	19	0.021
C1573R	1	0.001
C1573Y	1	0.001
C1960Y	1	0.001
C2473Y	2	0.002
C341R	1	0.001
D1280V	1	0.001
D1420Y	30	0.034
D156G	1	0.001
D1902N	25	0.028
D1923A	2	0.002
D2238del	1	0.001
D2665G	2	0.002
D3272E	1	0.001

[1]Within the CARE study population [63]

Table 3.1 b. (continued)

Mutation	Occurrences[1]	Frequency[1]
S2807L	1	0.001
S2835P	3	0.003
S326R	6	0.007
S384F	4	0.004
S581P	1	0.001
S976I	6	0.007
T1414M	11	0.012
T1915M	104	0.117
T1974N	1	0.001
T1980P	1	0.001
T3013I	1	0.001
T3374I	4	0.004
T3401M	1	0.001
T598A	5	0.006
T768I	1	0.001
T774A	1	0.001
V145del	1	0.001
V2138F	17	0.019
V2728I	17	0.019
V3079I	4	0.004
V3081A	1	0.001
V3244I	21	0.024
Y42C	7	0.008
Total:	889	

Table 3.2 SNP info from HapMap, primer pairs and conditions

HapMap SNP	Primer Name	Primers	Anneal Temp. (°C)	MgCl2 Conc. (mM)	UCSC May 2004 position
rs2025416	rs2025416_F	TCAGCCAGCCTTGTTTTACC	62	2.5	31720435
	rs2025416_R	AGTTTCTGCTTTGGGGGTTC			
rs983130	rs983130_F	CAACCAAGAGCTGCTTATTTGAT	60	1.5	31720975
	rs983130_R	TGGTCCTCACTGACCTTTCA			
rs2157961	rs2157961_F	CGGTGCTATGAAGAGCCAAT	60	1.5	31726553
	rs2157961_R	ATTTGGCTGCTCCAGTGTCT			
rs1380945	rs1380945_F	CAAGTCCCCAAAGCAACTTC	60	1.5	31740104
	rs1380945_R	TGCTGAGGACTGGTGATGTC			
rs9534262	rs9534262_F	TGATCTTGAACAATGTAGTTTTTGT	58	2.5	31834646
	rs9534262_R	TTAGCAATCCCCAAATAGTGG			
rs3764792	rs3764792_F	TCTCCCTTCTTTGGGTGTTTT	60	1.5	31849117
	rs3764792_R	GCTTCGGAAACATTTCTACCC			
rs15869	rs15869_F	TTCTCCGGCTGCACAGAA	62	2.5	31871012
	rs15869_R	TAGTTTTAAGATATGCAACTGAAGCAA			
rs380627	rs380627_F	CCCTTTTGTTCTTGCTGCTC	60	1.5	31950293
	rs380627_R	CTCTATCAGCCCCTTTGCAG			
rs169600	rs169600_F	GTGGAGGGAAGTGTTGTGGT	60	1.5	31953620
	rs169600_R	GCATAAGCCAATGGTGTTCA			
rs2010997	rs2010997_F	CGGTTTTGGATTAGGGATTG	60	1.5	31968506
	rs2010997_R	CACCACTGATTCCCCAGAGT			
IVS26_84G-A	IVS26_84G-A_F	GTTCCCCTCTCCCTATCAGC	60	1.5	31869265
	IVS26_84G-A_R	TCAGCCATTAGCCAATGTTAAA			
rs643595	rs643595_F	GTGCCTTGGGTCTGAGTGTT	60	1.5	31337508
	rs643595_R	ATTCTCTGCGGTTCAACTCC			
rs348	rs348_F	TTTGATCCTTTCAAAATACTGTGC	60	1.5	31347504
	rs348_R	TGCCACATATACCCTACATTGAA			
rs582274	rs582274_F	TCTCACCTGGCTGAAACTCC	60	1.5	31381206
	rs582274_R	TTGTGGGTCAGAAATGCAAA			
rs381	rs381_F	GCCCACTTCACCTTTTCACT	60	1.5	31399506
	rs381_R	TTTTCACTACACCGCTCCTG			
rs424118	rs424118_F	GGCTCAGGTTGAGACAGTGG	-	-	31504069
	rs424118_R	ACTTCCGCGGCTCACAAA			
rs369666	rs369666_F	CAATTGCAAGCCCTCATTTT	-	-	31512966
	rs369666_R	TGTGTGTGACCTTGGCTTTC			
rs436227	rs436227_F	AGTAGCATGGGGCATCTTTG	60	2.5	31532424
	rs436227_R	GCTCAAAGCACTCCAGGAAC			
rs204561	rs204561_F	CCACCACACCCCATATTCTC	60	1.5	31622844
	rs204561_R	TCTTCACGACGATGAGGATG			
rs204565	rs204565_F	TCATAATTCAACCAGGATTTGC	60	2.5	31626135
	rs204565_R	TGTGTGTACCAAACTATCCCATC			
rs798974	rs798974_F	TGAACATGTGCCCAGCTTAC	60	1.5	31637065
	rs798974_R	TGTTCATGCAGGTTGTCCAT			
rs3742320	rs3742320_F	GAAGCCCTTTCCTCACACTG	60	2.5	32062418
	rs3742320_R	CAACCTCAACTGCCACTGAA			
rs208426	rs208426_F	ATGTATGTGGCTGCCTCTCC	60	1.5	32089371

Table 3.2 (continued)

HapMap SNP	Primer Name	Primers	Anneal Temp. (°C)	MgCl2 Conc. (mM)	UCSC May 2004 position
	rs208426_R	AAATTGGGCCAAGAACATTG			
rs408711	rs408711_F	CCCACAATGGGATATCGAGT	60	2.5	32111724
	rs408711_R	AATCCATACTGGGCCATGTT			
rs2301393	rs2301393_F	CAGCTCTCAGTCATTGCAACA	60	1.5	32130434
	rs2301393_R	GGCCTTATGCCACTCCTCTA			
rs614770	rs614770_F	TGAGAAATTAAACCAGGGAATGA	60	2.5	32143705
	rs614770_R	AAATTGGCAAAGATGCATGG			
rs962454	rs962454_F	AAATGGGGTAGCCAAAATGA	60	1.5	32191268
	rs962454_R	CCAACCCATCAATATTTCATTCA			
rs506645	rs506645_F	GTATTTGGGGATGGCGGTAT	60	1.5	32205709
	rs506645_R	GCCATTGGCATAAGGAGAGA			

Table 3.3 Missense mutations predicted to be associated with function

a. Full-length BRCA1

Eutherians	Mammals
P142H	Y130F
Y179C	P142H
S186Y	S186Y
R496C	I379M
P514R	F461L
S616del	P514R
D695Y	S616del
S784L	D695Y
N810Y	S784L
R866C	N810Y
S1512I	R841W
T1561I	R866C
L1564P	Q1395R
M1689R	S1512I
R1699W	T1561I
M1783T	M1689R
I1824N	R1699W
	A1708V
	M1783T
	I1824N

b. BRCA1 Exon 11

Eutherians	Mammals
S308G	I379M
I379M	F461L
F461L	P514R
H476R	S616del
P514R	D695Y
E597K	S784L
D695Y	N810Y
S784L	R841W
N810Y	R866C
R841W	K1109N
R866C	
K1109N	
S616del	

c. BRCA2

Eutherians	Mammals
Y42C	Y42C
S326R	E238Q
C341R	N289H
S384F	N319T
I449T	S326R
E462G	Q347R
I505T	E808D
P655R	A938E
L929S	S976I
A938E	N987I
S976I	L1019V
N987I	D1280V
E1250G	K1286del
D1280V	D1420Y
K1286del	F1524V
E1382del	N1758del
D1420Y	T1980P
N1758del	F2058Y
P2187L	D2238del
D2238del	I2490T
G2274V	R2502L
I2490T	R2502C
R2502C	E2571G
R2502L	L2587F
E2571G	D3272E
S2807L	P3280S
E2856A	
T3013I	
G3212R	
T3374I	
T3401M	

Table 3.4 Frequency of proline at BRCA2 amino acid 655 in Jewish individuals

	Ashkenazi	Sephardic	Total
PP	218	86	304
PR	7	2	9
RR	2	0	2
Total	227 (0.024)[1]	88 (0.011)	315 (0.021)

[1]PP-proline, proline; PR-proline, arginine;
RR- arginine, arginine
[2]Population frequency of P

Conclusions

In the preceding chapters, I used phylogenetic methods to identify regions and sites of conservation in mammalian BRCA1 and BRCA2 proteins. Within the 207 unclassified variants that occurred 1455 times in the CARE case-control study, I identified a single missense change that occurred in six Jewish women with breast cancer and not in any controls. The combination of multiple sequences from divergent species and a large case-control dataset permitted the identification of the P655R missense change in BRCA2. Further analysis is required to determine whether this change is associated with breast cancer or is an ancient variant specific to the Jewish population.

The major limitation of using phylogenic methods to assess the effect of missense changes in the *BRCA* genes is the polymorphic nature of the genes both within humans (http://research.nhgri.nih.gov/bic/) and within mammalian species (Tables 1.1, 2.2). Only the N- and C-terminal regions of BRCA1 and the eight BRC domains of BRCA2 are highly conserved across species. Within the human population, most variants occur at low frequency, which limits the statistical power of case-control studies. In future case-control studies, selection for individuals from reproductively isolated, ethnic populations, like the Ashkenazi Jewish population, will decrease the number of different ethnic-specific polymorphisms and increase the frequency of rare and weakly penetrant variants specific to a single, ethnic population.

To gain more insight into the history of the P655R variant and its association with breast cancer, the Ostrander lab will continue sequencing SNPs until the haplotype can be determined with confidence in the six women from the CARE study. The haplotype surrounding the P655R variant in the 11 Jewish individuals from the National Institutes of Heath population study will provide information about the age of P655R in the Jewish population and whether it was present before the split of Ashkenazi and Sephardic Jewish populations. When the cancer status of the women from the Washington, D.C population study is available, the Ostrander and Brody labs may be able to determine if P655R is associated with breast cancer and at what rate. P655R is 5' of the BRC repeats important for DSB repair, and no putative protein interaction domains have been described that may be affected by a P655R mutation. There is no BRCA2 functional assay that includes the region of BRCA2 exon 11 around P655R, but the general localization and cross-linking sensitivity assays described in [132] may provide useful information regarding P655R's function. Because I successfully identified a missense change that appears to be associated with breast cancer in Jewish cases, the Ostrander and Malone labs would like to search for additional missense changes in ethnic subsets of the CARE population that may be associated with cases more often than controls.

A successful future in studies attempting to determine the disease-association status of BRCA missense changes will likely require a multi-method approach. Current methods to identify missense changes associated with function in BRCA1 [3, 39, 90] and BRCA2 [90, 132] use a combination of linkage studies, structural and functional assays, and multiple sequence alignment methods. Wu et al. combined the results of BRCA2 functional assays with co-segregation, co-occurrence, and interspecies variation data to analyze a set of 11 missense changes and indels. *In vitro* assays for ectopic expression, cell viability, homologous recombination defects, and genome stability predict that four are deleterious missense changes and these data are supported by GCD results in an alignment of rat, mouse, cat, dog, chicken, and pufferfish. They screened 476 controls with no family history of breast or ovarian cancer and found two of the 11 in the control population. Because biallelic inactivation of BRCA2 is embryonic lethal or results in Fanconi anemia, the five variants that co-occurred with a known deleterious mutation are unlikely to be deleterious. Finally, they determined the odds of causality based on family data from Myriad Genetics Laboratories and found that three of the variants had odds in favor of causality. The non-functional analyses all provided support for the functional assays. While my predictions for disease-association are based only on alignments, I also predicted that only two of the 11 variants are disease-associated. The multi-method approach will be important for presenting convincing predictions.

The work I have presented in my dissertation and the studies I discussed above demonstrate that steady progress is being made toward understanding the effect of missense changes in the BRCA1 and BRCA2 proteins. As neutral missense variants are discovered and classified as such, case control studies can focus on determining whether the remaining unclassified missense changes are disease-association. While the association of P655R with breast cancer remains to be determined, there are other missense changes hidden within the BIC database that are associated with disease.

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Appendix A Alignment of BRCA1 exon 11 nucleotides corresponding to amino acids 282-1152 for 57 eutherian and 1 marsupial mammal

```
Homo               TCATTACAGCATGAGAACAGCAGTTTATTACTCACTAAAGACAGAATGAATGTAGAAAAG
Pan                TCATTACAGCATGAGAACAGCAGTTTATTACTCACTAAAGACAGAATGAATGTAGAAAAG
Gorilla            TCATTACAGCATGAGAACAGCAGTTTATTACTCACTAAAGACAGAATGAATGTAGAAAAG
Pongo              TCATTACAGCATGAGAACAGCAGTTTATTACTCACTAAAGACAGAATGAATGTAGAAAAG
Macaca             TCATTACAGCATGAGAACAGT---TTGTTACTCACTAAAGACAGAATGAATGTAGAAAAG
Alouatta           TCATTACAGCATGAGAACAGCAGTTTGTTACTCACTAAAGACACACTGAATGTAGAAAAG
Otolemur           TCATTACAGCATGAGAGCAGCAGTTTATTACTCACTAAAGACAAAATGAATGTAGAAAAG
Cynocephalus       TCATTACAGCATGAGAACAGCAGTTTATTACGCACTAAAGACAGAATAAATGTTGAAAAG
Tupaia             TCATTACAGCATGAGAACAGCAGTTTATTACTCACTAAGGACAGAATGAATGTAGAAAAG
Lepus              NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNAAG
Hystrix            NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
Pedetes            TTATTACAGCATGGGAGCAGCAATTTATTAGTCACTAAAGACAGAATGAATGTAGAAAAG
Aplodontia         TCATTACAGCATGAGAACAGCAGTTTATTACTCACTAAAGACAGAATGAATGTAGAAAAG
Sciurus            TCATTACAGCATGAGAACAGCAGTTTATTACTCACTAAAGACAGAATGAATGTAGAAAAG
Glaucomys          TCATTACAGCATGAGAACAGCAGTTTATTACTCACTAAAGACAGAATGAATGTAGAAAAG
Graphiurus         TCATTACAGCATGAGAACAGCAGTTTATTACTCACTAAAGACAGAATGAATGTAGAAAAG
Oryzomys           TCATTACAGCATGAGAACAGCAGTCTATTACTCACCGAAGACAGAATGAATGTAGAAAAG
Meriones           TCATTACAGCATGAGAACAGTAGCTTATTACTCACTGAAGACAGAATGAATGTAGAAAAG
Mus                TCATTACAGCCTGAGACCAGCAGTTTATTGCTCATTGAAGACAGAATGAATGCAGAAAAG
Rattus             TCATTACAGCGTGGGACCCGCAGTTTATTGTTCACTGAGGACAGACTGGATGCAGAAAAG
Scalopus           TTATTACAGCATGAAAACAGCAGTTTATTACTCACTGAAAACAGAATGAATGTAGAAAAG
Erinaceus          NNNNNNNNNCGTGAGAACAGCAGTTTATTACTCACTAAAGGCAAAATGAATGTAGAAAAG
Myotis             TCATTACAGCATGAGAACAGCAGTTTACTACTCACCAAAGACAGAATGAATGTAGAAAAG
Tadarida           TCATTACAGCATGAGAACAGCAGTTTACTACTCACTAAAGACAGAATGAATGTAGAAAAG
Taphozous          TCAGTACAGCATGAGAACAGCAGTTTACTACTCACTAAAGACAGAATGAACGTAGAAAAG
Tonatia            TCATTANAGCNTGAGAACAGCAGTTTACTGCTCACTGAGGACCAGATGAGTGTGGGAAAG
Megaderma          TCATTACAGCATGAGAACAGCAATTTATTACTGACTGAAGACATAATGAATGTAGAAAAG
Pteropus           TCTTTACAGCATGAGAACAGT---TTATTATACACTAAAGACAGAATGAATGTAGAAAAG
Hipposideros       TCTTTACATTATGAGCACAGCAGTTTATTACTCACTGAAGACAGAATGAATGTAGAAAAG
Cynopterus         TCATTACAGCATGAGAACAGCAGTTTATTATACACTAAAGACAGAATGAATGTAGAAAAG
Equus              TCATTGCAGCATGAGAACAGCAGTTTATTACTCACTAAAGACAGAATGAATGTAGAAAAG
Diceros            TCATTGCAGCATGAGAACAGCAGTGTATTACTCACTAAAGACAGAATGAATGTAGAAAAG
Manis              TCATTACAGCATGAGAACAGCAGTTTATTACTCACTAAAGACAGAATAAATGTAGAAAAG
Canis              TCATTACAGCATGAGAACAGCAGTTTATTACTCACTAAACACAGAATGAATGTAGAAAAG
Felis              TCATTACAGCATGAGAACAGCAGTTTATTACTCACTAAAGGCAGAATGAATGTAGAAAAG
Sus                TCGTTACAGCATGAGAACAGCAGTTTATTACTCACTAAAGACAGAATGAATGTAGAAAAG
Lama               TCATTACAGCATGAGAACAGCAGTTTATTACTCACTAAGGACAGAATGAATGTAGAAAAG
Bos                TCATTACAGCATGAGAACAGCAGTTTATTGCTCACTGAAAACAGACTGAATGTAGAAAAG
Hippopotamus       TCATTACAGCATGAGAACAGCAGTTTATTACTCACTAAAGACAGAATGAATGCAGAAAAG
Megaptera          TCATTACAACATGAAAACAGCAGTTTATTACTCACTAAAGACAGAATGAATGTAGAAAAG
Physeter           TCATTACAGCATGAAAACAGCAGTTTATTACTCACTAAAGACAGAATGAATGTAGAAAAG
Tamandua           TCATTACAGCATGAGAACAGCAGTTTATTACTCACTAAAGACAGAAAGAATGTAGAAAAG
Bradypus           TCATTACAGCGTGAGAACAGCAGTTTATTACTCACTAAAAACAGAATGAATGTAGAAAAG
Dasypus            TTATTACAGCATGAGAACAGCAGTTTATTACTCACTAAAGACAGAATGAATGTAGAAAAG
Chaetophractus     TTATTACAGCATGAGAACAGCAGTTTATTACTCACTAAAGACAGAGTGAATGTAGAAAAG
Loxodonta          TCATTACAGCATAAGAACAGCAGTTTATTACTCACTAAAGACAGAATGAATGTAGAAAAG
Elephas            TCATTACAGCATAAGAACAGCAGTTTATTACTCACTAAAGACAGAATGAATGTAGAAAAG
Dugong             TCATTACAGCATGAGAATAGCAGTTTATTACTCACTAAAGACAGAATGAATGTAGAAAAG
Trichechus         TCATTACAGCATGAGAATAGCAGTTTATTACTCACTAAAGACAGAATGAATGTAGAAAAG
Procavia           TCGTTACAGCATGAGAACAGCAGTTTATTACTCACTAAAGACAGAATGGATGTAGAAAAG
Dendrohyrax        TCATTACAGCATGAGAACAGCAGTTTATTACTCACTAAAGACAGAATGGATGTAGAAAAG
Orycteropus        TCGTTACAGCATGAGAACAGCAGTTTATCACTCACTAAAGACAGAATGAATGTAGAAAAG
Tenrec             TCGGCACAGCGCGAGGACTGCAGCTTATTACTCACCGAAGACAGACTGGATGGAGAAAAG
Echinops           TCATTACAGCGTGAGAACTACAGTTTATTACTCACTAAAGACAGACTGAATGTAGAAAAG
Elephantulus       TCATTACAGCATGAGAGCAGCAGTTTATTACTCACTAAAGACAGAATGAATGTAGAAAAG
Rhynchocyon        TCATTACTGCATGAGAACAGCAGGTTATTGCTCAGTAAAGACAGAATGGATGTAGAAAAG
Amblysomus         TCATTACAGCATGAGAACAGCAGTTTATTACTCACTAAAGACAGAATGAATGTAGAAAAG
Vombatus           TCATTACTTCCTAAAACCAGCAGTTTATTGCCCAACACAGACAGAATGAATGTAGAAAAG
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Homo                GCTGAATTCTGTAATAAAAGCAAACAGCCTGGCTTAGCAAGGAGCCAACATAACAGATGG
Pan                 GCTGAATTCTGTAATAAAAGCAAACAGCCTGGCTTAGCAAGGAGCCAACATAACAGATGG
Gorilla             GCTGAATTCTGTAATAAAAACAAACAGCCTGGCTTAGCAAGGAGCCAACATAACAGATGG
Pongo               GCTGAATTCTGTAATAAAAGCAAACAGCCTGGCTTAGCAAGGAGCCAACATAACAGATGG
Macaca              GCTGAATTCTGTAATAAAAGCAAACAGCCTGGCTTGGCAAGGAGCCAACATAACAGATGG
Alouatta            GCTGAATTCTGTAATAAAAGCAAACAGCCTGGCTTAGCAAGGAGCCAACATAACAGATGG
Otolemur            GCTGAATTTTGTAATAAAAGCAAACAGCCTGGCTTAGCAAGGAGCCAACAGAGCAGATCG
Cynocephalus        ACTGAATTCTGTAATAAAAGCAAACAGCCTGGCTTAGCAAGGAGCCAGGAGAGCAGATGG
Tupaia              GCTGAATTGTGTAATAAAAGCCAACAACCTGACTTAGCAAGGAGCCAGCAGAGCAGATGG
Lepus               GCTGAATTCTGTAATAAGAGCAAACAGCCTGGCTTAGCAAGAAGCCAACAGAGCAGATGG
Hystrix             NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNAGCCAACAGAGCAGGTGG
Pedetes             GCTGATTTTTGTAATAAAAGCAAACAGCCTGGCTTAGCAAGGAGCCAACATAACAGATGG
Aplodontia          GCTGAATTCTGTAATAAAAGCAAACAGCCTGGCTTAGCAAGGAGCCAACAGAGCAGATGG
Sciurus             GCTGAATTCTGTAATAAAAGCAAACAGCCTGGCTTTGCAAGGAGCCAACAGAGCAGATGG
Glaucomys           GCTGAATTCTGTAATAAAAGCAAACAGCCTGGCTTAGCAAGGAGCCAGCAGAGCAGATGG
Graphiurus          GCTGAATTCTGTAATAAAAGCAAACAGCCTGGCTTAGCAAGGAGCCAACAGAGCAGATGG
Oryzomys            GCTGAACTCTATAATAAAAGCAAACAGTCTGACTTAGCAAGGAGCCAACGGAACAGATGG
Meriones            GCTGAATTCTGTAATAAAAGCAAACAGTCTGGCTTAGCAAGGAGCCAACAGAGCAGATGG
Mus                 GCTGAATTCTGTAATAAAAGCAAACAGCCTGGCATAGCAGTGAGCCAGCAGAGCAGATGG
Rattus              GCTGAATTCTGTGATAGAAGCAAACAGTCTGGCGCAGCAGTGAGCCAGCAGAGCAGATGG
Scalopus            GCTGAATTCTGTAATAAAAGCAAACAGCCTGACTTAGCAAAGAGCCAGCAGAACAGATGG
Erinaceus           GCTGAATTCTGTAGTAAAAGCAAACAGCCTGGCTTAGCAAGGAGCCAACAGAGCAGATGG
Myotis              GCTGAATTCTGTAATAAAAGCAAGCAGCCTGGCTTAGCAAGGAGCCAGCAGAGCAGATGG
Tadarida            GCTGAATTCTGTAATAAAAGCAAGCAGCCTGGCTTAGCAAAGAGCCAGCAGAGCAGATGG
Taphozous           CTTGACTTCTGTAATAAAAGCAAGCAGCCTGGCTTAGCAAGGAGCCAGCAGAGCAGATGG
Tonatia             GCTGAATTCCGTCATGAAAGCAAGCAGCCCGGCTTAGCGAGGAGCCAGCAGAGCAGATGG
Megaderma           GCTGAATTCTGTAATAAAAGCAAACAGCCTGTGTTAGCAAGGAGCCAGCAGAGCAGATGG
Pteropus            ACTGACTTCTGTAATAAAAGCAAACAGCCTGGCTTAGCAAGGAGCCAACAGAACAGATGG
Hipposideros        GCTGAATTCTGTAATAAAAGCAAGCAGCCTGGCTTAGCAAGGAGCCAACAGAGCAGATGG
Cynopterus          ACTGACTTCTGTAATAAAAGCAAACAGCCTGGCTTAGCAAGGAGCCAGCAGAACAGATGG
Equus               GCTGAATTCTGTAATAAAAGCAAACAGCCTGGCTTAGCAAAGAGCCAACAGAGCAGACGG
Diceros             GCTGAATTCTGTAATAAAAGTGAACAGCCTGGTTTAGCCAAGAGCCAACAGAGCAGATGG
Manis               ACTGAATTCTGTAATAAAAGCAAACAGCCTGGCTTAGCAAGGAGCCTGCAAAGCAGATGG
Canis               GCTGAAATCTGTAATAACAGCAAACAGCCTGGCTTAGCAAGGAGCCAACAGAGCAGATGG
Felis               GCTGAATTCTGTAATGAAAGCAAACAGCCTGGCGTAGCAAGGAGCCAACAGAGCAGATGG
Sus                 GCTGAATTTTGTAATAAAAGCAAGCAGCCTGTCTTAGCAAAGAGCCAACAGAGCAGATGG
Lama                GCTGAATTCTGTAATAAAAGCAAACAGCCTGTCTTAGCAAGGAGCCAACAGAGCAGATGG
Bos                 GCTGAATTCTGTAATAAAAGCAAACAGCCTGTCTTAGTAAAGAGCCAGCAGAGCAGATGG
Hippopotamus        GCTGAATTCTGTAATAAAAGCNAACAGCCTCTCTTAGCAAAGAGCCAACAGAGCAGATGG
Megaptera           GCTGAATTCTGTAATAAAAGCAAACAGCCTGTCTCAGCAAAGAGCCAACAGAGCAGATGG
Physeter            GCTGAATTCTGTAATAAAAGCAAACAGCCTGTCTTAGCAAAGAGCCAACAGAGCAGATGG
Tamandua            GCTGAATTCTGTGATAAAAGCAAACAGCCTGGCTTAGCAAGGAGCCAGCAGAGCAGATGG
Bradypus            GCTGAATTCTGTAATAAAAGCAAGCAGCCTGGCTTAGCAAGGAGCCAACAGAACAGATGG
Dasypus             GCTGAATTCTGTAATAAAAGCAAACAGCCTGGCTTAGCAAGGCGCCAACAGAGCAGATGG
Chaetophractus      GCTGAATTCTGTAATAAAAGCAAACAGCCTGGCTTAGCAAGGCGCCAACAGAGCAGATGG
Loxodonta           GCTGAATTCTGTAACAAAAGCAAACAGCCTGGCTTAGCAAGAAGCCAACAGAGCAGATGG
Elephas             GCTGAATTCTGTAACAAAAGCAAACAGCCTGGCTTAGCAAGAAGCCAACAGAGCAGATGG
Dugong              GCTGAATTCTGTCATAAAAGCAAACAGCCTGGCTTAGCAAGGAGCCAGCAGAGCAGATGG
Trichechus          GCTGAATTCTGTCATAAAAGCAAACAGCCTGGCTTAACAAGGAGCCAGCAGAGCAGATGG
Procavia            GCTGAATTCTGTAGTAAGAGCAAACAGCCTGGCTTAGCAAGGAGCCAACAGAGCAGATGG
Dendrohyrax         GCTGAATTCTGTAGTAAGAGCAAACAGCCTGGCTTAGCAAGGAGCCAACAGAGCAGATGG
Orycteropus         GCTGAATTCTGTAATAAAAGCAAACAGCCTGGCTTAGTGAGGAGCCAACAGAGCAGATGG
Tenrec              GCTGGATTCTGCAAGGAAAGCAAACAGCCTGGCTTAGCAAGGAGCCAGCATAGCAGATGG
Echinops            GCTGGATTCTGTAATGAAAGCAAACAGCCCGGCTTAGCAAGGAGCCAACATAACAGATGG
Elephantulus        GCTGAATTCTATAATAAAAGCAAACAGCCTGGCTTAGCAAGGAGCCAACAGAGCAGATGG
Rhynchocyon         GCTGAATTCTGTAATAAAAGCAAACAGCCTGGCTTAGCAAGGAGCCAACAGAGCAGATGG
Amblysomus          GCTGAATTCTGTAATAAAAACAAACAGTCTGGCTTAGCGAGGAGCCAGCAGAGCAGATGG
Vombatus            GCTGAACTCTGCCATAAAAACAAACAGCCTGCCTTAGGAAGGAACCAAGAGAGCAGTCTC
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Homo                GCTGGAAGTAAGGAAACATGTAATGATAGGCGGACTCCCAGCACAGAAAAAAAGGTAGAT
Pan                 GCTGGAAGTAAGGAAACATGTAATGATAGGCGGACTCCCAGCACAGAAAAAAAGGTAGAT
Gorilla             GCTGGAAGTAAGGAAACATGTAATGATAGGCGGACTCCCAGCACAGAAAAAAAGGTAGAT
Pongo               GCTGGAAGTAAGGAAACATGTAATGATAGGCAGACTCCCAGCACAGAAAAAAAGGTAGAC
Macaca              ACTGGAAGTAAGGAAACATGTAATGATAGGCAGACTCCCAGCACAGAGAAAAAGGTAGAT
Alouatta            GCTGAAAGTGAGGAAACATGTAATGATAGGCAGACTCCCAGCACAGAGAAAAAGGTAGAT
Otolemur            GCTCAAAGTAAGGAAACATGCAATGATAGGCACACTTGCAGCCCTGAGCAAAAGGTAGAT
Cynocephalus        GCTGAAAGTAAGGAAACATGTAATGATAGGCAGACGCCCAGCACAGAGAAAAAGATAGAT
Tupaia              ACTGAAAATAAGGAAACATGTAATGATAGGCAGATTCCCAGCACAGAAAAAAAGGTAGAT
Lepus               GCTGAAAGTAAGGAAACATGTAATGATAGGCAGACTCCCAGCACAGAGAAAAAGGTAGTT
Hystrix             GCTGAGAGCAAGGAGAGGTGCCATGACAGGCAGGCTCCTGGCACAGAGCAGAAGGTAGAG
Pedetes             GCTGAAAGTAAGGAAACATGTAATGATAGGCAGACTCCCAGCACAAAGAAAAAGCTAGAT
Aplodontia          GCTAAAAGTAAGGAAACCTGTAATGATAGGCAAACTCCCAGCGCAGAGAAAAAGGTAGAT
Sciurus             GCTAAAAGTAAGGAAACCTGTAATGATAGGCAAACTCCAAGCACAGAGAAAAAGGTAGAT
Glaucomys           GCTAAAAGTAAGGAAACCTGTAATGATAGGCAAATTCCCAGCTCAGAGAAAAAGGTAGAT
Graphiurus          GCTGAAAGTAAGGAAACATGTAATGATAGGCAAACCCCCAGCACAGAGAAAAAGGTAGAT
Oryzomys            GCTGAAAGTAAAGAATCATGTAATAATAGGCAAATTCCCAGTGCTGAAAAAAAGGTAGAT
Meriones            GCTGAAAGTAAAGAAACATGTAATGACAGGCAGATTCCCAGCACTGAGAAAAAGGTAGAT
Mus                 GCTGCAAGTAAAGGAACATGTAACGACAGGCAGGTTCCCAGCACTGGGGAAAAGGTAGGT
Rattus              GCTGACAGTAAAGAAACATGTAATGGCAGGCCGGTTCCCCGCACTGAGGGAAAGGCAGAT
Scalopus            GCTGAAAGTAAAGAAACATGTAATGATAGGCAGACTTCCAGCCCAGAGAAAAGGGTAGAC
Erinaceus           GCTGAAAATATGGAAACATGTAATGATAGGCAGACTCCTAGCCCAGACAAAGAAGTAGAT
Myotis              GCTGAAAGTAAAGAAACATGTAATGATAGGCAGACTCCCAGCACAGAGAAAAGGGTAATT
Tadarida            GCTGAAAGTAAAGAAACATGTAATGATAGGCAGACTCTCAGCACAGAGAAAAGGGTAGTT
Taphozous           GCTGAAAGTAAAGAAACATGTAATGATAGGCAGACTCCCAGCACAGAGAAAAGGGTAGTT
Tonatia             GCTGAAAGTAAAGAAACATGTGACGATAGGCAGGCTCCCAGCGCAGAGGAAAGGGCAGTT
Megaderma           GCTAACAGTAAAGAAATATGTAATGATAGGCAGACTCCCAACACAGAGAAAAGGGTAGTT
Pteropus            GTTGAAACTAAGGAAACATGTAACGATATGCAGACTTCCAGCACAGAGAAAAAGGTAGTT
Hipposideros        GCTGAAAGTAAGGAAACATGTAATGATAGGCAGACTCCCAGCACAGAGGAAAATGTAGTT
Cynopterus          GTTGAAACTAAGGAAACATGTAATGATAGGCAGACTTCCAGCANAGAGAAAAAGGTAGTT
Equus               GCTGAAAGTAAGGAAACATGTAATGATAGGCAGGCCCCCAACTCAGAGGAAAAGCTAGTT
Diceros             GCTGAAAGTAAGGAAACATGTAATGATAGGCAGACTCCCAACTCAGAGAAAAAGCTAGTT
Manis               GCTGAATGTAAAGAAACATGTAACGATAGGCAGGCTCTCAGCACAGGGAAAAAGGTAGTT
Canis               GCTGAAAGTAAGGAAACATGTAATGATAGGCAGATTCCCAGCACAGAGAAAAAGGTAGTT
Felis               GCTGAAAGTAAGGAAACATGTAATGATAGGCAGACTCCCAGCACAGAGAAAAAGGTAGTT
Sus                 GCTGAAAGTAAGGGCACATGTAATGATAGGCAGACTCCTAACACAGAGAAAAAGGTAGTT
Lama                GCTGAAAGTAAGGACACATGTAATGATAGGCAGACTCCCAGCACAGAGAAAAAGGTGGCT
Bos                 GCTGAAAGTAAGGGCACATGTAAGGATAGGCAGATTCCCAGCACTGAGAAAAAGATAGTT
Hippopotamus        GCTGAAAGTAAGGACACATGTAATGATAGACAGACTCCCAGCACAGAGAAAAAGGTAGTT
Megaptera           GCTGAAAGTAAGGACACATGTAATGATAGGCAGACTCCCAGTACAGAGAAAAAGGTAGTT
Physeter            GCTGAAAGTAAGGACACATGTAATGATAGGCAGACTCCCAGTACAGAGAAAAAGGTAGTT
Tamandua            GCTGAAAGTAAGGAAACATGTAATGATAGGCACACTACCAGCACAGAGAAAAAAGTAGAT
Bradypus            GCTGAAAGTAAGGAAACACGTAATGATAGGCAGACTCCCAGCACAGAGAAAAAGGTAGAT
Dasypus             GCTGAAAGTAAGGAAACATGTAATGATAGGCAGACTCCCAGCATAGAGAAAAAGGTAGAT
Chaetophractus      GCTGAAAGTAAGGAAACATGTAATGATAGGCAGACTCCCAACACAGAGAAAAAGGTAGAT
Loxodonta           GCTGAAAGTAAGGAAACATGTAATGATAGGCAGACTCCTAGCACAGAGAAAAAGGTAGAT
Elephas             GCTGAAAGTAAGGAAACATGTAATGATAGGCAGACTCCTAGCACAGAGAAAAAGGTAGAT
Dugong              GCTGAAAGTAAGGAAACATGTAATGATAGGCAGACTCCTAGCACAGAGAAAAAGGTAGAT
Trichechus          GCTGAAAGTAAGGAAACATGTAATGATAGGCAGACTCCTAGCACAGAGAAAAAGGTAGAT
Procavia            GCTGAGAGTACGGAAACATGTAATGGTAGGCAGATTCTTAGAACAGAGAAAAAGGTAGAA
Dendrohyrax         GCTGAGAGTACGGAAACATGTAATGATAGGCAGATTCTTAGAACAGAGAAAAAGGTAGAT
Orycteropus         GCTGAAAGTAAGGAAACATGTAATGATAGGCAGACTCTTAGCACAGGGGAAAAGGTAGAT
Tenrec              GCTGAAAGTAGGGGAACGGGTAATGACAAGCCGACTCGTAACACAGAGGAAGAGGTAGTT
Echinops            GCTGAAAGTAAGGAGACATGTAATGACAAGCCGACTCCTAGCACAGAGAAAAAGGTAGAT
Elephantulus        GCTGAAAGTAAGGAAACATGTAATGATAGGCAGACTCCTAGCACAGAAAAAAAGGTAGCT
Rhynchocyon         ACTGAAAATAAGGAAACATGTAATCATAGGCAGACTCCTAGTATAGAGAAAAAATTAGAT
Amblysomus          GCTGGAAGTAAGGCAGCGTGCAATGACAAGCAGACTCCTAGCACACAGACAGAGCTATAT
Vombatus            GATGAAAGTAAGGAAATATGTAGCCCTGGGAAGACCCCAGGTGCCTGTGAGCGGCATGAG
                      *         *      *
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Homo	CTGAATGCTGATCCCCTGTGTGAGAGAAAAGAATGGAATAAGCAGAAACTGCCATGCTCA
Pan	CTGAATGCTGATCCCCTGTGTGAGAGAAAAGAATGGAATAAGCAGAAACTGCCATGCTCA
Gorilla	CTGAATGCTGATCCCCTGTGTGAGAGAAACGAATGGAATAAGCAGAAACTGCCATGCTCA
Pongo	CTGAATGCTGATCCCCTGTGTGAGAGAAAAGAATGGAATAAGCAGAAACTGCCATGCTCA
Macaca	CTGAATGCTAATGCCCTGTATGAGAGAAAAGAATGGAATAAGCAAAAACTGCCATGCTCT
Alouatta	GTGGATGCTGATCCCCTGCATGGGAGAAAAGAATGGAATAAGCAGAAACCTCCGTGCTCT
Otolemur	CTGAATACTGCTCCCCCATATGGGAGAAAAGAACAGAATAAGGAGAAACTTCTATGCTCC
Cynocephalus	CTAAATGCTGATTCCCAGCATGGGAGAAAAGAACGGAATATGCAGAAACCTCCATACCCT
Tupaia	CTAAATGCTGATCCCCTGTGTGGGAAGAAAAAACAAGCTAAGCAGAAACYGCTATGTTCT
Lepus	CTGAATGTTGACTGCCTGTATGGGAGAAAACAACAGGATAAGCAGAAACCTCCATGCCCT
Hystrix	CTGACTGCTGAGCCCCTCCACGAGAGAAAAAGACGGAAAAAGCAGAACCCTCCGAGCTCC
Pedetes	CTGAATGCTGATCCCTTCTATGGGAGAAAAGAACGGAATAAGCAGAAACCTCCATGCTCT
Aplodontia	CTGAATGCTGATCCCCTATATGAGAGAAAAGAACCAAGTAAACAGAAACCTCCATACTCT
Sciurus	CTGAATGCCGATCCCCAATATGAGAGAAAAGAACCAAGTAAACAGAAACCTCCATGCTCT
Glaucomys	TTGAATGCTGATCCCCAATATGAGAAAAAAGAACCAAGTAAGCAGAAACATCCATGCTCT
Graphiurus	CTGAATACTGATCCCCTACATAGGAGTAAAGAACAGAATAAACAGAAACCTCCATGCTCT
Oryzomys	CTGAACGCTGAGTCCTTCTGTGGAAGAAAAAAATGGAATAATCAGAAAAGTCTGTGCCCT
Meriones	TCTAATGCTGATTCTCTCTGTGGGAGAAAAAAATGCAATAATGAGAAAAGTCTGTGCCTT
Mus	CCAAACGCTGACTCCCTTAGTGATAGAGAGAAGTGGACTCACCCGCAAAGTCTGTGCCCT
Rattus	CCAAATGTGGATTCCCTCTGTGGTAGAAAGCAGTGGAATCATCCGAAAAGCCTGTGCCCT
Scalopus	CCGAATGCTGATCCCATGTATGGGAGAAAAGAACTGAATAAGCAGAAACCTCCATGCTCT
Erinaceus	CTGAATGCTGATTCCTTATATGAGAGAAAAGAACTAAACGAGCAGATCTCTTCATACTCC
Myotis	CTGGATGCTGATCCTCTGAATGGGGAAAAAGAACTT---------------CCACGCTCT
Tadarida	CTGAATGCTGATCCTCTGAATAGGAGAAAAGAACCT---------------CCAGGCTCT
Taphozous	GTGAATGCTGATACCCTGGATGGGAGAAAAGAACCT---------------CCATACTCT
Tonatia	CTGAATGCTGATCCCCAGAATGGGAGGGAAGAATCT---------------CCATCCTCT
Megaderma	CTGAATGCTGATCCCTTGAATGAGAGAAAAGAACTGAATAATCAGAAACCTCTATGCTCT
Pteropus	CTGAATGCTGATCCCCTGAATGGGAGAATAGAACTGAATAAGCAGAAACCTCCATGCTCT
Hipposideros	CTGAATACTGATCCCCTGAATGGGAGAAAAGAACTGAATAAGCAGAAACCTCCATGCTCT
Cynopterus	CTGAATGCTGATCCCCTGAATGGAAGAATAAAACTGAATAAGCAGAAACCTCCATGCTCT
Equus	CTGAATGCTGATCCGCTGTATGGGAGAGAAGAACTGAATAAGCAGAAACCTCCACGCTCT
Diceros	CTGAACGCTGATCCYCTGTATGGGAGAAAAGAACTGAATAAGCAGAAACCTCCATGTTCT
Manis	CTGAATGCTGATCCCCTGTGTGGGAGAAAAGAACTGAATAAGCAGAAACCTTCATGCTCT
Canis	GTGAATGCTGATCTCCTGTGTGGGAGAAAAGAACTGAATAAACAGAAACCTCCACACTCT
Felis	CTGAATGCTGATCCCCTGTGTAGGAGAAAA---CTGAGTAAGCAGAAATCTCCATGCTCT
Sus	CTGAATACTGATCTCCTGTATGGGAGAAACGAACTGAATAAGCAGAAACCTGCGTGCTCT
Lama	CTGAATGCCGATCGCTTATATGGGAGCGAAGAACTGAATAAGCAGAAACCTGCATGCTCT
Bos	CTGAATACTGATCCCCTGTACAGAAGAAAAGAACTGCGTAAGCAGAAACCTGCATGCCCT
Hippopotamus	CTGAACGCTGATCCCCTATACGGGAGAAAAGAACTGAATAAGCAGAAACGTGCATGCTCT
Megaptera	CTGAATGCTGATCCCCTGTATGGGAGAAAAGAACTGAATAAGCAGAAACCTGCATGCTCT
Physeter	CTGAATGCTGATCCCCTATATGGGAGAAAAGAACTGAATAAGCAGAAATCTGCATGCTCT
Tamandua	GTGGATGCTGATCCCCTGCATCGGAGAAAAGAACTGAAGAAGTGGAAATCTCCATACTCT
Bradypus	GTGGATGCTGATCCCCTGTATGGGCGAAAAGAACTGAATAAGCAGAAACCTCCATGCTCT
Dasypus	GTGGATGCTGATCCCCTGTATGGGCGAAAAGAACTGAATAAGCAGAAACCTCCATGCTCT
Chaetophractus	GTGGCTGCTGATTCCCTGTATGGGCGAAAAGAACTGAATAAGCAGAAACTTCCATGCTCT
Loxodonta	GTGAATGCTGATCCCTTGTATGAGAGAAAAGAAGTGAATAAGCAGAAACCTCCACGCTCT
Elephas	GTGAATGCTAATCCCTTGTATGAGAGAAAAGAAGTGAATAAGCAGAAACCTCCACGCTCT
Dugong	ATGAATGCTAATCCATTGTATGAGAGAAAAGAAGTGAATAAGCAGAAACCTCCATGCTCC
Trichechus	ATGAATGCTAATCCATTGTATGAGAGAAAAGAAGTGAATAAGCAGAAACCTCCATGCTCC
Procavia	ACGAATGCTGATCCTTTGTATGGGAAAAAAGAAGGGAATAAGCAGAAACCTCCATGCTCT
Dendrohyrax	ACAAATGCTGATCCTTTGTATGGTAAAAAAGAAGGGAATAAGCAGAAACCTCCATGCTCT
Orycteropus	ATGAAGGCTGATCCCTTGTATGGGAGAAAAGAAGTGAATAAGCAGAAACCTCCATGCTCT
Tenrec	GTGAGCGCTGACTCCGCGCATGGGAGGAAAGGAGTGTCTAAGCAGAAACCTCCGCGCCAG
Echinops	AAGAATGCTGACCCCGTGCATGGGAGAAAAGGAGTGCCTAAGCAGAAACCTCCGTGCCAT
Elephantulus	GTGAGTGCTGATCTTTATTATGGGATAAAAGAAGTGAATAAGCAGAAATCTCCGCACTCT
Rhynchocyon	ATGAATGCTGATCCCTCTTATGGGCGAAAAGAAGTGAATAAGCAGAAATATGAATGCTCT
Amblysomus	AGGAGTGCTGGTCCCATGCACAGGAGAAAAGAAGTAAATAAGCTGAAATCTCCATGGTCT
Vombatus	CTGAATGACCATCATCTGTGTGAGAGGCAAGGCCTAGAGAAGCCGCAGCACCCTGAGAGC

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Homo               GAGAATCCTAGAGATACTGAAGATGTTCCTTGGATAACACTAAATAGCAGCATTCAGAAA
Pan                GAGAATCCTAGAGATACTGAAGATGTTCCTTGGATAACACTAAATAGCAGCATTCAGAAA
Gorilla            GAGAATCCTAGAGATACTGAAGATGTTCCTTGGATAACACTAAATAGCAGCATTCAGAAA
Pongo              GAGAATCCTAGAGATACTGAAGATGTTCCTTGGATAACACTAAATAGCAGCATTCAGAAA
Macaca             GAGAATCCTAGAGACACTGAAGATGTTCCTTGGATAACACTAAATAGCAGCATTCAGAAA
Alouatta           GAGAATCCTAGAGATACTGAAGATGTTGCTTGGATAATGCTAAATAGCAGCATTCAGAAA
Otolemur           AAGAATCCTAGAGATAGCCAAGATGTTCCTTGGATAACACTAAATAGCAGCATTCAGAAA
Cynocephalus       GAGAGTCCTAGAGATACCCAAGATGTTCCTTGGATAACACTAAACAGCAGCATTCAGAAA
Tupaia             AACAGTCCTAGAGATGACCAAGATTCTCCTTGGATAACTCTAAATAGTAGCATTCAGAAA
Lepus              GAGACCTCTGGAGATAACCAAGATGTTTCTTGGATAACAGTAAATAGCAGCATTCGGAAA
Hystrix            GAGGCTCATGGAGGGACCCAGGATGTTCCTTGGATCACACTAAATAGCAGCATTCAGAAA
Pedetes            GAGAATCCTAGAGATACCCAAGATGTTTCTTGGGTGACACTAAATAGCAGCATTCAAAAA
Aplodontia         GAGAGTCCTAGAGATACCCAAGATATTCCTTGGATAACACTAAATAGCAGCATTCAGAAA
Sciurus            GAGAATTCTAGAGATAGCCAAGATGTTCCTTGGATAACACTAAATAGCAGCATTCGGAAA
Glaucomys          GAGAATTCCAGAGATACCCAAGATGTTCCTTGGATAACACTAAATAGCAGCATTCGGAAA
Graphiurus         GAGAATCCTAGCGATACCCAAGATATTCCTTGGATAACACTAAATAGCAGCATTCAGAAA
Oryzomys           GAGAATTCTAGAGCTACCCAAGATGTTCCTTGGATAACACTGAATAGCAGCATCCAGAAA
Meriones           GAGGATTCTGGAGCTACCCAAAATGTTCCTTGGATAACACTAAATAGCAGCATTCGGAAA
Mus                GAGAATTCTGGAGCTACCACCGATGTTCCTTGGATAACACTAAATAGCAGCGTTGAGAAA
Rattus             GAGAATTCTGGAGCTACCACTGACGTTCCTTGGATAACACTGAATAGCAGCATTCAGAAA
Scalopus           GACAGCCCCAGAAATTCCCAAGGTGTTGCCTGGATAACACTGAACAGTAGCATTCGAAAA
Erinaceus          AGCAGTCCTAAAGATTCCAAAGACATTTCTTGGGTAGCACTGAAT---AGCATACAGAAA
Myotis             GACCATCCCAGAGATTCCCAAGATGTGCCTTGGATAACACGGAGCAGTAGCATACAGAAA
Tadarida           AACTATCCTAGAGATTCCCAAGATGTTCCTTGGATAACACGGAGTAGTAGCATACAGAAA
Taphozous          GACTGTCCTAATGATTCCCAAGATGTCCCTTGGATAACAGGGAATAGTAGCATACAGAAA
Tonatia            GACCACCCTAGAGATTCCCAAGATGTTCCTTGGATAACACGGAATAGCAGCATACAGAAA
Megaderma          GACAGTCCTAGAGATTCCCAAGACGTTCCTTGGATAACACGTAATAGTAGCATACAGAAA
Pteropus           GACAGTCCTAGAGATTCTCAAGATATTTCTTGGATAACACGGAATAGTAGCATACAGAAA
Hipposideros       GACAGTCCTAGGGATTCCCAAGTTGTTGCATGGATAACACAGAATAGTAGCATACAGAAA
Cynopterus         GACAGTCCTAGAGATTCCAAAGATATTCCTTGGATAACACGGAATAGTAGCATACAGAAA
Equus              GACAGTCCTAGAGACTCCCAAGATGTTCCTTGGATAACACTGAATAGTAGCATACAGAAA
Diceros            GACAGTCCTAGAGATTCCCAAGATATTCCTTGGATAACACGGAATAGTAGCATACAGAAA
Manis              GACAGTCCTAGAGTTTCTCAAGACGTTCCTTGGATAACACTAAATAGTAGCATACRGAAA
Canis              GATAGTCCTAGAGATTCCCAAGATGTTCCTTGGATAACACTGAATAGTAGCATACGGAAA
Felis              GACAGTCCTAGAGATTCCCAAGATGTACCTTGGATAACACTGAATAGTAGCATACAGAAA
Sus                GACAGTCCTAGAGATTCCCAAGATGTTCCTTGGATAACATTGAATAGTAGCATACAGAAA
Lama               GACAGTCCTAGAGATTCCCAAGATGTTCCTTGGATAACACTGAATAGTAGCATACAGAAA
Bos                GACAGTCCTGGAGATTCCCAAGATGTTCCTTGGGTAACCCTGAATAATAGCATACAGAAA
Hippopotamus       GACGGCCCTAGCGATTCCCAAGATGTTCCTTGGATAACACTGAATAGTAGCATACAGAAA
Megaptera          GACAGTCCTAGAGATTCCCAAGAGTTTCCTTGGATAACAGTGAATAGTCGCATACAGAAA
Physeter           GACAGTCCTAGAGATTCCCAAGAGTTTCCTTGGATAGCAGTGAATAGTAGCATACAGAAA
Tamandua           GAGAATCCTAGAGGTACCCAAGATATTCCTTGGATAACACTGAATAGTAGCATTCAGAAA
Bradypus           GAGAGTCCTCAAAATACCCAAGATATTCCTTGGATAACACTGAATAGTAGCATTCAGAAA
Dasypus            GAGAGTCATAGAGATACCCAAGATATTCCTTGGATAATGCTGAATAGTAGCATTCAGAAA
Chaetophractus     GAGAGTCCTAGAGATACCCAAGATATTCCTTGGATAACGCTGAATAGTAGCATTCAGAAA
Loxodonta          GAGAATCTTAGAGACACCCAAGATATTCCTTGGATAACACTGAATAGTAGCATTCAGAAA
Elephas            GAGAATCTTAGAGACACCCAAGATATTCCTTGGATAACACTGAATAGTAGCATTCAGAAA
Dugong             GAGAGTGTTAGAGATACACAGGATATTCCTTGGCTAACACTGAATAGTAGCATTCAGAAA
Trichechus         GAGAGTGTTAGAGATACACAAGATATTCCTTGGCTGACACTGAATAGTAGCATTCAGAAA
Procavia           GAGAGTCGCACAGATACGCAAGATATTCCTTGGGTAACACTGAATAACAGCATTCAGAAA
Dendrohyrax        GAGAGTCGCACAGATACGCAAGATATTCCTTGGGTAACACTGAATAACAGCATTCAGAAA
Orycteropus        GAGAATCCTAGAGATACTGAAGATATTCCTTGGATAACACTGAATAGTAGCATTCAGAAA
Tenrec             AAAAGGCCCAGAAAGAGCCATGATGTGCCTTGGAAAACACGGAAGAGCAGCATTTCGAAG
Echinops           GGAAGTCCTAGAAAGAGCCACGATGTGCCTTGGAAAACACGGAAGAGTAGCATTTGGAAA
Elephantulus       GAGAGTCCAAACAATAACCAGAATACTCCTTGGATGACATTGAACAGTAGCATTCGGAAA
Rhynchocyon        GAAAGCCCTCAAGATACCCAAGATATTCCTTGGATGACACTGAATAGTAGCGTTCAGAAA
Amblysomus         GAGAGTCCTGGAGCTACCCAAGAGATTCCTTGGATAACACTGAATAGTAGCATTCGGAAA
Vombatus           CCTAGAGGTAATCCTCAGAACTGCCTGTCTGGAACCAAACTGAAAAGCAGCATTCAGAAA
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Homo                 GTTAATGAGTGGTTTTCCAGAAGTGATGAACTGTTAGGTTCTGATGACTCACATGATGGG
Pan                  GTTAATGAGTGGTTTTCCAGAAGTGATGAACTGTTAGGTTCTGATGACTCACATGATGGG
Gorilla              GTTAATGAGTGGTTTTCCAGAAGTGATGAACTGTTAGGTTCTGATGACTCACATGATGGG
Pongo                GTTAATGAGTGGTTTTCCAGAAGTGACGAACTGTTAGGTTCTGATGACTCACATGATGGG
Macaca               GTTAATGAGTGGTTTTCCAGAAGTGATGAACTGTTAAGTTCTGATGACTCACATGATGGG
Alouatta             GTTAATGAGTGGTTTTCCAGAAGTGATGAACTGTTAACTTCTGATGACTCACATGATGGG
Otolemur             GTTAATGAATGGTTTTCTAGAAGTGATGAAATGTTAACTTCTGATGACTCACATGATGAG
Cynocephalus         GTTAATGAGTGGTTTTCCAGAAGTGATGAAATTTTAGCTTCTGATGACTCACGTGACAGG
Tupaia               GTTAATGAATGGTTTTCCAGAAGTGATGAAATGTTAACTTCTAACGACTCACATGATGGT
Lepus                GTTAACGAGTGGTTCTCCAGAAGTAATGAAATGTTAACTCCTGATGACTCACTTGACCGG
Hystrix              GTTAATGAGTGGTTTTCCAGAAGTGACAAAGCAGTGACTTCTGACAGCACCTGTGACAGG
Pedetes              GTTAATGAGTGGTTTTCCAGAAGGGATGAAATGTTAACTTCTGATGACTTACACGACGGA
Aplodontia           GTTAATGAGTGGTTTTCCAGAAGTGATGAAATGTTAACTTCTGATGACTCACATGATGGG
Sciurus              GTTAATGAGTGGTTTTCCAGAAGTGACGAAATGTTAACTTCTGATGACCCAGATGATGGG
Glaucomys            GTTAACGAGTGGTTTTCCAGAAGTGACGAAATGTTAACTTCTGATGACTCAGATGATGGG
Graphiurus           GTTAACGAGTGGTTTTCCAGAAGTAACGAAATATTAACTTCGGATGACTCACATGATGAG
Oryzomys             GTTAACGAGTGGTTTTCCAAAACTGGTGAGATGTTAACTTCTGATGGCGCGTCTGACAGG
Meriones             GTTAATGAGTGGTTTTCCAGAACTGGTGAGATGTTAACTTCTGACAGTGCATCTGACAAG
Mus                  GTTAATGAGTGGTTTTCCAGAACTGGTGAAATGTTAACTTCTGACAGCGCATCTGCCAGG
Rattus               GTGAATGAGTGGTTTTCCAGAACTGGTGAAATGTTAACTTCTGACAATGCATCTGACAGG
Scalopus             GTTAATGAGTGGTTTTCCAGAAGTGATGAAATATTAACTTCTGATGAATCTCGTGATGGG
Erinaceus            GTGAATGAATGGCTTTCCAGAAGTGATGAACTGTTAACTTCTGATGACTCATATGATAAG
Myotis               GTTAATGAGTGGTTTTCCAGGCGTGATGAAATACTAACTTCTGATGGCTCACATAATGGC
Tadarida             GTTAATGAGTGGTTCTCCAGACGTGATGAAATACTAACTACTGGTGGCTCACATAACGGT
Taphozous            GTTAGTGAGTGGTTTTCCAGGCGTGATGAAATATTAACTTCTGATGGATCACATGATGGG
Tonatia              GTTAATGAGTGGTTTTCCAGACGTGATGAAACACGGACTTCCAACGGCTCCCACGGTGGG
Megaderma            GTTAATGAGTGGTTTTCCAGACGTGATGAAATACTAACTTCTCATGGTTCACATGATGGG
Pteropus             GTTAATGAGTGGTTTTCCAGACGTGATGAAATATTAACTTCTGATGTCTCACCTGATGGG
Hipposideros         GTTAATGAGTGGTTTTCCAGACGTGATGAAATATTAACTTCTCATAGCTCATGTTATGGG
Cynopterus           GTTAATGAGTGGTTTTCCAGACGTGATGAAACATTAACTTCTGATGTCTTACTTGATGAG
Equus                GTTAATGAGTGGTTTTCCAGAAGTGAGGAAATGTTAACTTCTGATGACTCATGTGACGGA
Diceros              GTTAATGAGTGGTTTTCCAGAAGTGATGAAATATTAACTTCTGATGACTCACATGATGGG
Manis                GTTAATGAGTGGTTTTCCAGAAGTGATGAAATGTTAACTTCTGATGATCCATGTGATGGG
Canis                GTTAATGAGTGGTTTTCCAGAAGTGACGAAATATTAACTTCTGATGATTCACATGACAGA
Felis                GTTAATGAGTGGTTTTCCAGAAGTGATGAAATGTTAACTTCTGATGACTCACATGATGAG
Sus                  GTTAATGAGTGGTTTTCTAGAAGCGATGAAATGTTAACTTCTGACGACTCACAGGACAGG
Lama                 GTGAATGAGTGGTTTTCCAGAAGCGACGAAATGTTACCTTCTGATGACTCACATGAAGTG
Bos                  GTTAATGACTGGTTTTCCAGAAGTGATGAAATATTAACTTCTGATGACTCGTGCGATGGG
Hippopotamus         GTTAATGAATGGTTTTCCAGGAGTGGCGAGATGTTAACTTCTGACGACTTATGTGTTAAG
Megaptera            GTTAATGAATGGTTTTCCAGAAGTGATGAAATGTTAACTTCTAACGACTCACGTGATGGG
Physeter             GTTAATGAATGGTTTTCCAGAAGTGATGAAATGTTAACTTCTAACGACTTACGTGATGGG
Tamandua             GTTAATGAGTGGTTTTCCAGAAGTGATGACATATTGACTTCTAATGACTCATGCAATGAG
Bradypus             GTTAATGAGTGGTTTTCCAGAAGTGATGACATACTAACTTCTGATGACTCACACAATGGG
Dasypus              GTTAACGAGTGGTTTTCCAGAGGTGATGACATATTAACTTCTGATGACTCACACGATAGG
Chaetophractus       GTTAATGAGTGGTTTTCCAGAAGTGATGACCTATTAACTTCTGATGACTCACACGATGGG
Loxodonta            GTTAATGAGTGGTTTTTCAGAAGTGACGGCCTG---------GATGTCTTAAATGATGAG
Elephas              GTTAATGAGTGGTTTTTCAGAAGTGACGGCCTG---------GATGTCTTAAATGATGAG
Dugong               GTTAATGAGTGGTTTTTCAGAAGTGATGGCCTG---------GATGACTTGCATGATAAG
Trichechus           GTTAATGAGTGGTTTTTCAGAAGTGATGGCCTG---------GATGACTTGCATGATAAG
Procavia             GTTAATGAGTGGTTTTCCAGAAGTGACAACCTA---------AGTGATTCACCTAGTGAG
Dendrohyrax          GTTAATGAGTGGTTTTCCAGAAGTGACAACCTA---------AGTGATTCACCTAGTGAG
Orycteropus          GTTAATGAGTGGTTTTCCAGAAGTGATGGCCTG---------GATGGCTCACATGATGAA
Tenrec               GTTAACGAGTGGTTTTCCAAAAGCCACGGCCTG---------GGTGACTCTCGCGATGGG
Echinops             GTCAATGAGTGGTTTTCCAAAAGCGATGGCCTG---------GGTGACTCGCATGATGAG
Elephantulus         GTTAATGACTGGTTTTCCAGAAGCGGTGGCCTG---------GATGGCTGCCATGATAGA
Rhynchocyon          GTTAATGCATGGTTTTCCAGAAGTGATGGCCTC---------GATGATGCCCCTGATGTA
Amblysomus           GTTAATGAGTGGTTTTCCAGAAGTGATGGCCTG---------GATGAGTCACATGATGAG
Vombatus             GTTAATGAGTGGTTATCCAGAAGTAGTGACATTTAGCCTCTGATAACTCCAACGGTAGG
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Homo            GAGTCTGAATCAAATGCCAAAGTAGCTGATGTATTGGACGTTCTAAATGAGGTAGATGAA
Pan             GGGTCTGAATCAAATGCCAAAGTAGCTGATGTATTGGACGTTCTAAATGAGGTAGATGAA
Gorilla         GGGTCTGAATCAAATGCCAAAGTAGCTGATGTATTGGACGTTCTAAATGAGGTAGATGAA
Pongo           AGGTCTGAATCAAATGCCAAAGTAGCGGATGTATTGGACGTTCTAAATGAGGTAGATGAA
Macaca          GGGTCTGAATCAAATGCCAAAGTAGCTGATGTATTGGACGTTCTAAATGAGGTAGATGAA
Alouatta        GGGTCTGAATCAAATGCCAAAGTAGCTGAAGCATTGGAAGTTCTAAATGAGGTAGATGGA
Otolemur        GGTTCTGAATCACATGCTGAAGTAGCTGGAGCCTTAGAAGTTCCAAGTGAAGTAGATGGA
Cynocephalus    GTGTCTGAATCAAATGCCAAAGTAGCTGGTGCATTAGAAGTTCCAAATGATGTAGATGGA
Tupaia          GAGTCTGAA------------ATAGCTGGTGCATTYGAAGYTCCAAATAAAGTAGATGAA
Lepus           CGGTCTGAATCAAATGCCAAAGTGGCTGGTGCATTAGAAGTCCCAAAGGAGGTAGATGGA
Hystrix         GAGTCCAAGTCAGATGCTGAAGAAGCTGGTGTG---------GCAGAAGATCCAAAAGGC
Pedetes         GTGTCTGAATCAAATGCTGAAGTACTTGGTGCATTAGAAGTTCCAGATGAAATAAAAGGA
Aplodontia      GTT---GAATCAAATGCTGAAATAACTGGTGTATTAGAAATTCTAAATGAAGTAGATGGA
Sciurus         GGTTCTGAATCAAATGCTGAAGTAACTGGTGTATTAGAAATTCCAAATGAAGTAGATGGA
Glaucomys       GGTTCTGAATCAAATGCTGAAATAGCTGGTATATTAGAAATTCCAAATGAAGTAGATGGA
Graphiurus      GGGTCTGAATCAAATGCTGAAGTAGCTGGTGCCTTA---GTTCCAAATGAAGTAGATAGA
Oryzomys        AGACTCAGGTCACCTGCTGAAGCAGCTGTC------GAAGAA------------AATGGA
Meriones        AGGCAGGCATCAAATGCTGAAGCAGCTGTTGCGCTAGAAGTTTCAAATGAAGTAGATGGA
Mus             AGGCACGAGTCAAATGCTGAAGCAGCTGTTGTGTTGGAAGTTTCAAACGAAGTGGATGGG
Rattus          AGGCCTGCGTCAAATGCAGAAGCTGCTGTTGTGTTAGAAGTTTCAAATGAAGTGGATGGA
Scalopus        GAGTCCCCATCAAATATTGAAATGACTGGTGAAGTAGAAGTTCCAAACACAGTAGATGGA
Erinaceus       GGATCTAAATCAAAAACTGAAGTAACTGTAACAACAGAAGTTCCAAATGCAATAGATAGR
Myotis          AAGTCTGAGTCAAATGCTGAAGTAGCTGGTGCAGTGGAAGTTGCAAATGAAGTAGATGGG
Tadarida        AGATTTGAATCAAATGTTGAAGTAGCTGGTGCAGTAGAAGTTCCAAATGAAGTAGATGGA
Taphozous       AGATCTGAATCAAATATGGAAGTAGCTGGTGCAGTAGAAGTTCCATATGAAGTAGATGGA
Tonatia         AGGCCTGAGTCAGACACGGAAGGAGCCGACACGGTAGAAGCTCCGGACGAAGTGCGTGGA
Megaderma       ACAGGTGGATCAAATACAGAAGAAGCTGGTGCAGCAGAAATTCTAAATGAAGTAGATGGA
Pteropus        AGGTCTGAATCAAAT---------------GTGGTAGAAGTTCCAAATGAAGTAGATGGA
Hipposideros    AGAGCTGAATCAAATACAGAAGTATCTGGTGCAGTAGAAGTTCCACTTGAAGTAGATGGA
Cynopterus      AGGTCTGAATCAAAT---------------GTGGTAGAAGTTCCAAATGAAGTAGATGGA
Equus           GGGCCTGAATCAAATACAGAAGTAGCTGGTGCAGTAGAAGTTCCAAATGAAGTACGTGGA
Diceros         GGGCCTGAATCAAATACTGAAGTAGCTGGTGCAGTAGAAGTTCAAAATGAAGTAGATGGA
Manis           AGGTCTGAATCAAATACTGAAGTAGCTGGTGCAGTAGAAGTTCCAAATGAAGTAGATGAA
Canis           GGATCTGAATTGAATACTGAAGTAGGTGGTGCAGTAGAAGTTCCAAATGAAGTGGGTGAA
Felis           GGATCTGAATCGAATCCTGGAGTAGCTGGTGCA---GAAGTTCCAAATGTAGTGGATGGA
Sus             AGGTCTGAATCAAATACTGGGGTAGCTGGTGCAGCAGAGGTTCCAAATGAAGCAGATGGA
Lama            GGGCCTGAATCAAATACTGAAGTAGCTGGTGCAGTGGAAGTTCCAAATGAAGTAGATGGC
Bos             GGGTYTGAATCAAATAATGAAGTAGCTGGTGCAGTGGAAATTCCAAATAAAGTAGATGGA
Hippopotamus    GGGTGTGAATCAAATACTGAAGTAGCTGGTGCAGCGGAAGTTCCAAATGAAATTGATGGG
Megaptera       GGATTTGAATCAAACACTGAAGTAGCTTGTGCAGTGGAAGTTCCAAAGGAAGTTGATGGA
Physeter        GGATTTGAATCAAACCCTGAAGTAGCTCGTGCAGTGGAAGTTCCACAGGAAGTTGATGGA
Tamandua        GGGTCTGAATTAAATGCAGAAGTAGCTGATGCATCAAAAGTTCCAAATGACGTAGATAGA
Bradypus        GGGTCTGAATCAAATGCAGAAGTAGTTGGTGCATTGAAAGTTCCAAATGAAGTAGATGGA
Dasypus         GGGTCTGAATTAAATGCAGAAGTAGCTGGTGCATTGAAAGTTTCAAAAGAAGTAGATGAA
Chaetophractus  GGGTCTGAATCAAAAGCAGAAGTAGCTGGTGCATTAAAAGTTCCAAATGAAGTAAATGGA
Loxodonta       GGGCCTGAATCCAGTGCAGAAGTAGCTGGTGCATTAGAAGTTCCAAATGAAGTACAT---
Elephas         GGGCCTGAATCCAGTGCAGAAGTAGCTGGTGCATTAGAAGTTCCAAATGAAGTACAT---
Dugong          GGGTCTGAGTCAAATGCAGAAGTAGCTGGTGCTTTAGAAGTTCCAGAAGAAGTACATGGA
Trichechus      GGGTCTGAATCAAATGCAGAAGTAGCTGGTGCATTAGAAGTTCCAGAAGAAGTACATGGA
Procavia        GGGTCTGAATTAAATGGAAAAGTGGCTGGTCCAGTAAAACTTCCAGGTGAAGTACATAGA
Dendrohyrax     GGGTCTGAATTAAATGGAAAAGTGGCTGGTCCAGTAAAGCTTCCAGGTGAAGTACATAGA
Orycteropus     GGGTCTGAATCAAATGCAGAAATAGGTGGTGCATTAGAAGTTTCAAATGAAGTACATAGT
Tenrec          CGGCCTGAGTCAGGCGCAGACGTAGCTGTAGCCTTCGAAGTTCCAGACGAAGCATGTGAA
Echinops        CGGCCTGAATCAGATGCAGACGTCGCTGGGGCCTTCGAAGTTCCAGATGAAGCACGCGAA
Elephantulus    ---TCTGAATCGAATGTAGTAATAGCTGGTGAAGTGGAAGTTCCAAATGAAGTACACGGA
Rhynchocyon     GGGTCTGAATCAAATACAGCAATAACTGGTGCACTGGAAGTTTCAAAGGAAGTACATGGA
Amblysomus      GGGTCTGAATCAAATGCAGAGGTTGCTTGTAAATTCGAATTTCCCAAGGAAGTACAAGGA
Vombatus        AGCCATGAGCAGAGCGCAGAGGTGCCTAGTGCCTTAGAAGATCCAGATACCGCAGAGGGA
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Homo                TATTCTGGTTCTTCAGAGAAAATAGACTTACTGGCCAGTGATCCTCATGAGGCTTTAATA
Pan                 TATTCTGGTTCTTCAGAGAAAATAGACTTACTGGCCAGCGATCCTCATGAGGCTTTAATA
Gorilla             TATTCTGGTTCTTCAGAGAAAATAGACTTACTGGCCAGTGATCCTCATGAGGCTTTAATA
Pongo               TATTCTGGTTCTTCAGAGAAAATAGACTTACTGGCCAGTGATCCTCATGAGGCTTTAATT
Macaca              TATTCTGGTTCTTCAGAGAAAATAGACTTACTGGCCAGTGATCCTCATGAGCCTTTAATA
Alouatta            TATTCTAGTTCTTCAGAGAAAATAGACTTACTGGCCAGTGATCCTCATGATCATTTGATA
Otolemur            TATTCCAGTTCCTCAGAGAAAATAGACTTACTGGCCAGTGATCCTCATTATCCTATAATA
Cynocephalus        TATTCTGATTCTTCAGAGAAAGTTGATTTAATGGCCAGTGATCCTCATGATGCTTTAATA
Tupaia              TATTCTGGTTCTTCAGAAAAAATAGACTTAATGGCCAACAATCTTCATGATGCTTTAATA
Lepus               TATTCTGGTTCTACAGAGAAAATAGACTTACTGGCCAGTGATTCCCATAATGCTTTAATA
Hystrix             CTAGATGGCTCTTCAGAGAAAGTAGGCTTGCTGACCAGCAGTCCTCAAAAAGCTATAATC
Pedetes             CATTCTGGTTCTTCAGAGAAAATAGACTTACTAGCCAGTGATCCTCATAATGCTTTAACA
Aplodontia          TTTTCAGGTTCTTCAGGGAAAATAGACTTATTGGCCACTGATCCGTATAATGCTTTAATT
Sciurus             TTTTCTGGTTCTTCAGAGAAAATAGACTTGTTGGCCACTGATCCACATAATGCTTTAATG
Glaucomys           TTTTCTGGTTCTTCGGAGAAAATAGACTTGTTGGCCACTGATCCGCATAATGCTTTAATT
Graphiurus          AATTCTGGTTCTTCAGAGAAAATAGACCTACTGGCCAGTGATCCACATAATGCTTTAATA
Oryzomys            TGTTCCAGTTCTTCAAAGGAGACAGACTCTGTGGCCATTCATCCCCACAGTGCTTTAATG
Meriones            TGTGTCAGTAATTCAAAGAAAACAGACTTGGTAACCTCTGATCCCCATCATGCTGTAATG
Mus                 GGTTTTAGTTCTTCAAGGAAAACAGACTTAGTAACCCCCGACCCCCATCATACTTTAATG
Rattus              TGTTTCAGTTCTTCAAAGAAAATAGACTTAGTTGCCCCTGATCCCGATAATGCTGTAATG
Scalopus            TTTTCTGGTTCTTCAGAGAAAATAGACTTAATGGCCAGCGATCCTCCC---GCTTTAATG
Erinaceus           TTTTTTGGTTCTTCAGAGAAAATAAACTTAACAGCCAGTGATCCTCATGTTGCTTTAATA
Myotis              TATTCTGGTTCTCCAGGGAAAATAACCTTAATGGCCCATGATCCTCATGGTGCTTTAACC
Tadarida            TATTCTGGTTCTCCAGAGAAAATAGCCTTAATGGCCTGTGATCCTCCTGATGCTTTAATA
Taphozous           TATTCTGATTCTCCAGAGAAAATAGGCTTAATGGCCAGTGATCCTCTTGGTGCTTTACTA
Tonatia             TGCCCTGGCTCTCCAGAGAACACAGCCTCGCCGGCCGGCGAGCCTCATGGCGCTTTAATG
Megaderma           TATTCTGGTTCTTCAGAGAAAATAGCTTTAATGGCCAGTGATCCTCCTGGTGCTTCAATT
Pteropus            TACTCTGGTGCTTCAGAGAAAATAGCTTTAAAGGCCAATGATCCTCATGGTGCTTTAATG
Hipposideros        TTTTCTGGCTCTACAGAGAAAATAACCTTAATGACCAGTGATCCTCATGATGCTGTAATA
Cynopterus          TACTCTGGTGCTTCAGAGGAAATAGCCTTAAAGGCCAGTGATCCTCATGGTGCTTTAATA
Equus               TATTCTGGTTCTTCAGAGAAAATAGACTTAATGGCCGGTGATCCTTCTAGTGCTTTAATA
Diceros             TATTCTGGTTCTTCAGAGAAAATAGGCTTAATGGCCAGTGATCCTCCTGGTGCTTTAATA
Manis               AATTGTGGTTCTTCAGAGAAAAAAGACTTAATGGCCAGTGATCCTCATGATGCTTTAATA
Canis               TATTCTGGTTCTTCTGAGAAAATAGACTTAATGGCCAGTGATCCTCAGGATGCTTTCATA
Felis               TATTCTGGTTCTTCTGAGAAAATAGACTTAATGGCCAGTGATCCTCATGATGCTTTGATA
Sus                 CATTTGGGTTCTTCAGAGAAAATAGACTTAATGGCCAGTGACCCTCATGGTGCTTTAATA
Lama                TATTCAGGCTCTTCAGAGAAAATAGACTTAATGGCCAGTGATCCTCATGGTGCTTTAAAA
Bos                 TATTCAGGTTCTTCAGAGAAAATCAACTTAATGGCCAGTGATCCTCATGGTACTTTAATA
Hippopotamus        TGTTTGGGTTCTTCAGAGAAAATAGATTTAATGGCCCGTGACCCTCGTGGTGCCTTAATA
Megaptera           TATTTGGGTTCTTCAGAGAAAATAGACTTAATGGCCAGTGATCCTCATGGTGCTTTAATA
Physeter            TATTTGGGTTCTTCAGAGAAAATAGACTTAATGGCCAGTGATCCTCATGGTGCTTTAATA
Tamandua            TATTCTGGTTCTTCAGAGAAAATAGACTTAATAGCCAGTGACCCTCATAATGCTTTAATA
Bradypus            TATTCTGGTTCTTCAGAGAAGATAGACTTAATAGCCAGTGATCCTCACAATGCTTTAATA
Dasypus             TATTCTAGTTTTTCAGAGAAGATAGACTTAATGGCCATTAATCCTCATGATACTTTACAA
Chaetophractus      TATTCTAGTTCTTCAGAGAAGATAGACTTATTGGCCAGTGATCCTCATAATGCTTTAATA
Loxodonta           ---TCTAATTCTTCAGAGAAAATAGACCTAATGGCCAGTGATCTGCATGGTGCTTTAATA
Elephas             ---TCTAATTCTTCAGAGAAAATAGACCTAATGGCCAGTGATCTGCGTGGTGCTTTAATA
Dugong              TATTCTAGTTCTTCAGAGAAAATAGACTTAATGGCTAGTGATCCTCATAGTGCTTTAATA
Trichechus          TATTCTAGTTCTTCAGAGAAAATAGACTTAATGGCCAGTGATCCTCATAGTGCTTTAATA
Procavia            TATTCTAGTTTTCCAGAGAACATAGATTTAATGGCCAGTGGTCCTCCTGGT---------
Dendrohyrax         TATTCTAGTTTTCCAGAGAACATAGATTTAATGGCCAGTGGTCCTCCTGGTGATTTAATA
Orycteropus         TACTCTGGTTCTTCAGAGAAAATAGACTTAATGGCCAGTGAACCTCATGTTGCTTTAATA
Tenrec              TCTTATAGTTCTCCAGAGAAAACAGACCTGATGGCCAGGGACCCTCCTATTCCCTTACTG
Echinops            TCTTCTAGTTCACCAGAGAAAACAGACTTGATGGTCAGTGATCCTCATGTTCCTTTACTG
Elephantulus        TATTCTATTTATTCAGAGAAATTAGACTTAATGCCCAACAATCCTCATGATACTTCACTG
Rhynchocyon         TATTCTAGTTCTTCAGAGAAAGTACACACAATGACTGGTGATCCTCAGGGTGCTTCAGTA
Amblysomus          TATTCTAGTTCTTCAGAGAAAATGGACTTAATGGCCAATGATCCTCATGATGCTTTAATA
Vombatus            AATTCTAGCGTTTCTGAGAAGACTGACCCAGTGGCTGACAGCACTGATGATGCCTGGCTA
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Homo              TGTAAAAGTGAAAGAGTTCACTCCAAATCAGTAGAGAGTAATATTGAAGACAAAATATTT
Pan               TGTAAAAGTGAAAGAGTTCACTCCAAATCAGTAGAGAGTAATACTGAAGACAAAATATTT
Gorilla           TGTAAAAGTGAAAGAGTTCACTCCAAATCAGTAGAGAGTAATATTGAAGACAAAATATTT
Pongo             TGTAAAAGTGAAAGAGTTCACTCCAAATCAGTAGAGAGTAATATTGAAGACAAAATATTT
Macaca            TGTAAAAGTGAAAGAGTTCACTCCAGTTCAGTAGAGAGTAATATTAAAGACAAAATATTT
Alouatta          TGTAAAAGTGAAAGAGTTCACTGCAAATCAGTAGAGAGTAGTATTGAAGATAAAATATTT
Otolemur          TGTAAAAGTGAAAGAGTTCACTCCAAACCAATAAAGAGTAAAGTTGAAGATAAAATATTT
Cynocephalus      TGTAAAAGTGAAAGAATCCACTCCAGACCAGTAGAGAGTAATATCAAAGATAAAATATTT
Tupaia            AGTAAAAGTGAAGGAATCTACTCCAAACCAGTAGAGGGTAATATTGAAGATAAAATATTT
Lepus             TGTGAAAGCAAAAGAGTCCATTCCAAACCAGTAGAGAATAATATCAAAGATAAAATATTT
Hystrix           TGTGCCAGGGAGAGGGTCTGCTCCAAAGCACTGAAGAGTGACATGGAAGATAAAGTATTT
Pedetes           TGTAAAAGTGAAAGAGTCTGCGCTAAGCCAGTGGAGAGTAATATTGAAGATAAAGTATTT
Aplodontia        TCCAAACGTGAAAGAGTCTGCTCAAAAGCAGTAGAGAGTAATATTGAAGATAAAATATTT
Sciurus           TCTAAATGTGAAAGAGTCTGCTCCAAAGCAGTCGAGAGTAATATTGAAGATAAAATATTT
Glaucomys         TCTAAATGTAAAAGAGTCTGCTCCAAAGCAGTCAAGAGTAATATTGAAGATAAAATATTT
Graphiurus        TGTAAAAGTGAAAGAGTCCGCTCCAAACCAGTAGAGAGTAATATTGAAGACAAAATATTT
Oryzomys          GATAAAAGCAAAAGAGACTGC---AAACCAGTGGAGAAAAATATCAAAGACAAAATATTT
Meriones          TGTAAAAGTGAAAGAGACCTCTCCAAACCAGTAAAGAACAATATCAAAGATAAAATATTT
Mus               TGTAAAAGTGGAAGAGACTTCTCCAAACCAGTAGAGGATAATATCAGTGATAAAATATTT
Rattus            TGTACAAGTGGAAGAGACTTCTCCAAGCCAGTAGAGAATATTATCAACGATAAAATATTT
Scalopus          TGTAAAAGTGAAAGAGTCCGCACCAAACCAGTAGAAAGTAATATTGAAGATAAGATATTT
Erinaceus         CGTGAAGGTGAAGGAGTCCACTTCAAACCAGTAAAGAATAATATTGAAGATAAAATATTT
Myotis            TGTGAAAGTGAAAGAGTTCACTCCAAACCAGTAGAAAGTAATATTGAAGATAAAATATTT
Tadarida          TGT------GAAAGAGTCTCCTCTAAACCACTAGAAAGTAATATTGAAGATAAAATATTT
Taphozous         TGTGAAAGTGAAAGAATCCACTCCAAACCAGTAGAAAGTAATATTGAAGATAAAATATTT
Tonatia           TGCGGAAGTGAAAGCGTCCACTCCAAACCAGTGGAGAGTAATATTGAAGATAAAATATTT
Megaderma         TGTGAAAGTGAAAGAGTCTACTCCAAACCAGTAGAAAGTAATATTGAAGATAAAATATTT
Pteropus          TGC------GAAAGAGTTCACTCCAAACTGGTAGAAAGTAATATTGAAGATAAAATATTT
Hipposideros      TGTGAAAGTGGAAGAGTCCACTCCAAACCATTGGAAAGTACTATTGAAGATAAAATATTT
Cynopterus        TGT------GAAAGAGTTCACTCCAAATTGATAGAAAGTAATATTGAAGATAAAATATTT
Equus             TGTGAAAGTGAAAGAGTCCGCTCCAAACCAGTAGAGAATAATATTGAAGATAGAATATTT
Diceros           TGTGAAAGTGAAAGAGTCCACTCCAAACCAGTAGAGAATAATATTGAAGATAAAATATTT
Manis             CGTGAAAGTAAAAGAGGCCACTCCAAACCAGTAGAGAGTAATACTGAAGATAAAATATTT
Canis             TGTGAAAGTGAAAGAGTCCACACCAAGCCAGTAGGAGGTAATATCGAAGATAAAATATTT
Felis             TGTGAAAGTGAAAGAGTTCACACCAAACCAGTAGAGAGTAATATTGAAGATAAAATATTT
Sus               CGTGAACGTGAAAGAGGGCACTCCAAACCAGCAGAGAGTAATATTGAAGATAAAATATTT
Lama              TGTGAAAATGAAAAAGTCCACGCCAAACCAGTAGGGAGTAACATTGAAGATAAAATATTT
Bos               CAC------GAAAGAGTCCACTCCAAACCCGTAGAGAGTAATATTGAAGATAAAATATTT
Hippopotamus      CGTGAAAGTGAAAGAGTCCACGCCAAACCAGTAGAGAGTAATATTGAAGATAAAATATTT
Megaptera         CGTGAAAGTGAAAGAGTCCACTCCAAACCAGTAGAGAGTAATATTGAAGATAAAATATTT
Physeter          CGTGAAAGTGAAAGAGTCCACTCCAAACCAGTAGAGAGTAATATTGAAGATAAAATATTT
Tamandua          TGTGCAAGTGAAAAAGTCCAGTCCAAACCAACAGAGAGTAATATCAAAGATAAAATATTT
Bradypus          TTTGCAGGTGAAAGAGTCCAGTCCAAACCAACAGAGACTAACATTGAAGATAAAATATTT
Dasypus           TTTGCAAGTGAAAGAGTCCAATTGAAACCAGCAGAGAGTAACATCAAAGATAAAATATTT
Chaetophractus    TTTGCAAGTGAAAGAGTCCAATCCAAACCAGCAGAGAGTAACATCAAAGATAAAATATTT
Loxodonta         TGTGAAAGTGAAAGAGTCCCCTCCAAACCAGCAGAAAGTAACATCGAAGATAAAATATTT
Elephas           TGTGAAAGTGAAAGAGTCCCCTCCAAACCAGCAGAAAGTAACATCGAAGATAAAATATTT
Dugong            TGTGAAAGTGAAAGAGTCCTCTTCAAACCAGCAGAAAGTAACATTGAAGATAAAATATTT
Trichechus        TGTGAAAGTGAAAGAGTCCTCTCCAAACCAGCAGAAAGTAACATTGAAGATAAAATATTT
Procavia          ---------GAAAGAATCCCCTGCAAACCACCAAAAAGTAACATCAAAGATAAAATATTT
Dendrohyrax       TGTGAAAGTGAAAGAATCCCCTGCAAACCACCAAAAAGTAACATCAAAGATAAAATATTT
Orycteropus       TGTGAAAGTGAAAGAGTCCTCTCCAAACCAGCAGAAAGTAACATCGAAGATAAGATATTT
Tenrec            CATAAAAGCGCAAGAGTCTTTTCCAAACCAGTAGAAAGTAACATCGAAGACAAAATATTT
Echinops          CCTAAAAGTGAAATAGTCCTTTCCAAACCAGTAGAAAGTAACATCGAAGACAAAATATTT
Elephantulus      TATGAAAGTGAAAGAACCCTCTCCAAACCAGCTGAAAACAACATTGAAGATAAAATATTT
Rhynchocyon       TGTGAAAGTGAAAGAGTCTTCTCTAAACCAGCAGAAAATAACGTTGAAGATAAAATATTT
Amblysomus        TGTGAAAATGAGAGAATCCTCTCCAAACCAGCTGTAAGTAACATTGAAGATAAAATTTTT
Vombatus          CATGTGCCTAAAAGAAGCTGTCTCAGGCCTGCAGAAAACAATATTGAAGATAAAATATTT
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Homo              GGGAAAACCTATCGGAAGAAGGCAAGCCTCCCCAACTTAAGCCATGTAACTGAAAATCTA
Pan               GGGAAAACCTATCGGAGGAAGGCAAGCCTCCCCAACTTAAGCCATGTAACTGAAAATCTA
Gorilla           GGGAAAACCTATCGGAGGAAGGCAAGCCTCCCCAGCTTAAGCCATGTAACTGAAAATCTA
Pongo             GGGAAAACCTATCGGAGGAAGGCAAGCCTCCCCAACTTAAGCCATGTAACTGAAAATCTA
Macaca            GGGAAAACCTATCGGAGGAAGGCAAACCTTCCCAATTTAAGCCATGTAACTGAAAATCTA
Alouatta          GGGAAAACCTATCGGAGGAAGGCAAGCCTCCCTAACTTGAGCCACGTAACTGAAAATCTA
Otolemur          GGGAAAACTTATCGGAGGAAGGCAAGCCTCCCTAACTTAAGCCATGTAACTGAAAATCTA
Cynocephalus      GGGAAAACCTATCAGAGGAAGACAAGCCTCCCTAACTTGAGCCACGTAAATGAAGATCTA
Tupaia            GGGAAAACCTATCGGAGGAAAGCAAGTCTTCCTAACTTGAGCCGTGTAACTGATGATCTA
Lepus             GGGAAAACCTACCACAGGAAGACAAGCCTCCCTAACTTGAGCCACATAACTGAAGATCTA
Hystrix           GGGAAAACCTATCAGAGGAGGGTGAGCCTCCGCAGCTCAAGCCACGGAGCTGAAAGTCTG
Pedetes           GGGAAGACCTATCGGAGGAAGATAAGCCTCCCTAATTTGAGCCCCATAACTGAAAATCTA
Aplodontia        GGGAAAACCTATCGGAGGAAGGCGAGCTTCCCTAATTTGAGCCACGTAACTGAAAATCTA
Sciurus           GGGAAAACCTATCGGAGGAAGGCAAGCCTCCCTAACTTGAGCCATATAACTGAAAATCTA
Glaucomys         GGGAAAACCTATCAGAGGAAGGCAAGCCTCCCTAACTTGAGCCATATAACTGAAAATCTA
Graphiurus        GGGAAAACCTATCGGAGGAAGGCGAGCCTCCCTAACTTGAGCCATGTTCCTGAAAATCTA
Oryzomys          GGGAAAACATATCAGAGAAAGGGAAGCTTCCCTCAGTTGAACCACGTAACTGAA------
Meriones          GGGAAAACATATCAGAGAAAGGGAAGCCTCCCTCACTTGAACCATGTGACTGAA------
Mus               GGGAAATCCTATCAGAGAAAGGGAAGCCGCCCTCACCTGAACCATGTGACTGAA------
Rattus            GGGAAAACCTATCAGAGAAAGGGAAGCCGCCCTCACTTGAACCATGTGACTGAA------
Scalopus          GGGAAAACCTATCGGAGGAAGACAAGCCTCCCAAACTTGAGCCACGTGGCTGAATATTTA
Erinaceus         GGGAAAACCTATGGGAGGAAGGCAAGCCTTCTTAATTTGAGCCACGTAACTGAAGATGTA
Myotis            GGGAAAACCTATCGGAGGAAGGCAAGCCTCCCAAACTTGAGCCACATAACTAAAAATCTA
Tadarida          GGGAAAACCTATCGGAGAAAGGCAAGCTTCCCTAACTTGAGCCACATAAGTGAAAATCTA
Taphozous         GGGAAAACCTATCGGAGGAAGGCAAGCCTCCCTAACTTGAGCCATATAACTGAAAATCTA
Tonatia           GGGAAAACCTATCGGAGGAAGGCAAGCCTCCCTAACTTGAGCCACGTAACTGACAGGCTA
Megaderma         GGGAAAACCTACAGGAGGAAGGCAAGCCTCCCTAACTTGGGCCACAGAGCTGAAAATCTA
Pteropus          GGGAAAACATATCGGAGGAAAGCAAGCCTCCCTAACTTGAGCCACATAACTGAAAATCTA
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Cynopterus        GGGAAAACATATCGGAGGAAAGCAAGCCTCCCTAACTTAAGCCACATAACTGAAAATCTA
Equus             GGGAAAACCTATCGGAGGAAGGCAAGCTTCCCTAACTTGAGCCACATAACTGAAGATCTA
Diceros           GGGAAAACCTATCGGAGGAAGGCAAGCCTCCTTAACTTGAGCCACATAACTGAAGATCTA
Manis             GGGAAAACCTATCGGAAGAAGGCAAGTCTCTCTCACTTGAGCCACGTAACTGAAAATCTA
Canis             GGAAAAACCTATCGGAGGAAGGCAAGCCTCCCTAAGGTGAGCCACACAACTGAAGTTCTA
Felis             GGGAAAACCTATCGGAGGAAGGCAAGCCTTCCTAACTTGAGCCACACAAGTGAAGATCTC
Sus               GGGAAAACCTATCGGAGGAAGGCAAGCCTCCCTAACTTGAGCCACGTAATTGAAGATCTA
Lama              GGGAAAACCTATCGGAGGAAGGCAAGCCTCCCTAACTTGACCCACAGAGCTGAAGATCTA
Bos               GGGAAAACCTATCGGAGGAAGTCAAGTCTCCCTAACTTCAGCCACATAGCTGAAGATCTA
Hippopotamus      GGGAAAACCTATCGGAGGAAGGCAAGCCTCCCTAACTTGAGCCACATAGCTGAAGATCTA
Megaptera         GGGAAAACCTATCGGAGGAAGGCAAGCCTCCCTAACTTGAGCCACATAGCTGAACATCTA
Physeter          GGGAAAACCTATCGGAGGAAGGCAAGCCTCCCTAACTTGAGCCACGTAGCTGAAAATCTA
Tamandua          GGGAAAACCTATCACAGGAAGGCAAGCCTCCCTAACTTGAGCCGTATAGCTAAAGATCTT
Bradypus          GGGAAAACCTATCACAGGAAGGCAAGCCTCCCTAACTTGAGCCACATAGCTGAAAATCTT
Dasypus           GGGAAAACCTATCATAGGAAGGCAAGCCTCCCTAACTTGAGCCACATAACCCGAAACCTT
Chaetophractus    GGGAAAACCTATCACAGGAAGGCAAGCTTTCCTAACTTGAGCCACATAACTGAGGATCTT
Loxodonta         GGGAAAACCTATCGGAGGAAGGCAGGTATGTCTCATTTGAGCCACATAACTGAAGATCTG
Elephas           GGGAAAACCTATCGGAGGAAGGCAGGTATCTCTCATTTGAGCCACATAACTGAAGATCTG
Dugong            GGGAAAACCTATCGGAGGAAGGCAATTCTCCCTCATTTGAGCCATGTAACTGAAGATCTA
Trichechus        GGGAAAACCTATCGGAGGAAGGCAATTCTCCCTCATTTGAGCCATGTAACTGAAGATCTA
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Tenrec            GGGAAAACGTATCGGAGGAAGTCAAGCCTCCTTAACTCGAGCCATGTAACTGAAGATCTG
Echinops          GGGAAAACGTATCGGAGGAAGTCAAGTCTCCTTAACTCGAGCCATGTAACCGAAGATCTA
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Vombatus          GGAAAAACCTATCGGAGAAAGTCAGGTCACCCTAATTTGAATTATGTAACTGAAAACTTG
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Homo	ATTATAGGAGCATTTGTTACTGAGCCACAGATAATACAAGAGCGTCCCCTCACAAATAAA
Pan	ATTATAGGAGCATTTGTTACTGAGCCACAGATAATACAAGAGCGTCCCCTCACAAATAAA
Gorilla	ATTATAGGAGCATTTGTTACTGAGCCACAGATAATACAAGAGCGTCCCCTCACAAATAAA
Pongo	ATTATAGGAGCATTTGTTACTGAGCCACAGATAATACAAGAGCGTCCCCTCACAAATAAA
Macaca	ATTATAGGAGCACTTGTTACTGAGTCACAGATAATGCAAGAGCGTCCCCTCACAAATAAA
Alouatta	ATTATAGGAGCATTTGTTACTGAGCCACAGATAATACAAGAGCATCCTCTCACAAATAAA
Otolemur	ATTATAAGAGCAGCTGCTACTGAGCCACAGATAACACAAGAGTGTTCCCTCACAAATAAA
Cynocephalus	ATTATAGGAGCATTTGTTACAGAACCACAGATAACACAAGAGCGTCCCCTCACAAATAAG
Tupaia	ATTAGAGGGGCATTTGTTACAGAGCCTGAGATAACTCGAGAGCGTCCCTTCACAAATAAA
Lepus	ACTATAGGAGCATTTGCTGCGGAACCACTGGTACCA------TGTCCCCCCGCAAATAAA
Hystrix	ACCGTGGGAGCGTTTGTTAGAGAGCCGCAGCTGACACTGGAGCGCTCCTTCACAAATAAA
Pedetes	ATTGTAGGAGCATTTGCCACAAAACCACAGATAAGACAAGAACATCCCCTCACAAACAAA
Aplodontia	ATTACAGGAGCATGGGCCACAGAACCACAAATAGCACAAGAGCGTCCCTTCACAAATAAA
Sciurus	ATTATAGGAGCATTTGCCACAGAACCACAAATAACACAAGAGCGTCCCCTCACAAATAAA
Glaucomys	ATTATAGGAGCATTTGCCAGAGAACCACAAATAACACAAGAGCGTCCCCTCACAAATAAA
Graphiurus	ATTACAGGAGCATTTGCCACAGAGCCACAGATAACACAAGAGCGTCCCCTCACAAATAAA
Oryzomys	ATTATAAACACATTTACTATAGAACCACAGATAACACAAGAGCATTCCTTCACAAATAAA
Meriones	ATTATAGGTACATTTATTGCAGAACCACAGACGACACAAGAACAGCCCTTCACAAATAAA
Mus	ATTATAGGCACATTTATTACAGAACCACAGATAACACAAGAGCAGCCCTTCACAAATAAA
Rattus	ATTATAGGCACATTTACTACAGAACCACAGATTATACAAGAGCAGCCCTTCACAAATAAA
Scalopus	ATTACAGGGACATCTGTCACAGAACCTCAGATAGTTCAAGAGCGTCCCTTCACAAATAGA
Erinaceus	ATTATA------------AGGGAACCTCAGGTAGCCAAAGAGCCTCTCCTTGCAACTAAA
Myotis	ATTGTAGGAGCATCTGCTATAGAACCTCAGATAGCACAAGAGTGTCCCCTCACAAATAAA
Tadarida	ATTATAGGAGCATCTGCTATAGAACCCCAGGTAACAAAAGAATGTCCCCTCACAAATAAA
Taphozous	ATTATAGGAGCACCTACTATACAATCTCAGATAACACAAAATTGTCCCCTCACAGATAAA
Tonatia	ACTACGGGACTGTCCGCTCCAGACCCTCAGATAACACGAGAGCGTCCCTTCACCAACAAA
Megaderma	ATTATAGGAGCATCTGCTGTAGAACCTCAGATAATACAAGAGTGTCTCCTCATAAATAAA
Pteropus	ATTACAGGAGCATCTGCTATAGAACCTCAGATAACACAAGAGTATCCCCTCACAAATAAA
Hipposideros	ATTATAGGAGCATCTGCTGTAGAACCTCAGATAACACAAGAGTGTCCCCTCACAAACAAA
Cynopterus	ATTACAAGAGCATCTGCTACAGAACCTCAGATAACACAAGAGTGCCCCCTCACAAATAAA
Equus	ATTATAGGGGCATCTGCTATAGAACCTCAGATTACACAAGAGCGTCCACTCACAAATAGA
Diceros	ATTATAGGAGCATCTGCTATAGAATCTCAGATTACACAGGAGCGTCCCCTCACAAATAAA
Manis	ATTATTGGAGCATTTGCAGTAGAACCTCAGATAACACAAGAGCGTCCCCTCAGAAATAGA
Canis	ACTATAGGAGCGTGTGCTATAGAACCTCAGACAATGCAAACCCATCCCTTCATGAATAAA
Felis	ATTATAGGAGCATGTGCTATAGAACCTCAGATAACGCAAGCCTATCCCCTCACAAATAAA
Sus	ATTTTAGGAGCATCTGCTGTAGAGCCTCAAATAACACAAGAGCGCCCCCTCACAAATAAA
Lama	ATTCTAGGAGCATCTGTTCTAGAGCCTCAGATAACACAAGAGCGCCCCTTCACAAATAAA
Bos	ATTCTAGGCGCATTTACTGTAGAACCTCAGATAACACAAGAGCAGCCCCTCACAAATAAA
Hippopotamus	ATTAAAGGAGCATCTGCTGTAGGACCTCAGATAACACAAGAGCGCCCCCTCACAAATAAA
Megaptera	ATTATAGGAGCATCTACTGTAGAACCTCAGATAACACAAGAGCGCCCCCTCACAAATAAA
Physeter	ATTATAGGAGCATCTACTGTAGGACCTCAGATTACACAAGAGCGCCCCCTCACAAATAAA
Tamandua	TTTATAGGAGCTGTTGCTGCAGAACCTAAGATAACACAAGAGCTCCCCCTGACAAATGAA
Bradypus	TTTATAGGAGCCATTGCTACAAAACCTAAGATAACACAAGAGCACCCCCTGACAAAGAAA
Dasypus	TTTATAGGAGCTATTGCTGCAGAGCCCAAGATAACACAAGAGCATTCCCTCCAAAATAAA
Chaetophractus	TTTATAGGAGCTATTGCTACAGAACCCAAGATAATACAAGAGCATTCCCTCACAAATAAA
Loxodonta	ATTATGGGAGCTATTGCTTCAGAACCTCAGATAGCACGAGAACATCCTTTTACAAATAAA
Elephas	ATTATGGGAGCTATTGCTTCAGAACCTCAGATAGCACGAGAACATCCTTTTACAAATAAA
Dugong	ATTATAGGAGCTGTTGCTACAGAACCTCAGATAGCACAAGAACGTCCTCTTACAAATAAA
Trichechus	ATTATAGGAGCTGTTGCTACAGAACCTCAGATAGCACAAGAACGTCCCCTTACAAATAAA
Procavia	GTTAAAGGCGCCATTGCTACACAACCACAGATAGCACGAGAACATCCTCTTACAAATAAG
Dendrohyrax	GTTAAAGGCGCCATTACTACACAACCACAGATAGCACGAGAACATCCTCTTACAAATAAG
Orycteropus	ATTTTAGGAGCTATTGCTACAGAACCTCAGGTTGCACGAGAATGTCCTCTTGGAAATAAA
Tenrec	GTGCTAGGAGCTGCGGCTGCCGTACCTCCGGTAGCACAAGAGCAGCTTCTTACCAGTAAA
Echinops	ATGGTAGGAGCTGCTGCTGCTGTACCTCCGATAGCGCAAGAGCACCTTCTTACCAGTAAA
Elephantulus	ATTACAGGAGCTGTTGCTACAGAATGTCAAACAGCACAAGAACGCCCTCTTACAAATAAA
Rhynchocyon	ATTGTAGGAGCTGTTGCTACAGGACCTCAGACAGCACAAGAACACCCTCTTATAAATAAA
Amblysomus	ATGATAGGAGCTGTTGCTACAGAAGCTCAGATGGCACAAGAACGTCCTCTTACAAATAAA
Vombatus	TTTGCTGAAGCTGTGGCTCCTGATTCCTTGATCCCTCTAGAGGCTCCCAAAAACACCAGG

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Homo                TTAAAGCGTAAAAGGAGACCTACATCAGGCCTTCATCCTGAGGATTTTATCAAGAAAGCA
Pan                 TTAAAGCGTAAAAGGAGAGCTACATCAGGCCTTCATCCTGAGGATTTTATCAAGAAAGCA
Gorilla             TTAAAGCGTAAAAGGAGAGCTACATCAGGCCTTCATCCTGAGGATTTTATCAAGAAAGCA
Pongo               TTAAAGCGTAAAAGGAGAGCTACATCAGGCCTTCATCÇTGAGGATTTTATCAAGAAAGCA
Macaca              TTAAAGCGTAAAAGGAGAACTACATCAGGTCTTCATCCTGAGGATTTTATAAAGAAAGCA
Alouatta            TTAAAGCGTAAAAGGAGAGTTACATCAGGACTTCATCCTGAGGATTTTATCAAGAAAGCA
Otolemur            TTAAAACGTAAAAGGAGAACTACATCAGGTCTTTGTCCTGAGGATTTTATCAAGAAGGCA
Cynocephalus        GTAAAGCCTAAAAGGAGAACTACATCAGGCCTTCATCCTGAGGATTTTATCAAGAAAGCA
Tupaia              TTAAAGCGGAAAAGGAGAACTATATCAGGCCTTCATCCTGAAGATTTTATCAAGAAAACA
Lepus               TTAAAGCGTAAAAGAAGAACTTCTTCAGGCCTTCAACCTGAAGATTTTATCAAGAAGGTA
Hystrix             ATAAAGCGCAAGAGGAGAACCACATCGTGCCTTCATCCTGAGGACTTTGTCAAGAAAGCA
Pedetes             TTAAAACGTAAAAGGAAAGCTACATCATTCCTTCGTCCTGAGGATTTTATCAAGAAAGTA
Aplodontia          TTAAAGCGTAAAAGGAGAACTACACCATGCCTTCATCCTGAGGATTTTATCAAGAAAACA
Sciurus             TTAAAGCGTAAAAGGAGAACTACATCATGCCTTCATCCTGAGGATTTTATCAAGAAAGCA
Glaucomys           TTAAGACGTAAAAGGAGAACTACATCATGCCTTCATCCTGAGGACTTTATCAAGAAAACA
Graphiurus          TTAAAGCGTAAACGGAAATCTACGCTGTGCCTTCATCCTGAGGATTTTATCAAGAAAACA
Oryzomys            TTAAAACGCAAAAGGAGAACTACA---TGCCTTCATCCTGAGGATTTTATCAAGAAAGCA
Meriones            TTAAAGAGTAAAAGGAGAAGTACA---TGCCTTTATCCTGAGGATTTTATCAAGAAAGCA
Mus                 TTAAAACGTAAGAGA---AGTACA---TCCCTTCAACCTGAGGACTTCATCAAGAAAGCA
Rattus              TTAAAACGCAAAAGA---AGTACA---TGCCTTCATCCTGAGGACTTTATCAAGAAAGCA
Scalopus            TTAAAACGTAAAAGGAGAACTCTACCAGGCCTTTGTCCTGAGGATTTTATCAAGAAAGTA
Erinaceus           TTAAAACGTAAAAGGAGAACTGATGTAGGTCTTTGTCCTGAGGATTTTATCAAGAAAGTA
Myotis              CTAAAGCGTAAAAGGAGAAGTACATCNGGCCTTCATCCTGAGGATTTTATTAAGAAAGTA
Tadarida            CTAAAGCGTAAAAGAAGA---ACATCAAGCCTTCATCCTGAGGATTTTATCAAGAAAGTA
Taphozous           CTAAAGCATAAAAGAAGAACTACATCAGGCCTTCGTCCTGAGGATTTTATCAAGAAGGTA
Tonatia             CTAAAGCGTAAAAGGAGAACTACACCGGGCCTTCACCCAGAGGATTTTATCAAGACAGTG
Megaderma           CTAAAGCGTAAAAGGAGAACTACATCAGCCCTCCATCCTGAGGATTTTATCAAGAAAGTA
Pteropus            CTAAAGCGTAAAAGGAGAACTACATCAGGCCTTCATCCTGAGGATTTTATCAAGAAAATA
Hipposideros        CTAAGGCGTAAGAGGCGAACTACGTCAGGCCTTCATCCTGAGGATTTCATCAAGAAAGTA
Cynopterus          CTAAAACGTAAAAGAAGAACTACATCAGGCCTTCATCCTGAGGATTTTATCAAGAAAATA
Equus               GTGAAGCATAAAAGGAGAACGTCATCAGGCCTTCATCCTGAGGATTTTATCAAGAAAGTA
Diceros             CTGAAGCATAAAAGGAGAACTACATCAGGCCTTCATCCTGAGGATTTTATCAAGAAAGTA
Manis               GTAAAGCGTAAAAGGAGAACTACATCAGGCCTTCATCCTGAGGATTTTATCAAGAAAGTA
Canis               GCAGAGCATAAAAGGAGAACTACATCTAGCCTTCATCCTGAGGATTTTATCAAGAAAGTA
Felis               ACAAAGCGTAAAAGGAGATCTACCGCAGGCCTTCATCCTGAGGATTTTATCAAGAAAGTA
Sus                 CTAAAGCGGAAAAGGAGAGGTACATCAGGCCTTGATCCCGAGGATTTTATCAAGAGAGCC
Lama                CTAAAGCGTAAAAGGAGAACTCTACCAGGTCTTCATCCTGAGGATTTTATCAAGAAAGTC
Bos                 CTAAAATGTAAAAGGAGAGGTACATCAGGCCTTCAGCCTGAGGATTTTATCAAGAAAGTC
Hippopotamus        CTAAAGCGTAAAAGGAGGCGGACATCGGGCCTTCATCCTGAGGATTTTATCAAGAAAGTC
Megaptera           CTAAAGCGTAAAAGGAGAAGTACATCAGGCCTTCATCCTGAGGATTTTATCAAGAAAGTC
Physeter            CTAAAGCGTAAAAGGAGAAGTACATCAGGCCTTCATCCTGAGGATTTTATCAAGAAAGTC
Tamandua            ATGAAGCTTAAAAGGAGGACTACATCAGGACTTCATCCTGAGGATTTTATCAAGAAAGTA
Bradypus            ATAAAGCATAAAAGTAGGACTACATCAGGCCTTCATCCTGAGGATTTTATCAAGAAAGTC
Dasypus             ATAAAGCGTAAAAGGAGAACTGCATCAGGCCTTCGTCCTGAGGATTTATCCAAGAAAGTA
Chaetophractus      ATAAAGCGTAAAAGGAGAACTACGTCATGCCTTCATCCTGAGGATTTTATCAAGAAAGTA
Loxodonta           TTAAAGCGTAAAAGGAGA---ACATCAGGCCTTCATCCTGAGGATTTTATCAAGAAAGTA
Elephas             TTAAAGCGTAAAAGGAGA---ACATCAGGCCTTCATCCTGAGGATTTTATCAAGAAAGTA
Dugong              TTAAAGCGTAAAAGGAGA---ACATCAGGCCTTCATCCTGAGGATTTCATCAAGAAAGTA
Trichechus          TTAAAGCGTAAAAGGAGA---ACATCAGGCCTTCATCCTGAGGATTTCATCAAGAAAGTA
Procavia            TTACAGCATAAAAGGAGA---ACATCAGGCCTTCATCCTGAGGATTTTATCAAAAAAGCA
Dendrohyrax         TTACAGCATAAAAGGAGA---ACATCAGGCCTTCATCCTGAGGATTTTATCAAAAAAGCA
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Echinops            TTAAAACGC---AGAAGA---TCATCCGTCCTCCACCCTGAGGACTTTATCAAGAAAGCA
Elephantulus        TTAAAGCGTAAAAGAAGA---ACATCAGGCCTTCAGCCTGAGGATTTTATCAAGAAGGTA
Rhynchocyon         CTAAAGCGTAAAAGGAGA---ATATCTGGCCTTCGTCCTGAAGATTTTATCAAGAAGGTA
Amblysomus          TTAAAGCGCAAAAGGAGA---ACCTCAGGCCTTCATCCTGAGGATTTTATCAAGAAAGCA
Vombatus            TTAAAGCGTAAAGGAAGGAGCATAGCTGACCTGCAGCCTGAGGATTTCATCAGGAAGACG
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Homo            GATTTGGCAGTT---CAAAAGACTCCTGAAATGATAAATCAGGGAACTAACCAAACGGAG
Pan             GATTTGGCAGTT---CAAAAGACTCCTGAAATGATAAATCAGGGAACTAACCAAATGGAG
Gorilla         GATTTGGCAGTT---CAAAAGACTCCTGAAATGATAAATCAGGGAACTAACCAAATGGAG
Pongo           GATTTGGCAGTT---CAAAAGACTCCTGAAATGATAAATCAGGGAACTAACCAAATGGAG
Macaca          GATTTGGCAGTT---CAAAAGACTCCTGAAATAATAAATCAGGGAACTAACCAAATGGAG
Alouatta        GATTTGGCAGTT---CAAAAGACTCCTGAAAAGATAAATCAGGGAACTAACCAAACAGAG
Otolemur        GATTTGGCAGTTGTTCAAAAGACACCTGAAAAGAGAATTCAGGGAACTAACCAAGTGGAT
Cynocephalus    GACTTGGCAGTTGTTCAAAAAACTCCTGAAAAGATAAATCAGGGAATTGACCAAATGGAG
Tupaia          GATTTGGCAGTTGTTCAAAAGACTCCTGAAAAGATAAATCAGAGAACTGACCAAATAGAG
Lepus           GATTTGGCAGTTGTTCCAAAAACCACTGCACAGATAAATCAGGGAACTGATCAAACGGTG
Hystrix         GATTTGACAGTGGCTCAAAAGACTCCTGAAAAGGTAAATCAGGGAACGAAGCAAATGGAG
Pedetes         GATTTGACAGTTATTCAAAAGACTCCTGAAAAGATAAATCAGGGAACTGCCCAAATGGGG
Aplodontia      GATTTAACAGTTGTTCAAAAGACTACTGAAAACATAAATGAGGGAACTGAGCAAATGGAA
Sciurus         GATTTGGCAGTTGTTCAAAAGACTCCTGAAAAGATGAATCAGGGAACTGACCAAATGAAA
Glaucomys       GATTTGGCAATTGTTCAAAAGACTCCTGAAAAGATAAATCAGGGAACTGACCAAATGGAA
Graphiurus      GATTTGACAGTTGTTCAAAAGACTCCTGAAAAGGTAAATCAGGAAACTGACCAAATGGAA
Oryzomys        GATTTAACAGTTATTCAAAAGACTCCAGAAAATAGAAATCAGGAAGCTGACCAAATAAAG
Meriones        GATTTAACCATTGTTCAAAAGACTCCTGAAAATATAAATCAGGGAACTGACCAAATGGAG
Mus             GATTCAGCAGGTGTTCAAAGGACTCCTGACAACATAAATCAGGGAACTGACCTAATGGAG
Rattus          GATTTAACAGTTGTTCAAAGGATTTCTGAAAATTTAAATCAGGGAACTGACCAAATGGAG
Scalopus        GATTTGGAAGTTGTTCAGAACACCCCTGAAAAGATAAGTGCGGGAACTGATCAAATGGAT
Erinaceus       GATGTGGCAATTGTTCAGAAGACTCCTGAAAAGATAATCAAGAGACCTGGCCAACTGGAT
Myotis          GATTTGGCAGTTGTTCAAAAGACTCCTGAAGAGATAATTAAGGGAACTGACCGAATAGAA
Tadarida        GATTTGGCAGTTGTTCAAAAGACTCTTGAAAAGGTAATTGAGGGAACTGACCAAATAGAA
Taphozous       GATTTGGCAGCTGTTCAGAAGACTCCTGAAAAGATAATTGAGGGAACTGATCAAACAGAA
Tonatia         GATTTGACCGTTGTCCAGAAGACTCCTGAGAAGACCATTGAGGGAACTGACCAAACAGAA
Megaderma       GATGTGGCAGTTGTTGAAAAGATTCCTGGAGATAGAATCAAGGGAACTGACCAAATAGAG
Pteropus        GATTTGGCAGTTGTTCAGAAAACTCCGGAAAACATAATTGAGGAAACTGACCAAATAGAG
Hipposideros    GATTTGACAGTTGTTCAAAAGACTCCTGAAAAGATAATTGAGAGAACTCACCAAACAGAA
Cynopterus      GATTTGACAACTGTTCAAAAAACTTCTGAAAATATAATTGAGGGAACTGACCAAATAGAG
Equus           GATTTGGCAGTTGTCCAAAAGACTCCTGAAAAGATAATTGAGGGAACTGACCAAATAGAG
Diceros         GATTTGGCAGTTGTCCAAAAGACTCCTGAAAAGATAATTGAGGGAACTGACCAAATAGAG
Manis           GATTTGGAAGTTGTTCAAAAGACTCCTGAAAAGATAATTGAGGGAACCGACCAAATAGAG
Canis           GAGTTAGGCATTGTTCCAAAGACTCCTGAAAAGCTAATTGAGGGAATCAACCAAATCAAG
Felis           GATTTGGCCATTGTTCAAAAGACTCCTGAAAAGCTAATTGAGGGAACCGATCGAATAGGG
Sus             GATTCGGCAGTTGTTCCAAAAACTCCTGAAAAGACAATTGAGGGAACTGATGAGACAGAG
Lama            GATTTGGCCGTTGTTCAAAAGTCTCCTGAAAAGATAATTGAGCGAACAGACCAAACAGAG
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Dugong          GATTTGGCAGTTGTTCAAAAGACTCCTGAAAAGATAAATCAAGAAACTGACCAAGTGGAG
Trichechus      GATTTGGCAGTTGTTCAAAAGACTCCTGAAAAGATAAATCAGGAAACTGACCAAGTGGAG
Procavia        GATTTGACAGTTGTTCAGAAGGCATCTGAGAAGATAAATCAGGAAACTGACAAAGTGGAG
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Orycteropus     GATTTGGCAGTT---CAAAAGACTCCTGAAAAGATAAATCAGGAAAATGACCAAATGGAA
Tenrec          GATTTGGCTGTCGTTCAAAAGACTCCTGAAACGATCCATCAGGGACCTGACCCAATGCAG
Echinops        GATTTGGCAGTTGTT------------GAAAAGATCAACCAGGGAACTGACCAAACACGG
Elephantulus    GATTTGACAGTTGTTCAAAAGATTCCTGAAAAGACAAATCAGGAAACTGAACAAATGGTG
Rhynchocyon     GATTTGACTAGT---CAGAAGACTCCTGAAAAGAGAAATCAGACCATTTACCAAGTGGAC
Amblysomus      GGCATGAAAGTTGTTCAAAAGACTCCTGAAAAGATAAATCAAGAAACTAACCAAATGGAG
Vombatus        GACGTTCCAGTTATTCACAAAACCCCTGAAAAGAAAAATCACTCTGTTGACCAAATTGAA
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Homo            CAGAATGGTCAAGTGATGAATATTACTAATAGTGGTCATGAGAATAAAACAAAAGGTGAT
Pan             CAGAATGGTCAAGTGATGAATATTACTAATAGTGGTCATGAGAATAAAACAAAAGGTGAT
Gorilla         CAGAATGGTCAAGTGATGAATATTACTAATAGTGGTCATGAGAATAAAACAAAAGGTGAT
Pongo           CAGAATGGTCAAGTGATGAATATTACTAATAGTGGTCATGAGAATAAAACAAAAGGTGAT
Macaca          CAGAATGGTCAAGTGATGAATATTACTAATAGTGCTCATGAGAATAAAACAAAAGGTGAT
Alouatta        CGGAATGATCAAGTGATGAATATTACTAACAGTGGTCATGAGAATAAAACAAAAGGTGAT
Otolemur        CAGAATAGTCACGTGGTAAATATTACTAATAGTGGTTATGAGAATGAAACAAAAGGTGAT
Cynocephalus    CAGAATGATCGAGTGATGAATATTATTAATAGTGGTCATGAGAATGAAACAAAGGATGAT
Tupaia          CATAATGGTCAGGTGATGAGTATTGCTAATAGTGGTCATGAGAATGAAACAAAAGGTGAT
Lepus           GACAGTGATCAGGTGATGAATATTACTAATTGTGGTAATGAGAATGAAACAGAAGGTGAC
Hystrix         GAGAGTAGTCAAGTGACAAATACTACTAATAACAGTCATGAGAATGAGACAAAAATGGGC
Pedetes         CAGAATGGTCAAGTGATAAATAATACCAATAATGATCTTGAAAATGAAACAAAAAATGAT
Aplodontia      CAGAATGATCAAGTAATGAACATTACTAATAGTGGTCAAGAGAATGAAGCAAAAGTTGAT
Sciurus         CAGAATGATCAAGTAATGAATATTACTAATAGTGGTCAAGAGAATGAAACAAAAGTTGAT
Glaucomys       CACAATGATCAAGTAATGAATATTACTAATAGTGGTCAAGAGAATGAAACAAAAGTTGAT
Graphiurus      CAAAATGATCAGGTAATGAGTATTACTAATAGAGGACATGAAAATGAATCAAAAAATGAT
Oryzomys        CCAAATGGCCAAGCGATGGGTATTAACAGTACTGGTCAAGAGAACGAAACAAAAGGGAAC
Meriones        CCAAATGACCAAGTGATGGGTATTACCAGTAATGGTCAGGAAAATGAAACAAAAAATAAT
Mus             CCAAATGAGCAAGCAGTGAGTACTACCAGTAACTGTCAGGAGAACCAAATAGCAGGTAGT
Rattus          CCAAATGACCAAGCAATGAGTATTACCAGTAACGGTCAGGAGAACAGAGCAACAGGTAAT
Scalopus        CAGAGTGGTCAAGTGATGGATGTTGCTTATAATGGTCATGGGAATGAAACAAAACGTGAT
Erinaceus       CAAAGTGACCAAGTAATGAATATTGCTACTAATGGTCATGAAACTGAAACAAAGAGTGAT
Myotis          CAGAATGGTCATGAGATGAATATTACTAATAATGATCATGAGAATGAAACAAAAGGTGAT
Tadarida        CAGAATGGTCATGTGATGAGTATTACTAGTAATTGTCATGAGAATAAAACAAAAGGTGAT
Taphozous       CAGAATGGTTCTGTGATGAATATTACTGATAATGGTCATGAGGATGAAACAAAATGTGAT
Tonatia         CAGAACGGTCGTGTGATGGATATTGCTAACAGTGGTCACGGGAATGAAGCAAAAGGTGAT
Megaderma       CAGCATGGTCATGTGATGAATATTACTAATTATGGTCATGAGAATGAAACA---------
Pteropus        CAGAATGGTCATGTGATGAATAGTACTAATAATGGTCATGAGAATGAAACAAAAGGTGAT
Hipposideros    CAGAATGGTCATGTGATGAACATTACTGATAATGGTCATGGGAATGAAACAAAAGGTGAT
Cynopterus      CAGAATGGTCATGTGATGAATAGTTCTAATGATGGTCATGAGAATGAAACAAAAGGTGAT
Equus           CAGAACAGTCATGTGATGAATATTACTCCTAATGGTCATGGGAATGAAACAAAAGGCGAT
Diceros         CAGAACGGTCGTGTGATGAGTATTGCTAATAATGGTCATGAGAATGAAACAAAAGGTGAT
Manis           CAGAATGCTCTTCTGATGAATAGAACAAATAACGGTCATAAGAATGAAACAAAAGGTGAT
Canis           CGAGATGGTCATGTGATAAATATTACAAATAATGGTCCTGAGAATGAAACAGAAGGTGAT
Felis           CAAAATGGCCATGTGATGAATAGAACAAATAATGGTCCTGAGAATGGGACAAAAGGTGAT
Sus             CAGAATGGTCAGGGGATGAATATTACCAGTAAAGGTCATGAGAATGAAACAAAAAGTGGT
Lama            CAGAATGGTCATGGGATGAATATTACTAGTAATGGTCATGAGAATGAAACAAACGACGAT
Bos             CAGAAATGTCATGGGATGAATATTACTAGTGATGGTCATGAGAATAAAACAAAACGTGAT
Hippopotamus    CAG---------------------------AATGGTCATGAGAATGAAATGAAAGGTGAT
Megaptera       CAGAATGGTCATGGGATGCATGTTACTAGTAATGGTCCTGAGACTGAAATGAAAGATGAT
Physeter        CAGAATGGTCATGGGGTGAATATTACTAGTAATGGTCATGAGACTGAAATGAAAGGTGAT
Tamandua        CAGAATTGTCAACTGATGAATATTGCCAATAGTGGTAATGAAAATGAAACAAAAGGTGAT
Bradypus        CAGAATAGTCAAGTGATAAATATTGCTAATAGTGGTCATGAGAATGAAACAAAAGATGAT
Dasypus         CAGAATGATCCAGTGATGAATATTGCTAATAGTGGTCATGAGAATGAAACAAAAGGTGAT
Chaetophractus  CAGAATGATCAAGTGATGAATAGTGCTAATAGTGGTCATGAAAATGAAACAAAAGGTGAT
Loxodonta       CAGAACGGTCAAGTGATGAATATTGCTAATGGTGGTCGTGAGAATGAAACAAAAGGTGAT
Elephas         CAGAACGGTCAAGTGATGAATATTGCTAATGGTGGTCGTGAGAATGAAACAAAAGGTGAT
Dugong          CAGAATGGTCAAGTGATGAATATTGCTAATGGTGGTCATGGAAATGAAACAAAAGATGAT
Trichechus      CAGAATGGTCAAGTGATGAATATTGCTAATGGTGGTCATGAAAATGAAACAAAAGATGAT
Procavia        CAGAGTGGTCAAGTGATAAATATTGGTAATGGTGGTCATGAGAATGAAACAAAAGATGAT
Dendrohyrax     CAGAGTGGTCAAGTGATAAATATTGCTAATGGTGGTCATGAGAAGGAAACAAAAGATGAT
Orycteropus     CAAAATGGTCAGGAGGAGAATATTGCTGATGGCTGTCATGAGAATGCAACAAAAGGTGAA
Tenrec          CCGAAGGGGCCAGTGCAGAAGATTCCCGATGGTGGTCCCGGGCGAGGGACAAAAGGCGAT
Echinops        CCGAAGGGTCAAGTGGAGCATACTCCCGATGGTGGTCACGGGCATGGAACAAAAGGCAAT
Elephantulus    CAGAATGGTCAAGTGAAGAATATTGCTAGTGGTGGTCATGAGAGTGATACAAAAGGTGAT
Rhynchocyon     ---AGTAGT------------ATTGCTGGCGGTGGTCATGAGCATGAAACGAAAGGTGAC
Amblysomus      CAGAATGATCAAGTGAGGAATATTGTTGATGGTGGTCATGAAAATGATACAAAAAGTGAT
Vombatus        CAAAGTGACCAAGTGATGAACACGGCTAACAGTCTTCCTGAGCAGAAAGCCCTAGGTGGT
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Homo                TCTATTCAGAATGAGAAAAATCCTAACCCAATAGAATCACTCGAAAAAGAATCTGCTTTC
Pan                 TCTATTCAGAATGAGAAAAATCCTAACCCAATAGAATCACTCGAAAAAGAATCTGCTTTC
Gorilla             TCTATTCAGAATGAGAAAAATCCTAACCCAATAGAATCACTAGAAAAAGAATCTGCTTTC
Pongo               TCTATTCAGAATGAGAAAAATCCTAACCCAATAGAATCACTCGAAAAAGAATCTGCTTTC
Macaca              TCTATTCAGAATGAGAAAAATCCTAACCCAATAGAATCACTGGAAGAAGAATCTGCTTTC
Alouatta            TCTATTCAGAATGAGAACAATCCTAACCCAGTAGAATCACTGGAAAAAGAATCA---TTC
Otolemur            TATGTTCAGAATGAAAAAAATGCTAACTCAACAGAATCATTGGAAAAAGAATCTTCTCTC
Cynocephalus        TATGTTCAGAAAGAGAAAAATGCTAACCCAACAGAATCATTGGAAAAAGAATCTGCTTTC
Tupaia              TATATTTCGAAAGAGAAAAATGCTAACCCAATGGAATCATTAGAAAAAGAATCTGCTCTC
Lepus               TATATTCAGAAAGAGACAAATGCTAACCCAACAGAATCCCTAGAAAAAGACTCTTCCTTC
Hystrix             AATGTTCAG------AGAAACCCTAACCCAGTACTATCAGTGGAAAAAGAGTCTGCTTCT
Pedetes             TATGTTCTGAAAGAGAAAAATGCTAACCCAATAGAATCATTGGAAAAAGAGTCTACTCAC
Aplodontia          TATGTTCAGAAAGAGAAAAATGCTAACCCGATAGAATCATTGGAAAAAGAATCTGCTTTC
Sciurus             AATGTTCAGAAAGAGAAAAATGCTAACCCAGTAGAATCATTGGAAAAAGAGTCTGGTTTC
Glaucomys           TATGTTCAGAAAGAGAAAAATGCTAACCCAGTTGAATCATTGGAAAAAGAGTCTGCTTTC
Graphiurus          TATGTTCAAAAAGAGAAAAATGTTAATCTAGTTGAATCATTGGAAAAGGAGTCTGCTTTC
Oryzomys            AGTCTTCAGAAAGAGAAAAATGTTACTCCAATAACATCACTGGGAAAAGAGTCTGTTTTC
Meriones            GATCTTCAGGAAGAGAAAACTGCTAATCCAGTAGGGTCACTGGGAAAAGAGTCTGCTTTC
Mus                 AATCTCCAGAAAGAGAAAAGCGCTCATCCAACTGAATCATTGAGAAAGGAACCTGCTTCC
Rattus              GATCTTCAGAGAGGGAGAAATGCTCATCCAATAGAATCATTGAGAAAGGAACCTGCTTTC
Scalopus            TATGTTCAGAAAGAGAAAAGTGCTAACCCAGCCGAATCTTTAGAAAAAGAATCTACCTTC
Erinaceus           TATGTTCAGAAGGAGAAAAATGCTAACCCAGCAGAATCACCAGACAAAGAATCTGCTTTT
Myotis              TGTGTTCAGAAAGAGAAAAATGCTAACCTAACAGAATCACTGGAAAAAGAATCTGCGTTC
Tadarida            TATGTTCAGAAAGAGAAAAATTCTAACCCAACAGAATCATTGGAAAAAGAATCTGCTTTC
Taphozous           TATGGTCAGAAAGAGAAAAATGCTAACCCAGCAGAATCATTGGAAAAAGAATCTGCTTTC
Tonatia             TATGTTCAGAATGAGAAGAGTTCTGACCCAACAGAATCACTGGGAGAAGAACCCGCTTTC
Megaderma           ------------------AATGCTCACTCAACAGAATCACTGGACAAAGAATCTGCTTTT
Pteropus            TATGTTCAGAAGAAGAAAAATACAAACCCAACAGAATCATTGGAAAAAGAATCTACTTTC
Hipposideros        TATGTTCAGAAAGAGGATAATGCTAACCCAACAGAATCATTGGAAAAAGAATCTGCTTTC
Cynopterus          TATGTTCAGAAGAAGAAAAATACAAACCCAACAGAATCATTGGAAAAAGAATCTGCTTTC
Equus               TATGTTCAGAATGAGAAAAACGCTTACCTAACAGAATCATTGGAGACAGAATCTGCTTTC
Diceros             TATGTTCAGAAAGAGAAAAATGCTAACCCAACAGAATCATTGGAGAAAGAATCTGCTTTC
Manis               TATGTTCAGAAAGAGAAAAATGCTAACCCAACAGAATCATTGAAAAAAGAACCTGCTTTC
Canis               TATGTTCAGAAAGAGAAAAATGCTAACCCAACAGAATCATTGGAAAAAGAATCTGCTTTT
Felis               TATGTTCAGAAAGAGAAAAATGCTAAGCCAACAGAATCATTGGAAAAAGAATCTGCTTTT
Sus                 AATGTTCAGAAAGAGAAAAATGTTAACCCAACTGCATCGTTGGGAAAAGAACCTGCTTTC
Lama                TATGTTCAGAAAGAGAAAAATGCTAACCCAACAGAATCATTGGAAAAAGAATCTGCTTTC
Bos                 TATGTTCAGAAAGAGCAAAACGCTAACCCAGCAGAATCATTGGAAAAAGAATCTGTTTTC
Hippopotamus        TATGTTCAGAAAGAAAAAAATGCTAACCCAACAGAATCTTTGGAAAAAGAATCTGCTTTC
Megaptera           TATGTTCAGAAAGAGAAAAATGCTAACCTAACAGAGTCATTGGAAAAACAATCTGCTTTC
Physeter            TGTGTTCAGAAAGAGAAAAATGCTAACCTAACAGAATCATTGGAAAAAGAATCTGCTTTC
Tamandua            TTTGTTCAGAAGGAGAAAAGTGCTAACCCAACAGAATCATCAGAAAAAGAATCTGCTTTC
Bradypus            TATGTTCAGAAAGAGAAAAATGCTAACCCAACAGAATCATTGGAAAAAGAATCTGCTTTC
Dasypus             TGTGTTCAGAAAGAGAAAAATGCTAATCCGACAGAATCATTGGGAAAAGAATCTGCTTTC
Chaetophractus      TATGTTCAGAAAGAGGAAAATGCTAACCCAATAGAATCATTGGAAAAAGAATCTGCTTTC
Loxodonta           TATGTTCAGAAAGAGAAGAATGCTATCCCAACAGAATCATTGGCAAAAGAATCTGCTTTC
Elephas             TATGTTCAGAAAGAGAAGAATGCTATCCCAACAGAATCATTGGCAAAAGAATCTGCTTTC
Dugong              TATGTTCAGAAAGAGAAGAATGCTAACCCAACAGAATCACTGACAAAGGAATCTGCTTTC
Trichechus          TATGTTCAGAAGGAGAAGAATGCTAACCCAACAGAATCACTGACAAAGGAATCTGCTTTC
Procavia            TATGTTCTGAAAGAGAAGAATGGTAACCCAGCAGAATCACTGAAAAAAGAATCTGTGTTC
Dendrohyrax         TATGTTCTGAAAGAGAAGAATGGTAACCCAGCAGAATCACTGAAAAAAGAATCTGTGTTC
Orycteropus         TACATGCAGAAAAAGAAGAGTGCAAATCCAACAGAATCATTGGCAACAGAATCTGTTTTC
Tenrec              CGTGTTCCGAAGGAGAAGAGTGCTAACCTGGCAGAAACATCGGCCAAAGAATCTGCCTTT
Echinops            TGTGTTCAGAAGGAG---AGTGCTGACCTGGCAGAATCATCGGCCAAAGAATCTGCCTTT
Elephantulus        TATGTTCAGGAAGAGAAGAATACTAACCCAACAGAGTCACTGGTAAGAGAATCTGATTTC
Rhynchocyon         TGTGTTCAGAAAGAGAAGAATGTTAGCCCAGCAGAATCATTGACAAAAGCTTCTGCTTTC
Amblysomus          TATGTTCAGAAAGAGAAGAGTGCTAACCCAGCCAAATCATTGGCAAAAGAGTCCGCTTTC
Vombatus            CATGTAGGGAAAGATGTTCAGGTATTAGAGCTGTTCTCTGCGGAGAAAGAATCCACTTTC
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Homo                AAAACGAAAGCTGAACCTATAAGCAGCAGTATAAGCAATATGGAACTCGAATTAAATATC
Pan                 AAAACGAAAGCTGAACCTATAAGCAGCAGTATAAGCAATATGGAACTCGAATTAAATATC
Gorilla             AAAACGAAAGCTGAACCTATAAGCAGCAGTATAAGCAATATGGAACTCGAATTAAATATC
Pongo               AAAACAAAAGCTGAACCTATAAGCAGCAGTATAAGCAATATGGAACTCGAATTAAATATC
Macaca              AAAACTAAAGCTGAACCTATAAGCAGCAGTATAAACAATATGGAACTAGAATTAAATATC
Alouatta            AAAAGTAAAGCTGAACCTATAAGCAGTAGTATAAGCAATATGGAATTAGAATTGAATGTC
Otolemur            GGAACTAAAGCTGAACCTATAAGCAGCAGTATAAGTAATATGAAATTAGAATTAAATATT
Cynocephalus        AGAACTAAAGCAGAACCTATAAGCAGCAGTATAAGCAATATGGAAATAGAATTAAATATC
Tupaia              AGAACTAAAGCTGAGCCCATAAGCAGCAGTGTAAGCAATATGGAACTAGAAATAAATAAC
Lepus               AGAACTAAAGTTGAACCTATAAGCAGCAGTATAAGCAATATGGAACTAGAATTAAATGTC
Hystrix             GGTACTAACGCAGAGCCCTCGAGCAGCAGCATAAACAACAGGGAACTAGAATTAAACACC
Pedetes             AGAACTAAAGCTGAACCTATAAGCATCAGTATAAGCAACATGGAACTAGAATTAAATACC
Aplodontia          AGAACTAAAGCTGAACCTATAAGCAGCAGTATAAGTAATATGGAACTGGAATTAAATATT
Sciurus             AAAACTAAAGCTGGACCTATAAGCAGCAGTATAAGCAATATGGAACTAGAATTAAATATC
Glaucomys           AGAACTAAAGCTGAACCTATAAGCAGTAGTATAAGCAACATGGAACTAGAATTAAATATC
Graphiurus          AGAACTAAAGCTGAACCTATAAGTAGTAGTATAAGCAATATGGAACTGGAATTAAATGTC
Oryzomys            ACAACGATAGCCAAGCCTGTAAGCAGCAGTATAAGCAATTTGGAGCTAGAATTAAATGTC
Meriones            ACAGCAAAAGCCAGACCTATAAGCAACAGTATAAGTGATTTGGAGATAGAATTAAGTGTC
Mus                 ACAGCAGGAGCCAAATCTATAAGCAACAGTGTAAGTGATTTGGAGGTAGAATTAAACGTC
Rattus              ACAGCTAAAGCCAAATCTATAAGCAACAGTATAAGTGATTTGGAGGTAGAATTAAATGTT
Scalopus            AGAATTAAAGCTAAGCCCATAAGTAGCAGTATAAGCAATATGGAACTAGAATTAAATATC
Erinaceus           AGAAATAAACCTGAACCTATAAGCAGCAGTATAAGCAATATGGAACTAGAATTAAATGTC
Myotis              ACAAGTAAAGCTGAACCTATAAGCAGCAGCATAAGCAATATGGAACTAGAATTAAATGTC
Tadarida            ACAACTAAAGCTGAACCTATAAGCAGCAGCATAAGCAATATGGAACTAGAGTTAAATATC
Taphozous           AGAACTAAAGCTGAACCTATAAGCAGCAGCATAAGCAACATGGAACTAGAGTTAAATATC
Tonatia             AGAACTAAAGCTGGACCTATAAGCAGCAGCATAAGCACCGTGGGACTAGAATTGAATGTC
Megaderma           AGAACTAAAGCTGAACCTATAAGCAGCAGTATAAGTAATATGGAACTAGAATTAAATATC
Pteropus            AAAACTAAAGCTGAACCTATATGCAGCAGCATAAGCAATATGGAACTAGAATTAAATATC
Hipposideros        AGAACTACAGCTGAACCTATAAGCAGCAGTATAAGCCATATGGAACTAGAATTAAATATC
Cynopterus          AGAACTAAAGTTGAGTCTGTACCCAACAACATAAGCAATGTGGAACTAGAATTAAATATT
Equus               AGAACTAAAGCTGAACCTATAAGCAGCAGCATAGGCAATCTGGAACTGGAATTAAATATC
Diceros             AGAACGAAAGCTGAACCTATAAGCAGCAGCATAAGCAATCTGGAACTGGAATTAAATATC
Manis               AGAACTAGAGCTGAACCTATAACCAGCAATATAAGCAATATGGAGCTAGAATTAAATATC
Canis               AGAACCAAAACTGAACCAATGAGCAGCAGGATAAGCAATATGGAACTGGAATTAAATAGC
Felis               AGAACCAAAGCTGAACCAATAAGCAGCAATATAAGTAATATGGAATCAGAATTAAATAGC
Sus                 AGAGCTAGGGCTGAACCTATAAGCAGCAGTATAAGCAATATGGAACTAGAATTGAATATC
Lama                AAAACTAAGGCTGAACCTATAAGCAGCAGTATAAGCAATATGGAACTAGAATTGAATACC
Bos                 AGAACTGAGGCTGAACCTATAAGCATCAGTATAAGCAATATGGAACTAGAATTGAATATC
Hippopotamus        AGAACTAAGGCTGAACCTATAAGCATCAGTATAAGCAATATGGAACTAGAATTGAATATC
Megaptera           AGAACTAAGCCTGAACCTATAAGCAGCAGTATAGGCAATATGGAACTAGAATTGAATATC
Physeter            AGAACTAAGGCTGAACCTATAAGCAGCAGTATAAGCAATATGGAACTAGAATTGAATATC
Tamandua            AGAACTAAAGGTGAACCTATAAGTAGTAGTATAAGCAATATGAAACTAGAATTAAATACC
Bradypus            AGAACTGAAGGTGAACCCATAAGCAGCAGTATAAGCAATATGGAACTAGAATTAAATATC
Dasypus             AGAACTAAAGGCGAACCTATAAGCAGCAGTATAAGCAATATGGAACTAGAATTAAATATT
Chaetophractus      AGAACTAAAGGTGAACCTATAAGCAGCAGTATAAGCAATATGGAACTAGAATTAAATATC
Loxodonta           AGAACTAAAGCTGAACCTATAAGCAGCAGTATAAGCAATATGGAACTAGAATTAAATATG
Elephas             AGAACTAAAGCTGAACCTATAAGCAGCAGTATAAGCAATATGGAGGTAGAATTAAATATG
Dugong              AGAACTAAAGCTGAACCTATAAGCAGCAGTATAAGCAATATGGAACTAGAATTAAATATG
Trichechus          AGAACTAAAGCTGAACCTATAAGCAGCAGTATAAGCAATATGGAACTAGAATTAAATATG
Procavia            AAAACTAAAGCTGAACCTATAAGCAACAGTATAAGCAATATGGAACTAGAATTAAATACA
Dendrohyrax         AAAACTAAAGCTGAACCTATAAGCAACAGTATAAGCAATATGGAACTAGAATTAAATACA
Orycteropus         AGAACTAAAGCTGAACCTATAAGCAGCAGTATAAGCAATTTGGAACTAGAATTAAATACA
Tenrec              CGAACTGTAGCTGAACCTTTGAGCAGCCGGAAAAGCAGTATGGAACTGGAGTTGCCTGTG
Echinops            CGAACTGTAGCTGAGCCTTTGAGCAGTAGGAAAAGCGGTATGGAACTGGAACCGACTGTG
Elephantulus        AGAAATAAAGCTGAACCTATAAGCAGCAGTATAAGCAAAATGGAGCTAGATTTAAATACA
Rhynchocyon         AGAACTAAGGATGAACCTATAAGCAGCAGTGTGAGCAGTATGGAACTAGAATTAAATATG
Amblysomus          ACAACTAAAGCGGAACCTATAAGCAGTAGTATAAGCAATATGGAACTAGAATTAAATATG
Vombatus            AGAACTGGAACAGAGCCTGTAGCTGGCAGCACAAACCATGGGGAGCTTGAATTAAATAGT
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Homo                CACAATTCAAAAGCACCTAAAAAGAATAGGCTGAGGAGGAAGTCTTCTACCAGGCATATT
Pan                 CACAATTCAAAAGCACCTAAAAAGAATAGGCTGAGGAGGAAGTCTTCTACCAGGCATATT
Gorilla             CACAATTCAAAAGCGCCTAAAAAGAATAGGCTGAGGAGGAAGTCTTCTACCAGGCATATT
Pongo               CATAATTCAAAAGCACCTAAAAAGAATAGGCTGAGGAGGAAGTCTTCTACCAGGCATATT
Macaca              CACAATTCAAAAGCACCTAAAAAAAATAGGCTGAGGAGGAAGTCTTCTACCAGGCATATT
Alouatta            CACAATTCCAAAGCATCTAAAAAGAATAGGCTGAGAAGGAAGTCTTCTACCAGGCATATT
Otolemur            CACAATTCAAAAGCAAGTAAAAAGAAAAGGCTGAGGAAGAAGTCTTCTAGCAGGCATATT
Cynocephalus        CACAATTCAAAACCATCTAAGAAGAATAGGCTGAGGAAGATGTCCTCTACTAGGCATATT
Tupaia              CACAGTTCAGAAGCACCTAAGAAGAATAGGCTGAGGAGAAAGTTTTCTGCTAGGCATATT
Lepus               CATAATTCAAAAAAACCCAAGAAGAATAGGCTGAGGAGGAAGTCCTCTACCAGGCGTGTT
Hystrix             CCTCTTGCAAAAGAACCTAAGGAAGACAGGCTGAGGGGGACGTCCTCAAGCAGACAC---
Pedetes             CACAATTCAAAAGCACCAAAGAAAAATAGGCTGAGGAGGAAGTCCTCTACCAGGCATATT
Aplodontia          CCCAATTCAAAAGCACCTACGAAAAACAGGCTGAGGAGGAAGTCCTCTACTAGGCATATT
Sciurus             CACAATTCAAAAGCACCTAAGAAAAATAGGCTGAGGAGGAAATCCTCTACTAGGCACATT
Glaucomys           CACAATTCAAAAGCACCTAAGAAAAATAGGCTGAGGAGGAAGTCTTCTACTAGGTACATT
Graphiurus          TACAATTCAAAAGCACCTAAGAAAAATAGACTGAGAAGGAAGTCTTCTACCAGGCATATT
Oryzomys            CACAATTCAGAAGCACCTAAGAAAAATAGGCTGAGGAGAAAATCTTCAACCAAATGTGTT
Meriones            TATAATTCAAATGCACCTAAGAAAAACAGGCTGAGGAGGAAGGCTTCTACCGTATGCGCT
Mus                 CACAGTTCAAAAGCACCTAAGAAAAATAGGCTGAGGAGGAAGTCTTCTATCAGGTGTGCT
Rattus              CACAGTTCAAAAGCACCTAAGAAAAATAGGCTGAGGAGGAAGTCT---ACCAGGTGTGTT
Scalopus            CACTCTTCAAAAGCACCTAAGAAGAACAGGCTGAGGAGGAAGTCTTCTACCAAGCATATT
Erinaceus           CACAGTTCAAAAGCACCTAAGAAGAATAAACTCAGGAGAAAGTCATCTGCCAGGCATATT
Myotis              CACAGTTCAAAAGCACCTAAGAAGAATAGGCTGAAGAGGAAGTCCTCTACCAGGCCTATT.
Tadarida            CACAGTTCAAAAGCACCTAAGAAGAATAGGCTGAAGAGGAAGTCCTCTACCAGGCACATT
Taphozous           AACAGTTCAAAAGCACCTAAGAAGAATAGACTGAGGAGGAAGTCCTCTACCAGGCATATT
Tonatia             CACGGTTCAAAAGCGCCCAGGAAGACTAAGCGGAGGGAGAAGACTGCTGCCGAGCATACT
Megaderma           CACAGTTTAAAAGCACCTAAGAAGAATAGGCTGAGGAGGAAGTCCTCTACAAGGCATATT
Pteropus            CACAGTTCAAAAGCAGTTAAGAAGAATAGGCTGAGGAGGAAGTCCTCTACCAGGCATATT
Hipposideros        CATAGTTCAAAAGCACCTAAGAAAAATAGGCTGAGGAGGAAGTCCTCTACCAGGCCTATT
Cynopterus          CACGGTTCAAAAGCACTCAAGAAGAATAGNCTGAGGAGGAAGTCCTNTACCAGGCATATT
Equus               CACAGTTCAAAAGCACCTAAGAAGAATAGGCTGAGGAGGAAGTCTTGTACCAAGCAGATT
Diceros             CACAGTTCAAAAGCACCTAAGAAGAATAGGCTGAGGAGGAAATCCTCTACCAGGCATATT
Manis               CATAGTTCAAAAGTACTTAAGAAGAATAGGCTGAGGAGGAAGTCTTCTACCAGGCACATT
Canis               TCCAGTTCAAAAGCACCTAAGAAGAACAGGCTGAGGAGGAAGTCCTCTGCCAGGCACACT
Felis               CACAGTTCAAGGGCACCTAAGGAGAACAGGCTGAGGAGGAAGTCCTCTACCAGGCACATG
Sus                 CATGGTTCGAAAGCACCAAAG---AACAGGCTGAGGAGGAAGTCCTCTACCAGGCAGATC
Lama                CATAGTTCAAAAGCACCTAAG---AATAGGCCGAGGAGGAAGTCCTCTACCAGGCAGATT
Bos                 CACCGTTCAAAAGCACCTAAG---AATAGGCTGAAGAGAAAGTCCTCTACCAGGAAAATT
Hippopotamus        CACAGTTCAAAAGCACCTAAG---AGTACGCTGAGAAGGAAGTCCTCTACCAGGCAGATT
Megaptera           CATAGTTCAAAAGCACCTAAA---AATAGGCTGAGGAGGAAGTCCTCTACCAGGAAGATT
Physeter            CATAGTTCAAAAGCACCTAAA---AATAGGCTGGGGNGGATGTCCTCTTCCAGGAAGATT
Tamandua            TGCAATTCAAAAGCATCTAAGAAGAATAGGCTGAGGAGAATGTCCTCTACCAGGCATATG
Bradypus            TTCAATTCAAAAGTATCTAAGAAGAATAGGCTGAAGAGGATGTCCTCTACCAGGCATATT
Dasypus             TTAAATTCAAAAGCATCTAAGAAGAATAGGCCGAAGAGGATGTCCTCTACCAGGCATATT
Chaetophractus      TATAATTCAAAAGCATCTAAGAAGAATAGGCTGAGGAGGATGTCCTCTACCAGGCATATT
Loxodonta           CATAATTCAAAAGCACCAAAGAAGAATAGGCTGAGGAGGAAGTCGTCAACCAGACATATT
Elephas             CATAATTCAAAAGCCCCAAAGAAGAATAGGCTGAGGAGGAAGTCGTCAACCAGGCATATT
Dugong              CATAATTCAAAAGCACCGAAGAAGAACAGGCTGAGGAGGAAGTCCTCTACCAGGCATATT
Trichechus          CATAATTCAAAAGCACTGAAGAAGAATCGGCTGAGGAGGAAGTCCTCTACCAGGCATATT
Procavia            CATAATTCAAAATCACTGAAGAAGAACAGGCTGAGGAAGAAGTCCTCCTCCAGACATGTT
Dendrohyrax         CATAATTCAAAATCACTGAAGAAGAACAGACTGAGGAAGAAGTCCTCCTCCAGACATGTT
Orycteropus         CACAATTCAAAGGCATCCAAGAAGAATAAGCTGAGGAGGAAATCCTCTACCAGGCATATT
Tenrec              TTCAGTTCAAGAGCGCAG---AAGAACAGGCTGAGGAGGAAGCCCTCTGCCAGGCACATC
Echinops            TTCAATGCAAAAGCACAN---AAGAACAGGCTGAGGAGGAAGCCCTCTGCCAGGCACATC
Elephantulus        CACAGTTCGGTAGCACCAAAGGAGAACAGGCTGAGGAGGATGTCCTCAACCGGGCATGTT
Rhynchocyon         TACAGTTCGATAGCACCAAAGAAGAACAGGCTGAGAAGGAAGTCCTCTACTAAGCGTATT
Amblysomus          TACAATTCTAAAGCACTGAGGAAGAATAGGTTGAGGAGGAAGTCCTCTTCCAGGCATATT
Vombatus            AGAAATGCCAAAATGACAAGAAAAGACAGGCTGAGGAAGAAGCCTTCAGCCAGGATCGTC
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Homo                CATGCGCTTGAACTAGTAGTCAGTAGAAATCTAAGCCCACCTAATTGTACTGAATTGCAA
Pan                 CATGCGCTTGAACTAGTAGTCAGTAGAAATCTAAGCCCACCTAATTGTACTGAATTGCAA
Gorilla             CATGCGCTTGAACTAGTAGTCAGTAGAAATCTAAGCCCACCTAATTGTACTGAATTGCAA
Pongo               CATGCGCTTGAACTAGTAGTCAGTAGAAATCTAAGCCCACCTAATTGTACTGAATTGCAA
Macaca              CATGCGCTTGAACTAGTAGTCAGTAGAAATCTAAGCCCACCTAACTGTACTGAACTACAA
Alouatta            CATGAGCTTGAACTAGTAGTCAGTAGAAATCTAAGCCCACCTAATTATACTGAAGTACAA
Otolemur            CGTGCACTTGAACTAGTAGTCAATAAAAATCCAAGCCCTCCTAATCATACCAACCTACAA
Cynocephalus        CATGCACTTGAACTAGTAGTCAATAGAAATCCAAGCCCACCTAATTATACTGAACTACAA
Tupaia              CGCACACTTGAACTAGTAGACAATAAAAGTCCAAGCCCACCTAATCGTACTGAACTACAA
Lepus               CATGCACTTGAACTAGTAGTCAATAAGAAACCGAGCCCACCTAATCATGCTGAACTACAA
Hystrix             AGACCT---------------------AATCCACACCTGCTGGATCACACAGAGCTGCAA
Pedetes             CATGCACTTGAACTAGTAGTCAATAAAAATCCAAGCCCACCTAATCAAACTGAACTACAA
Aplodontia          CATGCACTTGAACTAGTAGTTAATAAAAATGCAAGTCCACCTCATCGTACTGAACTACAG
Sciurus             CATGTGCTTGAACCAGTAGTTAATAGAAATACAAGTCCACCTCATCACACTGAATTACAA
Glaucomys           CATGTGCTTGAACCAGTAGTTAATAGAAATACAAGTCCACCTCATCACACTGAATTGCAA
Graphiurus          CATGCACTTGAACTAGTC---AGTAGAAATACAAGCCCACCTAATGGTACTGAACTACAA
Oryzomys            CTTGCACTTGAACTAGTC---AGTGGGAATCCAAGCCCACCTTCTTGTACTGAATTTCAA
Meriones            CTTGCAGTTGAACCAGTC---AGTAGGAATCCAAGCTCACCTACTCATGCTGAACTTCAA
Mus                 CTTCCACTTGAACCAATC---AGTAGAAATCCAAGCCCACCTACTTGTGCTGAGCTTCAA
Rattus              CTTCCACTCGAACCAATC---AGTAGAAATCCGAGCCCACCTACTTGTGCTGAACTTCAG
Scalopus            CATGCACTTGAACTGGTGGTCAAAAGAAATCCAAGCCCACCTAATCATACAGAACTACAA
Erinaceus           CATGCACTTGAAGTAGTAGTCAATAAAAACTCAAGCCCACCTAGCCATACAGAACTACAA
Myotis              CATGCACTTGAACTAGTAGTCAATAGAAATCCGAGCCCATCTAACCATACTGAACTACAA
Tadarida            TATGCACTTGAACTAGTAGTCAATAGAAATCCAAGCCCACCTAATCACACTGAACTACAA
Taphozous           TATGCACTTGAACTGGTAGTCAATAGAAATCCAAGCCCACCTAATCATATTGAACTACAA
Tonatia             TATGCACCTGGACTCGGGGTCAGCAAGAGCCCGAGCCCCCCTGCTCACGCCGGACTGCGG
Megaderma           CATGCACTTGAACTAGTC---AGTAGAAATCCAAGCCCACCTAATCATACTGAACTACAG
Pteropus            CATGCACTTGAACTAGTAGTCAATAGAAATCCAAGCCCACCTAATCATACTGAACTACAA
Hipposideros        CATGCACTTGAACTAGTAGTCAGTGGAAATCCACGCCCACCTAGTCAGACTGAGCTACAA
Cynopterus          CATGCACTTGAACTAGTAGTCAATAGAAATTCAAGCCCACCTAATCATACTGAACTACAA
Equus               CATGCACTTGAACTAGTAGTCAGTAAAAATCCAAGCCCACCTAATCATACTGAACTACAA
Diceros             CATGCACTTGAACTAGTAGTCAGTAGAAATCTAAGCCCACCTAATCATACTGAACTACAG
Manis               CATGCACTTGAACTAGTAGTCAATAGAAATCCAAGCCCCCCTAAACATACTGAACTACAA
Canis               TGTGCCCTTGAATTCGTAGTCAATAGAAATCTAAACCCACCTGATCATAGTGAACTACAG
Felis               CGTGCGCTGGAATTAGTAGTCAATAGAAATCCAAGCCCACCTGATCATACCGAACTACAG
Sus                 CATGCACTTGAACTAGTAGTCAATAGAAACCCAAGCCCACCTAGTCATACTGAGTTACAA
Lama                CATGCACTTGAACTAATAGTCAGTAGAAACCCAAGCCCACCTAATCACACTGAACTACAG
Bos                 CCTGAACTTGAACTAGTAGTCAGTAGAAACCCAAGTCTACCTAATCATACTGAGCTACCA
Hippopotamus        CATGCACTTGAACTAGTAGTCAGTAGAAACCCGAGCCCACCTAATCGTACTGAACTACAA
Megaptera           CATGCACTTGAACTAGTAGTCAGTAGAAACCCAAGCCCACCTAATCATACTGAACTACAA
Physeter            CATGCACTTGAACTAGTAGTCAGTAGAAACCCAAGCCCACCTAATCATACTGAACTACAA
Tamandua            CATGCACTTGAACTAGTAGCCAATAGAAAGCCAAGCCAGCCTAATCACACTGAACTACAA
Bradypus            CATGCACTTGAACTAGTAGCCAATAGAAATCCAAGCCAACCTAATCATAATGAACTACAA
Dasypus             CATGCACTTGAACTAGTCGGCAGTAGAAATCCAAGCCCACCTAATCATACTGAACTACAA
Chaetophractus      CATGCACTTGAACTAGTAGGCAATAGAAATCCAAGCCCACCTAAACATACTGAACTACAA
Loxodonta           CATGCACTTGAACTAGTAGTCAATAGAAATCCAAGTCCACCTACTCATACTGAACTACAA
Elephas             CATGCACTTGAACTAGTAGTCAATAGAAATCTAAGTCCACCTACTCATACTGAACTACAA
Dugong              CATGCACTTGAACTAGTAGTCAATAGAAATCCAAGTCCACCTACTCATACTGAACTACAA
Trichechus          CATGCACTTGAACTAGTAGTCAATAGAAATCCAAGTCCACCTACTCATACTGAACTACAA
Procavia            CATGCCCTTGAACTGGTAGTCAATAGAAATCCAAGTTCACCACCTCATACTGGGCTACAA
Dendrohyrax         CATGCCCTTGAACTGGTAGTCAATAGAAATCCAAGTTCACCACCTCATACTGGGCTACAA
Orycteropus         CATGCACTTGAACTAGTAGTCAATAGGAATCCAAGTCCCCCTAGTCATACTGAGTTACAG
Tenrec              CATCCGCTGGAACTAGTC---AACAGACAACCAAGCCCGACTACGCACACGGAGCTGCAA
Echinops            CACCCCCTGGAACTAGTC---AACAGACAGCCAAGCCCGACGAGGCACACAGAACTGCAA
Elephantulus        CACGCACTTGAACTAGTAGTCAATATAAGTCCAAGGTCACCTATCCATACTGAAGTACAG
Rhynchocyon         TGTGCACTTGAACTAGTAGTCGATAGAAATCCAACTTCACCTACCCATGCTGAGCTAGAG
Amblysomus          CACACACTTGACTTGGTAGTCAATAGAAATCCAAGTCCACCTCCTTACACTGAACTACAG
Vombatus            CGTGCTCTTGAGCTCGTAGTTGATAGAAACCCAAGCTCTTCTAATGAGAGTGAACTGCAG
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Homo                ATTGATAGTTGTTCTAGCAGTGAAGAGATAAAGAAAAAAAAGTACAACCAAATGCCAGTC
Pan                 ATTGATAGTTGTTCTAGCAGTGAAGAGATAAAGAAAAAAAAGTACAACCAAATGCCAGTC
Gorilla             ATTGATAGTTGTTCTAGCAGTGAAGAGATAAAGAAAAAAAAGTACAACCAAATGCCAGTC
Pongo               ATTGATAGTTGTTCTAGCAGTGAAGAGATAAAGAAAAAAAAATACAACCAAATGCCAGTC
Macaca              ATTGATAGTTGTTCTAGCAGTGAAGAGATAAAGAAAAAAAATTACAACCAAATGCCAGTC
Alouatta            ATTGATAGTTGTTCTAGCAGTGAAGAGATAAAGAAAAAAAATTACAACCAAATGCCAGTC
Otolemur            ATTGACAGTTGTTCTAGCAGTGAAGAAATAAAGGATAAAAGTTCTGACCAAATACCAGTC
Cynocephalus        ATTGATAGTTGTTCTAGCAGTGAAGAAATAGAGAAAAAAAATTCCAGCCAAATGCCAGTC
Tupaia              ATTGACAGTTATTCTAGCGGTGAAGAG---AGAAAGAAAAAGGGTGAGCAAATGCCAGTT
Lepus               ATTGACAGTTGTACTAGCAGTGAAGAAATG---------AATTTTGACCAAATACCAGTC
Hystrix             AGTGGCAATTCTATCAGCAGTGAAGAAATAAAGGAAAAAAGCTCCCCCCAAATGCCCATC
Pedetes             ATTGATAGTTGTAGTAGTAGCAATGAAATAAAGAAAAAATGTTCTGACCAAATGTCAGTC
Aplodontia          ATTGATCCTTGTACAAGCAGTGAAGAAATAAAGAAAGGGGATTCCAACCAAATG------
Sciurus             ATTGATAGTTTTACTAGCAGTGAAGAAATAAAGACAAGAAATTCCAACCAAATGCTAGTC
Glaucomys           ATTGATAGTTGTACTAGTAGTGAAGAAATAAAGACAAGAAATTCCAACCAAATGTCAGTC
Graphiurus          ATTGATAGTTATACTAGCAGTGAAGAAACACAGAAAGAAGATTCCAACCAGATGTCAGTT
Oryzomys            ATTGATAGTTGTAGTAGCAGTGAAGAAACAAAGAAAAACAATTCCAATCTAATGCCAGTC
Meriones            ATCGATAATTTTAGTAGCAGTGAAGAAACAAAGAAAAACAATTCCGACCAAGCACCCGTC
Mus                 ATCGATAGTTGTGGTAGCAGTGAAGAAACAAAGAAAAACCATTCCAACCAACAGCCAGCC
Rattus              ATCGAGAGTTGTGGTAGCAGTGAAGAAACAAAGAAAAACAATTCCAACCAAACCCCAGCC
Scalopus            ATTGATAGCTGTTCTAGCAGTGAAGAGATGAAGGAAAGAAATTCCAACCAAATGCCAGTA
Erinaceus           ATTGATAGCTGTTCTAGCAATGAAGAGATGAGGGGGGTGAAAGCTGATCAAATGCCAGTC
Myotis              ATTGATAGTTGTTCTAGCAGTGAAGAGGTGAAGGAAAAAAAATTCTGACCAAATACCAGTC
Tadarida            ATTGATAGCTGTTCTAGCAGTGAAGAGGTGAAGGAAAAAAAATTCTGACCAAATACCAGTC
Taphozous           ATTGATAGTTGTTCTAGCAGTGAAGAGGTGAAGAAAAGAAATTCTGACCAAATACCAGTC
Tonatia             ACGGACGGTTGTTCTGGCGGCGAGGAGGCAAAGATCGGGAATTCTGGGCAGAGGCCAGCC
Megaderma           ATTGATAGTTGTTCTAGCAATGAAGAGGTGGAGAAGAAAAACTCTGACCAAATGCCAGCC
Pteropus            ATTGATAGTTGTTCTAGCAGTGAAGAGCTGAAGGAAAAAAAATTCTGACCAAATGCCAGTC
Hipposideros        ATTGATAGTTGTTCTAGCAGTGAAGAGGTGAAGAAAAAAAATTTCTGACCAAGTGCCAGTC
Cynopterus          ATTGATAGTTGTTCCAGCAGTGAAGAACTGAAGGAAAAAAAATTCTGACCGAATGCCAGAC
Equus               ATCGATAGTTGTTCTAGTAGTGAAGAGATGAAGAAAAAAAAATTCTGACCAAATGCCGGTC
Diceros             GTTGATAGTTGTTCTAGCAGTGAGGAGATGAAGAAGAAAAGTCCCAGCCAGGTGCCAGTC
Manis               ATTGATAGTTGTTCTAGCAGTGAAGAGTTGAAA------------AACCAAATACCAGTC
Canis               ATTGAAAGTTGTTCTAGCAGTGAAGAGATGAAGAAACAGCATCTGGACCAAGTACCAGTC
Felis               ATTGATAGTTGTTCTAGCAGTGAAGAGATGAAAAGAAAAAGTTCGGAACAAATGCTAGTC
Sus                 ATTGATAGTTGTTCTAGCAGTGAAGAGATGAAGAAGAGAAATTCCGACCAAGTGCCAGTC
Lama                ATTGAGAGTTGTTCCAGCAGTGAAGAGATGAAGGAAAAACATTCTGACCAAATGCCAGTC
Bos                 ATTGATAGCAGTTCTAGCAATGAAGAGATGAAGAAAAAACATTCTAGCCAAATGCCAGTC
Hippopotamus        ATCGATAGTTGTTCTAGCAGTGAAGAGATGAAGAAAAAACATTCCTGCCAAATGCCAGTC
Megaptera           ATTGATAGTTGTTCTAGCAGTGAAGAGATGAAGAAAAAACATTCCAGCCAAATGCCAGTC
Physeter            ATTGATAGTTGTTCTAGCACTGAAGAGATGAAGAAAAAACATTCCAGCCAAATGCCAGTC
Tamandua            ATTGATAGTTGTTCTAGCAGTGAAGAAATAAAGAAAAAAAAATCTGACCAAAAGCCAATA
Bradypus            ATTGATAGTTGTTCTAGCAGTGAAGAGATAAAGAAAGAAAATTCTGTCCAAAAGCCAATA
Dasypus             ATTGATAGTTGTTCTAGCATTGAAGAGATAGAGAAAATAAATTCTAACCAAAAGCCAATC
Chaetophractus      ATTGATAGTTGTTCTAGCACTGAAGAGATAGAGAAAATAAATTCTAACCAAAAACCAATC
Loxodonta           ATTGACAGTTGGTCTAGCAGTGAAGAGACAAAGAAAAAAAGTTCTGAGCAAAAGCCAATC
Elephas             ATTGACAGTTGGTCTAGCAGTGAAGAGACAAAGAAAAAAAGTTCTGAGCAAAAGCCAATC
Dugong              ATTGATAGTTGGTCTAGCAGTGAAGAGATAAAGAAA---AGTTCTGAGCAAAAGCCAGTC
Trichechus          ATTGATAGTTGGTCTAGCAGTGACGAGATAAAGAAA---AGTTCTGAGCAAAAGCCAGTC
Procavia            ATTGATAGCTGGTCTGGCAGTGAAGAAATGAAGAAAACAAGTTCTGAGCAAAAGCCAGTC
Dendrohyrax         ATTGATAGTTGGTCTGGCAGTGAAGAAATGAAGAAAACAAGTTCTGAGCAAAAGCCAGTC
Orycteropus         ATTGATAGCTGGCCTAGCAGTGAAGAGTTAAAGAAAAAAAGTTCTGAGCACAAGCCAATC
Tenrec              ATCAGCAGTTGGCCTAGCAGTGAGGAGCTAAAGAAAGAAGAATCCGAGCCAAAGCCAATC
Echinops            ATCAGTAGCTGGCCTAGCAGTGAAGAGCTAAAGAAAGAAGAATCTGAGCCAAAGCCAGTC
Elephantulus        ATTGATGGTTGGTCTAGCAGTGAAGAG---ACGAAAAAACATTCCGAGCATAAGCCAGTC
Rhynchocyon         ATTGATAGTTGGCCTAGCAGTGAAGAG---AGGGAAAAATGTTCAGAGTTTAACTCCGTC
Amblysomus          ATTGATAGTTGGCCTAGCAGTGAAGAAATAAACGAAACAAGTTCTGAACAAAAGCCAACC
Vombatus            ATCGATAGCTATCCCAGCAGTGAAGAGATAAAAGGAACTAATTCTGAACAGAAGCAAATC
                                    *     * **
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Homo	AGGCACAGCAGAAACCTACAACTCATGGAAGGTAAAGAACCTGCAACTGGAGCCAAGAAG
Pan	AGGCACAGCAGAAACCTACAACTCATGGAAGATAAAGAACCTGCAACTGGAGTCAAGAAG
Gorilla	AGGCACAGCAGAAACCTACAGCTCATGGAAGATAAAGAACCTGCAACTGGAGCCAAGAAG
Pongo	AGGCACAGCAGAAACCTACAACTCATGGAAGATAAAGAACCTGCAACTGGAGCCAAGAAG
Macaca	AGGCACAGCAGAAACCTACAACTCATGGAAGATAAAGAATCTGCAACTGGAGCCAAGAAG
Alouatta	AGGCACAGCAGAAAGCTACAACTCATGGAAGATAAAGAACGTGCAGCTAGAGCCAAAAAG
Otolemur	AGGCATAGCAGAAAGCCTGGACTCATGGAAGATAGAGAACCTGCAACTGGAGCCAAGAAA
Cynocephalus	AGGCACAGCAGAAAGCTTCAACTCATGGAAAATAAAGAACCTGCAACTGGAGCCAAGAAG
Tupaia	GGACACAGCAGAAAGTTTCAACTTGAGGAAGAGAAAGAACCTACAACTGGAGCCAAGAAA
Lepus	AGTCACAGCAGACAGGCTCAAGTCATAGAAGATACAGAACCTCCAACTGGAGCTAGGAAG
Hystrix	AGGCACAGCAGGACGCTGCACCTCACAGGGGCTGTGGAAGCTTCTATTGGAGCCAGGGAG
Pedetes	AGGCAGAGCAGAAAGCTTCAACTCATGGAAGATGCAGAACCTGCAATGGGAGCAAAGAAG
Aplodontia	---------------CTTCAACTTTTGGAAGATGAAGAACCTGCAGTTGGAGTCAAGAAG
Sciurus	AGGCATGGCAGAAAGCTTCAACTCATGGAAGATGCAGAACCTGCAACCGAAGTCAGGAAG
Glaucomys	AGGCATGGCAAAAAGCTTCAGTTCATGGAAGATGCAGAACCTGCAACTGATGTCAGAAAA
Graphiurus	GGGCATGACAGAAAGCTTCAATTTATGGAAGATGCAGAATCTGTAACAGGAGTCAAG---
Oryzomys	AAGGACATTCAAAAGCCTCAGCTCATAGAGAACACAGACCCTGGGCCAGATACCAAGGAG
Meriones	AGGCACATTAGAAAGCCTCTACTCACAGCAGACCCAGAACCAGCACCTGAAGCCAAGAAG
Mus	GGGCACCTTAGAGAGCCTCAACTCATCGAAGACACTGAACCTGCAGCGGATGCCAAGAAG
Rattus	GGGCACATTAGAGAGCCTCAACTCATCGAAGACACAGAACCCGCAGCTGATGCCAAGAAG
Scalopus	AGACACAGCAAAAGGCTTCAACTCATGGAAGATAAAGACCCCGCAACTGAAGCCGTCAAG
Erinaceus	AGGCACAGCAAACAACTTCCACTCATTGAAGACAAAGAACCTGCAACTAGAGCCTTTAGT
Myotis	AGACACAGCAAGAAGCTTCAACTCATGGAAGGTAAAGAACCTGCAGCTGGAGCCAAGAAG
Tadarida	AGACACAGCAAAAAGCTTCAACTCATGGAAGGTAAAGAACCTGCAACTGGAGCCAAGAAG
Taphozous	AGGCACAGCAAAGAGCCTCAACTCGTGGAAGGTGAAGAACCTACGACTAGAGCCAAGAAG
Tonatia	AGGCGGAGCAGCAAGCTTCCGCTCGAGGAGGGTCAGGAGCCTGCAGCTGGGGCCAGCAAG
Megaderma	AGACACAACAAAAATCTTCAACTTATAGAAGATAAAGAACCTGCAACTAGAGCTAAGAAG
Pteropus	AGACACAGCAAAAAACTTCAATTCATAGAAGATAAAGAATCTTCAACTGGAGCCAAGAAG
Hipposideros	ACACACAGCAAAACGCTTGAACTCATAGAAGATCAAGAACCTGCAAATGGAGTCAAGAAG
Cynopterus	AGACACAGCAAAAAACTTCAGTTCGTAGAAGATAAAGAATCTGCAACTGGAGCCAAGAAG
Equus	AGACACAGCAAAAAGCTTCAACTCATGGAAGATAAAGAACCTGCCACTGGAGCCAAAAAG
Diceros	AGACATAGCAGAAAGCTTCAACTCACMGAAGATAAAGAACCCGCAGCTGGAGCCAAGAAA
Manis	AAACATNCCAAAAAGCTTCAACTCAAGGAAGATAGAGAACCTGCATCTAGAGCCAAGAAG
Canis	AGACACAACAAAACACTTCAGCTCATGCAAGATAAAGAACCTGCAGGTAGAGCTAAGAAA
Felis	AGACACAGCAAAACACTTCAACTCGTGGAAAATAAAGAACCTGCACCTGGAGCCAAGAAG
Sus	AGGCACAGCAAAAAGCTTCACCTCAGGGGAGATAAAGAACCTACAACTGGAGCCAAGAAG
Lama	AGGCACCGCAAAAAGCTTCAGCTCACGGGAGATAAAGAACCTACGACTGGAACCAAGAAG
Bos	AGGCAGAGCCAAAAGCTTCAACTCATTGGAGATAAAGAACTTACTGCTGGAGCCAAG---
Hippopotamus	AGGCACAGCAAAAAGCTTCAATTCATGGGATATAAAGAACCCGCAACTGGAGTCAGGAAG
Megaptera	AGGCACGGCAAAAAGCTTCAATTCATGGGAGATAAAGCACCTACAACTGGAGCCAAGAAG
Physeter	AGGTGCGGCAAAAAGCTTCAATTCATTGGAGATAAAGAACCTACAACTGGAGCCAAGAAG
Tamandua	AGACACAGCAGAACAGTTCAATTCATGAAAGATAAAGAAACTGCAATTGGAGCCAAGAAG
Bradypus	AGGCACAGCAGAATGCTTCAACTCCTGAAAGGTAAAGAAACTCCAACCGTAACCAAGAAG
Dasypus	AGACACAACAGAATGCTTCAACTCACGAAAGAAAAAGAAACCACAACTGGAGCCAAAAAG
Chaetophractus	AGACACAACAGAATGCTTCAACTCATGAAAGAAAAAGAAAACACAACTGGAGCTAAAAAG
Loxodonta	AGACACAACAGAAACCTTCAACTCATGAAAAATCAAGAAACCGCAACTGGAGCCAAGAAG
Elephas	AGACACAACAGAAACCTTCAACTCATGAAAAATCAAGAAACCGCAACTGGAGCCAAGAAG
Dugong	AGACACAACAGAAACCTTCAACTCATGAAAAACCAAGAAACCACAACTGGAGCCAAGAAA
Trichechus	AGACACAACAGAAACCTTCAACTCATGAAAAACCAAGAAACCACAACTGGAGCCAAGAAA
Procavia	AGACACAACATAAACCTCCAACTCATGAAAAACCAAGAAACCACAACTGGAGCCAAGAAG
Dendrohyrax	AGACACAACATAAACCTCCAACTCATGAAAAACCAAGAAACCACAACTGGAGCCAAGAAG
Orycteropus	AGACAGAATACAAACCTGCAACTCATGAAAGATCAAGAGGCCACAACTGGGGCCAAGAAG
Tenrec	AGACGGAGCCGGCACTTAAAGCGGAAAGA----------------------GCCAAGAAG
Echinops	AGACGGAGCCGGAACTTACAGCTCACGAAAGACCAAGAAATGGCCATCGGAGCCAAGAAG
Elephantulus	AGACCTAGCAGAAACGTTTCAGTTACAACAAATCAAGAAACTGAAACTGGGTCCAAGAAG
Rhynchocyon	AGACACAGCAGAACCTTTCAGCTTATGAAAGGTCAAGAAACTGAAATTGGAGACCAAAAG
Amblysomus	AGACACAGCAGAAACCTTCACCTCATGAAAGAACAGGAAACTGCAACTGGAACCAAGAAC
Vombatus	AGACGCAGCAGAAGGCTTCGGCTGCTATCAGAA---GAAATTGTGGTTGGAGCCAAGAAG

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Homo              AGTAACAAGCCAAATGAACAGACAAGTAAAAGACATGACAGCGATACTTTCCCAGAGCTG
Pan               AGTAACAAGCCAAATGAACAGACAAGTAAAAGACATGACAGCGATACTTTCCCAGAGCTG
Gorilla           AGTAACAAGCCAAATGAACAGACAAGTAAAAGACATGACAGCGATACTTTCCCAGAGCTG
Pongo             AGTAACAAGCCAAATGAACAGACAAGTAAAAGACATGACAGCGATACTTTCCCAGAGCTG
Macaca            AGTAACAAGCCAAATGAACAGACAAGTAAAAGACATGCCAGTGATACTTTCCCAGAACTG
Alouatta          AGTAGCAAGCCAAATGAACAAACAAGTAAAAGACATGCCAGTGATACTTTCCCAGAACTG
Otolemur          AGTAACAAGCCAAATGAGCAAATAAGTAAAAGACATGTCAGTGATACTTTCCCAGAAGTG
Cynocephalus      AGTAACAAGCCAAATGAACAAATAAGTAGAAGACATTCCAGTAATGCTTTCCCAGAACTG
Tupaia            AATAACCAGCCAAATACAGAAATAAGTGAAAGACATGCCAGTGGTGTTATCCCAGATCTG
Lepus             AAC---AAGCCAAGTGAACAAATAAGTAAAAGACATGCCAGTGATGTTTTCCCAGAAGTC
Hystrix           AGTAAGAAGCCAGCTGGACAAGTAAGGGAGAGACATGCCGGGGACTCTTTCCTAGAACCA
Pedetes           AATAACACGCCAGTTGAGAAAATAAGTGAGAAACATGCCACGGATGCTTTCCCAGAAGTG
Aplodontia        AGTAACAAACCAAATGAACAAATAAATAAGAGGAATACCAATGATGCTGTCCCAGATCTG
Sciurus           AGTAACAAGCTAAATGAACAAATAAATAAGAGACATACCAATAATGCTTTCCCAGGACTG
Glaucomys         AGTAACAAGCCAAATGAACAAGTAAATAAGAGACATACCAATGATGCTTTCCCAGGACTG
Graphiurus        AATAACAAGCCAAATGAACAGATAAGTAAGAGACATATCAATGATGCTTTCCCAGAGCTG
Oryzomys          AACAATGAGCCAAATGAACAAATAAGGAAGAGAAGGGCCAGTGATGCTTTCCCAGAAGAG
Meriones          ------GAGCGGAGTGAACAAGTAAGAAAGAGAACTGCCAGTGATGCTTTCCCAGAAGAA
Mus               AAC---GAGCCAAATGAACACATAAGGAAGAGACGTGCCAGCGATGCTTTCCCAGAAGAG
Rattus            AAC---GAGCCAAATGAACACATAAGGAAGAGAAGTGCCAGTGATGCGTTCCCAGAAGAG
Scalopus          AGTAACAAGCCAAAAGAACAAATT---AAAAGATTTGCCAGTGATACTTTGCCAGAACTA
Erinaceus         AGTAGCAAGTCAAATGAACAAATAAGTAAACAGTTTGTTGGTGAGACTTTTTCAGACCTA
Myotis            AGTAATAAGTCAGATGAACAAATAAATAAAAAACTTGCCAGTGATGCTTTTCTAGAACAA
Tadarida          AGTAACAAATCAAATGAACAAATAAATAAAAAACTTGCCAGTGATGTTTTTCCAGAACTA
Taphozous         AAT---AAGTCAAATGAACAAATAAATAAAAGACTTGCCAGTGATACTTTTCCAGAACTA
Tonatia           GGTGACCGGTCAGATGCACCGATGAATAAGAGACTTGCCAATGATGCTTTTCCGGAACTA
Megaderma         AGTAACAAGCCAGATGAACAAATAAATAAGAGACTTACCAGTGATGCTTTTTCAGAACTA
Pteropus          AATAACAAGCCAAATGAGACAATCAATAAAAGACTTGCCAGTGATGCTTTTCCAGAATTA
Hipposideros      AGGAACAAGCCAAATGAACAAATAAATAAGAGACTTACCAGTAATGCTTTTCCAGAACTA
Cynopterus        AATAACATGCCAAATGAGGCAATAAATAAAAGACTTTCCAGTGAAGCTTTTCCCGAATTA
Equus             AGTAACAAGCCAAATGAACAAATAAATAAAAGACTTGCCAGTGATGCTTTTCCAGAGCTA
Diceros           AGTAACAAGCCAAATGAACAGATAAATAAAAGACTCGCCAGTGATGCTTTTCCAGAACTA
Manis             AGTAACAAGCCAAATGAACAAATAAATAAAAGATTTACCAGTGACACTTTTCCAGAACTA
Canis             AGTAGTAAGCCAGGAGAACAAATAAATAAGAGACTCGCCAGCCATGCTTTTCCAGAGCTA
Felis             CGTAACAAGCCAAGTAAACAAATAAATAAAAGACTTGCCAGTAACACTTTTCCAGAGCTA
Sus               AATAATAGGCCACATGAACAAGTAAATAAAAGACCTATCAGTGATGCTTTTCCAGAACTA
Lama              AGTAACAAGCCACATCAACAAATAAATAAAAGACTTGTCGGTAACACTTTTCCAGAACTA
Bos               AATAACAAAACATATGAACAAATAAATAAAAGACTTGCTAGTGATGCTTTTCCAGAACTA
Hippopotamus      AGTAATAAACCACACGAACAAATAAATAAAACACTTGCCAGTGGTGCTTTTCCAGAACTA
Megaptera         AGTAACAAGCCACACGAACAAATAAATAAAAGACTTACCAGTGACGCTTATCCAGAACTA
Physeter          AGTAACAAGCCACATGAACAAATAAATAAAAGACTTGACAGTGACACTTATCCAGAACTA
Tamandua          AGTAACAAGCGAAATGAACAAATAAATAAAAGACATGCCAGTGATGCTTTCCCAGAACTA
Bradypus          AGTAACAAGCGAAATGAACAAATAAGTAAAAGGCATTCCAGTGATGCTTTCCCAGAACTA
Dasypus           AACAATAAGCCAAATGAACAAATAAGTGAAAGACATGCCAGTGATGCTTTCCTAGAACTT
Chaetophractus    AATAACAAGCCAAATGAACAAATAAGTGAAAGACATGCCAGTGATGTTTTCCCAGAACTA
Loxodonta         AGTAACAAGCCAAAGGAACAAATAAGTAAAAGACATGGCGCTGACTCTTACCCAGAACTA
Elephas           AGTAACAAGCCAAAGGAACAAATAAGTAAAAGACATGGCGCTGACTCTTACCCAGAACTA
Dugong            AGTAACAAGCCAAAGGAACAAATAAGTAAAAGACATGCCAGTGACGCTTACCCAGAACTA
Trichechus        AGTAACAAGCCAAAGGAACAAATAAGTAAAAGACATGCCAGTGACACTTACCCAGAACTA
Procavia          AGTAACAAGCCAAAGGAACAAATAAATAAAAGACACACTAGTAATCCTTACCCAGAACTA
Dendrohyrax       AGTAACAAGCCAAAGGAACAAATAAATAAAAGACACACTAGTAATCCTTACCCAGAACTA
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Tenrec            AATGACAAGCCAAACGGAGAAAGGGGCAAAAAACACGCCCCTGACACATTCCCAGACCGA
Echinops          AATGACAAACCAAATGAAGAAAGGGGCAAAAAACACGCCCCTGACACTTTCCCAGAACGA
Elephantulus      AATAACAAGCCAAATGAACAAATGAGTAAAAGACATGCCACTGACACTTCCCCAGGGCAC
Rhynchocyon       AATAATAAGCAAAATGAACAAATAAGTAAAAAACATGCCACTGACACTTCTCCAAAACGA
Amblysomus        AGTAACAAGCCAAATGAACAAATAAGTAAAAGACATGCCACTTACACTTTTTCAGAACTA
Vombatus          GCCCATAAGCCAGATGACCAAGCAGAAGAAAGTTGTATCAGTGAAGTTTTCCCAGAACTA
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Homo              AAGTTAACAAATGCACCTGGTTCTTTTACTAAGTGTTCAAATACCAGTGAACTTAAAGAA
Pan               AAGTTAACAAATGCACCTGGTTCTTTTACTAACTGTTCAAATACCAGTGAACTTAAAGAA
Gorilla           AAGTTAACAAATGCACCTGGTTCTTTTACTAACTGTTCAAATACCAGTGAACTTAAAGAA
Pongo             AAGTTAACAAATGCACCTGGTTCTTTTACTAACTGTTCAAATACCAGTGAGCTTAAAGAA
Macaca            AAGTTAACAAAGGTACCTGGTTCTTTTACTAACTGTTCAAATACTAGTGAA---AAAGAA
Alouatta          AGGTTAACAAACATACCTGGTTCTTTTACTAACTGTTCAAATACTAATGAATTTAAAGAA
Otolemur          GCATTAACAAATATATCTAGTTTTTTTACTAACTGTTCAGGTTCTAATAGACTTAAAGAA
Cynocephalus      CGGTTAACAAATGTACCTGTTTTTTTTGCTAACTGTTCAAGTTCTAATAAACTTCAAGAA
Tupaia            AAGTTAACAAACATACCTGGTTTTTTCACAAACTCTTCGAGTTCTAATAAACTTCCAGAA
Lepus             AAATTAACAAACATACCTGGTGTTTTTACAAACTGTTCAAGTTCTAATAAACTTCAAGAA
Hystrix           AGATTAGCAAGACTACCT---GCTTTTACTAACAGTTCAAGCCCTGATAACCTTAAAGAA
Pedetes           AAGGTAACAAACATACCTGGATTTTTAAATAACTGTTCAAATTCTAATAAACCAGAAGAA
Aplodontia        AAGTTAACAGGCTCTTCTGGTCTTTTTACTAACCGTTCAAGTTCCAGTAAACTTAAAGAA
Sciurus           AAGTTAAAAGGCATATCTGGTCTTTTTACTAACTGCTCAAGTTCTAGTAAAGTTGAAGAA
Glaucomys         AAGTTAACAGGCATATCTGGTATTTTTACTAACTGCTCAAGTTCTAGTAAAGTTGAAGAA
Graphiurus        ACGTTGACAAACAAACCTGGTCTATTTACTAACTGTTCGGGTTCTAATAAACTTAAAGAA
Oryzomys          AAGTGTACAAATATACCTGGTTTATTAACTAGCTGTCCAAGTTCTAATAAACCTCAAGGA
Meriones          AAA---------------------TTAACAAGCACAGACAGTCCAAGTGACCCCGAAGGG
Mus               AAATTAATGAACAAAGCTGGTTTATTAACTAGCTGTTCAAGTCCTAGAAAATCTCAAGGG
Rattus            AAATTAATGAACAAAGCTGGTTTATTAACTAGCTGTTCAAGTCCTAGAAAGCCTCAAGGA
Scalopus          AATTCAACACATGTACCTGGCTTTCTTAGCAACTATTCAAGTTCTAATAACCTTGAAGAG
Erinaceus         AATTTAACAAACATCCCTGGTTTTCTTACCAGCTGTTCAAGTTCCAATAAACATCAGGAA
Myotis            AACTTAACAAACATGCCTGGTGTTTTTACTAATGGTTTAAGCTCTAATAAGCTTAACGAG
Tadarida          AACTTAACAAACATACCTGGTTTTTTAAGTAATGATTCAAGTTCTAATAAACTTAAAGAG
Taphozous         AATTTAAAAAACATACCTGGTTTTTTTACTAATGGTTCAAGTTCTAATAAACTTCAAGAG
Tonatia           AATTTAACAAGCGTATCTGCCGTTTTTACTAATGGTTCAGGTTCTACTAAACTTAAAGAG
Megaderma         AATTTAACAAACACACCTGGTTTTGTTACCAACAGTTCAAATTCTGATAAACTTAAAGAG
Pteropus          AATATAACAAACATACCTGGTTTTTTTACTAATGGTTCAAGTTCTAATAAACTTCAAGAG
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Cynopterus        AATATAACAAACGTACCTGGTTTTTTTACTAATGGTTCAAGTTCTAATAAACGTCAAGAG
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Diceros           AAATTAACAAACGTACCTGGTTTTTTTGCTAACTGTTCAAGTTCTAATAAACTTCAAGAG
Manis             AATTTAACAAACATACCTGGTTTTTTTAGTAAATGTTCAAGTTCTAATAAACTTCAAGAG
Canis             ACTTTAACAAATGTATCTGGTTTTTTTGCTAACTATTCAAGTTCTAGTAAGCCTCAAGAG
Felis             AATTTAACAAACATACCTGGGGTTTTTACTAACTGTTCAAGTTCTAATACACTTCAAGAG
Sus               AATTTAACAAATGTACCTGTTTCTATTACTAACTGTTCAAATTCTAATAAGCTTCAAGAA
Lama              AATTTAACAAACACACCTGGTTTTTTTACTAAGTGTTCAAGTTCTAATAAACTTCAAGAG
Bos               AAGTTAACAAACACACCTGGTTATTTTACTAACTGTTCTAGT------AAACCTGAAGAG
Hippopotamus      AATGTAACAAACATACCTGGTTTTTTTACTAACTGTTCTAGTTCTAGTAAACTTCAAGAG
Megaptera         AATTTAACAAACATACCTGGTTTTTTTACTCACTGTTCTAGTTCTAATAAACTTCAAGAG
Physeter          AATTTAACAAACATACCTGTTTTTTTTACTCACTGTTCTAGTTCTAATAAACTTCAAGAG
Tamandua          AATTTAACAAACGTAACTGGTTTTCCTACTAAATGTTCAAATTCTGATAAACTTCAAGAA
Bradypus          AATTTAACAAATGTAACTGGTTTTCTTACTAAATGTTCAAGTTCTGATAAACTTCAAGAA
Dasypus           AAA------AATGTAACTGATTTTCTTCCTAAATGTTCAAGTTCTGATAAACTTCAAAAA
Chaetophractus    AAATTAACAAATGTAACCGATTTTCTTCCTAAATGTTCAAATCCTGATAAACTTCAAGAA
Loxodonta         CATTTAACAACCACAGCTGGCTTTATTACTAAGTGTTCAAGTTCTGATAATCTTCAAGAA
Elephas           CATTTAACAACCACAGCTGGCTTTATTACTAAGTGTTCAAGTTCTGATAATCTTCAAGAA
Dugong            AATTTAACAAGCACAACTGGCTTAATTACTAACTGTTCAAGTTCTCATAATTATCAAGAA
Trichechus        AATTTAACAAGCACAACTGGCTTAATTACTAACTGTTCAAGTTCTCATAATTATCAAAAA
Procavia          AATTTAACAAGCACAGCTGGCTTTATTACTGTATGTTCAAGTTCTGATAATCTTCAAGAA
Dendrohyrax       AATTTAACAAGCACAGCTGGCTTTATTACTGCGTGTTCAAGTTCTGATAATCTTCAAGAA
Orycteropus       AATTTAACAAACATAACTGGTTTTATTACTAATTGTTCAAGTTCTGATAATCTTCAAGAA
Tenrec            AAGTCAACAAGCACAACGGACTTAATTGCTAACTGTTCCGTTTCTGGCAGTCTTCATGGA
Echinops          AATTTAACAGACACAACTGACCTAATTACTACCTGTTCGTTTTCTGGTAATCTTCAAGCA
Elephantulus      AACATAACTGGC---------TTCATTACTGACTGTTCAAATACCAGCAGTCTTCAAGAA
Rhynchocyon       AACATAACTGGC---------TTTATCACAAACTGTTCAAATACTGATAATCTTCAAGAA
Amblysomus        AACATAACAAATAGAACTGACTTTATTACTAACTGCCCACGTTCTGATAATCTTCAAGAA
Vombatus          AAAATAGGAAACGTGCCTGCCTGTGCTACTGACAGTCTAACTACTGATAGGGATCAAGTG
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Homo	TTTGTCAATCCTAGCCTTCCAAGAGAAGAAAAAGAAGAGAAACTAGAAACAGTTAAAGTG
Pan	TTTGTCAATCCTAGCCTTCCAAGAGAAGAAGAAGAAGAGAAACTAGAAACAGTTAAAGTG
Gorilla	TTTGTCAATCCTAGCCTTCCAAGAGAAGAAAAAGAAGAGAAACTAGAAACAGTTAAAGTG
Pongo	TTTGTCAATCCTAGCCTTCCAAGAGAAGAAAAAGAAGAGAAACTAGGAACAGTTAAAGTG
Macaca	TTTGTCAATCCTAGCCTTTCAAGAGAAGAAAAAGAAGAGAAACTAGAAACAGTTAAAGTG
Alouatta	TTTGTCAATCCTAGCCTTCCAAGAGAACAAACAGAAGAGAAACTAGAAACAGTTAAACTG
Otolemur	TTTGTCAATCCTAGCCTTCAAAGAAAAAAAACAGAAGAGAACTTAGAAACAATTCAAGTG
Cynocephalus	TTTATCGATCCTAGCCTTCAAAGAGAAGAAATAGAAGAGAACCTAGAAACAATTCATGTG
Tupaia	TTTGTCCATCGTAGCCTTCAAAGAGAAAAA---GAAGAGAACCGAGAAACAATTCAAATA
Lepus	TCTGTCGATCCTAGCCTTCAAAGAAGGAAATAGAAGAGAACCTAGACACAGTTCAAGTG
Hystrix	TTTGTCAACCTTAGTGCACAGACAGAAGAGATGGAAGAGAACCCAGAAACAGTACAAGTG
Pedetes	TTTGTCAGTCCTGGCTTTCAGAGAGAAGAAATAGAAGAGAACCTAGAAACAATTCAAGTG
Aplodontia	TGTGTCAGTCCTAACCTTCAAAAAGAAGGGACAGAAGAGAACGTAGAAATAATTCAAGTG
Sciurus	TTTGTCAATCCTAACCTTCAGGAAGACGAAACAGAAGAGAACTTGAAA------------
Glaucomys	TTTATCAATCCTAACCTTCAGAAAGAAGGAACAGAAGAGAACATAGAAATAATTCAAGTG
Graphiurus	TTTGTCAATCCTGGCCTTCAAAAAGAAGAAATAGAAGAGAACCTAGAAGCAATTCAAGTG
Oryzomys	CCTGTCACTCCTAGCCCTCAGAGAAAAGAAGTAGAG---AAACTTGAAACAAGCCAAATG
Meriones	CCTGTCAAGCCTAGCCCTCAGAGAAAAGAAATAGAG---AAACTTGAAACAAGCAAAATG
Mus	CCTGTCAATCCCAGCCCTCAGAGAACAGGAACAGAG---CAACTTGAAACACGCCAAATG
Rattus	CCTGTCAATCCTAGCCCTGAGAGAAAAGGAATAGAG---CAACTTGAAATGTGCCAGATG
Scalopus	TTTTCCAATCCTAGCCTTCAAAGAGAAGAACTAGAAGAGAACCTAGGAACAAATCAAGTG
Erinaceus	TGTATTAATCCTAACCTACAAAGAGAGGTATTAGGAGAAAGCCGTGGGACTATTCAAGTG
Myotis	TTTGTCGATCCTAACCTACAAAGAGAAGAAACAGAAGAGAACCTAGGAGCAGTTCAAATG
Tadarida	TTTGTCAATCCTAACCTTCAAAGAGAAGAAATAACAGAGAACCTAGGAACAGTTCACATG
Taphozous	TTTGTTGATCCTAACCTTCGAAGAGAAGAAGTGGAAGAGAACCTAGGAACAATTCAAGTG
Tonatia	TGTGTCGATTCTAACCCTCAAGGAGAAGACACAGAAGAGAACCGAGGAACAGTTCAAGTG
Megaderma	TTTGTCAATCCTAGCCTTCAAAGAGAAGAAATAGAAGAGCATCTGGGAACGATTAAAGTG
Pteropus	TTTGTCAATCCTAGCCTTCAAAGAGAAGAAATAAAAGAGAACCTAGGAACAATTCAAGTG
Hipposideros	TTTGTCAATCCTAGCCTTCAAAGAGAAGAAATAGAAGAGAGCCTAGGAACAATTCAAGTG
Cynopterus	TTTGTCAATCCTAGCCTTCAAGGAGAAGAAATAAAAGAGAATCTACGAACAATTCAAGTG
Equus	TTTGTCAATCCTAGCCTTCAAAGAGAAGAAATAGAACAGAACCTAGGAGCAAATCGACTG
Diceros	TTTGTCAATCCTAGCCTTCAAAGAGAAGACATAGAACGGAACCTAGGAGCAATTCAAGTG
Manis	TTTGTTGACCCTAGCCTTCAAAGAGAAGAAATAGAAAATAATCTAGAAACAATTCTA---
Canis	TGCATCAACCCTGGCCTTCGAAGAGAAGAAATAGAAGAGAGCCGAAGAATGACTCAAGTG
Felis	TTTGTCAACCCTGGCATTCAAAGAGAAGAACTAGAAGAGAGCCGAGGAACGATTCACGTG
Sus	TCTGTCAGTCCTAACCTTCAAAGAGAAGAG---------AACCTAGGGACAATTCAAGTG
Lama	TTTGCCAATCCTAGCCTTCAAAGAGAAGAG---------AACCCAGGAGCAATTCAAGTA
Bos	TTTGTTCATCCTAGCCTTCAAAGAGAGGAG---------AACCTAGGAACAATTCAAGTG
Hippopotamus	GTTGTTAATCCTGGCCTTCCAAGAGAGGAG---------AACCTAGGAACAATTCAAGTG
Megaptera	TTTGTTAATCCTAGCCTTCAAAGAGAGGAG---------AACCTAGGAAAAATTCAAGTG
Physeter	TTTGTTAATCCTAGCCTTCAAAGAGAGGAG---------AACCTAGGAACAATTCAAGTG
Tamandua	TTTGTCAATTCTAGCCTGCAAGGAGAAGCAGCAGAG---AACCTAGAAACAATACAAGTG
Bradypus	TTTGTCAATTCTAGCCTGCAAGGAGAAGTAGCAGAG---AACCTAGAAACAATTCAAGTG
Dasypus	TTT---AATTCTAGCCTGCAAGGAGAAGTAGCAGAG---AACCTAGAAACAATTCAAGTG
Chaetophractus	TTTGTTAATTCTAGCCTGCAAGGGGAAGTAGCAGAG---AACCTAGAAACAATTCAAGTG
Loxodonta	TTTGTCAATCCTAGCCTTCAAGGAGAGAAAACAGAAGAAAACCTGGAAACAATTCAAGTG
Elephas	TTTGTCAATCCTAGCCTTCAAGGAGAGAAAACAGAAGAAAACCTGGAAACAATTCAAGTG
Dugong	TTT---AATCCTAGCCTTCAGGGAGAAGAAATAGAAGAAAATCTGGGAACAATTCAAGTG
Trichechus	TTTGTTAATCCTAGCCTTCAGGGAGAAGAAATAGAAGAAAATCTGGGAGCAACTCAAGTG
Procavia	CCTGTCAACCCCAGCCTTCAAGGAGAGGAAATAGAAGAAAACTTGGCAACAGTCCAAATG
Dendrohyrax	CCTGTCAACCCCAGCCTTCAAGGAGAGGAAATAGAAAAAAACTTGGCAACAGTCCAAATG
Orycteropus	TTTGTCAATCCTAGCCTTCAAGAAGAGGAAATAAAAGAGAACCTGGGAACAATTCAAGTG
Tenrec	GCTGTCTGTCCTGGCCTTCCAGGGGCAAAGCAAACAGAGAAACGGGGAGCAGTGCAGGTG
Echinops	TCTGTCTGTCCTAGCCTTCCAGGGGCAAACCTGAAAGAGAAACTGGGAACAGTGCAGGTG
Elephantulus	TGTTTTAATCCTAGACTTCAGGGAGAGGCAGTAGAAGACAACTTTGGACCAGTTCAAGTG
Rhynchocyon	TTTGTTAATCCTAGATTTGAAGGAGAGGAAATAGCC------GTGGGACCAATTCAAGTG
Amblysomus	CTTGTCAATCCTAGCCTTCAAGGAGAGGAAAGGGAAGAGAAATCGGAAACAATGCAAGTA
Vombatus	TTAGCTAGCTGCAGTTTCACAGAAGAAAGAGATGAAAGGAGCCTGGAAGCAATCCCAAGC

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Homo             TCTAATAATGCTGAAGACCCCAAAGATCTCATGTTAAGTGGAGAAAGGGTTTTGCAAACT
Pan              TCTAATAATGCCGAAGACCCCAAAGATCTCATGTTAAGTGGAGAAAGGGTTTTGCAAACT
Gorilla          TCTAATAATGCCGAAGACCCCAAAGATCTCATGTTAAGTGGAGAAAGGGTTTTGCAAACT
Pongo            TCTAATAATGCCAAAGACCCCAAAGATCTCATGTTAAGTGGAGGAAGGGTTTTGCAAACT
Macaca           TCTAATAATGCCAAAGACCCCAAAGATCTCATCTTAAGTGGAGAAAGGGTTTTACAAACT
Alouatta         TCTAATAATGCCAAAGACCCCAAAGATCTCATGTTAAGTGGAGAAAGTGTTTTGCAAATT
Otolemur         TCTAATAGTACCAAAGGTCCG---------GTGTTAAGTGGAGAAAGGGTTTTGCAAATT
Cynocephalus     TCTAATAGTGCCAAAGACCCCAAAGATTTGGTGTTAAGTGGGGAGAAGGGTTTGCAAACT
Tupaia           TCCAGTAGTACC---------AAAGATCTGGTATTAAGGGGAGAAAGGGGTTTGCAAGAT
Lepus            CCTAACAGTGCCATAGACCCCAAAGATCTCCTGTTATGTGGAGAAAGGGGCTTGCAAACT
Hystrix          TCCGAAAGTACCAGAGACTCCAAAGGTCCTGTGTTAAGTGGGGAAAAGGGAGTGCAAACC
Pedetes          TCTAATAGTACCAAAGACCCCAAAAATCTAGTGTTAAGTGCAGAAAAGGGTTTGCCACCT
Aplodontia       TCTAATAGTACCAGAGACCCCAAAGATATGGTGTTAAGTGGAGAAAGGGGTTTGCAAAAT
Sciurus          TCTAATGATACCAAAGACCCCAAAGATATGGTGTTAAGTGGAGAAAGGGTTTTGCAAACT
Glaucomys        TCTGATAATACCCAAGACCCCAAAGATACGGTGTTAAGTGGAGAAAGGGTTTTGCAAACT
Graphiurus       TCTACTAGTACCAAAGACCCCAAAGATCTGGTGTTAAGTGAAGAAAAGGGTTTGCAAACT
Oryzomys         TCGGGCAGTACCAAAGACCTGAAGGATCTGGTGCTGGGTGGAGAACAAGGTTTGTCCACT
Meriones         CCTGATAACACCAAGGAACTCAAGGATCTGGTGCTGGGCGGAGAACGGTGTTTATCCACA
Mus              TCTGACAGTGCCAAAGAACTCGGGGATCGGGTCCTAGGAGGAGAGCCCGGCAAAACCACT
Rattus           CCTGATAATAACAAAGAACTCGGGGATTTGGTCCTGGGAGGAGAGCCCGGGAAACCTACT
Scalopus         TCAAATAATACCAAAGACCCCAAAGATCCGATACTTAGTGGACAAAGAGATTTGCAAGCT
Erinaceus        TGTAATAATACCAAAAACCCTAAAGATCTGATAGTAAGTGGAAAGAGAGGTTTACAAATT
Myotis           TCTAATAGTACCAAAGACCTCGAAGATCTGACATTAAGTGGAGGAAGAAGTGTGCAAATT
Tadarida         TCTAATAGTACCAAAGACCTCAAAGATCTGATATTAAGTGGAGGAAGAAGTTTGCAAACT
Taphozous        TCTGATAGTACCAAAGACCTCAAAGATCTGATATTAAGTGGAGGAAGAAGTTTGCAAACT
Tonatia          TCTAGTAGCACCAAAGACCTCAAAGATCTGATATTCAGTGGGGGAAGAAGTTTGCAAACT
Megaderma        TCTAATAGTACCAAAGACCCCAAAGATCTGATACTAAGTGGAGGAAGAGGTTTGCAAACC
Pteropus         TCTAATAGTACCAAGGACCCCAAAATTTTGATCTTCGGTGAAGGAAGAGGTTCACAAACT
Hipposideros     TCTAATAGTACCAAAGGCCTCAAAGATTTGATATCAAATGGGGGAAGAGGCTTGCAAACT
Cynopterus       TCTAATAGCACCAAAGACCCCAAAATTCTAATCTTTGGTGAAGGAAGAGGTTCACAAACT
Equus            TCTAATAGTGCCAAAGACCCCAAAGATCTGATATTAAGTGGAGGAAAATGTTTGCAAGCT
Diceros          TCTAATAGTACCAAAGACCCCGAAGATCTGATATTAAGTGGAGGAAGAGGTTTGCARGCT
Manis            ---------ACCAAAGACCCCAAAGATGTGATATTACATAGAGGA---GGTTTGCAAACT
Canis            TCTGATAGTACCAGAGATCCCAAAGAGCTGGTATTGAGTGGAGGAAGAGGTTTGCAAACT
Felis            TCTGATAGGACCAGAGATCCCAAAGCGCTGGTATCGAGTGGAGGAAGAAGTTTGCAAACT
Sus              TCGAATAGTAACAAAGACCCCAAAGATGTGATGTTAAGTGGAGGAAAAGGTTTTCAAATT
Lama             TCGAACAGTACCAAAGACCCCAAAGTTCTGATATTAAGTGGAGGGAGAGGTTTACAAATT
Bos              TCGAATAGTACCAAAGACCCCAAAGATCTGATATTAAGAGAAGGAAAAGCTTTGCAAATT
Hippopotamus     TCAAATAGTACCAAAGACCCCAAAAATCTGATATTAAGTAGAGGAAAAGGTTTGCAAATT
Megaptera        TCGAATAGTACCAAAGACCCCAAAGATCTGACATTAAGTGGAGGAAAAGGTTTGCAAATT
Physeter         TCGAATAGTACTGAAGACCCCAAAGATCTGACATTAAGTGGAGGAAAAGGTTTGCAAATT
Tamandua         TCTGATACTACCATGGACCCTGAAGGTCTGGTATTAAGTGAAGGAAAGAATTTGCAAACT
Bradypus         TCTGATAGTACCAGAGACCCCGGAGCTCTGGTGTTAAGTGGAGGAAAGGGTTTGCAAACT
Dasypus          TCTGATAGTACCAGGGACCCTGAAGATCTGGTGGTAAGTGGAGAAAAGTGTTTGCAAACT
Chaetophractus   TCTGATACTACCAGGAATCCTGAAGATCTGGTGTTAAGTGAAGGAAAGAGTTTGCAAACT
Loxodonta        TCTAATATTACCAAAGAGCCCAAGGATCTAGTGTTAAATGGAGGAAGAGATTTGCAAACC
Elephas          TCTAATATTACCAAAGAGCCCAAGGATCTAGTGTTAAATGGAGGAAGAGATTTGCAAACC
Dugong           TCTAATAGAACCAGAGACCCCGAGGATCTAGTGTTAAATGGAGGAAGAGGTTTGCAAACT
Trichechus       TCTAATAGAACCAGAGACCCCGAGGATCTAGTGTTAAATGGAGGAAGAGGTTTGCAAACT
Procavia         TCTAATACTGCCAAAGAACCTGAGGATCTAGAGTTAAATGGAGGGAGAGTTTTGCAAACC
Dendrohyrax      TCTAATACTGCCAAAGAACCTGAGGATCTAGAGTTAAATGGAGGGGGAGTTTTGCAAACC
Orycteropus      TCTGATAGTACCAGAGATCCTACGGATGAGGTGTTAAACAGA---AGAGGTTTGCAAACT
Tenrec           TCTAATAGCGCCAGAGACCCCAAAGATGAGGTGTTGGGTAGAGCAAGGGGCCTGCAAACT
Echinops         TCTAATGGTACCAGAGACCCCAAAGGTGAGGTGTTGGGTAGAGCAAGGGGCCTGCAAACC
Elephantulus     TCTAATAGTATCAAAGATCCCAAGGATCAAGTATTAAATAGAGGAAGGTTGCAGCACACT
Rhynchocyon      TTGAATAGTACCAAGGACCCTGGAACTCAAGTGTTAAGTAAGGAAAGGGGTTTGCACACT
Amblysomus       TATGATAACACCAAAGAACCTGAGGATCAGGTGTTAAGTGGAAGAAGGGATTTGCAAATG
Vombatus         AGCAAAGACCAAGAT------------CTGCCCTTGAATGGAGGGGAGGGGTTGCAAGGT
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Homo                GAAAGATCTGTAGAGAGTAGCAGTATTTCATTGGTACCTGGTACTGATTATGGCACTCAG
Pan                 GAAAGATCTGTAGAGAGTAGCAGTATTTCATTGGTACCTGGTACTGATTATGGCACTCAG
Gorilla             GAAAGATCTGTAGAGAGTAGCAGTATTTCATTGGTACCTGGTACTGATTATGGCACTCAG
Pongo               GAAAGATCTGTAGAGAGTAGCAGTATTTCATTGGTACCTGGTACTGATTATGGCACTCAG
Macaca              GAAAGATCTGTAGAGAGTAGCAGTATTTCATTGGTACCTGGTACCGATTATGGCACTCAG
Alouatta            GAAAGATCTGTAGAGAGTAGCAGTATTTTGTTGATACCTGGTACTGATTATGGCACTCAG
Otolemur            GAAAGATCTATAAAAAGCACCAGTATTTCATTGGTACCTGATACTGATTATGGTACTCAG
Cynocephalus        GAAAGATCTGTAGAGAGTACCAGTATTTCATTAGTACCTGATACTGATTATGGCACTCAA
Tupaia              GTAAGGTCTGCAGAGAGTACCAGTATTTCTTTGGTACCTGATACTGATGATAACACCCAG
Lepus               GAAAGGTCTGCGGAGAGTACCAGTATTTCACTGGTACCTGATACTGAATATGGTACCCAG
Hystrix             GAGAGGTCTATGGAGAGCACTAGCATTTCACTAGTCCCTGACACTGACTGTGGCACTCAG
Pedetes             GAAAGATCTACAGAGAGTACTAGTGTTTCATTGGTACCTGATACTGACTATGACACTCAG
Aplodontia          GAAAGATCTGCAGAGAGTACCAGTATTTCATTAGTACCTGATACTGATTATGACACTCAG
Sciurus             GAAAGATCTGCAGAGAGTACCAGTATTTCATTGGGACCTGATACTGATTATGGCACTCAG
Glaucomys           GAGAGATCTGTAGAGAGTACCAGTATTTCATTGGTACCTGATACTGATTATGGCACTCAG
Graphiurus          GAAAGATCTACAGAGAGTACGAGTATGTCATTGGTACCTGATACTGATTATGGCACTCAG
Oryzomys            GAGAGGTCTGAGGAGAGCACTAGTGTTTCATTGGTAGCTGACACTGAGTATGATACTCAG
Meriones            GAAAGATCTGAGGAGAGTACCAGTGTTTCACTGGTACCCGACACTGATAATGACACTCAG
Mus                 GACCGATCTGAGGAGAGCACCAGCGTATCCTTGGTACCTGACACTGACTACGACACTCAG
Rattus              GAACCATCTGAGGAGAGCACCAGTGTGTCCTTGGTACCCGACACAGACTACGACACCCAG
Scalopus            GAAAGATCTGGCGAGAGTACCAATATTTCATTGGTACCTGAGACTGATTTTGGCAGTCAG
Erinaceus           GAAAGATCTGTAGAGAGTCCT------------GTAGAGAACACTGACTATGGCAGTCAG
Myotis              GATAGATCTAAAGAGAGTACCAATATTGTATTGGTACCTGAAACTGATTATGGCACACAG
Tadarida            GATAGATCTATGGAGAGTACCAATATTTTATTGGTACCTGAAACTGATTATGGCACGCAG
Taphozous           GATAGATCTATGGAGAGTACCAATATTTTATTGGTACCTGAAACTGATTATGACACTCAG
Tonatia             GACAGATCTGTGGAGAGTCCCAATATTGNATTGGTACCTGAAACTGACTGTGACACTCAG
Megaderma           GATCGTTCTATGGAGAGTACCAGTATTTCATTGGTACCTGATACTGATTATGGCACTCAG
Pteropus            GATCGATCTACAGAGAGTACCAGTATTTTATTGGTGCCTGAAACGGATTATGGCACTCAA
Hipposideros        GGTCAATCTATGGAAAGTACCAGTATTTTATTGGTACCTGATACTGATTATGGCAGTCAG
Cynopterus          GATCGATCTACAGAGAGTACCAGTATTTTATTGGGACCTGAAACGGATTATGGCACTCAA
Equus               GAAAGATCTGTAGAGAGTTCCGGTATTTCATTGGTACCTGATACTGATTATGGGACTCAG
Diceros             GAAAGATCTGTAGAGAGCACCAGTATTTCATTGGTACCTGATACTGATTATGGCACTCAG
Manis               GAAAGATGTGTAGAGAGTAACAGTATTTCATTGGTACCTGATACTGATTACGGCACTCAG
Canis               GAGAGATCTGTAGAGAGTACCAGTATTTCATTGGTACTTGATACTGATTATGGTACACAG
Felis               GAAAGATCTGTAGAGAGTACCAGTATTTCATTGGTACCTGATGCCGATTATGGCACTCAG
Sus                 GAAAGATCTGTAGAGAATACCAGTATTTCCCTGGTACCTGATACTGATTATGGCACTCAG
Lama                GAAAGATCTGTAGAGAATACCAGTATTTCCTTGGTACCTGAAACTGATTATGACACTCAG
Bos                 GAAAGATCTGTAGAGAGTACCAATATTTCCTTGGTTCCTGATACTGATTATAGCACTCAG
Hippopotamus        GAAAGATCTATAGAGAGCACCAGTATTTCCTTGGTACCTGATACTGATTATGGCACTCAG
Megaptera           GAAAGATCTGTAGAGAGTACCGGTATTTCCTTGGTACCTGATACTGATTATGGCACTCAG
Physeter            GAAAGATCTGTAGAGAGTTCCAGTATTTCCTTGGTACCTGATACTGATTATGGCACTCAG
Tamandua            GAAAGATCTGTAGAGAGCACCAGTATTTCATTGGTGCCTGACACTGATTATGGCACTCAA
Bradypus            GAAAGATCTCTAGAGAGTACCAGTATTACAATGATACCTGAAACTGATTATGACACTCAA
Dasypus             GAAAGATCTGCAGAGAGTACCGGTATTTCAGTGGTACCTGATACTGATTATGGCACTCAA
Chaetophractus      CAAAGGTCTGCAGAGAGTACCAGTATTTCAGTGGTACCTGATACTGATTATGGCACTCAA
Loxodonta           AAAAAATCTATTGAGAGTACCAATATCTCAGTGATACCTGATACTGTTTATGGCACTCAG
Elephas             AAAAAATCTATTGAGAGTACCAATATCTCAGTGATACCTGATACTGTTTATGGCACTCAG
Dugong              GAAATATCTGTTGAGAGTACCAGTATCTCAGTGATACCTGATACTGACTATGGCAGTCAG
Trichechus          GAAATATCTGTTGAGAGTACCAGTATCTCAGTGATACCTGATACTGATTATGGCAGTCAG
Procavia            AAAAGATCTGTTGAAAGTACTAGTACCTCAGTGATACCTGATGCTGACTGTGGTGCTCAG
Dendrohyrax         AAAAGATCTGTTGAAAGTACCAGTACCTCAGTGATACCTGATGCTGACTGTGGTGCTCAG
Orycteropus         GAAAGATCTGTGGAGAATACCAGTATTTCAGTGAAACCTGATACTGATTATAGCACTCAG
Tenrec              GCAAGATCTGTTGAGAGCACCAGTTTTTCACTGATACCTGCTGCTGCTGACGGCACCCCG
Echinops            GCAAGATCTGTTGAGAGTACCAGTGTTTCACTGATACCTGATGCTGATGATGGCCCTCAG
Elephantulus        GGAAAATGTGTTGAGAGTACCAGTATTTCAGTGTTATCTGATACTGATTATGGCACTCAG
Rhynchocyon         GGGAATTATGTTGAGAGTACCAGTATTTCAGTAATACCTGATACTGATGATGGTATTCAA
Amblysomus          GAAAGATCTGTTGAGAGTACCAGTGTTTCAGTGATACCCGATACTGATCATGGCACTCAG
Vombatus            GAAAGAGCCCCAGGAAGCCTGGAGGCTTTGGAGGTTCCTGATACTGATTGGGACACTCAG
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Homo            GAAAGTATCTCGTTACTGGAAGTTAGCACTCTAGGGAAGGCAAAAACAGAACCAAATAAA
Pan             GAAAGTATCTCGTTACTGGAAGTTAGCACTCTAGGGAAGGCAAAAACAGAACCAAATAAA
Gorilla         GAAAGTATCTCGTTACTGGAAGTTAGCACTCTAGGGAAGGCAAAAACAGAACCAAATAAA
Pongo           GAAAGTATCTCGTTACTGGAAGTTAGCACTCTAGGGAAGGCAAAAACAGAACCAAATAAA
Macaca          GAAAGTATCTCATTACTGGAAGTTAGCACTCTAGGGAAGGCAAAAACAGAACGAAATAAA
Alouatta        GAAAGTATCTCATTACTGGAAGTTAGCACTCTGGGGAAGGCAAAAACAGAACCAAATAAA
Otolemur        GACAGTAACTCGTTACTGAAAGTTAAAGTCTTACGGAAGGTGAAAACAGCACCAAATAAA
Cynocephalus    GACAGTATCTCAATATTAGAAGCTAACATCCTAGGGAAGGCAAAAACAGCACCAAGTCAA
Tupaia          GATAGCATCTCATTACTAGATGCTAACCCCCTAAGGAAGGCAAAAACAGCACCAAATCAA
Lepus           GACAGCATCTCATTACTGGGCGCTAACACCCTTGGGAAGGCAAAAACAGCAGCAAATGGA
Hystrix         GACAGTGTCTCCTTACTGGAAGCCGACAGCCTCAGGAAGGCACGGAGAGCATCGCATCAG
Pedetes         GACAGTATCTCATTACTGGAAACTAACACCCTCAGGAAGGCAAAAACAATGTCAAATCAG
Aplodontia      GACAGTATCTCATTACTGGAAGCTAACACCTTTGGAAAAGCAAGAACAGCATCAAATCAA
Sciurus         GACAGTATCTCATTACTGGAAGCTAACACCTTTGGAAAAGCAAGAACAGCATCAAATCAA
Glaucomys       GACAGTATCTCATTACTGGAAGCTAACACCTTTGGAAAAGCAAGAACAGCATCAAATCAA
Graphiurus      GACAGTATCTCAGTACTGCAAGCTGACACCCTTGGAAAGGCAAGAACAGCATCAAATCAA
Oryzomys        AATAGTGTGTCATTACTGGAAGCTAACACTGTCAGATATGCAAAAACAGGATCAAGTCAG
Meriones        AACAGCGTCTCAGTACTGGATGCTAACACTGTCAGATCTGCAAAAACAGGGTCAATTCAG
Mus             AACAGTGTCTCAGTCCTGGACGCTCACACTGTCAGATATGCAAGAACAGGATCCGCTCAG
Rattus          AACAGTGTCTCAATACTGGAAGCGAACACTGTCAGATATGCAAGAACAGGATCAGTTCAG
Scalopus        GATAGTGTCTCATTACTGGAAATTGACATCCTAGGCAAGGCAAAAAAAGTGCCGAATCAG
Erinaceus       GATAGTATCTCATTACTGGAAACTGATACTCTAGGGAAGGCAAAAAAGACACCAAATCAA
Myotis          GATAGTGTCTCATTACTGGAACCTGACATCCCAGGGAAGGCAAAAACAGCTCCAAATCAA
Tadarida        GATAGTATCTCATTACTGGAACCTGACACCCCAGGGAAGGCAAAAAAAGCTCCAAATCAA
Taphozous       TATAGTATCTCATTACTGGAACCTGACACCCCAGGGAAGGCAAAAACAGCACCAAGTCAA
Tonatia         GATAGCGTCTCCCTGCTGGCACCTGACACCCCAGGGAAGGCAGAAACAGCACCAGGCCAA
Megaderma       GCTAGTATGTCATTACTGGAACCTGACACCCCAGGGAAGGTAAAAACAGCACCAAATCGA
Pteropus        GATAGTATCTCATTACTGGAACCTGACATCCCAGAGAGGGTAAAGACAGCACCAAACCAT
Hipposideros    GATAGTATGTCATTACTCGAACCTGACACCCCAGGGAAGGCAAAGACTGCACCAAATCAA
Cynopterus      GATAGTATCTCATTACTGGAATCTGACATCCCAGGGAGGGCAAAGACAGCACCAAACCAA
Equus           GATAGTATCTCACTGCTGGAAGCTGACACCCTAGGGAAGGCAAAAACAGCACCAAATCAA
Diceros         GGTAGTATCTCATTACTGGAAGCTGACACCCTAGGGAAGGCAAAAACAGCACCAGATCAA
Manis           GATAGTATCTCATTACTGGAAGCTGACACACTAGGGAAGACAAAAACAGCACCAAATCAA
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Felis           GATAGTATCTCATTACTGGAAGCTGACACCCTAGGGAAGGCAAAAACAGCACCAAATCAA
Sus             GACAGTATCTCATTACTGGAAACTGACACCCTAGGAAAGGCAAAAACAACACCCAATCAA
Lama            GACAGTGTCTCATTACTGGAAGCTGACACCCTAGGGAAGGCAAAAACAGCACCAAATCAA
Bos             GATAGTATCTCATTACTAGAAGCTAAAACCCCAGAAAAGGCAAAGACTGCACCAAATCCA
Hippopotamus    GACAGTATCTCATTACTGGAAGCTGACACCCTAGGGAAGGCAAAGACAGCAACAAATCAA
Megaptera       GATAGTATCTCATTACTGGAAGCTGACACCCTAGGGAAGGCAAAGACAGCACCAAATCAA
Physeter        GATAGTATCTCATTACTGGAAGCTGACACCCTAGGGAAGGCAAAGACAGCACCAAATCAA
Tamandua        GATAGTATCTCATTACTAGAAGCTGCTACCCTAGGGAAAGCAAAGCAGCACCAAATCAA
Bradypus        GACAGTATCTCCTTACTGGAAGCTGACACCCTAGGGAAAGCAAAAGCAGCACCAAATCAA
Dasypus         GACAGTATCTCATTACTGGAAGCTGACACCCTGGGGAAGGCAAAAACAGCACTAAATCAA
Chaetophractus  GACAGTGTCTCATTACTGGAAGCTGACACCCTGGGGAAGGCAAAAACAGCACTAAATCAA
Loxodonta       GACAGCGTCTCATTGCTGGGAGCTGACACCCCAGGGAAGGCAAAAACAGCACCAAATCGA
Elephas         GACAGCGTCTCATTGCTGGGAGCTGACACCCCAGGGAAGGCAAAAACAGCACCAAATCAA
Dugong          AACAGCATCTCATTACTGGAAGCTGACACCCTCAGGAAGGCAAAAACAGCACCAAATCAA
Trichechus      AACAGCATCTCATTACTGGAAGCTGACACCCTCAGGAAGGCAAAAACAGCACCAAATCAC
Procavia        GACAGCATCTCGTTACTGGAAGCTGACACTCTAGGGAAGGCAAAAACAGCACCAAATCAA
Dendrohyrax     GACAGTATCTCGTTACTGGAAGCTGACACTCTAGGGAAGGCAAAAACAGCACCAAATCAA
Orycteropus     GACAGCATCTTATTACTGAAAGCTAACTCCCTAAGGAAGGCAAAAACAGCACCA------
Tenrec          GGTGGCGTCTCAATAATGGAAGCAGGCAGCCGAGGACAGGCACAAACAGCACCAGATCCA
Echinops        GGTACCATCTCAATCATGGAAGCAGGCAACCGAGGGGAGGCACAAACAGCACCAGGTGAA
Elephantulus    AATAGCATCTCATTACTGGAGGCTGGCACCCTAGGGAAGGCAGAAACAGCACCAGATCAA
Rhynchocyon     AATAGCACCTCATTACTGGAAGCTGGCACATTAGAAAAGGCAGAAACAGCATTGACTCAA
Amblysomus      AACCACACCTCATTACCGGAAGCTGGCACCCTCGGGAAGGCAGAAACAGCACCAAATCAA
Vombatus        GACAGTACCTCATTGTTTCCAGCTGATACTCCCAATAAAGCAGGA------CCCAGTCCT
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Homo            TGTGTGAGTCAGTGTGCAGCATTTGAAAACCCCAAGGGACTAATTCATGGTTGTTCCAAA
Pan             TGTGTGAGTCAGTGTGCAGCATTTGAAAACCCCAAGGGACTAATTCATGGTTGTTCCAAA
Gorilla         TGTGTGAGTCAGTGTGCAGCATTTGAAAACCCCAAGGGACTAATTCATGGTTGTTCCAAA
Pongo           TGTGTGAGTCAGTGTGCAGCATTTGAAAACCCCAAGGAACTAATTCATGGTTGTTTCAAA
Macaca          TGTATGAGTCAGTGTGCAGCATTTGAAAACCCCAAGGAACTAATTCATGGTTGTTCTGAA
Alouatta        TGTGTGAGTCAGTGTGCAGCATTTGAAAACCCCAAGGAACTAATTCATGGTTGTTCTAAA
Otolemur        CATGCAAGTCAGGGTACAGCCACTGAAAACCCCAAGGAACTAATCCATGGTTGCTCTAAA
Cynocephalus    CATGCAAATCAGTGTGCAGCAATTGAAAACCCCAAAGAACTTATCCATGGTTGTCCTAAA
Tupaia          TGTGTAAATCAGAGTGCAACAACTGAAAACCCCAAGGAACTTATACACAGTTGTTCTAAA
Lepus           CATGTGAGTGAGAGCACAACAATTGGAAATCCCAAGGAACTTAGCCATGATTGTTTGAAA
Hystrix         TGTATGGCTCAATATGTGGCGGTTGCGAAGCCCAAGGAACTTCTGCCTGCTTGTTCTGAA
Pedetes         TGTATGACTCAGTATGTAGCAATTGAACACCCCAAGGAACTTAGCCATAGTTGTTCTAAA
Aplodontia      CATGTTACTCAGTTTGTAGCAGTTAAAAACCCCAAGGAATTTATCCATGGTAATTCTAAA
Sciurus         CATGTTACTCAGTATGTGGCAATCGAAAACCCCAAGGAT---------GGTCTTTTTAAA
Glaucomys       CATGTTACTCAGTATGTGGCAATTGAAAATCCCAAAGAATTTGTCCATGGTCATTCTAAA
Graphiurus      TGTGTGACTCAATATGAAGCAATTGAAAACCCTAAGGAACTTATCCATGGT---TCTAAA
Oryzomys        TGTCTGACTCAGTTTGTAGCAAGTGAGACCCCCAAGGATCTGGCTCATGGT---TCTAAC
Meriones        TGTTTGACTCAGTTTGTAGCAAGTGAAAACACCAAGGAACTTGTCTATGGT---TCTAAA
Mus             TGTATGACTCAGTTTGTAGCAAGCGAAAACCCCAAGGAACTCGTCCATGGC---TCTAAC
Rattus          TGTATGACTCAGTTTGTCGCAAGTGAAAACCCCAAGGAACTTGTCCATGGT---TCTAAC
Scalopus        TGTGCAAGTCTGTGTACAAAAATTGAAAACTCTAAGGAACTTATTCATAGTTGTTCTAAA
Erinaceus       TGTGTAAGTCTGTGTGTAGCAACTGAAACCCCCAAAGAACTTAGCCATAGTTGTTCTAAA
Myotis          TGTGGGGATCTGTGTGCAGCAGTTAAAAATCCTAAAGAACTTATTCGTGGTTGTTCTAAA
Tadarida        TATGCGGGTCTGTGTGCAGAAATTAAAAACCNCAAGGAACTTATCCATGGTTGTTCTAAC
Taphozous       CATGCGAGTCTGTGTGCAGCAATTGAAAACCCCAAGGAGTTTAACCATGGTTGTTCTAAA
Tonatia         CGTGTGGGTGGGTGCGCAGCTGCTGGAAGCCCGAAGGAACTTATCCGTGATTGTTCGAAG
Megaderma       CGTGCAGGTGTGTGTGCTGCAATTGAAAACCCCAAGGAAATTATCCATGGTTGTTCTAAA
Pteropus        CAT------------GCAGCAATTAAAAACCCCAGAGAACTTATTCATGGTTGTTCTGAA
Hipposideros    CATGTGGGTGTATGTACAGCAGTTGAAAACCCCGAGGAACTTATCCATGGTGGTTCTAAT
Cynopterus      CATGCAGATCTGTGTGCAGCAATTGAAAACCCCAGAGAACTTATTCATGATTGTTTTAAA
Equus           TGTGCAAATCTATGCGCAGCAATTGAAAACCCCAAGGAACTTACCCATGATTGTTCTAAG
Diceros         CGTGCAAGTCTATGTGCAGCAATTGAAAACCCCAAGGAACTTATCCATGATTGTTCTAAA
Manis           TGTGCAAGTCTGTGTGCAGCAATTGAAAACCCCAAGGAACTTACCCATTGTTGTGCTAAA
Canis           CAGGCGAATCTGTGTGCAACAATTGAGAACCCCAAGGAACCTATCCATGGTTGTTCTAAG
Felis           CGTGTGAGTCTGTGTGCAGCAATTGAAAACCCCAAGGAAGCTATCCGTGGTTGTTCCAAA
Sus             CATGTGAGGCTGTGTGCAGCAACTGAAAACCCCAAAGAACTTAGCCTTGGTTGTTCTAAA
Lama            TGTGTGAGTCTCTGTGCAGCAACTGAAAACCCCAAGGAACTTATCCATAGTTGTTCTAAA
Bos             TGTGTGAGTCTGTGTACAGCAACCAAAAACCTCAAGGAACTTATCCATAGGGATTTTAAA
Hippopotamus    CGTGTGGGTCTGTGTGCAGCAACTGAAAACCCCAAGGAACTTATCCATGGTTATTCCAAA
Megaptera       CATGTGAGTCTGTGTGCAGCAATTGAAAGCCCCAAGGAACTTATCCATGGTTGTTCTAAA
Physeter        CATGTGAGTCTGTGTGCAGCAATTGAAAGCCCCAAGGAACTTATCCACGGTTGTTCTAAA
Tamandua        CATGTGAGTCTGTGTGCAGCAGTTGGAAATGCCACTGAACTTGTCCATGGTTGTTCTAAA
Bradypus        CATGTGAGTCAGTATGCAGCAATTGGAAATGCCACTAAACTTTTCCATGGTTGTTCTAAA
Dasypus         CATGTGAGTCAGTATGTAGCAATTAGAAATGCCACTGAACTTTCCCATGGTTGTTCTAAA
Chaetophractus  CCTATGAGTCAGTATGCAGCAATTAAAAATGCCACTGAACTCTCCCATGGTTGTGCTAAA
Loxodonta       TGTGCAAGTCAGTGTACAGCAATTGAAAACCCAAGTGAACTTACCAACAGTTGTCCTAAA
Elephas         TGTGCAAGTCAGTGTACAGCAATTGAAAACCCAAGTGAACTTACCAACAGTTGTCCTAAA
Dugong          TGTGCAAGTCAGTGTGCAGCAATTGAAAACCCCAATGAACTTATCCATGGTTGTCCTAAA
Trichechus      TGTGCAAGTCAGTGTGCAGCAATTGAAAACCCCAATGAACTTATCCATGGTTGTCCTAAA
Procavia        GGGGCAGGTCAATGTTCGGCAATCGAAAACCCCAACGAACTTATTCATGGTAGTCCTAAA
Dendrohyrax     GGGGCAGGTCAATGTTCAGCAATCGAAAACCCCAACGAACTTATTCATGGTAGTCCTAAA
Orycteropus     ------AGTCAGTGTGCAGCAATTGAAAATCCTAACAAACTTAGCCATGGTTTTCCTAAA
Tenrec          TGTGCAAGGCAGTGTACAGCAACGGACAACCCCAGCGAAAGTGCCCACGGTCTTTCCAGA
Echinops        TGTGCAAGGCAGTGTGCAGCAACTGAAAACCCCAACAGGAGTGTCCAGGGTCTTTCCAAA
Elephantulus    TGTGCAAGTCACTGTGCAGCAATGGAAAACTCCAAGAAACATGTTCATGACTTTCCTAAA
Rhynchocyon     TGTGCAAGTCACTGTGCAACAATTTTAAACCCCAACACACATGTTCATGGCTTTCCTAAA
Amblysomus      TGTACAAGTCAGTGTAAAGCAATTGAAAATCCCAACCAACTTATCCATGGTTGTCCT---
Vombatus        CACAGAAGCCACAGTGAAATAATGGAAACCCCCAAGGAACTCTTAGATGGTTGTTCAAAA
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Homo              GATAATAGAAATGACACAGAAGGCTTTAAGTATCCATTGGGACATGAAGTTAACCACAGT
Pan               GATACTAGAAATGACACAGAAGGCTTTAAGTATCCATTGGGACATGAAGTTAACCACAGT
Gorilla           GATACTAGAAATGACACAGAAGGCTTTAAGTATCCATTGGGACATGAAGTTAACCACAGT
Pongo             GATACTAGAAATGACACAGAAGGGTTTAAGTATCCATTGGGACATGAAGTTAACCACAGT
Macaca            GATACTAGAAATGACACAGAAGGCTTTAAGTATCCATTGGGAAGTGAAGTTAACCACAGT
Alouatta          GATACTAGAAATGGCACAGAAGGCTTGAAGTATCCATTGGGACCTGAAGTTAACTACAGT
Otolemur          GATACTGGAAATGACACAGAGGGCTATAAGGATCCATTGAGACATGAAATTAACCACATT
Cynocephalus      GGTACTAGAAATGACACAGAGGATTTTAAGGATCCATTGAGATGTGGAGTTGACCACATT
Tupaia            ACTACTAGGAAT------GAAGGCTTCAAGGATCCATTGAAAAGTGAAGTTAATCATATT
Lepus             GATACTGGAAATGACCCAGACAACTGTAAGGATCCACTGAGAAGTGAAGTTGAC------
Hystrix           GACACTGGAAACGGCACAGACAGCTTAAATGATCCATTGAGATGTGGAGGGAGCCACATC
Pedetes           GATACTAGAAATGACACGAAGGGCTTTAAGGATGCACTGCGACGTGAAGTTAACCATATT
Aplodontia        GATACTAGAAATGACACAGAGGATATTAAGGATTCATTGAGACATGAAGTTAACCACCTT
Sciurus           GATACTAGAAATGACCCA------------GATTCATTGAGATGTGAAGTTAACCACATT
Glaucomys         GATACTAAAAATGACCCAGAGGGTTTCAAGGATTCATTGAGATGTGAAGTTAACCACATT
Graphiurus        GATACTAGAAATGACACAGAAGGCTTTAAAGATTCATTGAGATGTGAAGTTAACCACATT
Oryzomys          AATGCTGGAAGTAGCACAGAGTGTGTCAAGCATCAGTTGAGACATGAACTCAGCCACATT
Meriones          GATGCTGGAAGTGACACAGAATGCTTTAAGCATCCATCGAAACACGAGCTTAACCACATT
Mus               AATGCTGGGAGTGGCACAGAGGGTCTCAAGCCCCCCTTGAGACACGCGCTTAACCTCAGT
Rattus            AATGCTGGAAGTGGCTCGGAGTGCTTCAAGCACCCATTGAGACATGAACTTAACCACAAT
Scalopus          GATACTAGAAATGACACACAGGGCTGTAAGGATCCACTGAAATACGAAGTTAACCACACT
Erinaceus         GATACTAGAAATGACACTGAAGGCTTTAGGGATTCACTCAGATGTGAAGTTGATCACACG
Myotis            GATATTAGAAATGACAGAGAGGGCTTTAAGGATCTATTGAGATGTGAAGTTAACCACACG
Tadarida          GATAATAGAAATGACAGAGAGGACATTAAGGATCTATTGAGACCTGAAGTTAACCACANN
Taphozous         GATACTAGAAGTGACACAGAGGGTGTTAAGGATCTACTGAGATGTGAAATTAACCNCACN
Tonatia           GACACA------------GAGGGCGTTAAGGATCTCCCGAGATGTGAAGTTCAGGAGACN
Megaderma         GATACTAGAAATGACACAGGGGACTTTAAGGATCCACTAAGAGGTGAAGTTAACCACACN
Pteropus          GATACTAGAAATGATGCAGAGGGCTTTAAAGATCCATTGAGACGTGAAGTTAACTACANN
Hipposideros      GATACTAGAAATGACACAGAGAGCTTTAAGGATTCATTGAGACATGAAGTTAACCACGGT
Cynopterus        GAAACTAGAAATGACACAGAGAGCTTTAAAGATCCATTGAGACATGAAGTTAACTCCACN
Equus             GATACTAGAAATGATACACAGGGCGTTAAGGATCCATTGAGACGTGAAGTTAACCACACT
Diceros           GATACTAGAAATGACACAGAGGGCCTTAAGGATCCATTGAGATGTGAAGTTAACCACACT
Manis             GATATTAGAAATGACACAGAGAGCTTTAAGGATCTATTGAGACATGAAGATAACCACACT
Canis             GACACTAGAAATGACACAGAGGGTTTTGTAGTTCCATTGACGTGCAAAGATAACCACACT
Felis             GATACTAGAAATGGCACAGAGAGTTTTACAGATCCTCTGAGACGTGAAGATANCCATACT
Sus               GGTGTTAGAAACGACACAGGGGACTTTAAGGATCCCCTGGCTCATGATGTTAACCACACT
Lama              GATACTAGAAATGGCACAGCAGGCTTTAAGGATCCATTGGGATGTGATGTTAATCACACT
Bos               GATACCAAAAACAACACAGAGGGCTTTCAGGATCTACTGGGACATGACATTAACGTCATT
Hippopotamus      GATACTAGAAACGACATGGACGGCGTCCAGCATCCATTGGGACAGGATGTTAACCACACT
Megaptera         GATATTAGAAACGACACAGAGGACTTTCAGGATCCACTGGGACATCACGTTAACCACATT
Physeter          GATATTAGAAACGACACAGAGGACTTTAAGGATCCACTGGGACATCACGTTAACCACATT
Tamandua          GATACTAGAAATGACACTGAAGATTTTAAGGATTCATTGAGACATGAAGTTAACCACACA
Bradypus          GATACTAGAAGTGACACTGAGAATTTTAAGGATCCATTGAGACATGAAGTTAACCACACA
Dasypus           GACACTAGAAATGACACTGAAGATTTTAAGGATTCATTGAGACATGAAGTTAACCACACT
Chaetophractus    GACACTAGAAATGACACTGAGGATTTTAAGGATCCGTTGAGACATGAAGTTACCCACACT
Loxodonta         GATACTAGAAATGACACAGAGGGTTTTAAGGATCTATTGAGATGTGAAGCTAGCCACATT
Elephas           GATACTAGAAATGACACAGAGGGTTTTAAGGATCTATTGAGATGTGAAGCTAGCCACATT
Dugong            GATACTAGAAATGACACAGAGGATTTTAAGGATCTGTTGAGATGTGAAGTTAACCACATT
Trichechus        GATACTAGAAATGACACAGAGGATTTTAAGGATCTGTTGAGATGTGAAGTTAACCACGTT
Procavia          GACACTAGAAATGATATAGAGGGTTTTAAGGATCCACTGAGATGCAAAGTTAACCCTATT
Dendrohyrax       GACACTAGAAATGATATAGAGGGTTTTAAGGATCCACTGAGATGCGAAGTTAACCCTATT
Orycteropus       GATACCAGAAATGACATAGAGGGTTTTAAGGATCTATTTAGAGGTGAAGATAACCACGTT
Tenrec            GATACTAGAAACAGCACGGAGGGCTTTGCGGATCTATTGACACATGGCGTTCCCCACATC
Echinops          GACACTAGAAATAACAGGGAGGGCTCTGAGGATCTCTTGACACACGACGTTAACCACCTT
Elephantulus      GATACTGGAAATGATACAAAGGGTTTAAAGGACTCATTGAAATGTGATGCTAGCCACAGT
Rhynchocyon       GATCCTGCAAATGACACAGAGGGTGTTAAGGATCTGTTGAAATGTAATCCTAACCACCTT
Amblysomus        ------AGAAATGACACAGAGGGCTTTAAGGATCTATTGAAACATGAAGTTAAACACAAT
Vombatus          AACACTGAAAGTGACGAAGAAGATTTGAGGAGCCTGATGAGACAGGAAGTTAAAAATGCC
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Homo            CGGGAAACAAGCATAGAAATGGAAGAAAGTGAACTTGATGCTCAGTATTTGCAGAATACA
Pan             CGGGAAACAAGCATAGAAATGGAAGAAAGTGAACTTGATGCTCAGTATTTGCAGAATACA
Gorilla         CGGGAAACAAGCATAGAAATGGAAGAAAGTGAACTTGATGCTCAGTATTTGCAGAATACA
Pongo           CAGGAAACAAGCATAGAAATGGAAGAAAGTGAACTTGATACTCAGTATTTGCAGAATACA
Macaca          CAGGAAACAAGCATAGAAATAGAAGAAAGTGAACTTGATACTCAGTATTTGCAGAATACA
Alouatta        CAGGAAACAAGCATAGATATGAGAGAAAGTGAACTTGATACTCAATATTTGCAGAATACA
Otolemur        CAGAAGATAAGCATGGAAATGGAAGACAGTGAACTTGATACTCAGTATTTACAGAATACA
Cynocephalus    CAGAAGACAAGCATAGAAATGCAAGAGAGTGAACTTGATACTCAGTATTTACAAAATATA
Tupaia          CAGGAGATGAGTGTAGAAATGGAGGAGAGTGAACTTGATACTCAGTATTTACAGAATACA
Lepus           CAAGAGACAAGCGTAGAAATGGAAGAGAGTGAGTTTGATACTCAGTATTTACAGAATACA
Hystrix         CAGGAGGCAAATATAGAAATGGAAGATAGTGAACTCGACACTCAGTATTTACAGAATACA
Pedetes         CAGGAGACAAACACAGAAATGGAAGAGAGTGAACTTGATACTCAGTATTTGCAGAACACA
Aplodontia      CAGGAGACAAACATAGAAATGGAGGAAAGTGAACTTGATACACAGTATTTAGAGAATACG
Sciurus         CAGGAGACAAACGTAGAAATGGAAGAAAGTGAACTTGATACTCAGTATTTAGAGAATACA
Glaucomys       CAAGAGACAAATGTAGAAATGGAAGAAAGTGAACTTGATACTCAGTCTTTAGAGAATACA
Graphiurus      CAGGAGACAAATGCAGAAATGGAAGAGAGTGAACTTGATACTCAGTATTTACAGAATACA
Oryzomys        CAGGAGACA---GTAGAAATAGAAGAGGGAGAACTTGATACTCAGTATTTACAAAAGACA
Meriones        CCAGAGACA---GTAGAAATGGAAGGGAGTGAACTGGATACTCAATATTTGCAGAATACA
Mus             CAGGAGAAA---GTAGAAATGGAAGACAGTGAACTTGATACTCAGTATTTGCAGAATACA
Rattus          CAAGAGACA---ATAGAAATGGAAGACAGTGAACTTGATACTCAGTATTTGCAGAATACA
Scalopus        CAGGAGATAAGGATAGAGATGGAAGAGAATGAACTTGATACACAGTATTTACAGTCTACG
Erinaceus       CAGGAGACAAGCACAGAACTGGAGGAGAGTGAACTTGATACACAGTATTTACAGAATACC
Myotis          CAGGAGACAAGCATAGAAGTGGAAGAGAGTGAACTTGATACACAGGAATTACAGAATACA
Tadarida        NNNNNNNNNNNNNNNNNNNNGGAAGAGAGTGAACTTGATACACAGTATTTACAGAATACA
Taphozous       NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNGAATACA
Tonatia         NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
Megaderma       NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
Pteropus        NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
Hipposideros    CAGGAGACAAGCATAGAAATGGAAGAGAGTGAACTTGATACACAGTATTTACAGGAAACA
Cynopterus      NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
Equus           CAGGAGACAAGCATAGAAATGGAAGAGAGTGAATTTGATACGCAGTATCTACAGAATATG
Diceros         CAGGAGACAAGCATAGAAATGGAAGAGAGTGAACTTGATACACAGTATCTACAGAATACG
Manis           CAGGAGACAAGCATAGGAACGGAAGAGAATAAACTTGATAAGCAGTACTTACAGAATACT
Canis           CAAGAGACAAGCATAGAAATGGAAGAGAGTGAACTTGACACGCAGTGCTTACGCAATATG
Felis           CAGGAGACAAGTATAGAAATGGAAGAGAATGAACTTGATACGCAGTGGTTATACAATACG
Sus             CAGGAAGCAAGCATAGAAGTGGAAGAGAATGAACTTGATACACAGTATTTGCAGAGTATG
Lama            CAGGAGGCAAGCATGGAAGTGGAAGAGAGTGAACTTGATACTCAGTATTTGCAGAATACG
Bos             CAGGAGACAAGCAGAGAAATGGAAGACAGTGAACTTGATACACAGTATTTGCAGAATACA
Hippopotamus    CAGGATGCAAGCATAGAAGTGGAAGACAGTGAACTTGATACACAGTATTTGCAGAATACA
Megaptera       CAGGAGGCGAGCGCAGAAATGGAAGAGAATGAACTTGATACACAGTATTTGCAGAATATG
Physeter        CAGGAGGCGAGCACAGNNNNNNNNNNNNNNNNACTTGATACTCAGTTTTTGCAGAATATG
Tamandua        CAAGGGACAGTCATAGAAAAGGAAGAGAGTGAACTTGATACTCAGTATTTNNNNNNNNNN
Bradypus        CAGGAGACATTTGTAGAAATGGAAGAGAGTGAACTTGATACTCAGTATTTACAGAATACA
Dasypus         CAGGGGACAAATGTTGAAATAGAAGAGAGTGAACTTGATACTCAGTATTTGCAGAATACA
Chaetophractus  CAGGAGACTAGTGTAGAAATGGAAGAGAGTGAACTTGATACTCAGTATTTACAGAATACA
Loxodonta       CAGGAGACATGCATAGAAATAGAAGAGAGTGAACTTGATACTCAGTATTTGCAGAGTACA
Elephas         CAGGAGACATGCATAGAAATAGAAGAGAGTGAACTTGATACTCAGTATTTACAGAGTACA
Dugong          CAGGAGACGTGCGTAGAAATGGAAGACAGNGAACTTGATACTCAGTATTTGCAGAGTACA
Trichechus      CAGGAGACATGCATAGAAATGGAAGACAGTGAACTTGATACTCAGTATTTGCAGAGTACA
Procavia        CAGGAGATATGTGTAGAAATGGATGAAAATGAACTTGATACTCAGTATATACAGAGTACA
Dendrohyrax     CAGGAGATATGTGTAGAAATGGATGAAAATGAACTTGATACTCAGTATATACAGAGTACA
Orycteropus     CAGGAGACATACATAGAAATGGAAGAGAGTGAACTTGATACTCAGTATTTACAGAATACA
Tenrec          CAAGAGACATGCACAGAAATGGAAGAGAGTGAACTTGATATTCAGTCTCTACAGAATATG
Echinops        CAAGAGACATGCACAGAAATGGAAGAGAGTGAACTTGATATTCAATCCTTACAGAATACA
Elephantulus    AAGGATACGTACATGGAAATGGAAGATAGTGAACTTGATACTCAGTATTTACAGCATACA
Rhynchocyon     CAGGATACGTGCATAGAAATGGAAGATAGTGAACTAGATACTCAGTATTTACAGAATACA
Amblysomus      CAGGAGACATGCATAGAAATGGAAGAGGGTGAGCTTGATATTCAGTATTTACAGAATACA
Vombatus        TCCAAGACAACCACAGAAATGGAGGATAGTGAACTCGACACCCAGTATTTACAAAATACC
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Homo                TTCAAGGTTTCAAAGCGCCAGTCATTTGCTCCGTTTTCAAATCCAGGAAATGCAGAAGAG
Pan                 TTCAAGGTTTCAAAGCGCCAGTCATTTGCTCTGTTTTCAAATCCAGGAAATCCAGAAGAG
Gorilla             TTCAAGGTTTCAAAGCGCCAGTCATTTGCTCTGTTTTCAAATCCAGGAAATCCAGAAGAG
Pongo               TTCAAGGTTTCAAAGCGCCAGTCATTTGCTCTGTTTTCAAATCCAGGAAATCCAGAAGAG
Macaca              TTCAAGGTTTCAAAGCGCCAGTCCTTTGCTCTGTTTTCAAATCCAGGAAATCCAGAAGAG
Alouatta            TTCAAGGTTTCAAAGCGCCAGTCATTTGCTCTGTTTTCAAATCCAGGAAATCCAGAAAAG
Otolemur            TTCAAGTTTTCAAAGCGTCAGTCGTTTGCTCTGTTTTCAAACCTAGGA---------AAG
Cynocephalus        TTCAAGGTTTCAAAACGTCAGTCATTTGCTCTCTTTTCAAATCCAGGAAATCCAGAAAAG
Tupaia              TTCAGGAGTTCAAAGCGTCAGTCATTTGCTCTGTCTTCAAATCCAGGAAATCCAGAAAAG
Lepus               TTCATGGGTTCAAAGCGTCGTTCATTTGCTCTGTGTTCAAAACCAGGAGATCCAGAAAAG
Hystrix             TTCCAGGCTTCAAAGCGTCAGTCATTTGCTCTCTTTTCAAATCCAGGAAACTCAAAAAAG
Pedetes             TTCCAAGCTTCAAAGCGTCAATCATTTGCTTTATTTCCAAATTCAAGAAATCCAGAAAAA
Aplodontia          TTCCAGTTTTCAAAGCGTCAGTCATTTGCTCTGTTTTCATATCCAGGAAAACCAGAAAAG
Sciurus             TTCCAAGTTTCAAAACGTCAGTCATTTGCTCTGTTTTCAAATCAAGGAAATCTAGAAAAG
Glaucomys           TTCCAAGTTTCAAAGCGTCAGTCATTTGCTCTGTTTTCAAATCCAGGAAATCTAGAAAAG
Graphiurus          TTCCAAGCGTCAAGCCGTCAGTCCTTTGCTCTGTTTTCAAATTCAGGA---------AAG
Oryzomys            TTTCAAGTTTCAAATCGTCAGACATTTACTTTATTTTCAAAACCAGGAGATCCCCAAAAG
Meriones            TTTCAAGTTTCAAAGCGTCAGTCATTTGCTTTATTTTCAAAACCAAGAAGTCCCCTAAAT
Mus                 TTTCAAGTTTCAAAGCGTCAGTCATTTGCTTTATTTTCAAAACCTAGAAGTCCCCAAAAG
Rattus              TTTCAAGTTTCAAAGCGTCAGTCATTTGCTTTATTTTCAAAACTTAGAAGTCCCCAAAAG
Scalopus            TTCAAAGCTTCAAAGCGTCAATCATTTGCTCTGTCTTCACATCCGGGAAATTCAGAAAAG
Erinaceus           TTCAAGGTTTCAAAACGTCGGTCATTTGCTCTGTTTTCAAGTCCAGAGAATTCAGAAAAG
Myotis              TTCAAGGTGTCAAAGCGCCAGTCATTTGCTCTGTTTTCAAAT----------CCAGAAAG
Tadarida            TTCAAGGTTTCAAAACGTCAGTCGTTTGCTCTGTTTTCAAAT----------CCAGAAAG
Taphozous           TTCNNGNTTTCAAAGCGTCAGTCATTTGCTCTGTTTTCAAATTCAGAAAATCCAGAAAAG
Tonatia             NNNNNNNNNNNNNNNNNNNNNNNNNNTGCTCTGTGTTCAAATCCAGGNAATCCAGGAAAG
Megaderma           NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNTTTCAAATCCAGGAAATCCAGAAAAG
Pteropus            NNNNNNNNNNNNNNNNNNNNNNNNN---------NNTTCAAACCCAGGAAATCTAGAAAG
Hipposideros        TTCAAGGTTTCAAAGCGTCAATCATTTGCTCTGTTTTCAAATCCAAGAAATCAAAGAAAG
Cynopterus          NNNNNNNNNNNNNNNNNNNNNNNNN---------NNTTCAGACCCAGGAAATCTAGAAAG
Equus               TTCAAGGTTTCAAAGCGTCAGTCATTTGCTCTGTTTTCAAATCCAGGAAGTCCAGAAAAG
Diceros             TTCAAGGTTTCAAAGCGTCAGTCATTTGCTCTGTTTTCAAATTCAGGAAATCCAGAAAAG
Manis               TTCAGGGTTTCAAAGCATCAGTCATTTGCTCAGTTTTCAAATATGGGAAATCCAGAAAAA
Canis               TTCAAGGTTTCAAAGCGTCAGTCATTTGCTCTGTTTTCATATCCAAGAGATCCGGAAGAG
Felis               TTCAAGGGTTCAAAACGTCAGTCATTTGCTCTGTTTTCAAATCCAGGAAACCCAGAAAAG
Sus                 TTCAAGGTTTCAAAGCGTCAGACATTTGCTCTGTTTTCAAATCCAGCAAATCCAGAAAAG
Lama                TTCAAGGTTTCAAAGCGTCAGACATTTGCTCTGTTTTCAAATCCAGGAGATTCAGAAAAG
Bos                 TTCAAGGCTTCAAAGCGTCAGACATTTGCTCTGTTTTCCAATCCAGGAAATCCACAAAAG
Hippopotamus        TTCAGGGTTTCAAAGCGTCAGACATTTGCCCTGTTTTCAAATCCAGGAAATCCAGGAAAG
Megaptera           TTCAGGGTTTCAAAGCGTCAGACGTTTGTTCTGTTTTCAAATCCA---------GAAAAG
Physeter            TTCAAGGTTTCAAAGCGTCAGACGTTTGCTCTGTTTTCAAATCCAGAAAATCCAGAAAAG
Tamandua            TACAAGATTTCAAAGCGTCAGTCATTTGCTCTGTATTCAAATTCT---------GAAAAG
Bradypus            TTCAAGATTTCAAAGCGTCAATCATTTGCTCTGTTTTCAAATCCA---------GAAAAG
Dasypus             TTCAAGATTTCAAAGCGCCAGTCATTTGCTCTGTTTTCGAATCCA---------GAAAAT
Chaetophractus      TTCAAGATTTCAAAGCGTCAGTCATTTGCTCTGTTTTCGAATCCA---------GAAAAT
Loxodonta           TTCAAGGTTTCAAAGCGTCAGTCATTTGCTCTGTTTTCAAATCCA---------GAAAAG
Elephas             TTCAAGGTTTCAAAGCGTCAGTCATTTGCTCTGTTTTCAAATCCA---------GAAAAG
Dugong              TTCAAGGTTTCAAAGCGTCAGTCATTTGCTCTGTTTTCAAATCCA---------GAAAAG
Trichechus          TTCAAGGTTTCAAAGCGTCAGTCATTTGCTCTGTTTTCAAATCCA---------GAAAAG
Procavia            TTCAAGGTTTCAAAGCGTCATTCTTTTGCTCTGTTTTCAAGTCCG---------GAAAAG
Dendrohyrax         TTCAAGGTTTCAAAGCGTCATTCTTTTGCTCTGTTTTCAAATCCA---------GAAAAG
Orycteropus         TTCAAGGTTTCAAAGCGTCAGTCATTTGCTCTGTTTTCAAATCCA---------GAAAAG
Tenrec              TTCAAAGTCTCCAAGCGTCAGTCATTTGCTCTCTCTTCAAATCCA---------GAAAAG
Echinops            TTCAAAGTCTCAAAGCGTCAGTCATTTGCTCTGTCTTCAAATCCA---------GAAAAG
Elephantulus        TTCAAGGTTTCAAAGCGTCAGTCATTTTCTCTGTTTCCAAATCCA---------GAAAGG
Rhynchocyon         TTCAAAGTTTCAAAACGTCAGTCATTTACCCTGTTTCCAAATCCA---------GAAAAA
Amblysomus          TTCAAGGTTTCAAAGCGTCGGTCATTTGCTCTGTTTTCAAATCCA---------GAAAAG
Vombatus            TTCAAACGTTCAAAGCGCCAGTCATTTGCTCTGCGTTCTAGCCCA---------AGGCAG
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Homo            GAATGTGCAACATTCTCTGCCCACTCTGGGTCCTTAAAGAAACAAAGTCCAAAAGTCACT
Pan             GAATGTGCAACATTCTCTGCCCACTGTAGGTCCTTAAAGAAACAAAGTCCAAAAGTCACT
Gorilla         GAATGTGCAACATTCTCTGCCCACTCTAGGTCCTTAAAGAAACAAAGTCCAAAAGTCACT
Pongo           GAATGTGCAACATTCTCTGCCCACTCTAGGTCCTTAAAGAAACAAAGTCCAAAAGTCACT
Macaca          GAATGTGCAACATTCTCTGCCCACTCTAGGTCCTTAAAGAAACAAAGTCCAAAAGTTACT
Alouatta        GAATGTGCAACATTCTCTGCCTGCTCTAGGTCCTTAAAGAAACAAAGTCCAAAGGTCACT
Otolemur        GAATGTGCAACAGTCTGTGCCCAGTCTGCGTCCTTAAGAAAA---GGTTCAAAAGTCATT
Cynocephalus    GAGTGTGCAACAGTCTATGCCCACTCCAGGTTGTTAAGGAAACAAAGTCCAAAAGTCACT
Tupaia          GAACAT------GTCTGTGTT------------------AAAGAAAGTCTG---------
Lepus           GAATGTGCAGCAGTCTGTACCCGCTCCAACTCCTCAAGGAAACAAAGTCCAGAAGTCACT
Hystrix         GAATCAACAACAGTCTGTGCCCACTCTGAGTCCTTTAAGAAACAAAATCCAGAAGTCATT
Pedetes         GAATGT------------GCCCACTCCATGTCGTTAAGGAAACAAAGTACAAAAGTCACT
Aplodontia      GAATGTTCAGCTGTCTGTACCCCCTCCAAGTCCTTTCAGAAACAAAGCTCAGAAGTCACT
Sciurus         GAATATGCAGTCATCTATACCCCCTCTAAGTCCTTACGGAAACAAAGCCCAGAAGTGATC
Glaucomys       GAATGTGCAGCCAACTATACCTCTTCCAAGTCCTTACGGAAACAAAGCCCAGACATGACT
Graphiurus      GAATGTACTACTGTCTATGCCTCCCCCAAGCCCTTAAGAAAACAAAGTCCAAAAGTCTCT
Oryzomys        GAGTGTATAGCAGCCTGTCCTTCCTCT---------AGGGAAGTGAGTCCAAAGGTGTCT
Meriones        GAGTGTGCGGCAGTCTATACTCACTCTAACTCCTTCCGGGGGCTGGACCAGCCGTGACT
Mus             GACTGT------------GCTCACTCT---------AAGGAACTGAGTCCAAAGGTGACA
Rattus          GACTGTACTCTGGTAGGTGCCCGCTCT---------AGGGAACCAAGTCCAAAGGTGACT
Scalopus        AAATATCCCCCAGTCTCTGCCCCTTCCAGGTCCTTGAAGAGACAAACTCCAAAAATCACT
Erinaceus       GCATGTACAAGAGGCTCTGTCCATTCTAAGTCTTTAAGGAAACAAAGTCCAAAAGTTATT
Myotis          GAATGTGCAACAGCCTATGCTCACTCCCAGTCTTTAAGGAAACAAAGTCCAAAAGTCACT
Tadarida        GAATATGCAACAGTCTATGGCCACTCCAGGTCCTTAAGGAAACAAAGTCCAAAAGTCACT
Taphozous       GAATGTGCAACAGTCTATGCCCACTCCAAGTCCTTAAGGAAACACAGTCCAAAAGTCACT
Tonatia         GAATGTGCAACCATGTATTCCCACTCCAGGTCCACAAGGAAACGAAGTCCAAAAGTTACT
Megaderma       GAATGTGCAACAGTCTGTGCCCACTCCAGTTCCTTAAGGAACGAAAGTCCAAAGGTCACT
Pteropus        GAATGTGCAACAGGCTATGCCCACTCCAAGTCCTTGAGGAAACAAAGTCCAAAAGTCACT
Hipposideros    GAATGTGCAACAATCCAG------TCCAGGTCCTTAAGGAAACAAAGTGCAAAAGTCACT
Cynopterus      GAATGTGCAACAGGCTATGCCCACTCCAGGTCCTTGATAAAACAAAGTCCAAAAGTCACT
Equus           AAGTGTGCAACAGTCAGTGCCCACTCCAGGTCCTTAAGGAAACAAAGTCCAAAAGTCACT
Diceros         GATTGTGCAGCAGTCTCTGCCCACACCAGGTCTTTAAGGAAACCAAGTCCGAAAGTCACT
Manis           GAATGTGCAGCAGTCAGTGCCCACTCTGGGTCCTTAAGGAAACAAAGTCCAAAAGTCACT
Canis           GACTGTGTAACAGTCTGTCCCCGCTCTGGGGCCTTTGGAAAACAAGGTCCAAAAGTCACT
Felis           GAATGTGCTACAGCCTGGGCCCGTTCCACGTCCTTAAGGAAACAAAGTCCAAAAGTCGCT
Sus             GAATGTACAACCGTCCATGCCCACTCCAAGTCCTTAAGAGAACAAAGTCCAAAAGTCACT
Lama            GAATGTGCAACGATCTATGCCCACTCTGGGCCCTTAAGGGAACAAAGTCCAAAAATCACT
Bos             GAATGTGCCACAGTCTTTGCCCACTCGGGGTCCTTAAGGGATCAAAGTCCAAGAGACCCC
Hippopotamus    GAACGTGCAACAGTCTGTGCTCATTCCGGGTCCTTAAGGGAACAAAGTCCAAGAGTCCCT
Megaptera       GAATGTGCAACAGTCTGTGCCCGCTCTGGGTCCTTAAGAGAACAAAGTCCAAGAGTCCCT
Physeter        GAATGTGCAACAGTCTGTGCCCACTCTGGGTCCTTAAGAGAACAAAGTCCAAGAGTCCCT
Tamandua        GAATGTGTAACAATCTGTGCCCACTCCAGGTCCGTACGGAAACAAAGTCCAAAAGTAACT
Bradypus        GAATGCGCAACAGTCTCTGCCCACTCCAGGCCCTTAGGAAAACAAAGTCCAAAAGTCACT
Dasypus         GAATGTGCAACAGTCTGTGCCCACTCCAGGTTCTTAGGGAAACAAAGTCCAAAAGTCACC
Chaetophractus  GAATGCGCAACAGTGTGTGCCCACTCCAGGTTCTTAGGCAAACAAAGTCCAAAAGTCATT
Loxodonta       AAATGTGCAACAATTTGTGCCCACTCCAAGTCCTTAAGGAAGCAAAGCCCAAAAGTCACT
Elephas         AAATGTGCAACAATTTGTGCCCACTCCAAGTCCTTAAGGAAGCAAAGCCCAAAAGTCACT
Dugong          GAATGTGCAACAATTTGTGCCCACTCCAAGTCCTTAAGGAAACAAAGTCCAAAAGTCACT
Trichechus      GAATGTGCAACAATTTGTGCCCACTCCAAGTCCTTAAGGAAACAAAGTCCAAAAGTCACT
Procavia        GAGTGTGCGACAAGTTATACCCACTCCAAGTCGTTAAGGAAAGAAAATCCCAAAGTCACT
Dendrohyrax     GAGTGTGTGAAAAGTTATACCCACTCCAAGTCGTTAAGGAAAGAAAATCCCAAAGTCACT
Orycteropus     GAATTTGCAACAGTCCATGCCCACTCCAGGTCCTTGAGGAAACAAAGTCCAAACATCACT
Tenrec          GAGTGTGCCACACTCTGTGCCCATCCTAGCGCCTTCAGGAAACAGAATCCAAACGATGCT
Echinops        GAGTGTGCCTCGCTCGGTGCCCGCCCT---------------------CCAAACATTGCT
Elephantulus    GACTATACA---------------------------------------------------
Rhynchocyon     GAATGTACAACAGTCTGTGCCCACTCCAGGCTCTCAAAGAAACAAAATCCAAGTGTCACT
Amblysomus      GAATGTGCAACAGTCAGTGCCCACTCTAGGTCCTTCAGGAAACAAAGTCCAAAAGCCACT
Vombatus        GAATGTAGGAAACCCTCTGCTGTCCCTGGGACTGTAAATCAGCAGAGTCCAGATAACACC
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Homo	TTTGAATGTGAACAAAAGGAAGAAAATCAAGGAAAGAATGAGTCTAATATCAAGCCTGTA
Pan	TTTGAACGTGAACAAAAGGAACAAAATCAAGGAAAGAATGAGTCTAATATCAAGCCTGTA
Gorilla	TTTGAATGTGAACAAAAGGAAGAAAATCAAGGAAAGAATGAGTCTAATATCAAGCCTGTA
Pongo	TTTGAATGTGAACAAAAGGAAGAAAATCAAGGAAAGAATGAGTCTAATATCAAGCCTGTA
Macaca	TCTGAATGTGAACAAAAGGAAGAAAATCAAGGAAAGAAACAGTCTAATATCAAGCCTGTA
Alouatta	CCTGAATGTGAACAAAAGGAAGAAAATCAAGGAGAGAAAGAGTCTAATATCGAGCTTGTA
Otolemur	CTTGAATGTGAACAAATAGAA---AATCCAGGAATGAAAGAGCCTAAAATCAAGCATATA
Cynocephalus	CCTGAATGTGAACAAAAAGAAGAAAATGAGGGAAATAAAGAGTCTAAAATCAAGCACATA
Tupaia	------------------------------------AAAGAGTCTAACATCCAACATATA
Lepus	CTTGAACGTGAACAAAAAGAAAGT---CAGAGAAAGGAAGAGTGGAAAATCAGTCATGTC
Hystrix	CCTGAATGTGAACAAACAGAAGAAAATTGGGGCAAGAAAGTGCCTAAAATTAGTTGTGTG
Pedetes	CTTGAATATGAACAAAAAGAAGAAAATCAAGGAAAAGAAGAGTCTAAAATCAAGCCTGCA
Aplodontia	CTTGAATGTGAGCAAAAAGAAGAAAATCAGGGAAAGAAAGAGCTTAAAATTAGGCATGTA
Sciurus	ATTGAATGTGAACAAAAAGAAGAAAATTGGGAAAAGAAAGAGTCTAAAATTAGGCATGTA
Glaucomys	CTTGAATGTGAGCAAGAAGAAGAAAATTGGGGAAAGAAAGAGTCTAAAATTAGGCATGTA
Graphiurus	CTTGAATATGAACAAAAAAAAGAAAATAAGGAAAAGAAAGAGGCTAAAATCACACATGTA
Oryzomys	TCTACAGGTGAACATGAAGAAGTAATTAGGGGACAGGAAGAGTCTGAAATCAAACGTGTA
Meriones	TCCGAAGGT------GAAGAAAGT---CAGGTACATGAAGAGTCTGAAATCAGTCACGTA
Mus	GCTAAAGGTAAACAAAAAGAACGT---CAGGGACAGGAAGAATTTGAAATCAGTCACGTA
Rattus	TCTAGAGGTGAACAAAAAGAACGT---CAGGGACAAGAAGAGTCTGAAATCAGTCATGTA
Scalopus	CTGGAATGTGAACTGAAAGAAGAAAATCAAGGGAAGAAAGAGTCTAAAACCGAGCATGTA
Erinaceus	CTGGACTGTGAACAAAAAGAAGAAAATCAAGGAGAGAAAGCATCTGAAATCAAGTATTTG
Myotis	CTTGAATGTGGACAAAAAGAAGAAAATCAGGGAAAGAAAGAATCTAAAATCAAGCATGTA
Tadarida	CTTGAATGTGGACAAAAAGAAGAAAATCAGGGAGAGAAAGAATCTGAAATCAAGTATGTA
Taphozous	CTTGGATGTGGTCAAAAAGAAGAAAATCAGGAAGAGAAAGAATCTAAAATCAAGCATGTA
Tonatia	CTTGAATGTGGACGAAAAGAA---CATCAGGGAGAGAAGGAATTTAATATGGAGCGTGCG
Megaderma	CTTGAATGTGGACAAAAAGAAGAAAATCACGGAAAGAAAGAGTCCAAAATCAAGCATGTG
Pteropus	CTTGAATGTGACCGAAAAGAA---AATCAGGGAAAGAAAGAGTCTAACGTCAAGCATGTG
Hipposideros	CTTGAATGTGGACAAAAAGAAGAAAATCAGGGAAAGAAAGATTCTAAAATCAAGCTTGTA
Cynopterus	CTTGAATGTGACCGAAAA---GGAAATCAGGGAAAGAAAGAGTCTAACATNGAGCATGTG
Equus	CTTAAATGTGGACAAAAAGAAGGAAAGGAGGGAAAGAAAGAGTCTAAAATCAAGAATGTG
Diceros	CTTGAATGTGGACAAAAAGAAGAAAATCAGGGAAAGAAAGAGTCTAAAGTCAAGCATGTG
Manis	CTTGCATATGGACAAAAAGAAGAAAATGAGGGAAAGAAAGAGTCTGAAATCAAGCATGTT
Canis	CTAGAATGTGGACAGAAAGAAGAAAGTCAGGGAAAGAAAGAGTCTGAAATCAGACATGTG
Felis	CTTGAATATGAACAAAAAGAAGAAAATCAGGGAAAGAATCAGTCTGAAATCAAGCATGTG
Sus	CATGAAGGTGGACAAAAAGATGAAAATCAGGGAAAGAGTGAGTCTAAAGTCAAGCATGGG
Lama	CTTGAATGTGGACAAAAAGAAGAAAATCAGAGAAAGAGCAAGTCTGAAATCAAGCATATG
Bos	CTCAAATGCAGACAAAAAGAAGACAGTCAGGGAAAGAGTGAGTCTAAAAGCCAGCACGTG
Hippopotamus	CTTGAATGCGGACAAAAAGAAGAAAATCAGGGCAAGAGTGAATCT---------AAAATG
Megaptera	CTTGAATGCAGACAAAAAGAAGAAAATCAGGGAAAGAGTGAGTCTAAAATCAAGCATGTG
Physeter	CTTGAATGCAGACAAAAAGAAGAAAATCAGGGAAAGAGTGAGTCTAAAATCAAGCATGTG
Tamandua	TTTGACTATAGACAAAAAGAAGAAAATCAAGGAAAGAAAGAGTCTAAGATCAAACATGTG
Bradypus	TTTGACTGTAGACAAAAAGAAGAT---CAGGAGAAGAAGGAGTCTAAAATCAAACACGTG
Dasypus	TTTGAATGTAGACATAAAGAAGAAAATCAGGGGAAGAAAGAGTCTAAAATCAAACATGTG
Chaetophractus	TTTGAATGTAGGCAAAAAGAAGAAAATCAGGGGAAGAAAGAGTCTAAAATCAAACATGTG
Loxodonta	CTTGTGTGTGGAGAAAAAGAAGAAAATCAAGGGAACAGAGAGCCTAAAATCAAGCATGAG
Elephas	CTTGTGTGTGGAGAAAAAGAAGAAAATCAAGGGAACAGAGAGCCTAAAATCAAGCATGAG
Dugong	CCTGAGTATGGAGAAGAAGAAGAAAATCAAGGGAACAAAGAGTCTAAAATCAAGCATGAG
Trichechus	CCTGAGTATGGAGAAAAAGAAGAAAATCAAGGGAACAAAGAGTCTAAAATCAAGCATGAG
Procavia	CTTCAGCGTGGAGAAGAAGAAGAAAATCAAGGGAACAAAGAATCTAAAATCAAGCAT---
Dendrohyrax	CTTCAGCGTGGAGAAGAAGAAGAAAATCAAGGGAACAAAGAATCTAAAATCAAGCAT---
Orycteropus	CTTGAGTGTGGAGAAAAAGAAGAAAATCAGGGGAACGAGGAATCTAAAATCAAGTGCGTA
Tenrec	CTTGAGGGTGGAGAA---GAAGGACTCGGGAGAACAAAGAGTCTACAATTAAGCCTGTG
Echinops	CTTGAGTGTGGGGAA---GAAGGACTGAGGAGAACAAAGAGTCTGCAGTTCGACCTGTG
Elephantulus	---AAGCTAGTG
Rhynchocyon	CTTGAGTGTAGAGAAAAAAAAGAAAATCAGGGGAATGAAGAGTCTAAAATGAAACATGTG
Amblysomus	CTTGAATGTGGCGAAAAAGAAGAAAATCAGGGGCACAAAGAGTCTAAAGTCAAGCATGTA
Vombatus	ACAGATTGTGGGGGCCAGGAAAAAGAACAGGGAAACAGAGAATCAAACAAGCCTGTGTGG

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Homo             CAGACAGTTAATATCACTGCAGGCTTTCCTGTGGTTGGTCAGAAAGATAAGCCAGTTGAT
Pan              CAGACAGTTAATATCACTGCAGGCTTTCCTGTGGTTTGTCAGAAAGATAAGCCAGTTGAT
Gorilla          CAGACAGTTAATATCACTGCAGGCTTTCCTGTGGTTTGTCAGAAAGATAAGCCAGTTGAT
Pongo            CAGACAGCTAATATCACTGCAGGCTTTCCTGTGGTTTGTCAGAAAGATAAGCCAGTTGAT
Macaca           CAGACAGTTAATATCACTGCAGGCTTTTCTGTGGTTTGTCAGAAAGATAAGCCAGTTGAT
Alouatta         GAGACAGTTAATACCACTGCAGGCTTTCCTATGGTTTGTCAGAAAGATAAGCCAGTTGAT
Otolemur         CAGGGAAATAATATCAATACAGGCTTCTCTGTAGTTTGTCAGAAAGATAAGACAGATGAT
Cynocephalus     CAGGCAGTTAATACCACTGTGGGCTTTTCTGTCCTTTGTCAGAATGTTAAGCCAGGTGAT
Tupaia           CAGGCAGTTAGTACC---------------ATGGTTTTTCAGAAAGATAAGCTAGGTGAT
Lepus            CAGGCAGCTGATAGCACTGTGGGCTTTCCTGTGGTGTGTCAGAAAGAAAAGGCAGGTGAT
Hystrix          CAAGAG---AGCGCC------------CCTCTGGTTTCTCAGAGGGATCAGCCAGGCACC
Pedetes          CAGGAAGTTAATACCACCGTGGGCTTTCCTGTGGTTTGTCAGGAAGATAAACCATGTGCT
Aplodontia       CAGGCAATTAATGCCACTATGGGCTTTCCTGTGGCTTGTCAGAAAGATAAACCTGGTGAT
Sciurus          CAAGCAGTTAATGCCACTATGGGCATT---------------------AAGCTAGATCGT
Glaucomys        CAGGCAATTAATGCTACTATG------------GTTTGTCAGAAAAGTAAGCCAGATGAT
Graphiurus       CAGGCAGTTAATACCCCTACAGACTTTCCTATGATTTGTCAGGAAGATAAGCCAGGTGAT
Oryzomys         CAGGTGACTAGTGCCACGGTGGGCTTCCCTCTGCTTCATCAGGAAGGTACGCCAGGCTCT
Meriones         CAGGCAGTTACTGCCGCAATGGACTTGCCTGTGCTTCGCCAGCAAGGTAAGCCAGGTGCC
Mus              CAAGCAGTTGCGGCCACAGTGGGCTTACCTGTTCTCTGTCAAGAAGGTAAGCTAGCTGCT
Rattus           CAGGCAGTCACAGTCACAGTAGGCTTACCTGTGCCCTGTCAGGAAGGTAAGCCAGGTGCT
Scalopus         CAGGCAGTACATAGAATTGCAGACTTAACTCTGGCTTGTCAGAACGATAAGCCACATGAT
Erinaceus        CCATCAGAACATACAACTACAGGCTTTCCTGTGGTGTGTTATAAAGATACATCAGGTGAT
Myotis           CAGGCAGTTCACACAGCTGTAGGCTTTCCTGTGGTTTGTGAGAAAGACAGACCAGGAGAG
Tadarida         CGGGGAGTTCACACAACTGCAGGCTTTCCTGTGGTTTGTGAGAAAGACGAACCAGAAGAA
Taphozous        CAGGCTGTTCACACAGCTGCAGGCCTTCCTGCCATTTGTGAGAAAGACAAGCCAGGAGAA
Tonatia          CAGCCACCTTACACAACAGCAGGCTTTCCTAAGGGTTGTGAGAAAGACAAACCAGGAGAG
Megaderma        CAGGCAGTTCCAACAACTGCAGGCTTTCCTGTGGTTTGTGAGAAAGAAAAACCAGGAGAT
Pteropus         CAGGCAGTTTATACAACTGTAGGCTTTCCTGTGGTTTGTGAGAAAGAAAAACCAGGAGAT
Hipposideros     CAGGCAGTTCATACAACTGCAGGCTATCCTGTGGTTTGTGAGAAAGATGAACCAGGAGAT
Cynopterus       CAGGCAGTTTATACAACTATAGGCTTTCCTGGGGTTTCTGAGAAAGACAAACCAGGAGAT
Equus            CAGTCAGTTCACACAACTGTGGGCTTTCCTGTGATTTGTCAGAAAGATAAGCCAGGTGAC
Diceros          CAGTCAGTTCATACAACTGTGGACTTTCCTGTGGTTTGTCAGAAAGATAAGCCAGGTGAT
Manis            CAAACAATTCATACAACTGCAGGCCCTCTTGTGGTTAGTCAGAAAGATGAGCCAGGTGAT
Canis            CAGGCAGTTCATACAAATGCAGGCTTTTCTGCAGTTAGTCAGAAAGCTAAGCCAGGCGAT
Felis            CAGGCAGTCCGTGCAACTGCAGGCTTTTCTGCAGTCAGTCAGAAAGTGGAGCCAGGTGAT
Sus              CAGTCAGTTCATACAACTGTGGACTTTCTAGTGGTTGGTCAAAGGATAAGCCGAGTGAT
Lama             CAGGCAGTTCATACAACTTTGAACTTTCCTGTGGTTGGTCAAAAGATAAGCCGAGTGAT
Bos              CAGGCCATTTGTACAACAGTGCACTTTCCTGTGGCTGATCAGCAAGATAGGCCAGGTGAC
Hippopotamus     CAGGCAATTTATACAACTGTGGACTTTGCTGTGGCTGGTCAAAATGATAGGCCGAGTGAT
Megaptera        CGGGCAATTAATACAACTGTGGACTTCCCTGTTGCTGGTCAAAAGATAAGCCGAGCGAT
Physeter         TGGGCAATTAATACAACTGTGGACTTCCCTGTTGCTGGTCAAAAGATAAGCCGAGCGAT
Tamandua         CAGGCAGTTCATACAACCGCAGGCTTCTCTGTAGTTTGTCAGAAAGATAAGCCCCATGAT
Bradypus         CAGGCAGTTCATACAACTGCAGACTTTCCTGTAGTTTGTCAGAAAGATAAGCCAGGTGAT
Dasypus          CAGGTAATTCACACAACTGCAGGCTTTCCTATAGTTTGTCAGAAAGATAAGCCAGGTGAT
Chaetophractus   CAGGCAGTTCATACAACTGCAGGCTTTCCTGTAGTTTGTCAGAAAGATAAGCCAGGTGAT
Loxodonta        CAGGCAGTTCATATGCCTACAGGCTATCCTGAGGCTTGTCAGAAAGAGAAGCCAAGTGAC
Elephas          CAGGCAGTTCATATGCCTGCAGGCTATCCTGAGGCTTGTCAGAAAGAGAAGCCAAGTGAC
Dugong           CAGGCAGTTCATACGACTGCGGGCTATCCTGAGGATTGTCAGAAAGAGAAGCCAAGTGAT
Trichechus       CAGGCAGTTCATACAACTGCTGGCTATCCTGAGGATTGTCAGAAAGAGAAGCCAAGTGAT
Procavia         ------GTTCATACAACTGCAAGCTGTCCTGAGGTTTGTCAGGAAGACACACCTAGTGAT
Dendrohyrax      ------GTTCATACAACTGCAAGCTGTCCTAAGGTTTGTCAGGAAGACGCACCTAGTGAT
Orycteropus      CAGCTAGTTCTTTCAACTACAGGCTATGCTGGAGCTTGTCAGAAAGAGAAGCCAAGTGAT
Tenrec           CGGGCAGTTCATACCACCGTGGGC------------------ACGGAGAAGCCAAGTGAT
Echinops         CAGGCAGTTCCTGCAACTGTGGGCGGTGCTGGAGGTAGTCCAACAGAGCAACCACGTGAT
Elephantulus     CAGCTAGTTCATACCACTGCGAGCTATCCTGGAGCCTGTGAGGAA---AAGCCAAATGAT
Rhynchocyon      CAGGTCGTTCATACATCTGTGCACTATCCGGGAGTTTGTGAAGAAGAGAAGCCAGATGAT
Amblysomus       CAGGCAGTTCATACAAGTGTGGGCTATCCTGGACTCTGTCAGAAAGAGAAGCCAAGTGAT
Vombatus         CCAAAGTCTGCAGTCATGAGCTTAGCTGCGGCTTGTCAGACAGAGGAGAGGCCAGGTGTT
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Homo            AATGCCAAATGTAGTATCAAAGGAGGCTCTAGGTTTTGTCTATCATCTCAGTTCAGAGGC
Pan             TATGCCAAATGTAGTATCAAAGGAGGCTCTAGGTTTTGTCTATCATCTCAGTTCAGAGGC
Gorilla         TATGCCAAATGTAGTATCAAAGGAGGCTCTAGGTTTTGTCTATCATCTCAGTTCAGAGGC
Pongo           TATGCCAAATGTAGTATCAAAGGAGGCTCTAGGTTTTGTCTATCATCTCAGTTCAGAGGC
Macaca          AATGCCAAATGTAGTATCAAAGGAGGCTCTAGGTTTTGTCTATCATCTCAGTTCAGAGGC
Alouatta        TATGCCAGATGT---ATCGAAGGAGGCTCTAGGCTTTGTCTATCATCTCAGTTCAGAGGC
Otolemur        TATGCCAAATACAGCATCAAAGAAGCATCTAGGTTTTGTTTGTCAAATCAGTTTCGAGAC
Cynocephalus    TATGCCAAATTTAGCATTAAAGGAGTCTCTAGGCATTGTTCATCATCTCAGTTCAGAGGC
Tupaia          TTTGCTACATCTGGCATTAAAGAAGTCCCTAGACTTTGTCCATCATCTCAGTTCAGAGGC
Lepus           TGTGCCAAATGGAGCACTAAAGAGATCTCTAGGCTTTGTCTGTCATCTCAGTCCAAAGGC
Hystrix         AGCATCATATGTAGCGGCACAGGAGTCTCGAGGCTCTGTCTCTCGTCTTGGTTCACAGGC
Pedetes         GATGCCAACCATAGCATTACAGGAGTGTCTAGACTTTGTCCATTGTCTCAGTTGACAGAC
Aplodontia      GATGCCAAATGTAGCATTACAGAAGTTTCTAGACTTTGTCCATCATTTCAGTTCAGAGCC
Sciurus         GATGCCCAATATAATATTACTGAAGTCTCTAGAATGTGTCCTTCATTTCAGTTCAGAGGC
Glaucomys       GATGCCCAATGTAGTGTTACAGAAGTCTCTAGAATTTTTCCATCATTTCAGTTCAGAGAC
Graphiurus      GATGCCAAACATAGCATTCCAGGAGTCTCCAGTCTTTATCCATCATTTCAACTCAGAGGC
Oryzomys        GAGAGGATGTGTGCT------GGAGTGTCCAGGCTTTGTTCATCATCCCAGTACGGAAGG
Meriones        AACACCTTGTGTGCT------GGAGTGTGTGGGCCCTGTCCATCATTTCAGTACAGAAGC
Mus             GATACAATGTGTGAT------AGAGGTTCTAGGCTTTGTCCATCATCTCATTACAGAAGC
Rattus          GTTACAATGTGTGCT------GATGTTTCTAGGCTTTGTCCGTCATCTCATTATAGAAGC
Scalopus        TCTGCCAAATGTAGCATAAAAGGAGTCTCTAGGCTTTGTCAGTCATCTCAGTTCAGAGGC
Erinaceus       TATGCCAAATGTAGCGTAAAAGGAGTCTCCAGGCATTGTCAGCCATCTCGGTTCAGAGGC
Myotis          TATGCCAAATACAGCATAAAAGGAACCTCTATGCATTGCCNGTCCTCTCAGTTCAGAGGC
Tadarida        TATGCCAAATGTAGCATAAAAGGAACCTCTAGCCTTTGTCAGCCACCTCAGTTCAGAGGC
Taphozous       TATGACAGATACAATATAAAAGGAATCTCTAGGCTTTGTCAGTTATCTCAGTTCAGAGGC
Tonatia         TGTGCCACATATACTATGAAAGGAATCTCTAAGCCTTGTCAGTCATCTTCGTTCAGAGGC
Megaderma       TATGCCAAATATACCAAAAAAGGAGTCTCTAGGCTTCGTCAGTCATCTCAGATCAGAGGC
Pteropus        TATGCTAAATATGGCATAAAAGAAGTCTCTAGGCTTTGTCAGTCATTTCAGTTCAGAGAA
Hipposideros    TATGCCAAATACAGCACAAAAGGAGTCTCTAGGCTTTGTCAATCATCTCTGTTCAGAAGC
Cynopterus      TATGCCAGATATGGCATAAAAGAAGTCTCTAGGCTTTGTCAGTCATTTCAGTCTAGAAGA
Equus           TATGTCAAATGTAGCACAAAAGAAGCCTCTAGGCTTTGTCAGTCATCTCAGTTCAGAGGC
Diceros         CATGTCAAATATAGCATAAAAGAACTCTCTAGGCTTTGTCAGTCATCTCAGTTCAGAGGC
Manis           TATGTAAAATTTGGCATAAAAGGAGTCTCTACGCATTGTCAGTCATCTCAGTTCAGAGGC
Canis           TTTGCCAAATGTAGCATAAAGGGAGTCTCTCGGCTTTGTCTGTCATCTCAGTTCAAAGGC
Felis           TATGCCAAATGTAGCATAAAAGGAGTCCCTGGGCTCTGTCAGTCATCTCAGTTCAGAGGC
Sus             TTTGCCAAATGTGGTGCAAAAGGAGTAACTGGGCTTTATCAGACATCACAGTTCAGAGGC
Lama            TATGCCAAATATAGCCCAAAAGGAATATCTAGGCTTTGTTGGCCATCACAGCTCAGAGGC
Bos             GATGCCAAATGTAGCGCAAAAGAAGTAACTAGGGTTTGTCAGTCATCACAGTTGAGAGGC
Hippopotamus    TACACCAAATGTAGCACTAAAGGAGTAACTAGGCTTTGTCCCTCATCACAGTTTGGAAGC
Megaptera       CATGCCAAACGTAGCCCAAAAAGAGTAACTAGGCTTTGTCAGTCATCACAGTTCAGAAGC
Physeter        CATGCCAAACGTAGCCCCAAAAGAGTAACTAGGCTTTGTCAGTCATCACAGTTCAGAAGC
Tamandua        TATGCCAAGTGTAGCATTCAGGGAGTCTCTAAGCTTTGTGAGTCATCTCAGTTCAGAGGC
Bradypus        TATGCTAAATGTAGCATTCAAGGAGTCTCTAAGCTTTGTCAGTTATTTCAGTTCAGAGGC
Dasypus         TATGCCAAAGGTAGCATTCAAGGAGTCTCTAGGCTTTGTCAGTCCTCTCAGGCCAGAGGC
Chaetophractus  TATGCCAAATGTAGCATTCAAGAAGTCTCTAGGCTTTGTCAGTCCTCTCAGTTCAGAGGC
Loxodonta       TATACCAAATATAGCATTAAAGGAGTCTCTGGGCTTTGTCAGTCATCTCAGTTCAGAGGC
Elephas         TATACCAAATATAGCATTAAAGGAGTCTCTGGGCTTTGTCAGTCATCTCAGTTCAGAGGC
Dugong          TATACCAAAAGTAGCATCAAAGGAGTCTCTAGGCTTTGTCAGTCATCTCAGTTCAGAGGC
Trichechus      TATACCAAATGTAGCACTAAAGGAGTCTCTAGGCTTTGTCAGTCATCTCAGTTCAGAGGC
Procavia        CGTACTAACTGTAGTGTTAAAGGACTCCCTAGGCTTTGTCACTCATCTCAATTCAAAGGT
Dendrohyrax     CGTACCAACTGTAGTGTTAAAGGACTCCCTAGGCTTTGTCACTCATCTCAATTCAAAGGT
Orycteropus     TATGCCAAATGTAGCATTAAAGGAGTCTCTAGACTTTGTCAGTCATCTCAATTCAGAGGC
Tenrec          TACACCAACAGTAGCTTTCAAGGAGTTTCTAGGCGTGGTCAGGCATCTCAATTCAGAGCC
Echinops        TATACCAAAAGTCACCTTCAAGGAGTGTCCAGGCTTGGTCAGGCAGCTCCATTCAGAGGC
Elephantulus    TTTACCAAATGTAGCATTAAAGGAGTCACTAGACTCTCTCATTCATCTCCATTGAGAGGC
Rhynchocyon     CACACCAAAGTTAGCATTAAAGGGATCTCTAGGCTTTGTCAGTCATCTCCTTTCAGGAGC
Amblysomus      TATACCAAAGGTAGCATTCAGGGGGCCTCTAGGCTTCATCAGTCATCTCAGTTCAGTGGC
Vombatus        TATGCCAAATGTAGCACCACAGAAGTGTCCAGGCTTTGTCACATAGCTCCATTAGGTGTC
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Homo	AACGAAACTGGACTCATTACTCCAAATAAACATGGACTTTTACAAAACCCATATCGTATA
Pan	AACGAAACTGGACTCATTACTCCAAATAAACATGGACTTTTACAAAACCCATATCATATA
Gorilla	AACGAAACTGGACTCATTACTCCAAATAAACATGGACTTTTACAAAACCCATATCATATA
Pongo	AACGAAACTGGACTCATTACTCCAAATAAACATGGACTTTCACAAAACCCATATCATATA
Macaca	AACGAAACTGGACTCATTACTCCAAATAAACATGGACTGTTACAAAACCCATACCATATA
Alouatta	AACGAAACTGGACTCATTATTCCAAATAAACATGGACTTTTACAGAACCCATATCATATG
Otolemur	AATGAAACTGAATCCATTACTGTAAATAAACTTGGAATTTTACAAAACCTCTATCATATA
Cynocephalus	AATGAAACTGAACTCATTACTGCAAATAAACATGGAATTTTACAAAACTCATGTCATATG
Tupaia	AATGAAACTGATCTCATTACTGCAAATAAACCTGAAGTTTCACAAAACCCGTATCATATG
Lepus	AGTGAAACTGAGCTCATTGCTGTAAGTAAACATGGGATGTCACAAAACCCATATCATATA
Hystrix	AGCAAAACTGAACTCGTCACAGCTGACAAACATGGAATTTCACAAAATCCATATCACATG
Pedetes	AATGAAACTGAACTCAGTACTGTAAATAAACATGGAGTTTTACAAAACCCATATCTTATT
Aplodontia	AATGAAACTAAACTCATTGCTGTAGATAAACATGTAATTTCTCAAAACCCATATCTTATG
Sciurus	AATGAAACTAAACTCATTACTGCAGATAAGCATGGAATTTCACAAAACCCATATCATATG
Glaucomys	AATCTAACTAAACTCATAACTGCAGATAAACATGGAATTTCACAAAACCCATATCATATG
Graphiurus	AACAAAACTGAACTTGTTACTGCAGATCAACATGGAATTTCACAAAACCCATATCATATG
Oryzomys	AAT---------CCCAGCTCTGCAGGTGACCTTGGAATTCCACAAAACTCACATCTTAAA
Meriones	AATGAAAGTGAAGGCAGCACCTCAGGTAAACCTGGAGTTCCACAAAACTCATATCTTAAA
Mus	GGGGAGAATGGACTCAGCGCCACAGGTAAATCAGGAATTTCACAAAACTCACATTTTAAA
Rattus	TGTGAGAATGGACTCAACACCACAGATAAATCTGGAATTTCACAAAACTCACATTTTAGA
Scalopus	AACGAAACAGAAGTCATTGTTGCAAATAAACGTTTAATCTTACAAAACCCATATCTTATT
Erinaceus	AGTGAACCTGAACTCATTGTTGCAAATAAAAATTTAATTTTACAAAACCTATATCATATA
Myotis	AACAAAACTGAACTCACTATTACAGATAAATATGGACTTTCCCCAAACCCATATCATATA
Tadarida	AACGAAACTGAACTCACTATTGCAAATAAACCCGGAATTTCACGAAACCCATATCATATA
Taphozous	AATGAAACTGAACTCACTATTGAAAATAAACACAGAATTTTACAAAACCCATATCATATA
Tonatia	AATGAAACTAAACTCACTATTGAAAATAAATATGGGATTTCACAAAACCCCTATCACATA
Megaderma	AACAAAACCGAACTCACTGTTACAAATAAACATGGAATTTCTCAAAACCCATATCATATA
Pteropus	AATGAAACTGAACTCACTATTGCAAATAAACTTGGAATTTCACAAAACCCATATCATATG
Hipposideros	AACGAAACTGAACTCACTATTGCAAATAAACATGGAATTTCTCAAAACCCACATAATATA
Cynopterus	AATGAAACTGAGCTCACTATTGCAAATAAACTTGGACTTTCACAAAACCCATATCATATG
Equus	AACGAAACNGAACTTATTACTGCAAATAAACATGGAATTTCACAAAACCCATATTATATA
Diceros	AATGAAACTGAACTCATTACTGCAAATAAACGTGAACTTTCACAAAACCTGTGTTATATA
Manis	AATAAAACTGAACTTATTTTTGCAAATAAACCTGGAATTTCACAATACCCATATCATATA
Canis	AAGGAAACTGAACTCCTTATTGCAAATTACCATGGAATTTCCCAAAACCCTTATCATATA
Felis	AATGAAACTGAACTCTTTATTGCAAATAACCATGACATTTCAAAAAACCCTTATCATATA
Sus	CACAAAACTGAGTTCATTAATGCAAATAAACCTGGGATTTCACAAAACCCATATGTCATA
Lama	AATGAATCTGAGTTCATTATTGCAAATAAACATGGGATTTTACAAAACCCATATCTTATA
Bos	CACAAAACTGAACTTGTTTTTGCAAATAAACAAGGGGTTTCAGAAAAACCAAATCTTATA
Hippopotamus	AACAAAACTGAGCACATTATTGCAAATAAATATGGAATTTCACAAAACCCATATGTTATA
Megaptera	AACAAAACTGAGCTCATTATTGCAAATAAACATGGGATTTCACAAAACCCATATCTTATA
Physeter	AACAAAACTGAGCTCATTATTGCAAATAAACATGGGATTTCACAAAACCCATATCTTATA
Tamandua	AATGAATCTGAACTCATTACTGCAAACGAACATGGAATTTCCCCAAATCCAGATCAAATG
Bradypus	AATGAATCTGAACCCATTACTGCAGATGAACATGAAATTTCACAAAATCCAGATCAGATG
Dasypus	AATGAATCTGAACTCATTAATTCAAATGAACATGAAATTTCACAAAACCCAGATCAAATG
Chaetophractus	AATGAATCTGAACTCATTACTGCAAATGAACATGAAATTTCACAAAACCCAGATCAAATG
Loxodonta	AGTGAATCTGAACTCATTACTGCAGATGGACATGGAATCTCACAAAACCCAGATCAAATA
Elephas	AGTGAATCTGAACTCATTACTGCAGATGGACATGGAATCTCACAAAACCCAGATCAAATA
Dugong	AGTGAATCCCAACACATTACTGCAGGTGAACATGGAATTTCACAAAATCCAGATCAAATG
Trichechus	AGTGAATCCGAACACATTACA---GGTGAACATGGAATTTCACAAAATCCAGATCAAATG
Procavia	AGTGAGTCTGAACTCATTACTGAAGGTGAACATGGAATTGCACAAAACCCGGATCAGATG
Dendrohyrax	AGTGAGTCTGAACTCATTACTGAAGGTGAACATGGAATTGCACAAAACCCAGATCAGATG
Orycteropus	AATGAATCTGAAATCATTACTGCAAATGAACATGGAGTCTCACAAAACCTGGATCAGACA
Tenrec	AGTGAATCTGACCCCGGTACCTCAGTCGAACACGGAAGTTTGCAAACCACAGAGCATACC
Echinops	AGTGAATCTGACCCCAGTACCTCAGTTGAACATGGGATTGTGCAGACCTCGGAGCNTGCC
Elephantulus	AATGAATCTGAACTCATTACCGCAAATGAACATGAAATGTCACATAGCCCAGATCAGACA
Rhynchocyon	AATGAATCTGAACGCATTACTGAAAATGAATGTAAAATGTCACATAGCCCAAACCAGACA
Amblysomus	AATGAATCTGAACAAATTACTGCAAATGAAAATGGAATTTCACAAAGCCCAGATCAAACA
Vombatus	ATTGACTGTGAACACATTGCTGGAAACAACCAGGGAATTTCGCAAGTTCCTGATCAAAAA

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Homo             CCACCACTTTTTCCCATCAAGTCATTTGTTAAAACTAAATGTAAGAAAAATCTGCTAGAG
Pan              CCACCACTTTTTCCCATCAAGTCATTTGTTAAAACTAAATGTAAGAAAAACCTGCTAGAG
Gorilla          CCACCACTTTTTCCCATCAAGTCATTTGTTAAAACTAAATGTAAGAAAAACCTGCTAGAG
Pongo            CCACCACTTTTTCCCATCAAGTCATTTGTTAAAACTAAATGTAAGAAAAACCTGCTAGAG
Macaca           CCACCACTTTTTCCTGTCAAGTCATTTGTTAAAACTAAATGTAACAAAAACCTGCTAGAG
Alouatta         TCACCGCTTATTCCCACCAGGTCATTTGTTAAAACTAAATGTAAGAAAAACCTGCTAGAA
Otolemur         CCACCACTTTCTCCTATCAGGCTATTTGATAAAACTAAATGTAATACAAACCTGTTAGAG
Cynocephalus     TCATCACTTTCCCCCATCAGGTCATCTGTTAAAATTAAATGTAAGAAGAACCTGTCAGAG
Tupaia           CCATTACTTTATCCTGTCAAGTCACCTATTATAACTAAAAGTAAGAAAAGCCTGTCAGAG
Lepus            CCACCAATTTCTCCCATCAAGACATCTGTTAAAGCCACACGCCAGGTACACCTGTCAGGG
Hystrix          CCATCAATTTCTCCCATCAGGCCATTTGTTAAAACTCCATGTAAGAAAACC---------
Pedetes          CCATCAATTTCTCCTGTCAAGTCATTCATTACAACTAAATATAAGAAAAGCCCATCAGAG
Aplodontia       CCATCAATTTCCCCCATAAAGCCATCTGTTAGAACTAAATGTAAA------------GAA
Sciurus          CCATCAATTTCTACCATCAGGTCATCTGTTAACTCTAAATGTAAGAAAAACCTATCAGAA
Glaucomys        CCATCCATTTCTCCCAGCAGGTCATCTGTTAACACTAAATGTAGGAGAAACCTATCAGAA
Graphiurus       CCGCCAATTTCTCCTATCACGTCATTTGTTAAAACTGAAGATAAA---AACTTATCAGAA
Oryzomys         CAATCAGTTTCTCCCATTACTTCCTTTGTGAAAACTGACCAAAGGAAAACTCTGTCGGAG
Meriones         CAATCAGTTTCTCCCGTGAGGTCATCTGTAAAAACTGACCGTAGAAAAACTCTGTCAGAG
Mus              CAATCAGTTTCTCCCATCAGGTCATCTATAAAAACTGACAATAGGAAACCTCTGACAGAG
Rattus           CAATCAGTTTCTCCCCTCAGGTCATCTATAAAAACTGACAATAGAAAAACTCTGACAGAG
Scalopus         CCACCACTTTCTTCAATTCAGTCATCTGTTAAAAGTGCTTGTAAGAAAAACCTGGCGGAG
Erinaceus        CCAACACTTCCTACCATCATGTCATCTACTAAGAGTATATGCAAGAAAAACCTGTCTGAG
Myotis           CCATCCATTTCTCCCATCAAGTCATTTGTTAAAACTGTAAGTAAGAAAAACCTGTCAAAG
Tadarida         CCATGCATTTCTCCCATCAGGTCCTTTGTTAAAACTATAAATAAGAAAAACCTGTCAGAG
Taphozous        TCACCCATCTCTCCCATCAGGTCATCTGTTAAAACGATAAGTAAGAAAAACCTGTCAGAG
Tonatia          CCACCCATTTCTCCCGTCAGGTCATCTGTTAAAACTACAAGTAAGAAGAACCTGTCAGAG
Megaderma        CCACCCATTTCTTCCATCAGGTCATCTGTTAAAACTATATGTAAGGAAAACCTGTCAGAG
Pteropus         CCATCCATTCCTCCCATCAAGTCATCTGTTAAAACTACATGTAAGAAAAATCTGTCAGAG
Hipposideros     CCACATATTTCTCCCATCAGGTCATCTGTTAAAACTGTATGTAAGAAAAACCTGTCAGAG
Cynopterus       CCATCCATTTCTCCCATCAAGTCATCTGTTAAAACTATATGTAAGAAAAATCTGTCAGAG
Equus            CCATCACTTTCTCCCATCAGGTCATCTGTTAAAACTGTATGTCAGAAAAACCTGCCAGAG
Diceros          CCATCACTTTCTCCCATCAGGTCATCTGTTAAAACTATATGTAAGAAAAATGTGTCAGAG
Manis            TCATCAATTTCTCCCATCAGGTCATCTGTTAAAATAATATGTAAGGAAAACCTGTCAGAG
Canis            CCACCACTTTCTCCCATCAGATCATGTGTTAAAACTCTATGTCAGGAAAACCTGTCAGAG
Felis            CCACCACTTTCTCCCATCAGATCATCTGTTAATGCTGTATGTAAGAAAAACCTGTCAGAG
Sus              CCATCCCTTTCTCCCATCAGGTCGTCTGTTAAAACTATATGTAAGAAAAACCTGTCAGAG
Lama             ACATCACTTTCTCCTAACAGGTCATCTGTTAAAACTATGTGTAAGAAAAACCCGTCCGAG
Bos              CCATCACTTTCTCCCATCAAGTCATCTGTTAAAACCATATGTAAGAAAAGCCCATCAGAG
Hippopotamus     CCATCACTTTCTCCCATCAGGTCATCTGTTAAAACTATACGGAAGAAAAACCTGTCAGAG
Megaptera        CCATCACTTTCTCCCATCAGGTCATCTGTTAAAACTATATGTAAGAAAAACCTGTCAGAG
Physeter         CCATCACTTTCTCCCATCAGGTCATCTGTTAAAACTATATGTAAGAAAAACCTGTCAGAG
Tamandua         CCATCACTTTCTCCCAACAGGTCATCTGTTAAAACTAAATATAAGAAAAACTTGTCAGAA
Bradypus         CCATCACTTTCTCCCATGAAGTCATCTGTTAAAAGTAAATTTAAGGAAAACCTGTCAGAG
Dasypus          CCATCACTTTCTCACATGAAGTCATCTGTTAAAACTAAATGTAAGGAAAACCTGTCAGAG
Chaetophractus   CCATCACTTTCTCACATCAGGTCATCTGTTAAAACTAAATGTAAGGAAAACCTGTCAGAG
Loxodonta        CCATCACTTTCTCCCACCAGGTCATCTGTTAAAACTAAATGTAAGACAAACCTGTTGGAA
Elephas          CCATCACTTTCTCCCACCAGGTCATCTGTTAAAACTAAATGTAAGACAAACCTGTTGGAA
Dugong           CCATTGCTTTCTCCCATCAGGGCATCTGTTAAAAGT------AAGAAAAACTTGTCAGAA
Trichechus       CCATTGCTTTCTCCCATCAGGGCATCTGTTAAAAGT------AAGAAAAACTTGTCAGAA
Procavia         CCATCATCTTCTCCCATCAGATCATCTGTTAACTCTAAGTGTAACAAAAACCTGTCAGAA
Dendrohyrax      CCATCATCTTCTCCCATCAGATCATCTGTTAACTCTAAGTGTAACAAAAACCTGTCAGAA
Orycteropus      CCATCACTTTCTCCCACTAGGTCATCTGTTAAAGCTAAATGTAAGACAAATCTGTCCAAA
Tenrec           CCACCACTCTCTCCCATCAGATCCTCCCTTAAAAGTAAATGTAAGGAAAAGCTGTCAGAA
Echinops         CCACCACTCGCTCCCATCAGGTCATCTGTTAACAGTGAACGTAAGGAA------------
Elephantulus     CCGTCACTTTCTCCCACCAAGGTTCCTGTTAAAATGACATGGAAGAAAAACCTGTCAGAA
Rhynchocyon      CCATCATTTTCTCCCACCAAGCCATCAGTTAGAACCAAATATAAGCAATTCTTGTCAGAA
Amblysomus       GCATTGCTTTCT------------------------AAATGTAAGAAAAACTTGTCTGAA
Vombatus         CCATCAGTTTCTCCAGCAAGGTCATCTGCTAAAACTATAAATACAAAAAACCTCCTGGAG
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Homo	GAAAACTTTGAGGAACATTCAATGTCACCTGAAAGAGAAATGGGAAATGAGAACATT---
Pan	GAAAACTTTGAGGAACATTCAATGTCACCTGAAAGAGAAATGGGAAATGAGAACATT---
Gorilla	GAAAACTTTGAGGAACATTCAATGTCACCTGAAAGAGAAATGGGAAATGAGAACATT---
Pongo	GAAAACTCTGAGGAACATTCAATGTCACCTGAAAGAGAAATGGGAAACGAGAACATT---
Macaca	GAAAACTCTGAGGAACATTCAGTGTCACCTGAAAGAGCAGTGGGAAACAAGAACATCATT
Alouatta	GAAAACTCTGAGGAACATTCAATGTCACCTGAAAGAGCAATGGGAAACAAGAACATCATT
Otolemur	GAAAGGTTTGAAGAACATTCAGTGTTACCTGAAAAAGCAGTAGGAAACGAGAACACCGTT
Cynocephalus	GAAAGGTTTGAGGAACATTCAGTGTCACCTGAAAGAGCAATGGCAAACAAGAGAATCATT
Tupaia	GAAGGGTTTGAGGAACAGGCAATGTCACTTGAAAGAGCAATGGAAAATGAGAACATCATT
Lepus	GAAAGGTCTGAGGAGCATTCCGTGTCATCTGAAAGAGCAGTGGGAAGCGAGAGCATCATT
Hystrix	---------------CGTTCCTCATCACCTGGAGAAGCCACAGGTAACCAGATCATCCTT
Pedetes	GAAAAGTTTGAGAAATATTCAGCATCACATGAAAATGCAATGGGAAATGAGAGCATCATT
Aplodontia	GAAAAGTTTAAGAAACATTTAAGGTCACCTGGAAAAGCAGTAGGATATAAAAGAATCATT
Sciurus	GAAAAGTTTGAGAAACATTCAAGGTCACCTGAAAAAGCAGTGGAATATAAGAGAATCATT
Glaucomys	GAAAAGTTTGAGAAAGATTCAAGGTCACCTAAAGAAGCGGTGGGATATAAGAGAATCATT
Graphiurus	GAAAGATTTGAGAAACATTCATTGTCACTTGAAAAAGCAGTGGGATGTGAGAGAATTGTT
Oryzomys	GGACAGTTTGAGAAACATACATTGTCAACTGAAAGGACAATGGGAAATGGGTCTGCTGAC
Meriones	GAACGACTTGAGAAGCATACATTGTCAGCTAAAAAGGCAGTGGGAAATGAGACCGTTGTT
Mus	GGACGATTTGAGAGACATACATCATCAACTGAGATGGCGGTGGGAAATGAGAACATTCTT
Rattus	GGNCGATTTGAGAAACAT---------ACTGAAAGGGGRATGGGAAATGAGACTGCTGTT
Scalopus	GAAAAGCTTGAGGAACACTCATGGTCACCCGAAAGAGAAACAGGAAACGGGAGCATCATT
Erinaceus	GAAAT-------------TCACTGTCGCCTGAAAGAGCAGTGACAAACAAAAGCATCATC
Myotis	GAAAAGTTTGAGGAACATTTAGTGTCACCTGAAAGAGCAATGGGAAATGAGAACATT---
Tadarida	GAAAAGTTTGAGGAACATTCAGTGTCACCTGAAAGAGCAATGAGAAATGAGAATATT---
Taphozous	GAAAAGTTTGAGAAACAGTCAGTGTCACCTGAAAAAGCAATGGGAAATGAGAACATCATT
Tonatia	GAGAAGTGTGAGGAACATTCAGTGTCACCTGCCAGAGCCGTGGGACGTGAGAACATCATT
Megaderma	GAAAACCTTGAGGCATATTTGGTGTCACCTGAAAGAGCAATGGGAAATGAGAGCATTGTT
Pteropus	GAAAAGTTTGAAGAACATTCAATATCCCCTGAAAGAACAATAGGAAATGAGACCATCATT
Hipposideros	GAAAACTTGGAGGAATATCCAGTGTCACCTGAAAGAGCAATGGGAAATGAGAGCATCATT
Cynopterus	GAAAAGTTTGAAGAACATTCAATATTCCCTGAAAGAGCAATAGGAAATGAGACCATCATT
Equus	GGAAAGCTTGAGGAACAGTCACTGTCACCTGAAAGAGCAATGGGAAATGAGAGCATTGTT
Diceros	GAAAAGCTTGAGGAACATTCAGTGTCCCCTGAAAGAGCACTGGGAAACAAGAGCGTCATT
Manis	GAAAAGTCTGTGGAACATTCGATGTCATTGGAAAAAGCAGTGGGAAACAAGAGCATCATT
Canis	GAAAAGTTTGAGCAACATTCAATGTCACCCGAAAGAGCAGTGGGAAATGAGAGAGTCATT
Felis	GAAAAGTTTGAGCAGCGTTCAATGTCACCTGAAAGAGCAGTGGGAAATGAGAGCGTCATT
Sus	GAAAAGTTTGAGGAACCTAAAATGTCACCCGAAAGAACAATGGGAAACGAGAGCATCATT
Lama	GAAAAGCTTGAGAAATGTGTCATATCACCTAAAAGAGTGATGGGAAACGAGAGCACCATT
Bos	---AAGTTTGAGGAACCTGTAACGTCACCTGAAAAAACATTGGGGAGTGAGAGCATCATT
Hippopotamus	GAAAAGTTTGAGGAACCTGTAGTGTCAGCTGAAAGAGCAATGGCAAATGAGAGCATCCTT
Megaptera	GAAAAGTTTGAGGAACCTGTAAGGTCACCTGAAAGAGCAATGGAAAACGAGAGCATCATT
Physeter	GAAAAGTTTGCGGAACCTGTAATGTCACCTGAAAGAGCAATGGAAAACGAGAGCATCATT
Tamandua	GAAAGGTTTGAGGAACATACAGTGTCACTTGATAGAGCAGTGGGAAATGAGAGCATCATT
Bradypus	GAAAGATTTGAGGAACATACAGTATCACTTGAAAGAGCAGTGGGAAAGGAGCACATCATT
Dasypus	GAAAAGTTTGAGGAACTTACAGTGTCACTTGAAAGAACAATGGTAAATGAGAACATCATT
Chaetophractus	GAAAAGTTTGAGGAACTTACAATATCACTTGAAAGAACAGTGGGAAATGAGAACATCGTT
Loxodonta	GAAAGGTTTGAGGAACATACAATATCACTTGAAAGAGCAATGAGAAATGAGAACGTCATT
Elephas	GAAAGGTTTGAGGAACATACAATATCACTTGAAAGAGCAATGAGAAATGAGAACGTCATT
Dugong	GAAAGGTTTGAGGAACATACAATATCACTTGAAAGAGCAGTAGGAAATGAGAGCATCGTT
Trichechus	GAAAGGTTTGAGGAACATACAATATCACTTGAAAGAGCAGTAGGAAATGAGAGCATCGTT
Procavia	GAGCGATTTAAGGAACATAAAATATTACTTGAAAGAACAACAGGAAATGAAACCATTGTC
Dendrohyrax	GAGCGATTTAAGGAACATAAAATATTATTTGAAAGAACAACAGGAAATGAAACCATTGTC
Orycteropus	GAAAGATTTGAGCAACAGAAAATATCACATGAAAGAGTAATGGGAAATGAGAGCACCATT
Tenrec	GAAAGATTGGAGGATCAGGCAGAATCCCTTGAAAGAGCCTCGGGGAATGAGAGCATCATT
Echinops	---AGACTGGAGGATCATGCAGAATCACTTGAAAGAGCCTCAGAAAACGAGAGTATCATT
Elephantulus	GAAAACTTTGAGGAACATACAATA------------ACAATGGGAAATGAGAGCATCGTT
Rhynchocyon	GAAGAGTTGGAGGAACATGCACTATCACCTGAAAGAGCAATGGAAAATGAGAGTTTCATT
Amblysomus	GAAAGATTTGAAGAACGTGCAGTATCACTCGAAAAAGCAGTGGGAAATGAGAGCATCATT
Vombatus	GAAAGGCTTGATGAACAGACCACATGTCCTGAAACAGCTATGGGAAATGAAAGCTTAGCC

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Homo                CCAAGTACAGTGAGCACAATTAGCCGTAATAACATTAGAGAAAATGTTTTTAAAGAAGCC
Pan                 CCAAGTACAGTGAGCACAATTAGCCGTAATAACATTAGAGAAAATGTTTTTAAAGAAGCC
Gorilla             CCAAGTACAGTGAGCACAATTAGCCGTAATAACATTAGAGAAAATGTTTTTAAAGAAGCC
Pongo               CCAAGTACAGTGAGCATAATTAGCCGTAATAACATTAGAGAAAATGTTTTTAAAGAAGCC
Macaca              CCAAGTACAGTGAGCACAATTAGCCATAATAACATTAGAGAAAATGCTTTTAAAGAAGCC
Alouatta            CCAAGTACAGTGAGCACAATTAGCCATAATAAC---AGAGAAAATGCTTTTAAAGAAACC
Otolemur            CCAAGTACAATGAATACAATTAACCAAAATAAC---AGAGAAAGTGCTTATAAAGAAGCC
Cynocephalus        CAAAGTACAGTGAACACAATTAGCCAAAATAACATTAGAGACAGTGCTTCTAAAGAAGCC
Tupaia              CAAAGTACAGTGAGCACAATTAGCCAAGATAACATTAGAGAAGGTGCTTTTAAAGAAGCC
Lepus               CAAAGCACAGTGAGCACAATTAGCCAAGAGTACATTAGAGAAAGTGCTTTGAAAGGATTC
Hystrix             CAGAGCACC------------AGCCAT---------------CGCGCTTGCAGAGAAGCC
Pedetes             CAAAGTATCGTGTACACAATTGGCCAAAATAACATTAGAGAAAATGCTTTTAAAGAGGCC
Aplodontia          CAAAGTACAGCGAACATAATTAGCCAGAATAACATTACAGAAAGTGCTTTTAAAGACGTG
Sciurus             CAAAGTACAGTAAGCACAATTAGCCAAAATAACATTGGACAAAGTGCTTTTAAAGAAGCG
Glaucomys           CAAAGTACAGTGAGCACAATTAGCCAAAATAACATTAGACAAAGTGCCTTTAAAGAAGCG
Graphiurus          CAAAGC---------ACAATTAGCCAAAATAATGTTAGAGAAAGTTCTTTTAAAGAAGCC
Oryzomys            CAAAGTACAATGTACACAGTTAGCCAAAACAAC---AGAAAAAATGCTTGTCAAGAAGCC
Meriones            CGAAGTTCAGTACATACAACTAGCCAAAATAAC---GGAGGAAATGCTTGTCAGGAAGCC
Mus                 CAGAGTACAGTGCACACAGTTAGCCTGAATAAC---AGAGGAAATGCTTGTCAAGAAGCC
Rattus              CAAAGTACAATACACACAATTAGTCTAAATAAC---AGAGGAGATGCTTGTCTAGAAGCC
Scalopus            GAAAGTACAGTGAGCAGGGTTAGCCAAAATAACAATAGAGAAAATGCTTTTAAGGAAGTC
Erinaceus           CAAAGTACAGTGAACACCATTAGCCAGACTAATGCCAGTGAAAATGCTCTTAAAGATGTC
Myotis              CAAAGTACAGTGAGCCCAATTAGCCTAAGTAACATTAGAGAAAGCGCTTTTAAAGAAAGC
Tadarida            CTAAGTACAGTGAGCCCAATTAGCCTAAATAAC---AGAGAAAGCACTTTTAAAGAAGGC
Taphozous           CAAAGTACAGTGAGCACAATTAGCCAAAATAATGTTAGAGAAAGAGCTGTTAAAGAAGGC
Tonatia             CAGAGTACAGCGGGCACTCCTAGCCAGAACAAAACCAGGGAAAGTGCCGCCAGAGAAGGC
Megaderma           CAAAGTACAGTGAGCACAGTTAGCCAAAGTAACATTAGAGAAAGCACTTTTAAAGAGGGC
Pteropus            CAAAGTACAGTGGGCACAATTAGCCAAAATAACATTAGAGAAAGCACTTTTAAAGAAGGC
Hipposideros        CAAAGTACAGTGAGCACAATTAGCCAAAATAACATTAGAGAAAGCACTTTTAAAGAAAGC
Cynopterus          CAAAGTACAGTGGGCACAATTAGCCAAAATAACATTAGAGAAAGCACTTTTAAAGAAGGC
Equus               CAAAGTACAGTGAGCACAATTAGCCAAAATAACATTAGAGAAAGCACATTGAAAGAAGTC
Diceros             CAAAGTACAGTGAGCACAATTAGCCAAAATAACATTAGAGAAAGCACTTTTAAAGAAGTC
Manis               CAAAGTACTGTGAGCACAATTAGCCAAAATAACATTAAAGGAAACAATTTTAAAGATGGC
Canis               CAAAGTACAGTGAGCACAATTAGCCAAAATAACATTAGAGAATGTGCTTCTAAAGAAGTC
Felis               CAAAGTACAGTGAACACAATTAGCCAAAATAACATTAGAGAAAACACTTTTAAAGAAGTT
Sus                 CCAAATACAGAGAGCACAGTTAGCCAAAATAACATTCAAGAGAGAACTTTTAAAGAAGGC
Lama                CAAAGTATAGTGAGTGCAATGAGCCAAAATAACATTAGAGAAAGCACTTTTAAAGAAGTC
Bos                 CAAAGTGCAGTGAGCACAATCAGCCAAAATAACATTCAAGAAAGCACTTTTAAAGAAGTC
Hippopotamus        CAAAGTACAGTGAACACAATTAGCCAAAATAACATTCGAGAAAACACTTTTAAAGAAGTC
Megaptera           CAAAGTACAGTGAGCACAATTAGCCAAAATAACATTCGAGAAAGCACTTTTAAAGAAGTC
Physeter            CAAAGTACAGTGAGCACAATCAGCCAAAATAACATTCGAGAAAGCACTTTTAAAGAAGTC
Tamandua            CAAAGTACAGTAAGCACAATTAGCCAAAATAACATTAGAGAAAGCACTTTTAAAGAAGCC
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Dasypus             CAAAGTACAGTAAGCACAATTAGCCACAGTAACATTAGAGAAAACACTTTTAAAGAAGCC
Chaetophractus      CAAAGTACAGTAAGCACAATTAGCCACAATAACATTAGAGAAAACGCTTTTAAAGAAGCC
Loxodonta           CAAAGTACAGTGAGCACAGTTAGCCAAAATAACATTAGGGAAAGTGCTTCTAAAGAAGCC
Elephas             CAAAGTACAGTGAGCACAGTTAGCCAAAATAACATTAGGGAAAGTGCTTCTAAAGAAGCC
Dugong              CAAAGTACAGTGAGCACAGTTAGCCAAAATGACATTAAGGAAAGTGCTTCTAAAGAAGCC
Trichechus          CAAAGTACAGTGAGCACAGTTAGCCAAAATAACATTAAGGAAAGTGCTTCTAAAGAAGCC
Procavia            CAAAGTACAGTGAGCACAGGTAGCCAAGATAACATTAGGGGAAGTGCTTCGAAAGAAACC
Dendrohyrax         CAAAGTACAGTGAGCACAGGTAGCCAAGATAACATTAGGGGAAGTGCTTCGAAAGAAACC
Orycteropus         CAGAGTACAGTGGGCACAGTTAGCCAAAGTAACATTAGGGAAAGTGCTTTTAAAGAAGCT
Tenrec              CAAAGTACAGTGAGCACAATTAGCCAAAATACGCTTAGAGAAAATGCTTTTAAAGGAACC
Echinops            CCAAGTACAGTGAGCACAATTAGCCAAAATACCCCGAGAGAAAATGCTTTCAAAGGAACC
Elephantulus        TATAGTCCAGTGAGCACAGTTAGCCAAAGTAATGTTAAGGGATATGCT------CAGGCC
Rhynchocyon         CACAGTACAGTGAACGCAGTTAGCCAAAATAACCTTAGGGGAAGTGTCTTTAAAGAAGGC
Amblysomus          CAAAGTACAGTGAGCACAGTTAGCCACAATAACATTAGGGAAAGGGCTTTTAAGGAAACC
Vombatus            CAAAGCAGCTTAAGTCCAGTAAGCCAAAGTAATAGCAGAGAATATATTTCTAAAGCAACT
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Homo                AGCTCAAGCAATATTAATGAAGTAGGTTCCAGTACTAATGAAGTGGGCTCCAGTATTAAT
Pan                 AGCTCAAGCAATATTAATGAAGTAGGTTCCAGTACTAATGAAGTGGGCTCCAGTATTAAT
Gorilla             AGCTCAAGCAATATTAATGAAGTAGGTTCCAGTACTAATGAAGTGGGCTCCAGTATTAAT
Pongo               AGCTCAAGCAATATTAATGAAGTAGGTTCCAGTACTAATGAAGTGGGCTCCAGTATTAAT
Macaca              AGCTCGAGCAATATTAATGAAGTAGGTTCCAGTACTAATGAAGTGGGCTCCAGTATTAAT
Alouatta            AGCTCAAGCAGTATTAATGAAGCAGGTTCTAGTACTAATGAAGTAGGCTCCAGTATTAAT
Otolemur            AGTTCAAGCAGTATCAATGAAGTAAGCTCGAGTACTAATGAAGTGGGCTCCAGTGTTAAC
Cynocephalus        AGCTCAAGCAGTATTAATGAAGTAGGTTCCAGTACTAATGAAGTAGGCTCCAGTATTAAT
Tupaia              AGCTCAAGCAGTATTAATGAAATAGGTCCTAGTACTAATGAAGGAAGCTCTAGTATTAAT
Lepus               AGCTCAAGCAGTATTAATGAAGGGGGCTCTAGTGCTAACGAAGTATGCTCCAGTGTGAAT
Hystrix             AGCTTGGGCAGTGGG------------------------------------------AAC
Pedetes             AGTTCAGGCAGTATT------------------------------------------AAT
Aplodontia          AACTCAGGCAGTATTAATGAAGTAGGCTCTAGTACTAATGAAGTAGGCTCCAGTATTAAT
Sciurus             AACTCAGACAGTATTAATGAAGCAGGCTCTAGTACTAATGAAGTAGGCTCCAGTATTAAT
Glaucomys           AACTCAGGCAGTATTAATGAAGTAGGCTCTAGTACTAATGAAGTAGGCTCCAGTATTAAT
Graphiurus          AACTCAGGCAGTAATACTGAAATAGGCAGTAGCACTAACGAAGTAGGCTCCAGTACTAAT
Oryzomys            AACTTGGGCAGTATT------------------------------------------AAT
Meriones            AGCTCAGGCAGTATT------------------------------------------AAT
Mus                 GGCTCGGGCAGTATT------------------------------------------CAT
Rattus              AGCTCAGGCAGTGTT------------------------------------------ATT
Scalopus            AGCTCAAGTAGTATTAACGAAGTAGGTTCCAGTACTAACGAAGCTGACTCTAGTATTAAT
Erinaceus           AGTTCAAGCAGTGTT---------------------AATGATATGGGTTCCAGTACTAAT
Myotis              AGCTCAAGCAGTACT---------------------AATGAAGGGGGCTCTAGTATCAAT
Tadarida            AGCTCAAGCAGTACT---------------------AATGAAGTAGGCTCTAGTACCAAT
Taphozous           AGCTCAAGCAGTACT---------------------AACGAAGTAGGCTCTAGTATCGAT
Tonatia             AGCTCGAGCGGCACT------------------------------------------AAC
Megaderma           AGCTCCAGCAATATTTATGAAGCAGATTCCAGTGCTAATGAAGTAGGCTCTAGTATCAGT
Pteropus            AGCTCAAGCAGTATTTATGAAGCAGGTTCCAGTACTAACGAACTAGGCTCTAGTGTCAAT
Hipposideros        AGCTCAAGCAATNTTTATGAAGCAGATTCCAGTACTAATGAAGTAGGCTCTAGTATCAAT
Cynopterus          AGCTCAAGCGGTATTTATGAAGCAGGTTCCAGTACCAATGAACTAGGCTCTAGTGTCAAT
Equus               AGCTCAAGCAGTATT---------------------AATGAAGTAGGCTCTAGTATTAAT
Diceros             GGCTCAAGCAGTATTAATGAAGTAGATTCCAGTACTAATGAAGTAGGCTCTAGTATTAAT
Manis               AGCTCCAGCAGCATTAATGAAATAGGTTCCAGTACTAATGAAGTAGGCTCTAGTATTAAT
Canis               GGCTCAAGCAGTGTTAATGAAGTAGTTTCCAGTACTAATGAAGTAGGCTCTAGTGTTAAT
Felis               AGCTCAAGCAGTGTTAATGAAGTAGGTTCCAGTGCTAATGAAGTAGGCTCTAGCATTAAT
Sus                 AGCTCAGGCAGTCCTAATGAAGTCGGGTCCAGTACCAACGAAGTAGGCTCTAGTATTAAT
Lama                AGCTCAAGCAGTGTCAATGAAGTAGGTTCCAGTACTAATGAAGTAGGTTCTAGTATTAAT
Bos                 AGCTCAAACAGTGTAAATGAAGTAGGTTCCAGTACTAATGAAGTAGGCTCTAGTGTTAAT
Hippopotamus        AGTTCAAGCAGTATTAATGAAGTAGTTTCCAGTACTAATGAAGTAGGCTCTAGTATCAGT
Megaptera           AGCTCAAGCAGTATTAATGAAGTAGGTTCCAGTACTAATGAAGTAGGCTCTAGTATTAAT
Physeter            AGCTCAAGCAGTACTAATGAAGTAGGTTCCAGTACCAATGAAGTAGGCTCTAGTATTAAT
Tamandua            AGCTCAAGCAGTATTAATGAAGTAGGTTCCAGTATTAATGAAGTGGGTTCCAGTATTAAT
Bradypus            AGCTCAAGCAGTATCAATGAAGTAGGTTCCAGTGTTAATGAAGTAGGTTCCAGTGTTAAT
Dasypus             AGCTCAAGCAGTATT------------------------------------------AAT
Chaetophractus      AGCTCAAGCAGTATT------------------------------------------AAT
Loxodonta           AGCTCAAGCAGTATT---------------------AATGAAGTATGTTCCAGTATTAAT
Elephas             AGCTCAAGCAGTATT---------------------AATGAAGTATGTTCCAGTATTAAT
Dugong              AGCTCAAGCAGTATT------------------------------------------AAT
Trichechus          AGCTCAAGCAGTATT---------------------AATGAAGTAGGTTCCAGTGTTAAT
Procavia            AGCTCAAGCAGTATT------------------------------------------AAT
Dendrohyrax         AGCTCAAGCAGTATT------------------------------------------AAT
Orycteropus         AGCTCAAGCAGTATT---------------------AATGAGGTAGGTTCCAGTGTTAAT
Tenrec              AGCTCAAGCAGTCTT------------------------------------------AAT
Echinops            AGCTCAAGCAGTCTT------------------------------------------AAT
Elephantulus        AGTTCAAGCAGTATTAACGAAGTAGGTTCCAGTACTAATGAAGGAGGTTCCAGTATTAAT
Rhynchocyon         AGCTCAAGCAGTATTAATGAAGCAGGATCCAGTACTAATGAAGTAAGTTCCAGTATTAAT
Amblysomus          AGCTCAAGTAGTACT---------------------AATGAAGTAGGTTCCAGTATTAAT
Vombatus            GACTTAAATAGATTT------------------------------------------ATC
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Homo                GAAATAGGTTCCAGTGATGAAAACATTCAAGCAGAACTAGGTAGAAACAGAGGGCCAAAA
Pan                 GAAGTAGGTTCCAGTGATGAAAACATTCAAGCAGAACTAGGTAGAAACAGAGGGCCAAAA
Gorilla             GAAGTAGGTTCCAGTGATGAAAACATTCAAGCAGAACTAGGTAGAAACAGAGGGCCAAAA
Pongo               GAAGTAGGTTCCAGTGATGAAAACATTCAAGCAGAACTAGGTAGAAGCAGAGGGCCAAAA
Macaca              GAAGTAGGTTCCAGTGATGAAAACATTCAAGCAGAACTAGGTAGAAACAGAGGGCCAAAA
Alouatta            GAAGTAGGTTCCAGTGATGAAAACATTCAAGCAGAGCTAGGTAGAAACAGAAGGCCAAAA
Otolemur            GAAGTAGGCCCCAGTAGTGAAAACATTCAAGCAGAACTAGATAAAAACAGAGGACCTAAG
Cynocephalus        GAAGTAGGTCCCAGTGGTGAAAACATTCAAGCAGAACTAGGTAGAAACAGAGGACCTAAA
Tupaia              GAGGTAGGTTCCAGTGGTGAAAACATTCAAGCAGAACTAGGTAAAAAGAGAGGATCCAAA
Lepus               GAAGTAGGATCCAGTGGTGAAAACATGCAAGCACAACCAGGCAGAAGCAGAGCACCTGAG
Hystrix             GAAGGGGGCTCCAGTGGGGAGCACATTCAAGCAGAACCCAGTAGACACCAAGAGCCTGAA
Pedetes             GAAGTAGGTTCCAGTGGTGAAAACATGCAAGTAGAACTAGGTAGAAACAGAGGACCTAAA
Aplodontia          GAAGTAGGTTCCAGTGGTGAGAACATTCAAGCAGAANNNNNNNNNNNNNNNNNNNNNNNN
Sciurus             GAAGTAGGTTCCAGTGGTGAAAACATTCAAGCAGAACTAGGTAGAAACAGAGGGCCCAAA
Glaucomys           GAAGTAGGTTCCAGTGGTGAAAACATTCAAGCAGAACTAGGTAGAAACAGAGGACCCAAA
Graphiurus          AAGAGGTTCCAGGGTGGTGAAAACATTCAAGCAGAACTAGCTAGAAAAAGAGGACCTAAA
Oryzomys            GAAGTATATTCCAGTGGTGAAACCGTCCAAGGACAACAAGGTAGAAAGAGAGGGACTAAG
Meriones            GAAGTATGTTCCAGCAGTGAAAACTTCCAGGGACAACGAGATAGAAACAGAGGGTCTAAG
Mus                 GAAGTATGTTCCACTGGTGACTCCTTCCCAGGACAACTAGGTAGAAACAGAGGGCCTAAG
Rattus              GAAGTACATTCCACTGGTGAAAACGTCCAGGGGCAACTAGATAGAAACAGAGGGCCTAAG
Scalopus            GAAGTAGGTTCCAGTGGTGAAAATATTCAAGCTGAACTAGATGGAAGCAGAGGACCTAAA
Erinaceus           GAAGTAGGTTCCAGTAGTGAAAACATTCAAGCTAAACTATGTAGAAACAGAGGACCCAGA
Myotis              GAAGTAGGTTCCAGTGGTGAAAACATTCATGCAGAACTAGATATAAACAAAGGATCAAAA
Tadarida            GAAGTAGGTTCCAGTGGTGAAAACATTCAAGCAGAACTAGGTAGAAACAGAGGATCAAAA
Taphozous           GAAGCAGGTTCCAGTGGTAAAAACATTGGAGCAGAACTAGATAGAAACAGAGGATCAAAA
Tonatia             GAAGTAGGCTCCAGTGGTGAAAACGGTCAAGCAGAGCCAGGCACAAACAGAGCATCAAAA
Megaderma           GAGGTAAGTTCCAGTGGTGAGAACATTCAAACAGAACTGGGTAGAAACCAAGGACCAAAA
Pteropus            GAAGTAGGTTCCAGTGGTGAAAACATTCAAGCAGAACTAAGTAGAAACAGAGGACCACAA
Hipposideros        GAAGTAGGTTCCAGTGGTGAAAACATTCAAGCAGAACTCGGCAGAAACAGAGGACCGAAA
Cynopterus          GAAGTAGGTTCCAGTGGTGAAAACATTCAAGCAGAACTAAGTAGAAACAGAGGACCAAAA
Equus               GAAGTAGGTTCCAGTGGTGAACACATTCAAGCAGAACTAGGCAGAAACAGAGGACCTAAA
Diceros             GAAGTAGGTTCCAGTGGTGAAAACATTGAAGCAGAGCTAGGCAGAAACAGAGGACCTAAA
Manis               GAAGTAGGTTCCAGTGGTGAAAAAATTCAAGCAGAACTAGGTAGAAACAGAGGACCTAAA
Canis               GAAGTAGGTTCCAGTGGTGAAAACATTCAAGCAGAACTAGGTAGAAACCGAGGACCTAAA
Felis               GAAGTAGGTTCCAGTGGTGAAAACATTCAAACAGAACTGGGTAGAAACCGAGGACCTAAG
Sus                 GAAGTAGGTTCCAGCGGTGAAAACGTTCGAGCAGAACCAGGTAGAAACAGAGGACCTAAA
Lama                GAAGTAGGTTCCAGTGGCGAAAACATTCAAGCAGAACTAGGTAGAAACATGGGACCTAAA
Bos                 GAAGTAGGTTCCAGTGGTGAAAACATTCAAGCAGAACCAGGTAGAAACAGAGAACCTAAA
Hippopotamus        GAAGTAGGTTCTAGTGGTGGAAACATTCAAGCAGAACTAGACAGAAAGAGAGGACCTAAA
Megaptera           GAAGTAGGTTCCAGTGGTGAAAACATTCAAGCAAAACTAGRTAGAAACAGAGGACCTAAA
Physeter            GAAGTAGGTTCCAGTGGTGAAAACATTCAAGCAAAACTAGATAGAAACAGAGGACCTAAA
Tamandua            GAAGTGGGTTCCAGTGGTGAGAACGTTCAAGCAGAGCTAGGTAGAAACAGA---CCTAAG
Bradypus            GAAGTAGGTTCCAGTGGTGAGAACACTCAAGCAGAGCTAGGTAGAAACAGAGGATCTAAA
Dasypus             GAAGTAGGGTCCAGTGATGAGAACATTCAAGCAGAAGTAGGTAGAAACAGAGCACCTAAA
Chaetophractus      GAAGTAGGTTCTAGTGGTGAAAACATTCAAGCAGAACTAGGTAGAAACAGAGCACCTAAA
Loxodonta           GAAGTAGGTTCTAGTGGTGAAAACATTCAAGCAGAAATAAGTAGGAAGAGAGGACCTAAA
Elephas             GAAGTAGGTTCTAGTGGTGAAAACATTCAAGCAGAAATAAGTAGGAAGAGAGGACCTAAA
Dugong              GAAGTAGGTTCTAGTGGCGAAAACATTCGAGCAGAGCTAGGTAGGAACAGAGGACCTAAA
Trichechus          GAAGTAGGTTCTAGTGGCGAAAACATTGAAGCAGAGCTAGGTAGGAACAGAGGACCTAAA
Procavia            GAAGTAGGTTCTAGTAGCGAAAACATTCAAGCAGAAATAAGTAGGAACAGAGAACCTAGA
Dendrohyrax         GAAGTAGGTTCTAGTAGCGAAAACATTCAAGCAGAAATAAGTAGGAACAGAGAACCTAGA
Orycteropus         GAAATAGGTTCTAGTGGTGAAAACATTCAAGCAGAACTAGGTAAGAACAGAGGACCTAAA
Tenrec              GAAGTAGGTTCTAGCAGCGAAAACATTCAGGCAGAACTAGCTAGGAACAGAGAACCTAAA
Echinops            GAAGTAGGTTCTAGCAGCGAAAACATTCAAGCAGAGCTAGCTAGGAACAGAGAACCTAAA
Elephantulus        GAAGTAGGTTCTAGTGGTGAAAACATCCAAGCAGAGCTCGATAGGAACAGAGGACCTGCA
Rhynchocyon         GAAGTATGTTCTAGTGATGAAAACATCCAAGCCGAACTAGATAGGAACAGAAGACCTGAA
Amblysomus          GAAGTAGGTTCTAGTAACGAAAACATCCAAGCAGAGGTAGGTAGGAACAGAGGACCTAAG
Vombatus            AGCATAGGCTCTAGTGGAGAAGGCAGTCAGGCACAAAAAGGTGAAAACAAAGAATCTGAA
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Homo	TTGAATGCTATGCTTAGATTAGGGGTTTTGCAACCTGAGGTCTATAAACAAAGTCTTCCT
Pan	TTGAATGCTATGCTTAGATTAGGGGTTTTGCAACCTGAGGTCTATAAACAAAGTCTTCCT
Gorilla	TTGAATGCTATGCTTAGATTAGGGGTTTTGCAACCTGAGGTCTATAAACAAAGTCTTCCT
Pongo	TTGAATGCTATGCTTAGATTAGGGGTTTTGCAACCTGAGGTCTATAAACAAAGTTTTCCT
Macaca	TTGAATGCTGTGCTTAGATTAGGGCTTTTGCAACCTGAGGTCTGTAAACAAAGTCTTCCT
Alouatta	TTGAATGCTATGCTTAGATTAGGGCTTCTGCAACCTGAGATTTGTAAGCAAAGTCTTCCT
Otolemur	TTGAATGCTGTGCTTAGATTAGGTCTTATGCAACCTGAAGTCTATAAACAAAATCTTCCT
Cynocephalus	TTAAGTGCTATGCTTAGATTAGGCCTCATGCAACCTGAAGTTTACAAGCAAAATCTTCCT
Tupaia	TTAAATGCTGTGCTTAGATTAGGTCTTATGCAACCCGAAGTCTATAAGCAAAGTCTTCCT
Lepus	TTAAATGCTGTGCTGAGAATAGGTCTTCTGCAGCCTGAAGTCTCTGAGCAAAGCCTTCCT
Hystrix	------------CTAAGATTAGGTCTGACGCAGCCCGAAGTCTACCAGCAAAGTCTTCCT
Pedetes	TTAAATTCTGTGCAAAGATTAGGTCATATACAACCTGAAGTATGTAAGCAAAGTCTTCCT
Aplodontia	NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
Sciurus	TTAAATGCTGTGCTTAGATTAGGTCTTATGCAACCTGAAGCCTGTAAACAAAATCTTCTA
Glaucomys	TTAAATGCTGTGCTTAGATTAGGTCTTATGCAACCTGAAGCCTGTAAACAAAATCTTCTA
Graphiurus	TTAAATGCTGTACTTAGGTTAGGTCTTATGCAACCTGAAGCTTATAAGCAAAGTCTTCCT
Oryzomys	TTAAACACTGTACTTTCATTAGGTCTTATGAAACCTGAAGTCTGTCAGCAAGGTTTTCCT
Meriones	GTAAATACCGTGCTTCCATTGGATCTTTTGCAGCCTGAAGTCTGTAAGCAA---------
Mus	GTGAACACTGTGCCTCCATTAGATAGTATGCAGCCTGGTGTCTGTCAGCAAAGTGTTCCT
Rattus	GTAAACACCGTGTCTCTATTAGATAGTACACAGCCTGGTGTCTCTAAGCAGAGTGCTCCT
Scalopus	TTAAATGCTATGCTCAGATTGGGTCTTATGCAACCTGAAGTCTATAAGCAAAGTCTTCCT
Erinaceus	TTAAATGCTACTCTTAGAGCAAGTCTTATGCAACCTGAAGTCTTTGAGCAGTGTCTTCTG
Myotis	TTAACTGCTATGCTCAGATTAGGTCTCATGCAACCCGAAGTCTATAAGCCAAGCCTTCCT
Tadarida	ATAAATGCTATGCTCAGATCAGGTCTCATGCAACCTGAAGTCTATAAGCCAAGCCTTTCT
Taphozous	TTAAGTGCTGTTCTCAGATTAGGTCTCATGCAACCCGAAGTCTATAAGCCAAGCCTTCCT
Tonatia	TTAAGCGCTCTTCTCAGATCAGGGCTCATGCAACCTGAAGTCTGTAAGCCGAGTCTTCCT
Megaderma	TTAAATGCTGTGCTCAGATTAGGTCTCATGCAACCTCAAGTCTATGTGCAAAGCCTTCCT
Pteropus	TTAAATGCTGTGCTTCAATTGGGTCTCATGCAGCCTGAAGTCTATAAGCAAAGCCTTCCT
Hipposideros	TTAAATGCTGTGCTCGGATTAGGTCTCGTGCAACCTGAAGTCTATAGGCAAAGCCTTCCT
Cynopterus	TTAAATGCTGTGCTTCAGTTGGGTCTCATGCAGCCTGAAGTCTATGAGCAAAGCCTTCCT
Equus	TTAAATGCTATTCTCAGATTAGGTCTTATGCAACCTGAAGTCTATAAGCAAAGTCTTCCT
Diceros	TTAAATGCTATTCTCAGATTAGGTCTTATGCAACCTGAAGTCTATAAGCAAAGTCTTCCA
Manis	TTAAGTGCTGTGCTCAGATTAGGTCTTATGCAACCTGAGGCCTATAAGCAAAATCTTCTT
Canis	TTAAATGCTATGCTCAGATTAGGTCTTATGCAACCTGAAGTCTGTAAGCAAAGCCTTTCT
Felis	TTAAGTGCTATGCTCAGGTTAGGTCTTATGCAACCTGAAGTCTATGAGCAAAGTCTTCCT
Sus	TTAAGTGCAATGCTCAGATTAGGTCTCATGCAACCCGAAGTTTATAAGCAAAGTCTTCCT
Lama	TTAAATGCTATGCTCAGATTAGGTCTTTTGCAACCTGAAGTCTGTAAGCAAAGTCTTCCT
Bos	TTAAGAGCTTTACTCGGATTAGGTCTTACGCAACCTGAAGTCTATAAGCAAAGTCTTCCT
Hippopotamus	CTAAGTGCTTTGCTTAGATTAGGTCTTATGCAACCTGAAGTATATAAGCAAAGTCTTCCT
Megaptera	TTAAGTGCTTTGCTCAGATTAGGTCTTATGCAACCCGAAGTCTATAAGCAAAGTCTTCCT
Physeter	TTAAGTGCTTTGCTCAGATTAGGTCTCATGCAACCCGAAGTCTATAAGCAAAGTCTTCCT
Tamandua	CTAAATGCTATGCTCAGATTAGGTCTTATGCAACCTGAAGTCTATGAGCAAAATCTTCCT
Bradypus	TTAAGTGCTATGCTCAGATTAAGTCTTATGCAACCTGAAGTCTATAAGCAAAGTCTTCCT
Dasypus	TTAAATGCTATGCTCAGATTAGGTCTTATGCAACCTGAAGTCTATAAGCAAAGTCTTCCT
Chaetophractus	TTAAATGCTATGCTCAGATTAGGTCTTATGCAACCTGAAGTCTATAAGCAAAGTCTTCCT
Loxodonta	TTAAATGCTGTGCTCAGATTAGGTCTTATGCAACCTGAAGTTTATAAACAAAGTCTTCCT
Elephas	TTAAATGCTGTGCTCAGATTAGGTCTTATGCAACCTGAAGTTTATAAACAAAGTCTTCCT
Dugong	TTAAATGCTGTGCTCAGATTAGGTCTTATGCAACCTGAAGTCTATAAACAAAGTCTTCCT
Trichechus	TTAAATGCTGTGCTCAGATTAGGTCTTATGCAACCTGAAGTGTATAAACAAAGTCTTCCT
Procavia	TTAAATGCTGTGCTCAGGTTAGGTGTTATGCAACCTGAAGTGTATAAACAAAGTCTTTCT
Dendrohyrax	TTAAATGCTGTGCTCAGGTTAGGTGTTATGCAACCTGAAGTGTATAAGCAAAGTCTTTCT
Orycteropus	TTGAATGCTGTGCTCAAATTATGTCTTATGCAACCTGAAGAGTATAAACAAAGTCCTCCT
Tenrec	TTGGATGCTGTGCTCAGACTAGGACTTGTGCAGCCTGAAGGCTGTAAGGAAAGTCTTCCC
Echinops	TTGGATGCTGTGCTCAGGTTGGGTCTTGTGCAACCTGAAGTCTGTAAGGAAAGTCTTCCT
Elephantulus	TTAAATGCTGTACTCAGATTAGGTCTTGTGCAACCTGAAGTCTATGAACAAAGTCTTCCT
Rhynchocyon	TTAAATGCTGTACTCAGGTTAGGTCTTATGCAACCTGAAGTGTATCAACCAAGTCTTCCA
Amblysomus	TTAAATGCTATGCTCACATTAGGTTTTATGCAACCTGAAGTCTATAAACAAAATCTTACT
Vombatus	TTAAATACACAACCCAAATTAAAGCTTGTGCAACCCCAAATCTGTCAACAAAGCTTTCCT

Homo	GGAAGTAATTGTAAGCATCCTGAAATAAAAAAGCAA---GAATATGAAGAAGTAGTTCAG
Pan	GAAAGTAATTGTAAGCATCCTGAAATAAAAAAGCAA---GAATATGAAGAAGTAGTTCAG
Gorilla	GGAAGTAATTGTAAGCATCCTGAAATAAAAAAGCAA---GAATATGAAGAAGTAGTTCAG
Pongo	GGAAGTAATGGTAAGCATCCTGAAATAAAAAAGCAA---GAATATGAAGAAGTACTTCAG
Macaca	ATAAGTAATTGTAAGCATCCTGAAATAAAAAAGCAA---GAACATGAAGAATTAGTTCAG
Alouatta	ATAAGTGATTGTAAACATCCTGAAATTAAAAAGCAA---GAACATGAAGAAGTAGTTCAG
Otolemur	ATAAGTAATTGTGAACATCCTAAAATAAAAGGGCAAGAAGAAAAT---GGAGTAGTTCAA
Cynocephalus	TTAGGTAATTGTAAACATCCTGAAATA---AGGCAAGAAGAAAATGAAGGAATAGTTCAG
Tupaia	TTAAGTAATCATAATGATCCTGAAATGAAAAGACAAGAAAAAAATGAAGGAGGAGTTCAG
Lepus	ATAAGTAATTCTGAACTTCCCAAACTACAAAGGCAAGGAGAAAACGAAGGAGTAGTTCAG
Hystrix	GTAGGTGACTGTAGACATCCCGAAATACAAACACGAGGAGAAAATGGAGTGGTAGCTCAG
Pedetes	GTAAGTTCA---AAACATCCTGAAATGAAAAAGCAACAAGAAAATGAGGGAGTAGTTCAG
Aplodontia	NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
Sciurus	---AGTAATTGTAAATACCCTGAAATAAAAAGACAAGGAGAAGATGAA---GTCGTTCAA
Glaucomys	---AGTAATTGTAAATACCCTGAAATAAAAAGACAAGGAGAAGATGAA---GTAGTTCAA
Graphiurus	GTAAGTAATTGTGAACATCCTGAAATAAAAAGGCAAGGAGAAGATGAA---GTAGTTCAG
Oryzomys	GTGAGTGATTATAAATATCTTGAAATGAAAAAGCAG---GAAGATGAG------------
Meriones	---AGTGATTATAAATATCTTGAAATGAAGAAGCAG---GAGGGCAAG------------
Mus	GTAAGTGAT---AAGTATCTTGAAATAAAAAAGCAG---GAGGGTGAG------------
Rattus	GTAAGTGAT---AAGTATCTTGAAATAAAG---CAG---GAGAGTAAG------------
Scalopus	AAAAGTACTTGTAAACATCCTGAAGTTAAAAGGCAAGGAGAAAATGAAGGCATAGTTCAG
Erinaceus	ATGAGTAACTGTAAACATTCTGAAATGAAAAGACAAGGAGAAAATGAAGGTGTTATTCAG
Myotis	GTAAGTAATTGTAAACATCCTGAAGTAAAAAGGCAAGGAGACAACGAAGGACTAGTTCAG
Tadarida	GTAAGTAATTGTGAACATCCTGAAATAAAAAGGCAAGGAGAAAATGAAGGAGTAGTTCAG
Taphozous	ATAAGTAATTGTAAACACTCTGAAGTAGAAAGGCAAGGAGAAAATGAAGTAGTAGTTCAG
Tonatia	CTGAGTAATTGTGAAGATCCTGAAATAAAAAGGCAA---GAAGATGGGGGAGTAGTGCAG
Megaderma	GTAAGCAATTGTGAACATTCTGAAATAAAAAGGCAAGGAGAAAATGAAGGAGTAGTTGAG
Pteropus	CTAAGTAATTGTAAACATCCTGAAATAAAAAGGCAAGGAGAAAATGAAGGAGTAGTTCAG
Hipposideros	GTAAGTAATTGTCAACATCCAGAAATAAAAAGGCAGGGAGAAAATGAAGGAATAGTTCAG
Cynopterus	CTAAGTAATTGTAAACATTCTGAAATAAAAAGGCAAGGAGAAAATGAAGGAGTGGTTCAG
Equus	ATAAGTAATTGTAAACATCTGGAAATAAAAAGGCAAGGAGAAAAGGAA---GTAGTTCAG
Diceros	ATAAGTAATTGTAAACATCCGGAAATAAAAAGGCGAGGAGAAAATGAAGGAGTAGTTCAG
Manis	ATAGGTAATCGTAAACACCCTGAAATTAAAAGACAAGGAGAAAAAGAAGGAGTAGTTCAG
Canis	TTAAGTAATTGTAAACATCCAGAAATGAAATGGCAAGGACAAAGTGAAGGAGCAGTTCTG
Felis	ATAAGTAATTGTAAATGTCCAGAAATGAAAAGGCAAGGAGAAAATGAAGGAGTAGTTCAG
Sus	GTAAGTAATTGTAACCACACAGAAATAAAAAGGCAAGGAGAAAATGAAGGCATATTTCAG
Lama	GTAAGTAATTGTAAACAACCTGAAATAAAAAGGCAAGGAGAAAATGAAGGCATCTTTCAG
Bos	GTAAGTAACTGTCACCATCCTGAAATAAAAAGGCAAGGAGAAAATGAGGACATGCCTCAG
Hippopotamus	GTAAGTAATTGTCAACATCCTGAAATAAAAAGGCAAGGAGAAAATGAAGGCATACTTCAG
Megaptera	ATAAGTAACTGTCAACTTCCTGAAATAAAAAGGCAAGGAGAAAGTGAAGGCACACTTCAG
Physeter	GTAAGTAACTGTCAACTTCCTGAAATAAAAAGGCAAGGAGAAAATGAAGGCACACTTCAG
Tamandua	ATAACTAATTTTAAACTTTCTGAAATTAAAAAACAAGGAGAAAATGAAGAAGTAGTTCAG
Bradypus	ATAACTAATTGTAAGCATCCTGAAATTAAAAAGCAAGGAGAAAATGAAGAAGTAGTTCAG
Dasypus	ATAACCAATTGTAAATATCCTGAAATAAAAAGTCAAGGAGAAAATGAAGAAGCAATTCGG
Chaetophractus	ATAACTAGTTGTAAACATCCTGAAATAAAAAGGCAAGGAGAAAATGAAGAAGCAATTCAG
Loxodonta	ATAAGTGACTGTAAACATCCTGGAATAAAAACGCAAGGAGAAAATGAAGGAGTAGTTCAG
Elephas	ATAAGTGACTGTAAACATCCTGGAATAAAAACGCAAGGAGAAAATGAAGGAGTAGTTCAG
Dugong	GTAAGTAACTGTAAACGTCCTGAAATAAAAAGGCAAGGAGAAAATGAAGGAGTAGTTCAG
Trichechus	GTAAGTAACTGTAAACATCCTGAAATAAAAAGGCAAGGAGAAAATGAAGGAGTCGTTGAG
Procavia	ATAAGTAACTGTAAACAGCCAGAAATAAAAAAGCGAGGAGAAAATGAAGGAGTAGTTCAG
Dendrohyrax	ATAAGTAACTGTAAACAGCCAGAAATAAAAAAGCAAGGAGAAAATGAAGGAGTAGTTCAG
Orycteropus	ATAAGTAATTGTAAACATCCTTCAATAAAAACCCAAGGACAAAATGAAGGAGTAGTTCAG
Tenrec	CTAAGGAAATGCAAGCATCCTGAAGTAGAAAGGCAAAAAGGCAATGGAGGACTAGTTCCA
Echinops	ATGAGGAAATGTAAGCATTCTGAAGTAAAAAGGCAAAAAGGCAATGGAGGACTAGTTCCA
Elephantulus	GCAGGAAATTGTAAACATCCTGAAATGACAAGGCCAGGAGACAGTGAAGGAGAAAAAAAG
Rhynchocyon	ACAAATAACTGTGAATATCTTGAAATTAGTGGGCCAGGAAAAAATGAAGGCATAATTCAG
Amblysomus	CTAAGTAATTGTAAACATCCTGAAATAACAAAGCAGGGAGACAATGAAGAAAGAGTTCAA
Vombatus	CAGGATAATTGCAAAGAGTCTAAAAGAAAAGGGAAGGGAGGAAATGGAAAATTAGCTCAG

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Homo               ACTGTTAATACAGATTTCTCTCCATATCTGATTTCAGATAACTTAGAACAGCCTATGGGA
Pan                ACTGTTAATACAGATTTCTCTCCATGTCTGATTTCAGATAACTTAGAACAGCCTATGGGA
Gorilla            ACTGTTAATACAGATTTCTCTCCATGTCTGATTTCAGATAACTTAGAACAGCCTATGGGA
Pongo              ACTGTTAATACAGACTTCTCTCCATGTCTGATTTCAGATAACCTAGAACAGCCTATGAGA
Macaca             ACTGTTAATACAGACTTCTCTCCATGTCTGATTTCAGATAACCTAGAACAGCCTATGGGA
Alouatta           ACTGTTAATACAGACGTCTCTCTATGTCTGATTTCATATAACCTAGAACAGCATATGGGA
Otolemur           CCTGTTAATCCAGATTTTTCTTCATGTCTAATTTCAGATAACCTAGAACAACCTACGAGA
Cynocephalus       GCTGTTAATACAAATCTGTCTCTGTGCCTAATTTCACATAACCTCGAACAACCTATGGAA
Tupaia             GCTATTAAA---GATTTACCTCCATGTCTAATTTCAGATAATCAAGAGCAT---ATGGGA
Lepus              GCTGTGAATAGAGATTTCTCTTCGTATCTGGTTCCTGATAGCCAAGAGCAGTCTATGGGA
Hystrix            GCTGTCCATGCAGATTTCTCTCCGTGTCTAATTTTAGATAACGTGGAACAGCCTATGGGA
Pedetes            GCTGTTGATGCAGATTTCTCGCCATGTCTAACTTCAAATAGCTTAGAACAACCTATGAGA
Aplodontia         NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
Sciurus            GTTGTTAATACAGATTTCTCTCCATGTCTCATTTCAGATGACTTAGAACAACCTATGGGA
Glaucomys          GTTGTTAATGCAGATTTCTCTCCATGTCTAATTTCAGATGACTTAGAACAACCTATGGGA
Graphiurus         GCTGTTGATACAGATTTTTCCCCATATCTAATTTCAGATAACCTAGAACACCCTATGGGA
Oryzomys           GCTGTTGATGCAGACTTCTCTTCATGTCTGTTCTCAGATAAGCTCAAACAACCTATGGGC
Meriones           GCAGTTGGTACAGACTTCTCTCCATGTCTGTTCTCAGATCATCTTGAACAATCTATGAGA
Mus                GCTGTCTGTGCAGACTTCTCTCCATGTCTATTCTCAGACCATCTTGAGCAATCTATG---
Rattus             GCTGTCAGTGCAGACTTCTCTCCATGTCTGTTCTCAGATCATCTTGAAAAACCTATGAGA
Scalopus           GCTGTTCATACAGATTTCTTTCCATGTCTGATTTCAGATAACCAAGAACAACCTATGGGA
Erinaceus          ACTGTTAATATAGAATCCGATTCATGCCCAAGACCAGATAACTTAGAACAACCGGTGGAA
Myotis             GCTGTTAATGCAGACTTCCCTCCATGTCAAATTTCAGATAACCTAGAACAACCTATGGGA
Tadarida           GCTGTTAATGCAGATTTCTCTCCATGTCAAATTTCAGATAACTTAGAACAATCTATGGGA
Taphozous          GCTGTTAATGCA------------TGTCAAATTTCAGATAACTTAGAACAGCCTATGGGA
Tonatia            GCTGTTAATGCAGATTTCTCTCCGTGTCAAATTTTAGATAACCTAGAACAACCTCTGGGA
Megaderma          GCTGTTAATGCAGAATTCTCTCCATGTCAAACTTCAGATAACCTGGAACAACCTATGGGA
Pteropus           GCTGTTAATGCAGATGTCTCTCTACGTCAGATTTCAGATAACTTAGAGCAACCTATGGGA
Hipposideros       GCTGTTAGTGCAGACTTCTCTCCATGTCAAATTTCAGATAACCTAGAACAACCTACGGGA
Cynopterus         GCTGTTAATGCAGATGTCTCTCCANGTCAAATTTCAGATAACTTAGAGCAACCTATGGGA
Equus              GCTGTTAACGCAGACTTTTCTCCGTGTCTAATTTCAGATAACCTAGAACAACCTATGGGA
Diceros            CCTGTTAATGCAGATTTCTCTCCGTGTCCAATTTCAGATAACCTAGAACAACCTGTGGGA
Manis              GTTGTTAATGCTGATTTCTCTCCATGTCTAATTTCAGATAACCTAGAACAACCTATGGGA
Canis              TCTGTTAGTGCAGATTTCTCTCCATGTCTGATTTCAGATAACCCAGAACAACCTATGGGA
Felis              TCTGTTAATGCAGATTTTTCTCCATGTCTAATTTCCGATAATGTAGAACAACCTATGGAA
Sus                GCTGTTAATGCAGATTTCTCCCCATATCTAATTTCAGATAACCCCGAACAACCTATGGGA
Lama               GCTGTTAATACCGACTTCTCTCCATGTCTAATTTCAGATAACCTAGAACAACCTATGGGA
Bos                GCTGTTAAGGCAGATTTCTCCCCATGTCTAATTTCAGATAACCTCGAACAACCTACGGGA
Hippopotamus       GCTGTTAATGCAGATTTCTCCCCGTGTCTAATTTCAGATAACCTAGAACAACCTATGGGA
Megaptera          GCTGTTAATGCAGATTTCTCCCCAAGTCTAATTTCAGATAACCTAGAACAACCTATGGGA
Physeter           GCTGTTAATGCAGATTTCTCCCCATGTCTAGTTTCAGATAACCTAGAACAACCTATGGGA
Tamandua           GCTGTTAATACAGATTTCTCCCCATGTCTAATTTCAGATAACCTAGAACTGCCTATGGGA
Bradypus           GCTGTTAAAACA------------TGTCTAATTTCAGATAACCTAGAACTACCTATGGGA
Dasypus            GCTGTTGATATAGACTTCTCTCCATGTCTAATTTCAGATAACCTACAACTACCTATGGGA
Chaetophractus     GCTGTTGATACTGATTTCTCTCCACATCTAATTTCAGATAACCTAGAACTACCTATGGGA
Loxodonta          GCTGTTAATACAGATTTCTCCCCATGTCTAATTTCAGATAACCTAGAACAACCTGTGGGA
Elephas            GCTGTTAATACAGATTTCTCCCCATGTCTAATTTCAGATAACCTAGAACAACCTGTGGGA
Dugong             GATGTTAATATGGATTTCTCTCCATGTCTAATTTCAGATAACCTAGAACAACCTATGGGA
Trichechus         GATGTTAATATGGATTTCTCTCCATGTCTAATTTCAGATAACCTAGAACAACCTATGGGA
Procavia           GCTGTTAGTACAGATTTCTCTGCATGTCCCATTTCAGAAAACCTAGAACAACCTGTGAGA
Dendrohyrax        GCTGTTAGTACGGATTTCTCTGCATGTCCCATTTCAGAAAACCTAGAACAACCTGTGAGA
Orycteropus        GCTGTTAATACAGGTTTTTCTTCATGTCTGATTTCAGATAACCTAGGACAACCTATGGGA
Tenrec             GCTGTCAATCCGGATCTCTCCCGCTATCTAATGTCACGTAACCCGGAGCAACCGATGGAG
Echinops           GCTGTTCATCCAGATTTCTCTCGCTATCTAATGTCACATAACCCAGAGCAGCCTATGGAG
Elephantulus       ACTGTTAATCCAGATTTCTCTCCATGTCTACTCTCAGATAATTTAGAACAACCTAGGGGA
Rhynchocyon        GCTGTTAATCCAGATTTTACTCCGTGTCTGATTTCAGATAACTTAGAACAACCTATGGGA
Amblysomus         GCTGCTGACCCAGGTTTCTCTCCGTGTCTAATTTCAGATAACCTAGAACCACCTATGGGA
Vombatus           GCCATCAGTACAGATTCATCTCCATGTTTA---------------GAACAAACTAAAGAG
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Homo	AGTAGTCATGCATCTCAGGTTTGTTCTGAGACACCTGATGAC
Pan	AGTAGTCATGCATCTCAGGTTTGTTCTGAGACACCTGATGAC
Gorilla	AGTAGTCATGCATCTCAGGTTTGTTCTGAGACACCTGATGAC
Pongo	AGTAGTCATGCATCTCAGGTTTGTTCTGAGACACCTAATGAC
Macaca	AGTAGTCATGCGTCTGAGGTTTGTTCTGAGACTCCTGATGAT
Alouatta	AGCAGTCATACATCTCAGGTTTGTTCTGAGACACCTGACAAC
Otolemur	AGTAGTCATGCTTCTCAGCTTTGTTCTGAGACACCTGATGAC
Cynocephalus	AGTAGTCATGCTTCCCAGGTTTGTTCTGAGACACCTGATGAC
Tupaia	AGTAGCCATGCTTCTCAGATTTGTTCTGAGACACCTGATGAT
Lepus	GGAAGGCATGCTTCTCAGATTTGTTCTGAGACACCTGATGAC
Hystrix	AATAATCCTGCTTCTCAGATCTGTTCTGAGACGCCCGATGAC
Pedetes	AGTGGTTGTGTTTCTCAGATTTGTTCTGAGACACCTGATGAC
Aplodontia	NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
Sciurus	AATAGTCATGTCACTCAGGTTTGTTCTGAGACTCCTGATGAC
Glaucomys	AATAGTCATGTCACTCAGGTTTGTTCTGAGACTCCTGATGAC
Graphiurus	AATACTCATGCTTCTCAGATTTGTTCTGAAACACCTGATGAC
Oryzomys	AGTGGTAATATTTTTCAGGTTTGTTCTGAGACACCTGATGAC
Meriones	AGTGGTAATATTTTCCAGGTTTGTTCTGAGACACCTGATGAC
Mus	AGTGGTAAGGTTTTTCAGGTTTGCTCTGAGACACCTGATGAC
Rattus	AGTGATAAGACTTTTCAGGTTTGCTCTGAGACACCTGATGAC
Scalopus	AGTAGTCATGCTTCTCAGGTTTGTTCTGAGACGCCTGAGGAC
Erinaceus	ACTAGTCAT---------GTTTGTTCTGAAACACCTGACGAT
Myotis	AGTAGTCCTGTTTCTCAGGTTTGTTCTGCGACACCGGATGAC
Tadarida	AGTACTCCTGCTTCTCAGGTTTGTTCTGAGACACCAGATGAC
Taphozous	AGTAGTCCTGTTTCTCAGGCTTGTTCTGAGACACCAGATGAC
Tonatia	AGCAGTCCCGCTTCTCGGGTTTGTTCCGAGACCCCAGACGAC
Megaderma	AGTAGTCATGCTTCTCAAATTTGTTCTGAGACACCGGATGAC
Pteropus	AACAGTAATGCTTCTCAGGTTTGTTCTGAGACACCGGATGAC
Hipposideros	AGTAGTCATGCTTCTCAGGTTTGTCCTGAGACACCGGATGAC
Cynopterus	AACAGTAATATTTCTCAGGTTTGTTCTGAGACACCGGATGAC
Equus	AGTAGTTGTGCTTCTCAGGTTTGTTCTGAGACACCTGATGAC
Diceros	ATTAGTTGTGCTTCTCAGGTTTGTTCTGAGACACCTGATGAC
Manis	AGTAGTCATGCTTCTCAGGTTTGTTCTGAGACACCTGAGGAC
Canis	AGTAGTCGGTCTTCTCAGGTTTGTTCTGAGACACCTGATGAC
Felis	AGTAGCCGTGCTTCTCAGGTTTGTTCTGAGACACCCAATGAC
Sus	AGTAGTCATGCTTCTCAGATTTGTTCTGAGACACCTGATGAC
Lama	AGCAGTCATGCTTCTCAGGTTTGTTCTGAGACACCTGATGAC
Bos	AGCCGTCATGCTTCTCAGGTTTGTTCTGAGACACCTGACAAC
Hippopotamus	AGCAGTCATGCTTCTCAGGTTTGTTCTGAAACACCTGATGAT
Megaptera	AGAAGCCATGCTTCTCAGGTTTGTTCTGAGACATCTGACGAG
Physeter	AGAAGCCATGCTTCTCAGGTTTGCTCTGAGACATCTGATGAG
Tamandua	AGTAGTCGTGTTTCTCAGATTTGTTCTGAGACACCTGATGAC
Bradypus	AGTAGTCATGCTTCTCAGATTTGTTCTGAGACACCTGATGAT
Dasypus	AATAGTTGTGCTTCCCAGATTTGTTCTGAGACACCTGATGAC
Chaetophractus	AATAGTCATGTTTCTCAGATTTGTTCTGAGACGCCTGATGAT
Loxodonta	ACTAGTCGTGCTTCTCAGGTTTGTTCTGAGACTCCCGACGAC
Elephas	ACTAGTCGTGCTTCTCAGGTTTGTTCTGAGACTCCCGACGAC
Dugong	AGTAGTCGTGCTTCTCAGATTTGTTCTGAGACTCCTGATGAC
Trichechus	AGTAGTCGTGCTTCTCAGATTTGTTCTGAGACTCCTGATGAC
Procavia	AGTAGTCACACTTCTCAGGTTTGTTCTCAGACTCCTGATAAC
Dendrohyrax	AGTAGTCACACTTCTCAGGTTTGTTCTCAGACTCCTGATAAC
Orycteropus	AGCAGTCATGCTTCTCAGATTTGTTCTGAGACACCTGATGAC
Tenrec	AGCAAC---GGTTCTCAGATTTGCTCGGAGACACCTGAAGAC
Echinops	GACAAT---GATCCTCAGATTTGTTCTGAGACACCTGAAGAC
Elephantulus	AGTTGTCATGCTTCTCAGATTTGTTCTGAGACACCAGATGAC
Rhynchocyon	AGTAATCATGCTTCTCAGATTTGTTCTGAAACACCTGATGAC
Amblysomus	AGTAATCATGCTTCTCAGATTTGTTCTGAGACACCTGATGAC
Vombatus	AGTACACATTCTTCTCAGGTTTGTTCTGAGACACCTGATGAC

Appendix B: Alignment of BRCA1 exon 11 amino acids 282-1152 for 57 eutherian and one marsupial mammal

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                    282                                                      341
Homo                SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQHNRWAGSKETCNDRRTPSTEKKVD
Pan                 SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQHNRWAGSKETCNDRRTPSTEKKVD
Gorilla             SLQHENSSLLLTKDRMNVEKAEFCNKNKQPGLARSQHNRWAGSKETCNDRRTPSTEKKVD
Pongo               SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQHNRWAGSKETCNDRQTPSTEKKVD
Macaca              SLQHENS-LLLTKDRMNVEKAEFCNKSKQPGLARSQHNRWTGSKETCNDRQTPSTEKKVD
Alouatta            SLQHENSSLLLTKDTLNVEKAEFCNKSKQPGLARSQHNRWAESEETCNDRQTPSTEKKVD
Otolemur            SLQHESSSLLLTKDKMNVEKAEFCNKSKQPGLARSQQSRSAQSKETCNDRHTCSPEQKVD
Cynocephalus        SLQHENSSLLRTKDRINVEKTEFCNKSKQPGLARSQESRWAESKETCNDRQTPSTEKKID
Tupaia              SLQHENSSLLLTKDRMNVEKAELCNKSQQPDLARSQQSRWTENKETCNDRQIPSTEKKVD
Lepus               XXXXXXXXXXXXXXXXXXXXKAEFCNKSKQPGLARSQQSRWAESKETCNDRQTPSTEKKVV
Hystrix             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXSQQSRWAESKERCHDRQAPGTEQKVE
Pedetes             LLQHGSSNLLVTKDRMNVEKADFCNKSKQPGLARSQHNRWAESKETCNDRQTPSTKKKLD
Aplodontia          SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAKSKETCNDRQTPSAEKKVD
Sciurus             SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGFARSQQSRWAKSKETCNDRQTPSTEKKVD
Glaucomys           SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAKSKETCNDRQIPSSEKKVD
Graphiurus          SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDRQTPSTEKKVD
Oryzomys            SLQHENSSLLLTEDRMNVEKAELYNKSKQSDLARSQRNRWAESKESCNNRQIPSAEKKVD
Meriones            SLQHENSSLLLTEDRMNVEKAEFCNKSKQSGLARSQQSRWAESKETCNDRQIPSTEKKVD
Mus                 SLQPETSSLLLIEDRMNAEKAEFCNKSKQPGIAVSQQSRWAASKGTCNDRQVPSTGEKVG
Rattus              SLQRGTRSLLFTEDRLDAEKAEFCDRSKQSGAAVSQQSRWADSKETCNGRPVPRTEGKAD
Scalopus            LLQHENSSLLLTENRMNVEKAEFCNKSKQPDLAKSQQNRWAESKETCNDRQTSSPEKRVD
Erinaceus           XXXRENSSLLLTKGKMNVEKAEFCSKSKQPGLARSQQSRWAENMETCNDRQTPSPDKEVD
Myotis              SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDRQTPSTEKRVI
Tadarida            SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLAKSQQSRWAESKETCNDRQTLSTEKRVV
Taphozous           SVQHENSSLLLTKDRMNVEKLDFCNKSKQPGLARSQQSRWAESKETCNDRQTPSTEKRVV
Tonatia             SLXXENSSLLLTEDQMSVGKAEFRHESKQPGLARSQQSRWAESKETCDDRQAPSAEERAV
Megaderma           SLQHENSNLLLTEDIMNVEKAEFCNKSKQPVLARSQQSRWANSKEICNDRQTPNTEKRVV
Pteropus            SLQHENS-LLYTKDRMNVEKTDFCNKSKQPGLARSQQNRWVETKETCNDMQTSSTEKKVV
Hipposideros        SLHYEHSSLLLTEDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDRQTPSTEENVV
Cynopterus          SLQHENSSLLYTKDRMNVEKTDFCNKSKQPGLARSQQNRWVETKETCNDRQTSSXEKKVV
Equus               SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLAKSQQSRRAESKETCNDRQAPNSEEKLV
Diceros             SLQHENSSVLLTKDRMNVEKAEFCNKSEQPGLAKSQQSRWAESKETCNDRQTPNSEKKLV
Manis               SLQHENSSLLLTKDRINVEKTEFCNKSKQPGLARSLQSRWAECKETCNDRQALSTGKKVV
Canis               SLQHENSSLLLTKHRMNVEKAEICNNSKQPGLARSQQSRWAESKETCNDRQIPSTEKKVV
Felis               SLQHENSSLLLTKGRMNVEKAEFCNESKQPGVARSQQSRWAESKETCNDRQTPSTEKKVV
Sus                 SLQHENSSLLLTKDRMNVEKAEFCNKSKQPVLAKSQQSRWAESKGTCNDRQTPNTEKKVV
Lama                SLQHENSSLLLTKDRMNVEKAEFCNKSKQPVLARSQQSRWAESKDTCNDRQTPSTEKKVA
Bos                 SLQHENSSLLLTENRLNVEKAEFCNKSKQPVLVKSQQSRWAESKGTCKDRQIPSTEKKIV
Hippopotamus        SLQHENSSLLLTKDRMNAEKAEFCNKSXQPLLAKSQQSRWAESKDTCNDRQTPSTEKKVV
Megaptera           SLQHENSSLLLTKDRMNVEKAEFCNKSKQPVSAKSQQSRWAESKDTCNDRQTPSTEKKVV
Physeter            SLQHENSSLLLTKDRMNVEKAEFCNKSKQPVLAKSQQSRWAESKDTCNDRQTPSTEKKVV
Tamandua            SLQHENSSLLLTKDRKNVEKAEFCDKSKQPGLARSQQSRWAESKETCNDRHTTSTEKKVD
Bradypus            SLQRENSSLLLTKNRMNVEKAEFCNKSKQPGLARSQQNRWAESKETRNDRQTPSTEKKVD
Dasypus             LLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARRQQSRWAESKETCNDRQTPSIEKKVD
Chaetophractus      LLQHENSSLLLTKDRVNVEKAEFCNKSKQPGLARRQQSRWAESKETCNDRQTPNTEKKVD
Loxodonta           SLQHKNSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDRQTPSTEKKVD
Elephas             SLQHKNSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDRQTPSTEKKVD
Dugong              SLQHENSSLLLTKDRMNVEKAEFCHKSKQPGLARSQQSRWAESKETCNDRQTPSTEKKVD
Trichechus          SLQHENSSLLLTKDRMNVEKAEFCHKSKQPGLTRSQQSRWAESKETCNDRQTPSTEKKVD
Procavia            SLQHENSSLLLTKDRMDVEKAEFCSKSKQPGLARSQQSRWAESTETCNGRQILRTEKKVE
Dendrohyrax         SLQHENSSLLLTKDRMDVEKAEFCSKSKQPGLARSQQSRWAESTETCNDRQILRTEKKVD
Orycteropus         SLQHENSSLSLTKDRMNVEKAEFCNKSKQPGLVRSQQSRWAESKETCNDRQTLSTGEKVD
Tenrec              SAQREDCSLLLTEDRLDGEKAGFCKESKQPGLARSQHSRWAESRGTGNDKPTRNTEEEVV
Echinops            SLQRENYSLLLTKDRLNVEKAGFCNESKQPGLARSQHNRWAESKETCNDKPTPSTEKKVD
Elephantulus        SLQHESSSLLLTKDRMNVEKAEFYNKSKQPGLARSQQSRWAESKETCNDRQTPSTEKKVA
Rhynchocyon         SLLHENSRLLLSKDRMDVEKAEFCNKSKQPGLARSQQSRWTENKETCNHRQTPSIEKKLD
Amblysomus          SLQHENSSLLLTKDRMNVEKAEFCNKNKQSGLARSQQSRWAGSKAACNDKQTPSTQTELY
Vombatus            SLLPKTSSLLPNTDRMNVEKAELCHKNKQPALGRNQESSLDESKEICSPGKTPGACERHE
                                                    ..                   .
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                    242                                                           401
Homo                LNADPLCERKEWNKQKLPCSENPRDTEDVPWITLNSSIQKVNEWFSRSDELLGSDDSHDG
Pan                 LNADPLCERKEWNKQKLPCSENPRDTEDVPWITLNSSIQKVNEWFSRSDELLGSDDSHDG
Gorilla             LNADPLCERNEWNKQKLPCSENPRDTEDVPWITLNSSIQKVNEWFSRSDELLGSDDSHDG
Pongo               LNADPLCERKEWNKQKLPCSENPRDTEDVPWITLNSSIQKVNEWFSRSDELLGSDDSHDG
Macaca              LNANALYERKEWNKQKLPCSENPRDTEDVPWITLNSSIQKVNEWFSRSDELLSSDDSHDG
Alouatta            VDADPLHGRKEWNKQKPPCSENPRDTEDVAWIMLNSSIQKVNEWFSRSDELLTSDDSHDG
Otolemur            LNTAPPYGRKEQNKEKLLCSKNPRDSQDVPWITLNSSIQKVNEWFSRSDEMLTSDDSHDE
Cynocephalus        LNADSQHGRKERNMQKPPYPESPRDTQDVPWITLNSSIQKVNEWFSRSDEILASDDSRDR
Tupaia              LNADPLCGKKKQAKQKXLCSNSPRDDQDSPWITLNSSIQKVNEWFSRSDEMLTSNDSHDG
Lepus               LNVDCLYGRKQQDKQKPPCPETSGDNQDVSWITVNSSIRKVNEWFSRSNEMLTPDDSLDR
Hystrix             LTAEPLHERKRRKKQNPPSSEAHGGTQDVPWITLNSSIQKVNEWFSRSDKAVTSDSTCDR
Pedetes             LNADPFYGRKERNKQKPPCSENPRDTQDVSWVTLNSSIQKVNEWFSRRDEMLTSDDLHDG
Aplodontia          LNADPLYERKEPSKQKPPYSESPRDTQDIPWITLNSSIQKVNEWFSRSDEMLTSDDSHDG
Sciurus             LNADPQYERKEPSKQKPPCSENSRDSQDVPWITLNSSIRKVNEWFSRSDEMLTSDDPDDG
Glaucomys           LNADPQYEKKEPSKQKHPCSENSRDTQDVPWITLNSSIRKVNEWFSRSDEMLTSDDSDDG
Graphiurus          LNTDPLHRSKEQNKQKPPCSENPSDTQDIPWITLNSSIQKVNEWFSRSNEILTSDDSHDE
Oryzomys            LNAESFCGRKKWNNQKSLCPENSRATQDVPWITLNSSIQKVNEWFSKTGEMLTSDGASDR
Meriones            SNADSLCGRKKCNNEKSLCLEDSGATQNVPWITLNSSIRKVNEWFSRTGEMLTSDSASDK
Mus                 PNADSLSDREKWTHPQSLCPENSGATTDVPWITLNSSVEKVNEWFSRTGEMLTSDSASAR
Rattus              PNVDSLCGRKQWNHPKSLCPENSGATTDVPWITLNSSIQKVNEWFSRTGEMLTSDNASDR
Scalopus            PNADPMYGRKELNKQKPPCSDSPRNSQGVAWITLNSSIRKVNEWFSRSDEILTSDESRDG
Erinaceus           LNADSLYERKELNEQISSYSSSPKDSKDISWVALN-SIQKVNEWLSRSDELLTSDDSYDK
Myotis              LDADPLNGEKEL-----PRSDHPRDSQDVPWITRSSSIQKVNEWFSRRDEILTSDGSHNG
Tadarida            LNADPLNRRKEP-----PGSNYPRDSQDVPWITRSSSIQKVNEWFSRRDEILTTGGSHNG
Taphozous           VNADTLDGRKEP-----PYSDCPNDSQDVPWITGNSSIQKVSEWFSRRDEILTSDGSHDG
Tonatia             LNADPQNGREES-----PSSDHPRDSQDVPWITRNSSIQKVNEWFSRRDETRTSNGSHGG
Megaderma           LNADPLNERKELNNQKPLCSDSPRDSQDVPWITRNSSIQKVNEWFSRRDEILTSHGSHDG
Pteropus            LNADPLNGRIELNKQKPPCSDSPRDSQDISWITRNSSIQKVNEWFSRRDEILTSDVSPDG
Hipposideros        LNTDPLNGRKELNKQKPPCSDSPRDSQVVAWITQNSSIQKVNEWFSRRDEILTSHSSCYG
Cynopterus          LNADPLNGRIKLNKQKPPCSDSPRDSKDIPWITRNSSIQKVNEWFSRRDETLTSDVLLDE
Equus               LNADPLYGREELNKQKPPRSDSPRDSQDVPWITLNSSIQKVNEWFSRSEEMLTSDDSCDG
Diceros             LNADPLYGRKELNKQKPPCSDSPRDSQDIPWITRNSSIQKVNEWFSRSDEILTSDDSHDG
Manis               LNADPLCGRKELNKQKPSCSDSPRVSQDVPWITLNSSIXKVNEWFSRSDEMLTSDDPCDG
Canis               VNADLLCGRKELNKQKPPHSDSPRDSQDVPWITLNSSIRKVNEWFSRSDEILTSDDSHDR
Felis               LNADPLCRRK-LSKQKSPCSDSPRDSQDVPWITLNSSIQKVNEWFSRSDEMLTSDDSHDE
Sus                 LNTDLLYGRNELNKQKPACSDSPRDSQDVPWITLNSSIQKVNEWFSRSDEMLTSDDSQDR
Lama                LNADRLYGSEELNKQKPACSDSPRDSQDVPWITLNSSIQKVNEWFSRSDEMLPSDDSHEV
Bos                 LNTDPLYRRKELRKQKPACPDSPGDSQDVPWVTLNNSIQKVNDWFSRSDEILTSDDSCDG
Hippopotamus        LNADPLYGRKELNKQKRACSDGPSDSQDVPWITLNSSIQKVNEWFSRSGEMLTSDDLCVK
Megaptera           LNADPLYGRKELNKQKPACSDSPRDSQEFPWITVNSRIQKVNEWFSRSDEMLTSNDSRDG
Physeter            LNADPLYGRKELNKQKSACSDSPRDSQEFPWIAVNSSIQKVNEWFSRSDEMLTSNDLRDG
Tamandua            VDADPLHRRKELKKWKSPYSENPRGTQDIPWITLNSSIQKVNEWFSRSDDILTSNDSCNE
Bradypus            VDADPLYGRKELNKQKPPCSESPQNTQDIPWITLNSSIQKVNEWFSRSDDILTSDDSHNG
Dasypus             VDADPLYGRKELNKQKPPCSESHRDTQDIPWIMLNSSIQKVNEWFSRGDDILTSDDSHDR
Chaetophractus      VAADSLYGRKELNKQKLPCSESPRDTQDIPWITLNSSIQKVNEWFSRSDDLLTSDDSHDG
Loxodonta           VNADPLYERKEVNKQKPPRSENLRDTQDIPWITLNSSIQKVNEWFFRSDGL---DVLNDE
Elephas             VNANPLYERKEVNKQKPPRSENLRDTQDIPWITLNSSIQKVNEWFFRSDGL---DVLNDE
Dugong              MNANPLYERKEVNKQKPPCSESVRDTQDIPWLTLNSSIQKVNEWFFRSDGL---DDLHDK
Trichechus          MNANPLYERKEVNKQKPPCSESVRDTQDIPWLTLNSSIQKVNEWFFRSDGL---DDLHDK
Procavia            TNADPLYGKKEGNKQKPPCSESRTDTQDIPWVTLNNSIQKVNEWFSRSDNL---SDSPSE
Dendrohyrax         TNADPLYGKKEGNKQKPPCSESRTDTQDIPWVTLNNSIQKVNEWFSRSDNL---SDSPSE
Orycteropus         MKADPLYGRKEVNKQKPPCSENPRDTEDIPWITLNSSIQKVNEWFSRSDGL---DGSHDE
Tenrec              VSADSAHGRKGVSKQKPPRQKRPRKSHDVPWKTRKSSISKVNEWFSKSHGL---GDSRDG
Echinops            KNADPVHGRKGVPKQKPPCHGSPRKSHDVPWKTRKSSIWKVNEWFSKSDGL---GDSHDE
Elephantulus        VSADLYYGIKEVNKQKSPHSESPNNNQNTPWMTLNSSIRKVNDWFSRSGGL---DGCHDR
Rhynchocyon         MNADPSYGRKEVNKQKYECSESPQDTQDIPWMTLNSSVQKVNAWFSRSDGL---DDAPDV
Amblysomus          RSAGPMHRRKEVNKLKSPWSESPGATQEIPWITLNSSIRKVNEWFSRSDGL---DESHDE
Vombatus            LNDHHLCERQGLEKPQHPESPRGNPQNCLSGTKLKSSIQKVNEWLSRSSDILASDNSNGR
                                                 .    .  : **.  *: :
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                    402                                                        461
Homo                ESESNAKVADVLDVLNEVDEYSGSSEKIDLLASDPHEALICKSERVHSKSVESNIEDKIF
Pan                 GSESNAKVADVLDVLNEVDEYSGSSEKIDLLASDPHEALICKSERVHSKSVESNTEDKIF
Gorilla             GSESNAKVADVLDVLNEVDEYSGSSEKIDLLASDPHEALICKSERVHSKSVESNIEDKIF
Pongo               RSESNAKVADVLDVLNEVDEYSGSSEKIDLLASDPHEALICKSERVHSKSVESNIEDKIF
Macaca              GSESNAKVADVLDVLNEVDEYSGSSEKIDLLASDPHEPLICKSERVHSSSVESNIKDKIF
Alouatta            GSESNAKVAEALEVLNEVDGYSSSSEKIDLLASDPHDHLICKSERVHCKSVESSIEDKIF
Otolemur            GSESHAEVAGALEVPSEVDGYSSSSEKIDLLASDPHYPIICKSERVHSKPIKSKVEDKIF
Cynocephalus        VSESNAKVAGALEVPNDVDGYSDSSEKVDLMASDPHDALICKSERIHSRPVESNIKDKIF
Tupaia              ESE----IAGAFEXPNKVDEYSGSSEKIDLMANNLHDALISKSEGIYSKPVEGNIEDKIF
Lepus               RSESNAKVAGALEVPKEVDGYSGSTEKIDLLASDSHNALICESKRVHSKPVENNIKDKIF
Hystrix             ESKSDAEEAGV---AEDPKGLDGSSEKVGLLTSSPQKAIICARERVCSKALKSDMEDKVF
Pedetes             VSESNAEVLGALEVPDEIKGHSGSSEKIDLLASDPHNALTCKSERVCAKPVESNIEDKVF
Aplodontia          V-ESNAEITGVLEILNEVDGFSGSSGKIDLLATDPYNALISKRERVCSKAVESNIEDKIF
Sciurus             GSESNAEVTGVLEIPNEVDGFSGSSEKIDLLATDPHNALMSKCERVCSKAVESNIEDKIF
Glaucomys           GSESNAEIAGILEIPNEVDGFSGSSEKIDLLATDPHNALISKCKRVCSKAVKSNIEDKIF
Graphiurus          GSESNAEVAGAL-VPNEVDRNSGSSEKIDLLASDPHNALICKSERVRSKPVESNIEDKIF
Oryzomys            RLRSPAEAAV--EE----NGCSSSSKETDSVAIHPHSALMDKSKRDC-KPVEKNIKDKIF
Meriones            RQASNAEAAVALEVSNEVDGCVSNSKKTDLVTSDPHHAVMCKSERDLSKPVKNNIKDKIF
Mus                 RHESNAEAAVVLEVSNEVDGGFSSSRKTDLVTPDPHHTLMCKSGRDFSKPVEDNISDKIF
Rattus              RPASNAEAAVVLEVSNEVDGCFSSSKKIDLVAPDPDNAVMCTSGRDFSKPVENIINDKIF
Scalopus            ESPSNIEMTGEVEVPNTVDGFSGSSEKIDLMASDPP-ALMCKSERVRTKPVESNIEDKIF
Erinaceus           GSKSKTEVTVTTEVPNAIDRFFGSSEKINLTASDPHVALIREGEGVHFKPVKNNIEDKIF
Myotis              KSESNAEVAGAVEVANEVDGYSGSGPGKITLMAHDPHGALTCESERVHSKPVESNIEDKIF
Tadarida            RFESNVEVAGAVEVPNEVDGYSGSPEKIALMACDPPDALIC--ERVSSKPLESNIEDKIF
Taphozous           RSESNMEVAGAVEVPYEVDGYSDSPEKIGLMASDPLGALLCESERIHSKPVESNIEDKIF
Tonatia             RPESDTEGADTVEAPDEVRGCPGSPENTASPAGEPHGALMCGSESVHSKPVESNIEDKIF
Megaderma           TGGSNTEEAGAAEILNEVDGYSGSSEKIALMASDPPGASICESERVYSKPVESNIEDKIF
Pteropus            RSESN-----VVEVPNEVDGYSGASEKIALKANDPHGALMC--ERVHSKLVESNIEDKIF
Hipposideros        RAESNTEVSGAVEVPLEVDGFSGSTEKITLMTSDPHDAVICESGRVHSKPLESTIEDKIF
Cynopterus          RSESN-----VVEVPNEVDGYSGASEEIALKASDPHGALIC--ERVHSKLIESNIEDKIF
Equus               GPESNTEVAGAVEVPNEVRGYSGSSEKIDLMAGDPSSALICESERVRSKPVENNIEDRIF
Diceros             GPESNTEVAGAVEVQNEVDGYSGSSEKIGLMASDPPGALICESERVHSKPVENNIEDKIF
Manis               RSESNTEVAGAVEVPNEVDENCGSSEKKDLMASDPHDALIRESKRGHSKPVESNTEDKIF
Canis               GSELNTEVGGAVEVPNEVGEYSGSSEKIDLMASDPQDAFICESERVHTKPVGGNIEDKIF
Felis               GSESNPGVAGA-EVPNVVDGYSGSSEKIDLMASDPHDALICESERVHTKPVESNIEDKIF
Sus                 RSESNTGVAGAAEVPNEADGHLGSSEKIDLMASDPHGALIRERERGHSKPAESNIEDKIF
Lama                GPESNTEVAGAVEVPNEVDGYSGSSEKIDLMASDPHGALKCENEKVHAKPVGSNIEDKIF
Bos                 GXESNNEVAGAVEIPNKVDGYSGSSEKINLMASDPHGTLIH--ERVHSKPVESNIEDKIF
Hippopotamus        GCESNTEVAGAAEVPNEIDGCLGSSEKIDLMARDPRGALIRESERVHAKPVESNIEDKIF
Megaptera           GFESNTEVACAVEVPKEVDGYLGSSEKIDLMASDPHGALIRESERVHSKPVESNIEDKIF
Physeter            GFESNPEVARAVEVPQEVDGYLGSSEKIDLMASDPHGALIRESERVHSKPVESNIEDKIF
Tamandua            GSELNAEVADASKVPNDVDRYSGSSEKIDLIASDPHNALICASEKVQSKPTESNIKDKIF
Bradypus            GSESNAEVVGALKVPNEVDGYSGSSEKIDLIASDPHNALIFAGERVQSKPTETNIEDKIF
Dasypus             GSELNAEVAGALKVSKEVDEYSSFSEKIDLMAINPHDTLQFASERVQLKPAESNIKDKIF
Chaetophractus      GSESKAEVAGALKVPNEVNGYSSSSEKIDLLASDPHNALIFASERVQSKPAESNIKDKIF
Loxodonta           GPESSAEVAGALEVPNEVH--SNSSEKIDLMASDLHGALICESERVPSKPAESNIEDKIF
Elephas             GPESSAEVAGALEVPNEVH--SNSSEKIDLMASDLRGALICESERVPSKPAESNIEDKIF
Dugong              GSESNAEVAGALEVPEEVHGYSSSSEKIDLMASDPHSALICESERVLFKPAESNIEDKIF
Trichechus          GSESNAEVAGALEVPEEVHGYSSSSEKIDLMASDPHSALICESERVLSKPAESNIEDKIF
Procavia            GSELNGKVAGPVKLPGEVHRYSSFPENIDLMASGPPG------ERIPCKPPKSNIKDKIF
Dendrohyrax         GSELNGKVAGPVKLPGEVHRYSSFPENIDLMASGPPGDLICESERIPCKPPKSNIKDKIF
Orycteropus         GSESNAEIGGALEVSNEVHSYSGSSEKIDLMASEPHVALICESERVLSKPAESNIEDKIF
Tenrec              RPESGADVAVAFEVPDEACESYSSPEKTDLMARDPPIPLLHKSARVFSKPVESNIEDKIF
Echinops            RPESDADVAGAFEVPDEARESSSSPEKTDLMVSDPHVPLLPKSEIVLSKPVESNIEDKIF
Elephantulus        -SESNVVIAGEVEVPNEVHGYSIYSEKLDLMPNNPHDTSLYESERTLSKPAENNIEDKIF
Rhynchocyon         GSESNTAITGALEVSKEVHGYSSSSEKVHTMTGDPQGASVCESERVFSKPAENNVEDKIF
Amblysomus          GSESNAEVACKFEFPKEVQGYSSSSEKMDLMANDPHDALICENERILSKPAVSNIEDKIF
Vombatus            SHEQSAEVPSALEDPDTAEGNSSVSEKTDPVADSTDDAWLHVPKRSCLRPAENNIEDKIF
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                262                                                         521
Homo            GKTYRKKASLPNLSHVTENLIIGAFVTEPQIIQERPLTNKLKRKRRPTSGLHPEDFIKKA
Pan             GKTYRRKASLPNLSHVTENLIIGAFVTEPQIIQERPLTNKLKRKRRATSGLHPEDFIKKA
Gorilla         GKTYRRKASLPSLSHVTENLIIGAFVTEPQIIQERPLTNKLKRKRRATSGLHPEDFIKKA
Pongo           GKTYRRKASLPNLSHVTENLIIGAFVTEPQIIQERPLTNKLKRKRRATSGLHPEDFIKKA
Macaca          GKTYRRKANLPNLSHVTENLIIGALVTESQIMQERPLTNKLKRKRRTTSGLHPEDFIKKA
Alouatta        GKTYRRKASLPNLSHVTENLIIGAFVTEPQIIQEHPLTNKLKRKRRVTSGLHPEDFIKKA
Otolemur        GKTYRRKASLPNLSHVTENLIIRAAATEPQITQECSLTNKLKRKRRTTSGLCPEDFIKKA
Cynocephalus    GKTYQRKTSLPNLSHVNEDLIIGAFVTEPQITQERPLTNKVKPKRRTTSGLHPEDFIKKA
Tupaia          GKTYRRKASLPNLSRVTDDLIRGAFVTEPEITRERPFTNKLKRKRRTISGLHPEDFIKKT
Lepus           GKTYHRKTSLPNLSHITEDLTIGAFAAEPLVP--CPPANKLKRKRRTSSGLQPEDFIKKV
Hystrix         GKTYQRRVSLRSSSHGAESLTVGAFVREPQLTLERSFTNKIKRKRRTTSCLHPEDFVKKA
Pedetes         GKTYRRKISLPNLSPITENLIVGAFATKPQIRQEHPLTNKLKRKRKATSFLRPEDFIKKV
Aplodontia      GKTYRRKASFPNLSHVTENLITGAWATEPQIAQERPFTNKLKRKRRTTPCLHPEDFIKKT
Sciurus         GKTYRRKASLPNLSHITENLIIGAFATEPQITQERPLTNKLKRKRRTTSCLHPEDFIKKA
Glaucomys       GKTYQRKASLPNLSHITENLIIGAFAREPQITQERPLTNKLRRKRRTTSCLHPEDFIKKT
Graphiurus      GKTYRRKASLPNLSHVPENLITGAFATEPQITQERPLTNKLKRKRKSTLCLHPEDFIKKT
Oryzomys        GKTYQRKGSFPQLNHVTE--IINTFTIEPQITQEHSFTNKLKRKRRTT-CLHPEDFIKKA
Meriones        GKTYQRKGSLPHLNHVTE--IIGTFIAEPQTTQEQPFTNKLKSKRRST-CLYPEDFIKKA
Mus             GKSYQRKGSRPHLNHVTE--IIGTFITEPQITQEQPFTNKLKRKR-ST-SLQPEDFIKKA
Rattus          GKTYQRKGSRPHLNHVTE--IIGTFTTEPQIIQEQPFTNKLKRKR-ST-CLHPEDFIKKA
Scalopus        GKTYRRKTSLPNLSHVAEYLITGTSVTEPQIVQERPFTNRLKRKRRTLPGLCPEDFIKKV
Erinaceus       GKTYGRKASLLNLSHVTEDVII----REPQVAKEPLLATKLKRKRRTDVGLCPEDFIKKV
Myotis          GKTYRRKASLPNLSHITKNLIVGASAIEPQIAQECPLTNKLKRKRRSTSGLHPEDFIKKV
Tadarida        GKTYRRKASFPNLSHISENLIIGASAIEPQVTKECPLTNKLKRKRR-TSSLHPEDFIKKV
Taphozous       GKTYRRKASLPNLSHITENLIIGAPTIQSQITQNCPLTDKLKHKRRTTSGLRPEDFIKKV
Tonatia         GKTYRRKASLPNLSHVTDRLTTGLSAPDPQITRERPFTNKLKRKRRTTPGLHPEDFIKTV
Megaderma       GKTYRRKASLPNLGHRAENLIIGASAVEPQIIQECLLINKLKRKRRTTSALHPEDFIKKV
Pteropus        GKTYRRKASLPNLSHITENLITGASAIEPQITQEYPLTNKLKRKRRTTSGLHPEDFIKKI
Hipposideros    GKTYRRKASLPNFSHTTENIIIGASAVEPQITQECPLTNKLRRKRRTTSGLHPEDFIKKV
Cynopterus      GKTYRRKASLPNLSHITENLITRASATEPQITQECPLTNKLKRKRRTTSGLHPEDFIKKI
Equus           GKTYRRKASFPNLSHITEDLIIGASAIEPQITQERPLTNRVKHKRRTSSGLHPEDFIKKV
Diceros         GKTYRRKASLLNLSHITEDLIIGASAIESQITQERPLTNKLKHKRRTTSGLHPEDFIKKV
Manis           GKTYRKKASLSHLSHVTENLIIGAFAVEPQITQERPLRNRVKRKRRTTSGLHPEDFIKKV
Canis           GKTYRRKASLPKVSHTTEVLTIGACAIEPQTMQTHPFMNKAEHKRRTTSSLHPEDFIKKV
Felis           GKTYRRKASLPNLSHTSEDLIIGACAIEPQITQAYPLTNKTKRKRRSTAGLHPEDFIKKV
Sus             GKTYRRKASLPNLSHVIEDLILGASAVEPQITQERPLTNKLKRKRRGTSGLDPEDFIKRA
Lama            GKTYRRKASLPNLTHRAEDLILGASVLEPQITQERPFTNKLKRKRRTLPGLHPEDFIKKV
Bos             GKTYRRKSSLPNFSHIAEDLILGAFTVEPQITQEQPLTNKLKCKRRGTSGLQPEDFIKKV
Hippopotamus    GKTYRRKASLPNLSHIAEDLIKGASAVGPQITQERPLTNKLKRKRRRTSGLHPEDFIKKV
Megaptera       GKTYRRKASLPNLSHIAEHLIIGASTVEPQITQERPLTNKLKRKRRSTSGLHPEDFIKKV
Physeter        GKTYRRKASLPNLSHVAENLIIGASTVGPQITQERPLTNKLKRKRRSTSGLHPEDFIKKV
Tamandua        GKTYHRKASLPNLSRIAKDLFIGAVAAEPKITQELPLTNEMKLKRRTTSGLHPEDFIKKV
Bradypus        GKTYHRKASLPNLSHIAENLFIGAIATKPKITQEHPLTKKIKHKSRTTSGLHPEDFIKKV
Dasypus         GKTYHRKASLPNLSHITRNLFIGAIAAEPKITQEHSLQNKIKRKRRTASGLRPEDLSKKV
Chaetophractus  GKTYHRKASFPNLSHITEDLFIGAIATEPKIIQEHSLTNKIKRKRRTTSCLHPEDFIKKV
Loxodonta       GKTYRRKAGMSHLSHITEDLIMGAIASEPQIAREHPFTNKLKRKRR-TSGLHPEDFIKKV
Elephas         GKTYRRKAGISHLSHITEDLIMGAIASEPQIAREHPFTNKLKRKRR-TSGLHPEDFIKKV
Dugong          GKTYRRKAILPHLSHVTEDLIIGAVATEPQIAQERPLTNKLKRKRR-TSGLHPEDFIKKV
Trichechus      GKTYRRKAILPHLSHVTEDLIIGAVATEPQIAQERPLTNKLKRKRR-TSGLHPEDFIKKV
Procavia        GKTYQRKGSLPHLSHITEDLVKGAIATQPQIAREHPLTNKLQHKRR-TSGLHPEDFIKKA
Dendrohyrax     GKTYQRKGSLPHLSHITEDLVKGAITTQPQIAREHPLTNKLQHKRR-TSGLHPEDFIKKA
Orycteropus     GKTYRRKSSLPNISHITEDLILGAIATEPQVARECPLGNKLKRKRR-TSGLHPEDFIKKV
Tenrec          GKTYRRKSSLLNSSHVTEDLVLGAAAAVPPVAQEQLLTSKLKRKRR-SFVLHPEDFIKKA
Echinops        GKTYRRKSSLLNSSHVTEDLMVGAAAAVPPIAQEHLLTSKLKR-RR-SSVLHPEDFIKKA
Elephantulus    GKTYRKKASLSNLSHVTQDLITGAVATECQTAQERPLTNKLKRKRR-TSGLQPEDFIKKV
Rhynchocyon     GKTYRRKSSLPNLNHITQDLIVGAVATGPQTAQEHPLINKLKRKRR-ISGLRPEDFIKKV
Amblysomus      GKTYRRKTSLPNLSHVTKDLMIGAVATEAQMAQERPLTNKLKRKRR-TSGLHPEDFIKKA
Vombatus        GKTYRRKSGHPNLNYVTENLFAEAVAPDSLIPLEAPKNTRLKRKGRSIADLQPEDFIRKT
                **:* ::                                . .        * ***: :
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                    522                                                     580
Homo                DLAV-QKTPEMINQGTNQTEQNGQVMNITNSGHENKTKGDSIQNEKNPNPIESLEKESAF
Pan                 DLAV-QKTPEMINQGTNQMEQNGQVMNITNSGHENKTKGDSIQNEKNPNPIESLEKESAF
Gorilla             DLAV-QKTPEMINQGTNQMEQNGQVMNITNSGHENKTKGDSIQNEKNPNPIESLEKESAF
Pongo               DLAV-QKTPEMINQGTNQMEQNGQVMNITNSGHENKTKGDSIQNEKNPNPIESLEKESAF
Macaca              DLAV-QKTPEIINQGTNQMEQNGQVMNITNSAHENKTKGDSIQNEKNPNPIESLEEESAF
Alouatta            DLAV-QKTPEKINQGTNQTERNDQVMNITNSGHENKTKGDSIQNENNPNPVESLEKES-F
Otolemur            DLAVVQKTPEKRIQGTNQVDQNSHVVNITNSGYENETKGDYVQNEKNANSTESLEKESSL
Cynocephalus        DLAVVQKTPEKINQGIDQMEQNDRVMNIINSGHENETKDDYVQKEKNANPTESLEKESAF
Tupaia              DLAVVQKTPEKINQRTDQIEHNGQVMSIANSGHENETKGDYISKEKNANPMESLEKESAL
Lepus               DLAVVPKTTAQINQGTDQTVDSDQVMNITNCGNENETEGDYIQKETNANPTESLEKDSSF
Hystrix             DLTVAQKTPEKVNQGTKQMEESSQVTNTTNNSHENETKMGNVQ--RNPNPVLSVEKESAS
Pedetes             DLTVIQKTPEKINQGTAQMGQNGQVINNTNNDLENETKNDYVLKEKNANPIESLEKESTH
Aplodontia          DLTVVQKTTENINEGTEQMEQNDQVMNITNSGQENEAKVDYVQKEKNANPIESLEKESAF
Sciurus             DLAVVQKTPEKMNQGTDQMKQNDQVMNITNSGQENETKVDNVQKEKNANPVESLEKESGF
Glaucomys           DLAIVQKTPEKINQGTDQMEHNDQVMNITNSGQENETKVDYVQKEKNANPVESLEKESAF
Graphiurus          DLTVVQKTPEKVNQETDQMEQNDQVMSITNRGHENESKNDYVQKEKNVNLVESLEKESAF
Oryzomys            DLTVIQKTPENRNQEADQIKPNGQAMGINSTGQENETKGNSLQKEKNVTPITSLGKESVF
Meriones            DLTIVQKTPENINQGTDQMEPNDQVMGITSNGQENETKNNDLQEEKTANPVGSLGKESAF
Mus                 DSAGVQRTPDNINQGTDLMEPNEQAVSTTSNCQENQIAGSNLQKEKSAHPTESLRKEPAS
Rattus              DLTVVQRISENLNQGTDQMEPNDQAMSITSNGQENRATGNDLQRGRNAHPIESLRKEPAF
Scalopus            DLEVVQNTPEKISAGTDQMDQSGQVMDVAYNGHGNETKRDYVQKEKSANPAESLEKESTF
Erinaceus           DVAIVQKTPEKIIKRPGQLDQSDQVMNIATNGHETETKSDYVQKEKNANPAESPDKESAF
Myotis              DLAVVQKTPEEIIKGTDRIEQNGHEMNITNNDHENETKGDCVQKEKNANLTESLEKESAF
Tadarida            DLAVVQKTLEKVIEGTDQIEQNGHVMSITSNCHENKTKGDYVQKEKNSNPTESLEKESAF
Taphozous           DLAAVQKTPEKIIEGTDQTEQNGSVMNITDNGHEDETKCDYGQKEKNANPAESLEKESAF
Tonatia             DLTVVQKTPEKTIEGTDQTEQNGRVMDIANSGHGNEAKGDYVQNEKSSDPTESLGEEPAF
Megaderma           DVAVVEKIPGDRIKGTDQIEQHGHVMNITNYGHENET---------NAHSTESLDKESAF
Pteropus            DLAVVQKTPENIIEETDQIEQNGHVMNSTNNGHENETKGDYVQKKKNTNPTESLEKESTF
Hipposideros        DLTVVQKTPEKIIERTHQTEQNGHVMNITDNGHGNETKGDYVQKEDNANPTESLEKESAF
Cynopterus          DLTTVQKTSENIIEGTDQIEQNGHVMNSSNDGHENETKGDYVQKKKNTNPTESLEKESAF
Equus               DLAVVQKTPEKIIEGTDQIEQNSHVMNITPNGHGNETKGDYVQNEKNAYLTESLETESAF
Diceros             DLAVVQKTPEKIIEGTDQIEQNGRVMSIANNGHENETKGDYVQKEKNANPTESLEKESAF
Manis               DLEVVQKTPEKIIEGTDQIEQNALLMNRTNNGHKNETKGDYVQKEKNANPTESLKKEPAF
Canis               ELGIVPKTPEKLIEGINQIKRDGHVINITNNGPENETEGDYVQKEKNANPTESLEKESAF
Felis               DLAIVQKTPEKLIEGTDRIGQNGHVMNRTNNGPENGTKGDYVQKEKNAKPTESLEKESAF
Sus                 DSAVVPKTPEKTIEGTDETEQNGQGMNITSKGHENETKSGNVQKEKNVNPTASLGKEPAF
Lama                DLAVVQKSPEKIIERTDQTEQNGHGMNITSNGHENETNDDYVQKEKNANPTESLEKESAF
Bos                 DLTIVPKTPEKMTEGTDQTEQKCHGMNITSDGHENKTKRDYVQKEQNANPAESLEKESVF
Hippopotamus        DAAVVPKTPEKIIEGTDQTEQ---------NGHENEMKGDYVQKEKNANPTESLEKESAF
Megaptera           DLAVIAKTPEKITEGTDQTEQNGHGMHVTSNGPETEMKDDYVQKEKNANLTESLEKQSAF
Physeter            DLAVIPKTPEKIIEGTDQTEQNGHGVNITSNGHETEMKGDCVQKEKNANLTESLEKESAF
Tamandua            DLTVVQKKPKMINQGTNQIEQNCQLMNIANSGNENETKGDFVQKEKSANPTESSEKESAF
Bradypus            DLTVVQKMPEKINQGTDQMEQNSQVINIANSGHENETKDDYVQKEKNANPTESLEKESAF
Dasypus             DLTVVQKTPEKINQGTDQMEQNDPVMNIANSGHENETKGDCVQKEKNANPTESLGKESAF
Chaetophractus      DLTVVQKTPEKINQGTDQMEQNDQVMNSANSGHENETKGDYVQKEENANPIESLEKESAF
Loxodonta           DLAVVQKIPEKINQETDHVEQNGQVMNIANGGRENETKGDYVQKEKNAIPTESLAKESAF
Elephas             DLAVVQKIPEKINQETDHVEQNGQVMNIANGGRENETKGDYVQKEKNAIPTESLAKESAF
Dugong              DLAVVQKTPEKINQETDQVEQNGQVMNIANGGHGNETKDDYVQKEKNANPTESLTKESAF
Trichechus          DLAVVQKTPEKINQETDQVEQNGQVMNIANGGHENETKDDYVQKEKNANPTESLTKESAF
Procavia            DLTVVQKASEKINQETDKVEQSGQVINIGNGGHENETKDDYVLKEKNGNPAESLKKESVF
Dendrohyrax         DLTVVQKASEKINQETDKVEQSGQVINIANGGHEKETKDDYVLKEKNGNPAESLKKESVF
Orycteropus         DLAV-QKTPEKINQENDQMEQNGQEENIADGCHENATKGEYMQKKKSANPTESLATESVF
Tenrec              DLAVVQKTPETIHQGPDPMQPKGPVQKIPDGGPGRGTKGDRVPKEKSANLAETSAKESAF
Echinops            DLAVV----EKINQGTDQTRPKGQVEHTPDGGHGHGTKGNCVQKE-SADLAESSAKESAF
Elephantulus        DLTVVQKIPEKTNQETEQMVQNGQVKNIASGGHESDTKGDYVQEEKNTNPTESLVRESDF
Rhynchocyon         DLTS-QKTPEKRNQTIYQVD-SS----IAGGGHEHETKGDCVQKEKNVSPAESLTKASAF
Amblysomus          GMKVVQKTPEKINQETNQMEQNDQVRNIVDGGHENDTKSDYVQKEKSANPAKSLAKESAF
Vombatus            DVPVIHKTPEKKNHSVDQIEQSDQVMNTANSLPEQKALGGHVGKDVQVLELFSAEKESTF
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                    581                                                      640
Homo                KTKAEPISSSISNMELELNIHNSKAPKKNRLRRKSSTRHIHALELVVSRNLSPPNCTELQ
Pan                 KTKAEPISSSISNMELELNIHNSKAPKKNRLRRKSSTRHIHALELVVSRNLSPPNCTELQ
Gorilla             KTKAEPISSSISNMELELNIHNSKAPKKNRLRRKSSTRHIHALELVVSRNLSPPNCTELQ
Pongo               KTKAEPISSSISNMELELNIHNSKAPKKNRLRRKSSTRHIHALELVVSRNLSPPNCTELQ
Macaca              KTKAEPISSSINNMELELNIHNSKAPKKNRLRRKSSTRHIHALELVVSRNLSPPNCTELQ
Alouatta            KSKAEPISSSISNMELELNVHNSKASKKNRLRRKSSTRHIHELELVVSRNLSPPNYTEVQ
Otolemur            GTKAEPISSSISNMKLELNIHNSKASKKKRLRKKSSSRHIRALELVVNKNPSPPNHTNLQ
Cynocephalus        RTKAEPISSSISNMEIELNIHNSKPSKKNRLRKMSSTRHIHALELVVNRNPSPPNYTELQ
Tupaia              RTKAEPISSSVSNMELEINNHSSEAPKKNRLRRKFSARHIRTLELVDNKSPSPPNRTELQ
Lepus               RTKVEPISSSISNMELELNVHNSKKPKKNRLRRKSSTRRVHALELVVNKKPSPPNHAELQ
Hystrix             GTNAEPSSSSINNRELELNTPLAKEPKEDRLRGTSSSRH-RP-------NPHLLDHTELQ
Pedetes             RTKAEPISISISNMELELNTHNSKAPKKNRLRRKSSTRHIHALELVVNKNPSPPNQTELQ
Aplodontia          RTKAEPISSSISNMELELNIPNSKAPTKNRLRRKSSTRHIHALELVVNKNASPPHRTELQ
Sciurus             KTKAGPISSSISNMELELNIHNSKAPKKNRLRRKSSTRHIHVLEPVVNRNTSPPHHTELQ
Glaucomys           RTKAEPISSSISNMELELNIHNSKAPKKNRLRRKSSTRYIHVLEPVVNRNTSPPHHTELQ
Graphiurus          RTKAEPISSSISNMELELNVYNSKAPKKNRLRRKSSTRHIHALELV-SRNTSPPNGTELQ
Oryzomys            TTIAKPVSSSISNLELELNVHNSEAPKKNRLRRKSSTKCVLALELV-SGNPSPPSCTEFQ
Meriones            TAKARPISNSISDLEIELSVYNSNAPKKNRLRRKASTVCALAVEPV-SRNPSSPTHAELQ
Mus                 TAGAKSISNSVSDLEVELNVHSSKAPKKNRLRRKSSIRCALPLEPI-SRNPSPPTCAELQ
Rattus              TAKAKSISNSISDLEVELNVHSSKAPKKNRLRRKS-TRCVLPLEPI-SRNPSPPTCAELQ
Scalopus            RIKAKPISSSISNMELELNIHSSKAPKKNRLRRKSSTKHIHALELVVKRNPSPPNHTELQ
Erinaceus           RNKPEPISSSISNMELELNVHSSKAPKKNKLRRKSSARHIHALEVVVNKNSSPPSHTELQ
Myotis              TSKAEPISSSISNMELELNVHSSKAPKKNRLKRKSSTRPIHALELVVNRNPSPSNHTELQ
Tadarida            TTKAEPISSSISNMELELNIHSSKAPKKNRLKRKSSTRHIYALELVVNRNPSPPNHTELQ
Taphozous           RTKAEPISSSISNMELELNINSSKAPKKNRLRRKSSTRHIYALELVVNRNPSPPNHIELQ
Tonatia             RTKAGPISSSISTVGLELNVHGSKAPRKTKRREKTAAEHTYAPGLGVSKSPSPPAHAGLR
Megaderma           RTKAEPISSSISNMELELNIHSLKAPKKNRLRRKSSTRHIHALELV-SRNPSPPNHTELQ
Pteropus            KTKAEPICSSISNMELELNIHSSKAVKKNRLRRKSSTRHIHALELVVNRNPSPPNHTELQ
Hipposideros        RTTAEPISSSISHMELELNIHSSKAPKKNRLRRKSSTRPIHALELVVSGNPRPPSQTELQ
Cynopterus          RTKVESVPNNISNVELELNIHGSKALKKNXLRRKSXTRHIHALELVVNRNSSPPNHTELQ
Equus               RTKAEPISSSIGNLELELNIHSSKAPKKNRLRRKSCTKQIHALELVVSKNPSPPNHTELQ
Diceros             RTKAEPISSSISNLELELNIHSSKAPKKNRLRRKSSTRHIHALELVVSRNLSPPNHTELQ
Manis               RTRAEPITSNISNMELELNIHSSKVLKKNRLRRKSSTRHIHALELVVNRNPSPPKHTELQ
Canis               RTKTEPMSSRISNMELELNSSSSKAPKKNRLRRKSSARHTCALEFVVNRNLNPPDHSELQ
Felis               RTKAEPISSNISNMESELNSHSSRAPKENRLRRKSSTRHMRALELVVNRNPSPPDHTELQ
Sus                 RARAEPISSSISNMELELNIHGSKAPK-NRLRRKSSTRQIHALELVVNRNPSPPSHTELQ
Lama                KTKAEPISSSISNMELELNTHSSKAPK-NRPRRKSSTRQIHALELIVSRNPSPPNHTELQ
Bos                 RTEAEPISISISNMELELNIHRSKAPK-NRLKRKSSTRKIPELELVVSRNPSLPNHTELP
Hippopotamus        RTKAEPISISISNMELELNIHSSKAPK-STLRRKSSTRQIHALELVVSRNPSPPNRTELQ
Megaptera           RTKPEPISSSIGNMELELNIHSSKAPK-NRLRRKSSTRKIHALELVVSRNPSPPNHTELQ
Physeter            RTKAEPISSSISNMELELNIHSSKAPK-NRLGXMSSSRKIHALELVVSRNPSPPNHTELQ
Tamandua            RTKGEPISSSISNMKLELNTCNSKASKKNRLRRMSSTRHMHALELVANRKPSQPNHTELQ
Bradypus            RTEGEPISSSISNMELELNIFNSKVSKKNRLKRMSSTRHIHALELVANRNPSQPNHNELQ
Dasypus             RTKGEPISSSISNMELELNILNSKASKKNRPKRMSSTRHIHALELVGSRNPSPPNHTELQ
Chaetophractus      RTKGEPISSSISNMELELNIYNSKASKKNRLRRMSSTRHIHALELVGNRNPSPPKHTELQ
Loxodonta           RTKAEPISSSISNMELELNMHNSKAPKKNRLRRKSSTRHIHALELVVNRNPSPPTHTELQ
Elephas             RTKAEPISSSISNMEVELNMHNSKAPKKNRLRRKSSTRHIHALELVVNRNLSPPTHTELQ
Dugong              RTKAEPISSSISNMELELNMHNSKAPKKNRLRRKSSTRHIHALELVVNRNPSPPTHTELQ
Trichechus          RTKAEPISSSISNMELELNMHNSKALKKNRLRRKSSTRHIHALELVVNRNPSPPTHTELQ
Procavia            KTKAEPISNSISNMELELNTHNSKSLKKNRLRKKSSSRHVHALELVVNRNPSSPPHTGLQ
Dendrohyrax         KTKAEPISNSISNMELELNTHNSKSLKKNRLRKKSSSRHVHALELVVNRNPSSPPHTGLQ
Orycteropus         RTKAEPISSSISNLELELNTHNSKASKKNKLRRKSSTRHIHALELVVNRNPSPPSHTELQ
Tenrec              RTVAEPLSSRKSSMELELPVFSSRAQ-KNRLRRKPSARHIHPLELV-NRQPSPTTHTELQ
Echinops            RTVAEPLSSRKSGMELEPTVFNAKAX-KNRLRRKPSARHIHPLELV-NRQPSPTRHTELQ
Elephantulus        RNKAEPISSSISKMELDLNTHSSVAPKENRLRRMSSTGHVHALELVVNISPRSPIHTEVQ
Rhynchocyon         RTKDEPISSSVSSMELELNMYSSIAPKKNRLRRKSSTKRICALELVVDRNPTSPTHAELE
Amblysomus          TTKAEPISSSISNMELELNMYNSKALRKNRLRRKSSSRHIHTLDLVVNRNPSPPPYTELQ
Vombatus            RTGTEPVAGSTNHGELELNSRNAKMTRKDRLRKKPSARIVRALELVVDRNPSSSNESELQ
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                     641                                                        700
Homo                 IDSCSSSEEIKKKKYNQMPVRHSRNLQLMEGKEPATGAKKSNKPNEQTSKRHDSDTFPEL
Pan                  IDSCSSSEEIKKKKYNQMPVRHSRNLQLMEDKEPATGVKKSNKPNEQTSKRHDSDTFPEL
Gorilla              IDSCSSSEEIKKKKYNQMPVRHSRNLQLMEDKEPATGAKKSNKPNEQTSKRHDSDTFPEL
Pongo                IDSCSSSEEIKKKKYNQMPVRHSRNLQLMEDKEPATGAKKSNKPNEQTSKRHDSDTFPEL
Macaca               IDSCSSSEEIKKKNYNQMPVRHSRNLQLMEDKESATGAKKSNKPNEQTSKRHASDTFPEL
Alouatta             IDSCSSSEEIKKKNYNQMPVRHSRKLQLMEDKERAARAKKSSKPNEQTSKRHASDTFPEL
Otolemur             IDSCSSSEEIKDKSSDQIPVRHSRKPGLMEDREPATGAKKSNKPNEQISKRHVSDTFPEV
Cynocephalus         IDSCSSSEEIEKKNSSQMPVRHSRKLQLMENKEPATGAKKSNKPNEQISRRHSSNAFPEL
Tupaia               IDSYSSGEE-RKKKGEQMPVGHSRKFQLEEEKEPTTGAKKNNQPNTEISERHASGVIPDL
Lepus                IDSCTSSEEM---NFDQIPVSHSRQAQVIEDTEPPTGARKN-KPSEQISKRHASDVFPEV
Hystrix              SGNSISSEEIKEKSSPQMPIRHSRTLHLTGAVEASIGARESKKPAGQVRERHAGDSFLEP
Pedetes              IDSCSSSNEIKKKCSDQMSVRQSRKLQLMEDAEPAMGAKKNNTPVEKISEKHATDAFPEV
Aplodontia           IDPCTSSEEIKKGDSNQM-------LQLLEDEEPAVGVKKSNKPNEQINKRNTNDAVPDL
Sciurus              IDSFTSSEEIKTRNSNQMLVRHGRKLQLMEDAEPATEVRKSNKLNEQINKRHTNNAFPGL
Glaucomys            IDSCTSSEEIKTRNSNQMSVRHGKKLQFMEDAEPATDVRKSNKPNEQVNKRHTNDAFPGL
Graphiurus           IDSYTSSEETQKEDSNQMSVGHDRKLQFMEDAESVTGVK-NNKPNEQISKRHINDAFPEL
Oryzomys             IDSCSSSEETKKNNSNLMPVKDIQKPQLIENTDPGPDTKENNEPNEQIRKRRASDAFPEE
Meriones             IDNFSSSEETKKNNSDQAPVRHIRKPLLTADPEPAPEAKK--ERSEQVRKRTASDAFPEE
Mus                  IDSCGSSEETKKNHSNQQPAGHLREPQLIEDTEPAADAKKN-EPNEHIRKRRASDAFPEE
Rattus               IESCGSSEETKKNNSNQTPAGHIREPQLIEDTEPAADAKKN-EPNEHIRKRSASDAFPEE
Scalopus             IDSCSSSEEMKERNSNQMPVRHSKRLQLMEDKDPATEAVKSNKPKEQI-KRFASDTLPEL
Erinaceus            IDSCSSNEEMRGVKADQMPVRHSKQLPLIEDKEPATRAFSSSKSNEQISKQFVGETFSDL
Myotis               IDSCSSSEEVKEKNSDQIPVRHSKKLQLMEGKEPAAGAKKSNKSDEQINKKLASDAFLEQ
Tadarida             IDSCSSSEEVKEKNSDQIPVRHSKKLQLMEGKEPATGAKKSNKSNEQINKKLASDVFPEL
Taphozous            IDSCSSSEEVKKRNSDQIPVRHSKEPQLVEGEEPTTRAKKN-KSNEQINKRLASDTFPEL
Tonatia              TDGCSGGEEAKIGNSGQRPARRSSKLPLEEGQEPAAGASKGDRSDAPMNKRLANDAFPEL
Megaderma            IDSCSSNEEVEKKNSDQMPARHNKNLQLIEDKEPATRAKKSNKPDEQINKRLTSDAFSEL
Pteropus             IDSCSSSEELKEKNSDQMPVRHSKKLQFIEDKESSTGAKKNNKPNETINKRLASDAFPEL
Hipposideros         IDSCSSSEEVKKKISDQVPVTHSKTLELIEDQEPANGVKKRNKPNEQINKRLTSNAFPEL
Cynopterus           IDSCSSSEELKEKNSDRMPDRHSKKLQFVEDKESATGAKKNNMPNEAINKRLSSEAFPEL
Equus                IDSCSSSEEMKKKNSDQMPVRHSKKLQLMEDKEPATGAKKSNKPNEQINKRLASDAFPEL
Diceros              VDSCSSSEEMKKKSPSQVPVRHSRKLQLTEDKEPAAGAKKSNKPNEQINKRLASDAFPEL
Manis                IDSCSSSEELK----NQIPVKHXKKLQLKEDREPASRAKKSNKPNEQINKRFTSDTFPEL
Canis                IESCSSSEEMKKQHLDQVPVRHNKTLQLMQDKEPAGRAKKSSKPGEQINKRLASHAFPEL
Felis                IDSCSSSEEMKRKSSEQMLVRHSKTLQLVENKEPAPGAKKRNKPSKQINKRLASNTFPEL
Sus                  IDSCSSSEEMKKRNSDQVPVRHSKKLHLRGDKEPTTGAKKNNRPHEQVNKRPISDAFPEL
Lama                 IESCSSSEEMKEKHSDQMPVRHRKKLQLTGDKEPTTGTKKSNKPHQQINKRLVGNTFPEL
Bos                  IDSSSSNEEMKKKHSSQMPVRQSQKLQLIGDKELTAGAK-NNKTYEQINKRLASDAFPEL
Hippopotamus         IDSCSSSEEMKKKHSCQMPVRHSKKLQFMGYKEPATGVRKSNKPHEQINKTLASGAFPEL
Megaptera            IDSCSSSEEMKKKHSSQMPVRHGKKLQFMGDKAPTTGAKKSNKPHEQINKRLTSDAYPEL
Physeter             IDSCSSTEEMKKKHSSQMPVRCGKKLQFIGDKEPTTGAKKSNKPHEQINKRLDSDTYPEL
Tamandua             IDSCSSSEEIKKKKSDQKPIRHSRTVQFMKDKETAIGAKKSNKRNEQINKRHASDAFPEL
Bradypus             IDSCSSSEEIKKENSVQKPIRHSRMLQLLKGKETPTVTKKSNKRNEQISKRHSSDAFPEL
Dasypus              IDSCSSIEEIEKINSNQKPIRHNRMLQLTKEKETTTGAKKNNKPNEQISERHASDAFLEL
Chaetophractus       IDSCSSTEEIEKINSNQKPIRHNRMLQLMKEKENTTGAKKNNKPNEQISERHASDVFPEL
Loxodonta            IDSWSSSEETKKKSSEQKPIRHNRNLQLMKNQETATGAKKSNKPKEQISKRHGADSYPEL
Elephas              IDSWSSSEETKKKSSEQKPIRHNRNLQLMKNQETATGAKKSNKPKEQISKRHGADSYPEL
Dugong               IDSWSSSEEIKK-SSEQKPVRHNRNLQLMKNQETTTGAKKSNKPKEQISKRHASDAYPEL
Trichechus           IDSWSSSDEIKK-SSEQKPVRHNRNLQLMKNQETTTGAKKSNKPKEQISKRHASDTYPEL
Procavia             IDSWSGSEEMKKTSSEQKPVRHNINLQLMKNQETTTGAKKSNKPKEQINKRHTSNPYPEL
Dendrohyrax          IDSWSGSEEMKKTSSEQKPVRHNINLQLMKNQETTTGAKKSNKPKEQINKRHTSNPYPEL
Orycteropus          IDSWPSSEELKKKSSEHKPIRQNTNLQLMKDQEATTGAKKSNKPNEQISTGHASDIFPKL
Tenrec               ISSWPSSEELKKEESEPKPIRRSRHLKRER-------AKKNDKPNGERGKKHAPDTFPDR
Echinops             ISSWPSSEELKKEESEPKPVRRSRNLQLTKDQEMAIGAKKNDKPNEERGKKHAPDTFPER
Elephantulus         IDGWSSSEE-TKKHSEHKPVRPSRNVSVTTNQETETGSKKNNKPNEQMSKRHATDTSPGH
Rhynchocyon          IDSWPSSEE-REKCSEFNSVRHSRTFQLMKGQETEIGDQKNNKQNEQISKKHATDTSPKR
Amblysomus           IDSWPSSEEINETSSEQKPTRHSRNLHLMKEQETATGTKNSNKPNEQISKRHATYTFSEL
Vombatus             IDSYPSSEEIKGTNSEQKQIRRSRRLRLLSE-EIVVGAKKAHKPDDQAEESCISEVFPEL
                          . :*
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                     701                                                        760
Homo                 KLTNAPGSFTKCSNTSELKEFVNPSLPREEKEEKLETVKVSNNAEDPKDLMLSGERVLQT
Pan                  KLTNAPGSFTNCSNTSELKEFVNPSLPREEEEEKLETVKVSNNAEDPKDLMLSGERVLQT
Gorilla              KLTNAPGSFTNCSNTSELKEFVNPSLPREEKEEKLETVKVSNNAEDPKDLMLSGERVLQT
Pongo                KLTNAPGSFTNCSNTSELKEFVNPSLPREEKEEKLGTVKVSNNAKDPKDLMLSGGRVLQT
Macaca               KLTKVPGSFTNCSNTSE-KEFVNPSLSREEKEEKLETVKVSNNAKDPKDLILSGERVLQT
Alouatta             RLTNIPGSFTNCSNTNEFKEFVNPSLPREQTEEKLETVKLSNNAKDPKDLMLSGESVLQI
Otolemur             ALTNISSFFTNCSGSNRLKEFVNPSLQRKKTEENLETIQVSNSTKGP---VLSGERVLQI
Cynocephalus         RLTNVPVFFANCSSSNKLQEFIDPSLQREEIEENLETIHVSNSAKDPKDLVLSGEKGLQT
Tupaia               KLTNIPGFFTNSSSSNKLPEFVHRSLQREK-EENRETIQISSST---KDLVLRGERGLQD
Lepus                KLTNIPGVFTNCSSSNKLQESVDPSLQRREIEENLDTVQVPNSAIDPKDLLLCGERGLQT
Hystrix              RLARLP-AFTNSSSPDNLKEFVNLSAQTEEMEENPETVQVSESTRDSKGPVLSGEKGVQT
Pedetes              KVTNIPGFLNNCSNSNKPEEFVSPGFQREEIEENLETIQVSNSTKDPKNLVLSAEKGLPP
Aplodontia           KLTGSSGLFTNRSSSSKLKECVSPNLQKEGTEENVEIIQVSNSTRDPKDMVLSGERGLQN
Sciurus              KLKGISGLFTNCSSSSKVEEFVNPNLQEDETEENLK----SNDTKDPKDMVLSGERVLQT
Glaucomys            KLTGISGIFTNCSSSSKVEEFINPNLQKEGTEENIEIIQVSDNTQDPKDTVLSGERVLQT
Graphiurus           TLTNKPGLFTNCSGSNKLKEFVNPGLQKEEIEENLEAIQVSTSTKDPKDLVLSEEKGLQT
Oryzomys             KCTNIPGLLTSCPSSNKPQGPVTPSPQRKEVE-KLETSQMSGSTKDLKDLVLGGEQGLST
Meriones             K-------LTSTDSPSDPEGPVKPSPQRKEIE-KLETSKMPDNTKELKDLVLGGERCLST
Mus                  KLMNKAGLLTSCSSPRKSQGPVNPSPQRTGTE-QLETRQMSDSAKELGDRVLGGEPGKTT
Rattus               KLMNKAGLLTSCSSPRKPQGPVNPSPERKGIE-QLEMCQMPDNNKELGDLVLGGEPGKPT
Scalopus             NSTHVPGFLSNYSSSNNLEEFSNPSLQREELEENLGTNQVSNNTKDPKDPILSGQRDLQA
Erinaceus            NLTNIPGFLTSCSSSNKHQECINPNLQREVLGESRGTIQVCNNTKNPKDLIVSGKRGLQI
Myotis               NLTNMPGVFTNGLSSNKLNEFVDPNLQREETEENLGAVQMSNSTKDLEDLTLSGGRSVQI
Tadarida             NLTNIPGFLSNDSSSNKLKEFVNPNLQREEITENLGTVHMSNSTKDLKDLILSGGRSLQT
Taphozous            NLKNIPGFFTNGSSSNKLQEFVDPNLRREEVEENLGTIQVSDSTKDLKDLILSGGRSLQT
Tonatia              NLTSVSAVFTNGSGSTKLKECVDSNPQGEDTEENRGTVQVSSSTKDLKDLIFSGGRSLQT
Megaderma            NLTNTPGFVTNSSNSDKLKEFVNPSLQREEIEEHLGTIKVSNSTKDPKDLILSGGRGLQT
Pteropus             NITNIPGFFTNGSSSNKLQEFVNPSLQREEIKENLGTIQVSNSTKDPKILIFGEGRGSQT
Hipposideros         NLTNIPGIL-NRSSSNKLQEFVNPSLQREEIEESLGTIQVSNSTKGLKDLISNGGRGLQT
Cynopterus           NITNVPGFFTNGSSSNKRQEFVNPSLQGEEIKENLRTIQVSNSTKDPKILIFGEGRGSQT
Equus                KLTNIPGFFTNCSSSNKLHEFVNPSLQREEIEQNLGANRLSNSAKDPKDLILSGGKCLQA
Diceros              KLTNVPGFFANCSSSNKLQEFVNPSLQREDIERNLGAIQVSNSTKDPEDLILSGGRGLQA
Manis                NLTNIPGFFSKCSSSNKLQEFVDPSLQREEIENNLETIL----TKDPKDVILHRG-GLQT
Canis                TLTNVSGFFANYSSSSKPQECINPGLRREEIEESRRMTQVSDSTRDPKELVLSGGRGLQT
Felis                NLTNIPGVFTNCSSSNTLQEFVNPGIQREELEESRGTIHVSDRTRDPKALVSSGGRSLQT
Sus                  NLTNVPVSITNCSNSNKLQESVSPNLQREE---NLGTIQVSNSNKDPKDVMLSGGKGFQI
Lama                 NLTNTPGFFTKCSSSNKLQEFANPSLQREE---NPGAIQVSNSTKDPKVLILSGGRGLQI
Bos                  KLTNTPGYFTNCSS--KPEEFVHPSLQREE---NLGTIQVSNSTKDPKDLILREGKALQI
Hippopotamus         NVTNIPGFFTNCSSSSKLQEVVNPGLPREE---NLGTIQVSNSTKDPKNLILSRGKGLQI
Megaptera            NLTNIPGFFTHCSSSNKLQEFVNPSLQREE---NLGKIQVSNSTKDPKDLTLSGGKGLQI
Physeter             NLTNIPVFFTHCSSSNKLQEFVNPSLQREE---NLGTIQVSNSTEDPKDLTLSGGKGLQI
Tamandua             NLTNVTGFPTKCSNSDKLQEFVNSSLQGEAAE-NLETIQVSDTTMDPEGLVLSEGKNLQT
Bradypus             NLTNVTGFLTKCSSSDKLQEFVNSSLQGEVAE-NLETIQVSDSTRDPGALVLSGGKGLQT
Dasypus              K--NVTDFLPKCSSSDKLQKF-NSSLQGEVAE-NLETIQVSDSTRDPEDLVVSGEKCLQT
Chaetophractus       KLTNVTDFLPKCSNPDKLQEFVNSSLQGEVAE-NLETIQVSDTTRNPEDLVLSEGKSLQT
Loxodonta            HLTTTAGFITKCSSSDNLQEFVNPSLQGEKTEENLETIQVSNITKEPKDLVLNGGRDLQT
Elephas              HLTTTAGFITKCSSSDNLQEFVNPSLQGEKTEENLETIQVSNITKEPKDLVLNGGRDLQT
Dugong               NLTSTTGLITNCSSSHNYQEF-NPSLQGEEIEENLGTIQVSNRTRDPEDLVLNGGRGLQT
Trichechus           NLTSTTGLITNCSSSHNYQKFVNPSLQGEEIEENLGATQVSNRTRDPEDLVLNGGRGLQT
Procavia             NLTSTAGFITVCSSSDNLQEPVNPSLQGEEIEENLATVQMSNTAKEPEDLELNGGRVLQT
Dendrohyrax          NLTSTAGFITACSSSDNLQEPVNPSLQGEEIEKNLATVQMSNTAKEPEDLELNGGGVLQT
Orycteropus          NLTNITGFITNCSSSDNLQEFVNPSLQEEEIKENLGTIQVSDSTRDPTDEVLNR-RGLQT
Tenrec               KSTSTTDLIANCSVSGSLHGAVCPGLPGAKQTEKRGAVQVSNSARDPKDEVLGRARGLQT
Echinops             NLTDTTDLITTCSFSGNLQASVCPSLPGANLKEKLGTVQVSNGTRDPKGEVLGRARGLQT
Elephantulus         NITG---FITDCSNTSSLQECFNPRLQGEAVEDNFGPVQVSNSIKDPKDQVLNRGRLQHT
Rhynchocyon          NITG---FITNCSNTDNLQEFVNPRFEGEEIA--VGPIQVLNSTKDPGTQVLSKERGLHT
Amblysomus           NITNRTDFITNCPRSDNLQELVNPSLQGEEREEKSETMQVYDNTKEPEDQVLSGRRDLQM
Vombatus             KIGNVPACATDSLTTDRDQVLASCSFTEERDERSLEAIPSSKDQD----LPLNGGEGLQG
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                    761                                                        820
Homo                ERSVESSSISLVPGTDYGTQESISLLEVSTLGKAKTEPNKCVSQCAAFENPKGLIHGCSK
Pan                 ERSVESSSISLVPGTDYGTQESISLLEVSTLGKAKTEPNKCVSQCAAFENPKGLIHGCSK
Gorilla             ERSVESSSISLVPGTDYGTQESISLLEVSTLGKAKTEPNKCVSQCAAFENPKGLIHGCSK
Pongo               ERSVESSSISLVPGTDYGTQESISLLEVSTLGKAKTEPNKCVSQCAAFENPKELIHGCFK
Macaca              ERSVESSSISLVPGTDYGTQESISLLEVSTLGKAKTERNKCMSQCAAFENPKELIHGCSE
Alouatta            ERSVESSSILLIPGTDYGTQESISLLEVSTLGKAKTEPNKCVSQCAAFENPKELIHGCSK
Otolemur            ERSIKSTSISLVPDTDYGTQDSNSLLKVKVLRKVKTAPNKHASQGTATENPKELIHGCSK
Cynocephalus        ERSVESTSISLVPDTDYGTQDSISILEANILGKAKTAPSQHANQCAAIENPKELIHGCPK
Tupaia              VRSAESTSISLVPDTDDNTQDSISLLDANPLRKAKTAPNQCVNQSATTENPKELIHSCSK
Lepus               ERSAESTSISLVPDTEYGTQDSISLLGANTLGKAKTAANGHVSESTTIGNPKELSHDCLK
Hystrix             ERSMESTSISLVPDTDCGTQDSVSLLEADSLRKARRASHQCMAQYVAVAKPKELLPACSE
Pedetes             ERSTESTSVSLVPDTDYDTQDSISLLETNTLRKAKTMSNQCMTQYVAIEHPKELSHSCSK
Aplodontia          ERSAESTSISLVPDTDYDTQDSISLLEANTFGKARTASNQHVTQFVAVKNPKEFIHGNSK
Sciurus             ERSAESTSISLGPDTDYGTQDSISLLEANTFGKARTASNQHVTQYVAIENPKD---GLFK
Glaucomys           ERSVESTSISLVPDTDYGTQDSISLLEANTFGKARTASNQHVTQYVAIENPKEFVHGHSK
Graphiurus          ERSTESTSMSLVPDTDYGTQDSISVLQADTLGKARTASNQCVTQYEAIENPKELIHG-SK
Oryzomys            ERSEESTSVSLVADTEYDTQNSVSLLEANTVRYAKTGSSQCLTQFVASETPKDLAHG-SN
Meriones            ERSEESTSVSLVPDTDNDTQNSVSVLDANTVRSAKTGSIQCLTQFVASENTKELVYG-SK
Mus                 DRSEESTSVSLVPDTDYDTQNSVSVLDAHTVRYARTGSAQCMTQFVASENPKELVHG-SN
Rattus              EPSEESTSVSLVPDTDYDTQNSVSILEANTVRYARTGSVQCMTQFVASENPKELVHG-SN
Scalopus            ERSGESTNISLVPETDFGSQDSVSLLEIDILGKAKKVPNQCASLCTKIENSKELIHSCSK
Erinaceus           ERSVESP----VENTDYGSQDSISLLETDTLGKAKKTPNQCVSLCVATETPKELSHSCSK
Myotis              DRSKESTNIVLVPETDYGTQDSVSLLEPDIPGKAKTAPNQCGDLCAAVKNPKELIRGCSK
Tadarida            DRSMESTNILLVPETDYGTQDSISLLEPDTPGKAKKAPNQYAGLCAEIKNXKELIHGCSN
Taphozous           DRSMESTNILLVPETDYDTQYSISLLEPDTPGKAKTAPSQHASLCAAIENPKEFNHGCSK
Tonatia             DRSVESPNIXLVPETDCDTQDSVSLLAPDTPGKAETAPGQRVGGCAAAGSPKELIRDCSK
Megaderma           DRSMESTSISLVPDTDYGTQASMSLLEPDTPGKVKTAPNRRAGVCAAIENPKEIIHGCSK
Pteropus            DRSTESTSILLVPETDYGTQDSISLLEPDIPERVKTAPNHH----AAIKNPRELIHGCSE
Hipposideros        GQSMESTSILLVPDTDYGSQDSMSLLEPDTPGKAKTAPNQHVGVCTAVENPEELIHGGSN
Cynopterus          DRSTESTSILLGPETDYGTQDSISLLESDIPGRAKTAPNQHADLCAAIENPRELIHDCFK
Equus               ERSVESSGISLVPDTDYGTQDSISLLEADTLGKAKTAPNQCANLCAAIENPKELTHDCSK
Diceros             ERSVESTSISLVPDTDYGTQGSISLLEADTLGKAKTAPDQRASLCAAIENPKELIHDCSK
Manis               ERCVESNSISLVPDTDYGTQDSISLLEADTLGKTKTAPNQCASLCAAIENPKELTHCCAK
Canis               ERSVESTSISLVLDTDYGTQDSISLLEADTLRKAKTVSNQQANLCATIENPKEPIHGCSK
Felis               ERSVESTSISLVPDADYGTQDSISLLEADTLGKAKTAPNQRVSLCAAIENPKEAIRGCSK
Sus                 ERSVENTSISLVPDTDYGTQDSISLLETDTLGKAKTTPNQHVRLCAATENPKELSLGCSK
Lama                ERSVENTSISLVPETDYDTQDSVSLLEADTLGKAKTAPNQCVSLCAATENPKELIHSCSK
Bos                 ERSVESTNISLVPDTDYSTQDSISLLEAKTPEKAKTAPNPCVSLCTATKNLKELIHRDFK
Hippopotamus        ERSIESTSISLVPDTDYGTQDSISLLEADTLGKAKTATNQRVGLCAATENPKELIHGYSK
Megaptera           ERSVESTGISLVPDTDYGTQDSISLLEADTLGKAKTAPNQHVSLCAAIESPKELIHGCSK
Physeter            ERSVESSSISLVPDTDYGTQDSISLLEADTLGKAKTAPNQHVSLCAAIESPKELIHGCSK
Tamandua            ERSVESTSISLVPDTDYGTQDSISLLEAATLGKAKAAPNQHVSLCAAVGNATELVHGCSK
Bradypus            ERSLESTSITMIPETDYDTQDSISLLEADTLGKAKAAPNQHVSQYAAIGNATKLFHGCSK
Dasypus             ERSAESTGISVVPDTDYGTQDSISLLEADTLGKAKTALNQHVSQYVAIRNATELSHGCSK
Chaetophractus      QRSAESTSISVVPDTDYGTQDSVSLLEADTLGKAKTALNQPMSQYAAIKNATELSHGCAK
Loxodonta           KKSIESTNISVIPDTVYGTQDSVSLLGADTPGKAKTAPNRCASQCTAIENPSELTNSCPK
Elephas             KKSIESTNISVIPDTVYGTQDSVSLLGADTPGKAKTAPNQCASQCTAIENPSELTNSCPK
Dugong              EISVESTSISVIPDTDYGSQNSISLLEADTLRKAKTAPNQCASQCAAIENPNELIHGCPK
Trichechus          EISVESTSISVIPDTDYGSQNSISLLEADTLRKAKTAPNHCASQCAAIENPNELIHGCPK
Procavia            KRSVESTSTSVIPDADCGAQDSISLLEADTLGKAKTAPNQGAGQCSAIENPNELIHGSPK
Dendrohyrax         KRSVESTSTSVIPDADCGAQDSISLLEADTLGKAKTAPNQGAGQCSAIENPNELIHGSPK
Orycteropus         ERSVENTSISVKPDTDYSTQDSILLLKANSLRKAKTAP----SQCAAIENPNKLSHGFPK
Tenrec              ARSVESTSFSLIPAAADGTPGGVSIMEAGSRGQAQTAPDPCARQCTATDNPSESAHGLSR
Echinops            ARSVESTSVSLIPDADDGPQGTISIMEAGNRGEAQTAPGECARQCAATENPNRSVQGLSK
Elephantulus        GKCVESTSISVLSDTDYGTQNSISLLEAGTLGKAETAPDQCASHCAAMENSKKHVHDFPK
Rhynchocyon         GNYVESTSISVIPDTDDGIQNSTSLLEAGTLEKAETALTQCASHCATILNPNTHVHGFPK
Amblysomus          ERSVESTSVSVIPDTDHGTQNHTSLPEAGTLGKAETAPNQCTSQCKAIENPNQLIHGCP-
Vombatus            ERAPGSLEALEVPDTDWDTQDSTSLFPADTPNKAG--PSPHRSHSEIMETPKELLDGCSK
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                    821                                                        880
Homo                DNRNDTEGFKYPLGHEVNHSRETSIEMEESELDAQYLQNTFKVSKRQSFAPFSNPGNAEE
Pan                 DTRNDTEGFKYPLGHEVNHSRETSIEMEESELDAQYLQNTFKVSKRQSFALFSNPGNPEE
Gorilla             DTRNDTEGFKYPLGHEVNHSRETSIEMEESELDAQYLQNTFKVSKRQSFALFSNPGNPEE
Pongo               DTRNDTEGFKYPLGHEVNHSQETSIEMEESELDTQYLQNTFKVSKRQSFALFSNPGNPEE
Macaca              DTRNDTEGFKYPLGSEVNHSQETSIEIEESELDTQYLQNTFKVSKRQSFALFSNPGNPEE
Alouatta            DTRNGTEGLKYPLGPEVNYSQETSIDMRESELDTQYLQNTFKVSKRQSFALFSNPGNPEK
Otolemur            DTGNDTEGYKDPLRHEINHIQKISMEMEDSELDTQYLQNTFKFSKRQSFALFSNLG---K
Cynocephalus        GTRNDTEDFKDPLRCGVDHIQKTSIEMQESELDTQYLQNIFKVSKRQSFALFSNPGNPEK
Tupaia              TTRN--EGFKDPLKSEVNHIQEMSVEMEESELDTQYLQNTFRSSKRQSFALSSNPGNPEK
Lepus               DTGNDPDNCKDPLRSEVD--QETSVEMEESEFDTQYLQNTFMGSKRRSFALCSKPGDPEK
Hystrix             DTGNGTDSLNDPLRCGGSHIQEANIEMEDSELDTQYLQNTFQASKRQSFALFSNPGNSKK
Pedetes             DTRNDTKGFKDALRREVNHIQETNTEMEESELDTQYLQNTFQASKRQSFALFPNSRNPEK
Aplodontia          DTRNDTEDIKDSLRHEVNHLQETNIEMEESELDTQYLENTFQFSKRQSFALFSYPGKPEK
Sciurus             DTRNDP----DSLRCEVNHIQETNVEMEESELDTQYLENTFQVSKRQSFALFSNQGNLEK
Glaucomys           DTKNDPEGFKDSLRCEVNHIQETNVEMEESELDTQSLENTFQVSKRQSFALFSNPGNLEK
Graphiurus          DTRNDTEGFKDSLRCEVNHIQETNAEMEESELDTQYLQNTFQASSRQSFALFSNSG---K
Oryzomys            NAGSSTECVKHQLRHELSHIQET-VEIEEGELDTQYLQKTFQVSNRQTFTLFSKPGDPQK
Meriones            DAGSDTECFKHPSKHELNHIPET-VEMEGSELDTQYLQNTFQVSKRQSFALFSKPRSPLN
Mus                 NAGSGTEGLKPPLRHALNLSQEK-VEMEDSELDTQYLQNTFQVSKRQSFALFSKPRSPQK
Rattus              NAGSGSECFKHPLRHELNHNQET-IEMEDSELDTQYLQNTFQVSKRQSFALFSKLRSPQK
Scalopus            DTRNDTQGCKDPLKYEVNHTQEIRIEMEENELDTQYLQSTFKASKRQSFALSSHPGNSEK
Erinaceus           DTRNDTEGFRDSLRCEVDHTQETSTELEESELDTQYLQNTFKVSKRRSFALFSSPENSEK
Myotis              DIRNDREGFKDLLRCEVNHTQETSIEVEESELDTQELQNTFKVSKRQSFALFSN---PEK
Tadarida            DNRNDREDIKDLLRPEVNHXXXXXXXXEESELDTQYLQNTFKVSKRQSFALFSN---PEK
Taphozous           DTRSDTEGVKDLLRCEINXTXXXXXXXXXXXXXXXXXXNTFXXSKRQSFALFSNSENPEK
Tonatia             DT----EGVKDLPRCEVQETXXXXXXXXXXXXXXXXXXXXXXXXXXXXXALCSNPGNPGK
Megaderma           DTRNDTGDFKDPLRGEVNHTXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXSNPGNPEK
Pteropus            DTRNDAEGFKDPLRREVNYXXXXXXXXXXXXXXXXXXXXXXXXXXXXX---XSNPGNLEK
Hipposideros        DTRNDTESFKDSLRHEVNHGQETSIEMEESELDTQYLQETFKVSKRQSFALFSNPRNQRK
Cynopterus          ETRNDTESFKDPLRHEVNSTXXXXXXXXXXXXXXXXXXXXXXXXXXXX---XSDPGNLEK
Equus               DTRNDTQGVKDPLRREVNHTQETSIEMEESEFDTQYLQNMFKVSKRQSFALFSNPGSPEK
Diceros             DTRNDTEGLKDPLRCEVNHTQETSIEMEESELDTQYLQNTFKVSKRQSFALFSNSGNPEK
Manis               DIRNDTESFKDLLRHEDNHTQETSIGTEENKLDKQYLQNTFRVSKHQSFAQFSNMGNPEK
Canis               DTRNDTEGFVVPLTCKDNHTQETSIEMEESELDTQCLRNMFKVSKRQSFALFSYPRDPEE
Felis               DTRNGTESFTDPLRREDXHTQETSIEMEENELDTQWLYNTFKGSKRQSFALFSNPGNPEK
Sus                 GVRNDTGDFKDPLAHDVNHTQEASIEVEENELDTQYLQSMFKVSKRQTFALFSNPANPEK
Lama                DTRNGTAGFKDPLGCDVNHTQEASMEVEESELDTQYLQNTFKVSKRQTFALFSNPGDSEK
Bos                 DTKNNTEGFQDLLGHDINVIQETSREMEDSELDTQYLQNTFKASKRQTFALFSNPGNPQK
Hippopotamus        DTRNDMDGVQHPLGQDVNHTQDASIEVEDSELDTQYLQNTFRVSKRQTFALFSNPGNPGK
Megaptera           DIRNDTEDFQDPLGHHVNHIQEASAEMEENELDTQYLQNMFRVSKRQTFVLFSNP---EK
Physeter            DIRNDTEDFKDPLGHHVNHIQEASTXXXXXXLDTQFLQNMFKVSKRQTFALFSNPENPEK
Tamandua            DTRNDTEDFKDSLRHEVNHTQGTVIEKEESELDTQYXXXXYKISKRQSFALYSNS---EK
Bradypus            DTRSDTENFKDPLRHEVNHTQETFVEMEESELDTQYLQNTFKISKRQSFALFSNP---EK
Dasypus             DTRNDTEDFKDSLRHEVNHTQGTNVEIEESELDTQYLQNTFKISKRQSFALFSNP---EN
Chaetophractus      DTRNDTEDFKDPLRHEVTHTQETSVEMEESELDTQYLQNTFKISKRQSFALFSNP---EN
Loxodonta           DTRNDTEGFKDLLRCEASHIQETCIEIEESELDTQYLQSTFKVSKRQSFALFSNP---EK
Elephas             DTRNDTEGFKDLLRCEASHIQETCIEIEESELDTQYLQSTFKVSKRQSFALFSNP---EK
Dugong              DTRNDTEDFKDLLRCEVNHIQETCVEMEDXELDTQYLQSTFKVSKRQSFALFSNP---EK
Trichechus          DTRNDTEDFKDLLRCEVNHVQETCIEMEDSELDTQYLQSTFKVSKRQSFALFSNP---EK
Procavia            DTRNDIEGFKDPLRCKVNPIQEICVEMDENELDTQYIQSTFKVSKRHSFALFSNP---EK
Dendrohyrax         DTRNDIEGFKDPLRCEVNPIQEICVEMDENELDTQYIQSTFKVSKRHSFALFSNP---EK
Orycteropus         DTRNDIEGFKDLFRGEDNHVQETYIEMEESELDTQYLQNTFKVSKRQSFALFSNP---EK
Tenrec              DTRNSTEGFADLLTHGVPHIQETCTEMEESELDIQSLQNMFKVSKRQSFALSSNP---EK
Echinops            DTRNNREGSEDLLTHDVNHLQETCTEMEESELDIQSLQNTFKVSKRQSFALSSNP---EK
Elephantulus        DTGNDTKGLKDSLKCDASHSKDTYMEMEDSELDTQYLQHTFKVSKRQSFSLFPNP---ER
Rhynchocyon         DPANDTEGVKDLLKCNPNHLQDTCIEMEDSELDTQYLQNTFKVSKRQSFTLFPNP---EK
Amblysomus          --RNDTEGFKDLLKHEVKHNQETCIEMEEGELDIQYLQNTFKVSKRRSFALFSNP---EK
Vombatus            NTESDEEDLRSLMRQEVKNASKTTTEMEDSELDTQYLQNTFKRSKRQSFALRSSP---RQ
                                                                        .      .
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                    881                                                        940
Homo                ECATFSAHSGSLKKQSPKVTFECEQKEENQGKNESNIKPVQTVNITAGFPVVGQKDKPVD
Pan                 ECATFSAHCRSLKKQSPKVTFEREQKEQNQGKNESNIKPVQTVNITAGFPVVCQKDKPVD
Gorilla             ECATFSAHSRSLKKQSPKVTFECEQKEENQGKNESNIKPVQTVNITAGFPVVCQKDKPVD
Pongo               ECATFSAHSRSLKKQSPKVTFECEQKEENQGKNESNIKPVQTANITAGFPVVCQKDKPVD
Macaca              ECATFSAHSRSLKKQSPKVTSECEQKEENQGKKQSNIKPVQTVNITAGFSVVCQKDKPVD
Alouatta            ECATFSACSRSLKKQSPKVTPECEQKEENQGEKESNIELVETVNTTAGFPMVCQKDKPVD
Otolemur            ECATVCAQSASLRK-GSKVILECEQIE-NPGMKEPKIKHIQGNNINTGFSVVCQKDKTDD
Cynocephalus        ECATVYAHSRLLRKQSPKVTPECEQKEENEGNKESKIKHIQAVNTTVGFSVLCQNVKPGD
Tupaia              EH--VCV------KESL---------------KESNIQHIQAVST-----MVFQKDKLGD
Lepus               ECAAVCTRSNSSRKQSPEVTLEREQKES-QRKEEWKISHVQAADSTVGFPVVCQKEKAGD
Hystrix             ESTTVCAHSESFKKQNPEVIPECEQTEENWGKKVPKISCVQE-SA----PLVSQRDQPGT
Pedetes             EC----AHSMSLRKQSTKVTLEYEQKEENQGKEESKIKPAQEVNTTVGFPVVCQEDKPCA
Aplodontia          ECSAVCTPSKSFQKQSSEVTLECEQKEENQGKKELKIRHVQAINATMGFPVACQKDKPGD
Sciurus             EYAVIYTPSKSLRKQSPEVIIECEQKEENWEKKESKIRHVQAVNATMGI-------KLDR
Glaucomys           ECAANYTSSKSLRKQSPDMTLECEQEEENWGKKESKIRHVQAINATM----VCQKSKPDD
Graphiurus          ECTTVYASPKPLRKQSPKVSLEYEQKKENKEKKEAKITHVQAVNTPTDFPMICQEDKPGD
Oryzomys            ECIAACPSS---REVSPKVSSTGEHEEVIRGQEESEIKRVQVTSATVGFPLLHQEGTPGS
Meriones            ECAAVYTHSNSFRGLGPAVTSEG--EES-QVHEESEISHVQAVTAAMDLPVLRQQGKPGA
Mus                 DC----AHS---KELSPKVTAKGKQKER-QGQEEFEISHVQAVAATVGLPVLCQEGKLAA
Rattus              DCTLVGARS---REPSPKVTSRGEQKER-QGQEESEISHVQAVTVTVGLPVPCQEGKPGA
Scalopus            KYPPVSAPSRSLKRQTPKITLECELKEENQGKKESKTEHVQAVHRIADLTLACQNDKPHD
Erinaceus           ACTRGSVHSKSLRKQSPKVILDCEQKEENQGEKASEIKYLPSEHTTTGFPVVCYKDTSGD
Myotis              ECATAYAHSQSLRKQSPKVTLECGQKEENQGKKESKIKHVQAVHTAVGFPVVCEKDRPGE
Tadarida            EYATVYGHSRSLRKQSPKVTLECGQKEENQGEKESEIKYVRGVHTTAGFPVVCEKDEPEE
Taphozous           ECATVYAHSKSLRKHSPKVTLGCGQKEENQEEKESKIKHVQAVHTAAGLPAICEKDKPGE
Tonatia             ECATMYSHSRSTRKRSPKVTLECGRKE-HQGEKEFNMERAQPPYTTAGFPKGCEKDKPGE
Megaderma           ECATVCAHSSSLRNESPKVTLECGQKEENHGKKESKIKHVQAVPTTAGFPVVCEKEKPGD
Pteropus            ECATGYAHSKSLRKQSPKVTLECDRKE-NQGKKESNVKHVQAVYTTVGFPVVCEKEKPGD
Hipposideros        ECATIQ--SRSLRKQSAKVTLECGQKEENQGKKDSKIKLVQAVHTTAGYPVVCEKDEPGD
Cynopterus          ECATGYAHSRSLIKQSPKVTLECDRK-GNQGKKESNXEHVQAVYTTIGFPGVSEKDKPGD
Equus               KCATVSAHSRSLRKQSPKVTLKCGQKEGKEGKKESKIKNVQSVHTTVGFPVICQKDKPGD
Diceros             DCAAVSAHTRSLRKPSPKVTLECGQKEENQGKKESKVKHVQSVHTTVDFPVVCQKDKPGD
Manis               ECAAVSAHSGSLRKQSPKVTLAYGQKEENEGKKESEIKHVQTIHTTAGPLVVSQKDEPGD
Canis               DCVTVCPRSGAFGKQGPKVTLECGQKEESQGKKESEIRHVQAVHTNAGFSAVSQKAKPGD
Felis               ECATAWARSTSLRKQSPKVALEYEQKEENQGKNQSEIKHVQAVRATAGFSAVSQKVEPGD
Sus                 ECTTVHAHSKSLREQSPKVTHEGGQKDENQGKSESKVKHGQSVHTTVDFLVVGQKDKPSD
Lama                ECATIYAHSGPLREQSPKITLECGQKEENQRKSKSEIKHMQAVHTTLNFPVVGQKDKPSD
Bos                 ECATVFAHSGSLRDQSPRDPLKCRQKEDSQGKSESKSQHVQAICTTVHFPVADQQDRPGD
Hippopotamus        ERATVCAHSGSLREQSPRVPLECGQKEENQGKSES---KMQAIYTTVDFAVAGQNDRPSD
Megaptera           ECATVCARSGSLREQSPRVPLECRQKEENQGKSESKIKHVRAINTTVDFPVAGQKDKPSD
Physeter            ECATVCAHSGSLREQSPRVPLECRQKEENQGKSESKIKHVWAINTTVDFPVAGQKDKPSD
Tamandua            ECVTICAHSRSVRKQSPKVTFDYRQKEENQGKKESKIKHVQAVHTTAGFSVVCQKDKPHD
Bradypus            ECATVSAHSRPLGKQSPKVTFDCRQKED-QEKKESKIKHVQAVHTTADFPVVCQKDKPGD
Dasypus             ECATVCAHSRFLGKQSPKVTFECRHKEENQGKKESKIKHVQVIHTTAGFPIVCQKDKPGD
Chaetophractus      ECATVCAHSRFLGKQSPKVIFECRQKEENQGKKESKIKHVQAVHTTAGFPVVCQKDKPGD
Loxodonta           KCATICAHSKSLRKQSPKVTLVCGEKEENQGNREPKIKHEQAVHMPTGYPEACQKEKPSD
Elephas             KCATICAHSKSLRKQSPKVTLVCGEKEENQGNREPKIKHEQAVHMPAGYPEACQKEKPSD
Dugong              ECATICAHSKSLRKQSPKVTPEYGEEEENQGNKESKIKHEQAVHTTAGYPEDCQKEKPSD
Trichechus          ECATICAHSKSLRKQSPKVTPEYGEKEENQGNKESKIKHEQAVHTTAGYPEDCQKEKPSD
Procavia            ECATSYTHSKSLRKENPKVTLQRGEEEENQGNKESKIKH---VHTTASCPEVCQEDTPSD
Dendrohyrax         ECVKSYTHSKSLRKENPKVTLQRGEEEENQGNKESKIKH---VHTTASCPKVCQEDAPSD
Orycteropus         EFATVHAHSRSLRKQSPNITLECGEKEENQGNEESKIKCVQLVLSTTGYAGACQKEKPSD
Tenrec              ECATLCAHPSAFRKQNPNDALEGGE-EGTRENKESTIKPVRAVHTTVG------TEKPSD
Echinops            ECASLGARP-------PNIALECGE-EGTEENKESAVRPVQAVPATVGGAGGSPTEQPRD
Elephantulus        DYT---------------------------------KLVQLVHTTASYPGACEE-KPND
Rhynchocyon         ECTTVCAHSRLSKKQNPSVTLECREKKENQGNEESKMKHVQVVHTSVHYPGVCEEEKPDD
Amblysomus          ECATVSAHSRSFRKQSPKATLECGEKEENQGHKESKVKHVQAVHTSVGYPGLCQKEKPSD
Vombatus            ECRKPSAVPGTVNQQSPDNTTDCGGQEKEQGNRESNKPVWPKSAVMSLAAACQTEERPGV
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                     940                                                         1000
Homo                 NAKCSIKGGSRFCLSSQFRGNETGLITPNKHGLLQNPYRIPPLFPIKSFVKTKCKKNLLE
Pan                  YAKCSIKGGSRFCLSSQFRGNETGLITPNKHGLLQNPYHIPPLFPIKSFVKTKCKKNLLE
Gorilla              YAKCSIKGGSRFCLSSQFRGNETGLITPNKHGLLQNPYHIPPLFPIKSFVKTKCKKNLLE
Pongo                YAKCSIKGGSRFCLSSQFRGNETGLITPNKHGLSQNPYHIPPLFPIKSFVKTKCKKNLLE
Macaca               NAKCSIKGGSRFCLSSQFRGNETGLITPNKHGLLQNPYHIPPLFPVKSFVKTKCNKNLLE
Alouatta             YARC-IEGGSRLCLSSQFRGNETGLIIPNKHGLLQNPYHMSPLIPTRSFVKTKCKKNLLE
Otolemur             YAKYSIKEASRFCLSNQFRDNETESITVNKLGILQNLYHIPPLSPIRLFDKTKCNTNLLE
Cynocephalus         YAKFSIKGVSRHCSSSQFRGNETELITANKHGILQNSCHMSSLSPIRSSVKIKCKKNLSE
Tupaia               FATSGIKEVPRLCPSSQFRGNETDLITANKPEVSQNPYHMPLLYPVKSPIITKSKKSLSE
Lepus                CAKWSTKEISRLCLSSQSKGSETELIAVSKHGMSQNPYHIPPISPIKTSVKATRQVHLSG
Hystrix              SIICSGTGVSRLCLSSWFTGSKTELVTADKHGISQNPYHMPSISPIRPFVKTPCKKT---
Pedetes              DANHSITGVSRLCPLSQLTDNETELSTVNKHGVLQNPYLIPSISPVKSFITTKYKKSPSE
Aplodontia           DAKCSITEVSRLCPSFQFRANETKLIAVDKHVISQNPYLMPSISPIKPSVRTKCK----E
Sciurus              DAQYNITEVSRMCPSFQFRGNETKLITADKHGISQNPYHMPSISTIRSSVNSKCKKNLSE
Glaucomys            DAQCSVTEVSRIFPSFQFRDNLTKLITADKHGISQNPYHMPSISPSRSSVNTKCRRNLSE
Graphiurus           DAKHSIPGVSSLYPSFQLRGNKTELVTADQHGISQNPYHMPPISPITSFVKTEDK-NLSE
Oryzomys             ERMCA--GVSRLCSSSQYGRN---PSSAGDLGIPQNSHLKQSVSPITSFVKTDQRKTLSE
Meriones             NTLCA--GVCGPCPSFQYRSNESEGSTSGKPGVPQNSYLKQSVSPVRSSVKTDRRKTLSE
Mus                  DTMCD--RGSRLCPSSHYRSGENGLSATGKSGISQNSHFKQSVSPIRSSIKTDNRKPLTE
Rattus               VTMCA--DVSRLCPSSHYRSCENGLNTTDKSGISQNSHFRQSVSPLRSSIKTDNRKTLTE
Scalopus             SAKCSIKGVSRLCQSSQFRGNETEVIVANKRLILQNPYLIPPLSSIQSSVKSACKKNLAE
Erinaceus            YAKCSVKGVSRHCQPSRFRGSEPELIVANKNLILQNLYHIPTLPTIMSSTKSICKKNLSE
Myotis               YAKYSIKGTSMHCXSSQFRGNKTELTITDKYGLSPNPYHIPSISPIKSFVKTVSKKNLSK
Tadarida             YAKCSIKGTSSLCQPPQFRGNETELTIANKPGISRNPYHIPCISPIRSFVKTINKKNLSE
Taphozous            YDRYNIKGISRLCQLSQFRGNETELTIENKHRILQNPYHISPISPIRSSVKTISKKNLSE
Tonatia              CATYTMKGISKPCQSSSFRGNETKLTIENKYGISQNPYHIPPISPVRSSVKTTSKKNLSE
Megaderma            YAKYTKKGVSRLRQSSQIRGNKTELTVTNKHGISQNPYHIPPISSIRSSVKTICKENLSE
Pteropus             YAKYGIKEVSRLCQSFQFRENETELTIANKLGISQNPYHMPSIPPIKSSVKTTCKKNLSE
Hipposideros         YAKYSTKGVSRLCQSSLFRSNETELTIANKHGISQNPHNIPHISPIRSSVKTVCKKNLSE
Cynopterus           YARYGIKEVSRLCQSFQSRRNETELTIANKLGLSQNPYHMPSISPIKSSVKTICKKNLSE
Equus                YVKCSTKEASRLCQSSQFRGNETELITANKHGISQNPYYIPSLSPIRSSVKTVCQKNLPE
Diceros              HVKYSIKELSRLCQSSQFRGNETELITANKRELSQNLCYIPSLSPIRSSVKTICKKNVSE
Manis                YVKFGIKGVSTHCQSSQFRGNKTELIFANKPGISQYPYHISSISPIRSSVKIICKENLSE
Canis                FAKCSIKGVSRLCLSSQFKGKETELLIANYHGISQNPYHIPPLSPIRSCVKTLCQENLSE
Felis                YAKCSIKGVPGLCQSSQFRGNETELFIANNHDISKNPYHIPPLSPIRSSVNAVCKKNLSE
Sus                  FAKCGAKGVTGLYQTSQFRGHKTEFINANKPGISQNPYVIPSLSPIRSSVKTICKKNLSE
Lama                 YAKYSPKGISRLCWPSQLRGNESEFIIANKHGILQNPYLITSLSPNRSSVKTMCKKNPSE
Bos                  DAKCSAKEVTRVCQSSQLRGHKTELVFANKQGVSEKPNLIPSLSPIKSSVKTICKKSPSE
Hippopotamus         YTKCSTKGVTRLCPSSQFGSNKTEHIIANKYGISQNPYVIPSLSPIRSSVKTIRKKNLSE
Megaptera            HAKRSPKRVTRLCQSSQFRSNKTELIIANKHGISQNPYLIPSLSPIRSSVKTICKKNLSE
Physeter             HAKRSPKRVTRLCQSSQFRSNKTELIIANKHGISQNPYLIPSLSPIRSSVKTICKKNLSE
Tamandua             YAKCSIQGVSKLCESSQFRGNESELITANEHGISPNPDQMPSLSPNRSSVKTKYKKNLSE
Bradypus             YAKCSIQGVSKLCQLFQFRGNESEPITADEHEISQNPDQMPSLSPMKSSVKSKFKENLSE
Dasypus              YAKGSIQGVSRLCQSSQARGNESELINSNEHEISQNPDQMPSLSHMKSSVKTKCKENLSE
Chaetophractus       YAKCSIQEVSRLCQSSQFRGNESELITANEHEISQNPDQMPSLSHIRSSVKTKCKENLSE
Loxodonta            YTKYSIKGVSGLCQSSQFRGSESELITADGHGISQNPDQIPSLSPTRSSVKTKCKTNLLE
Elephas              YTKYSIKGVSGLCQSSQFRGSESELITADGHGISQNPDQIPSLSPTRSSVKTKCKTNLLE
Dugong               YTKSSIKGVSRLCQSSQFRGSESQHITAGEHGISQNPDQMPLLSPIRASVKS--KKNLSE
Trichechus           YTKCSTKGVSRLCQSSQFRGSESEHIT-GEHGISQNPDQMPLLSPIRASVKS--KKNLSE
Procavia             RTNCSVKGLPRLCHSSQFKGSESELITEGEHGIAQNPDQMPSSSPIRSSVNSKCNKNLSE
Dendrohyrax          RTNCSVKGLPRLCHSSQFKGSESELITEGEHGIAQNPDQMPSSSPIRSSVNSKCNKNLSE
Orycteropus          YAKCSIKGVSRLCQSSQFRGNESEIITANEHGVSQNLDQTPSLSPTRSSVKAKCKTNLSK
Tenrec               YTNSSFQGVSRRGQASQFRASESDPGTSVEHGSLQTTEHTPPLSPIRSSLKSKCKEKLSE
Echinops             YTKSHLQGVSRLGQAAPFRGSESDPSTSVEHGIVQTSEXAPPLAPIRSSVNSERKE----
Elephantulus         FTKCSIKGVTRLSHSSPLRGNESELITANEHEMSHSPDQTPSLSPTKVPVKMTWKKNLSE
Rhynchocyon          HTKVSIKGISRLCQSSPFRSNESERITENECKMSHSPNQTPSFSPTKPSVRTKYKQFLSE
Amblysomus           YTKGSIQGASRLHQSSQFSGNESEQITANENGISQSPDQTALLS--------KCKKNLSE
Vombatus             YAKCSTTEVSRLCHIAPLGVIDCEHIAGNNQGISQVPDQKPSVSPARSSAKTINTKNLLE
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                    1001                                                       1059
Homo                ENFEEHSMSPEREMGNENI-PSTVSTISRNNIRENVFKEASSSNINEVGSSTNEVGSSIN
Pan                 ENFEEHSMSPEREMGNENI-PSTVSTISRNNIRENVFKEASSSNINEVGSSTNEVGSSIN
Gorilla             ENFEEHSMSPEREMGNENI-PSTVSTISRNNIRENVFKEASSSNINEVGSSTNEVGSSIN
Pongo               ENSEEHSMSPEREMGNENI-PSTVSIISRNNIRENVFKEASSSNINEVGSSTNEVGSSIN
Macaca              ENSEEHSVSPERAVGNKNIIPSTVSTISHNNIRENAFKEASSSNINEVGSSTNEVGSSIN
Alouatta            ENSEEHSMSPERAMGNKNIIPSTVSTISHNN-RENAFKETSSSSINEAGSSTNEVGSSIN
Otolemur            ERFEEHSVLPEKAVGNENTVPSTMNTINQNN-RESAYKEASSSSINEVSSSTNEVGSSVN
Cynocephalus        ERFEEHSVSPERAMANKRIIQSTVNTISQNNIRDSASKEASSSSINEVGSSTNEVGSSIN
Tupaia              EGFEEQAMSLERAMENENIIQSTVSTISQDNIREGAFKEASSSSINEIGPSTNEGSSSIN
Lepus               ERSEEHSVSSERAVGSESIIQSTVSTISQEYIRESALKGFSSSSINEGGSSANEVCSSVN
Hystrix             -----RSSSPGEATGNQIILQST----SH-----RACREASLGSG--------------N
Pedetes             EKFEKYSASHENAMGNESIIQSIVYTIGQNNIRENAFKEASSGSI--------------N
Aplodontia          EKFKKHLRSPGKAVGYKRIIQSTANIISQNNITESAFKDVNSGSINEVGSSTNEVGSSIN
Sciurus             EKFEKHSRSPEKAVEYKRIIQSTVSTISQNNIGQSAFKEANSDSINEAGSSTNEVGSSIN
Glaucomys           EKFEKDSRSPKEAVGYKRIIQSTVSTISQNNIRQSAFKEANSGSINEVGSSTNEVGSSIN
Graphiurus          ERFEKHSLSLEKAVGCERIVQS---TISQNNVRESSFKEANSGSNTEIGSSTNEVGSSTN
Oryzomys            GQFEKHTLSTERTMGNGSADQSTMYTVSQNN-RKNACQEANLGSI--------------N
Meriones            ERLEKHTLSAKKAVGNETVVRSSVHTTSQNN-GGNACQEASSGSI--------------N
Mus                 GRFERHTSSTEMAVGNENILQSTVHTVSLNN-RGNACQEAGSGSI--------------H
Rattus              GRFEKH---TERGMGNETAVQSTIHTISLNN-RGDACLEASSGSV--------------I
Scalopus            EKLEEHSWSPERETGNGSIIESTVSRVSQNNNRENAFKEVSSSSINEVGSSTNEADSSIN
Erinaceus           EN----SLSPERAVTNKSIIQSTVNTISQTNASENALKDVSSSSV-------NDMGSSTN
Myotis              EKFEEHLVSPERAMGNENI-QSTVSPISLSNIRESAFKESSSSST-------NEGGSSIN
Tadarida            EKFEEHSVSPERAMRNENI-LSTVSPISLNN-RESTFKEGSSSST-------NEVGSSTN
Taphozous           EKFEKQSVSPEKAMGNENIIQSTVSTISQNNVRERAVKEGSSSST-------NEVGSSID
Tonatia             EKCEEHSVSPARAVGRENIIQSTAGTPSQNKTRESAAREGSSSGT--------------N
Megaderma           ENLEAYLVSPERAMGNESIVQSTVSTVSQSNIRESTFKEGSSSNIYEADSSANEVGSSIS
Pteropus            EKFEEHSISPERTIGNETIIQSTVGTISQNNIRESTFKEGSSSSIYEAGSSTNELGSSVN
Hipposideros        ENLEEYPVSPERAMGNESIIQSTVSTISQNNIRESTFKESSSSNXYEADSSTNEVGSSIN
Cynopterus          EKFEEHSIFPERAIGNETIIQSTVGTISQNNIRESTFKEGSSSGIYEAGSSTNELGSSVN
Equus               GKLEEQSLSPERAMGNESIVQSTVSTISQNNIRESTLKEVSSSSI-------NEVGSSIN
Diceros             EKLEEHSVSPERALGNKSVIQSTVSTISQNNIRESTFKEVGSSSINEVDSSTNEVGSSIN
Manis               EKSVEHSMSLEKAVGNKSIIQSTVSTISQNNIKGNNFKDGSSSSINEIGSSTNEVGSSIN
Canis               EKFEQHSMSPERAVGNERVIQSTVSTISQNNIRECASKEVGSSSVNEVVSSTNEVGSSVN
Felis               EKFEQRSMSPERAVGNESVIQSTVNTISQNNIRENTFKEVSSSSVNEVGSSANEVGSSIN
Sus                 EKFEEPKMSPERTMGNESIIPNTESTVSQNNIQERTFKEGSSGSPNEVGSSTNEVGSSIN
Lama                EKLEKCVISPKRVMGNESTIQSIVSAMSQNNIRESTFKEVSSSSVNEVGSSTNEVGSSIN
Bos                 -KFEEPVTSPEKTLGSESIIQSAVSTISQNNIQESTFKEVSSNSVNEVGSSTNEVGSSVN
Hippopotamus        EKFEEPVVSAERAMANESILQSTVNTISQNNIRENTFKEVSSSSINEVVSSTNEVGSSIS
Megaptera           EKFEEPVRSPERAMENESIIQSTVSTISQNNIRESTFKEVSSSSINEVGSSTNEVGSSIN
Physeter            EKFAEPVMSPERAMENESIIQSTVSTISQNNIRESTFKEVSSSSTNEVGSSTNEVGSSIN
Tamandua            ERFEEHTVSLDRAVGNESIIQSTVSTISQNNIRESTFKEASSSSINEVGSSINEVGSSIN
Bradypus            ERFEEHTVSLERAVGKEHIIQRTVSPISQNNIRESAFKEASSSSINEVGSSVNEVGSSVN
Dasypus             EKFEELTVSLERTMVNENIIQSTVSTISHSNIRENTFKEASSSSI--------------N
Chaetophractus      EKFEELTISLERTVGNENIVQSTVSTISHNNIRENAFKEASSSSI--------------N
Loxodonta           ERFEEHTISLERAMRNENVIQSTVSTVSQNNIRESASKEASSSSI-------NEVCSSIN
Elephas             ERFEEHTISLERAMRNENVIQSTVSTVSQNNIRESASKEASSSSI-------NEVCSSIN
Dugong              ERFEEHTISLERAVGNESIVQSTVSTVSQNDIKESASKEASSSSI--------------N
Trichechus          ERFEEHTISLERAVGNESIVQSTVSTVSQNNIKESASKEASSSSI-------NEVGSSVN
Procavia            ERFKEHKILLERTTGNETIVQSTVSTGSQDNIRGSASKETSSSSI--------------N
Dendrohyrax         ERFKEHKILFERTTGNETIVQSTVSTGSQDNIRGSASKETSSSSI--------------N
Orycteropus         ERFEQQKISHERVMGNESTIQSTVGTVSQSNIRESAFKEASSSSI-------NEVGSSVN
Tenrec              ERLEDQAESLERASGNESIIQSTVSTISQNTLRENAVKGTSSSSL--------------N
Echinops            -RLEDHAESLERASENESIIPSTVSTISQNTPRENAFKGTSSSSL--------------N
Elephantulus        ENFEEHTI----TMGNESIVYSPVSTVSQSNVKGYA--QASSSSINEVGSSTNEGGSSIN
Rhynchocyon         EELEEHALSPERAMENESFIHSTVNAVSQNNLRGSVFKEGSSSSINEAGSSTNEVSSSIN
Amblysomus          ERFEERAVSLEKAVGNESIIQSTVSTVSHNNIRERAFKETSSSST-------NEVGSSIN
Vombatus            ERLDEQTTCPETAMGNESLAQSSLSPVSQSNSREYISKATDLNRF--------------I
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                    1060                                                       1118
Homo                EIGSSDENIQAELGRNRGPKLNAMLRLGVLQPEVYKQSLPGSNCKHPEIKKQ-EYEEVVQ
Pan                 EVGSSDENIQAELGRNRGPKLNAMLRLGVLQPEVYKQSLPESNCKHPEIKKQ-EYEEVVQ
Gorilla             EVGSSDENIQAELGRNRGPKLNAMLRLGVLQPEVYKQSLPGSNCKHPEIKKQ-EYEEVVQ
Pongo               EVGSSDENIQAELGRSRGPKLNAMLRLGVLQPEVYKQSFPGSNGKHPEIKKQ-EYEEVLQ
Macaca              EVGSSDENIQAELGRNRGPKLNAVLRLGLLQPEVCKQSLPISNCKHPEIKKQ-EHEELVQ
Alouatta            EVGSSDENIQAELGRNRRPKLNAMLRLGLLQPEICKQSLPISDCKHPEIKKQ-EHEEVVQ
Otolemur            EVGPSSENIQAELDKNRGPKLNAVLRLGLMQPEVYKQNLPISNCEHPKIKGQEEN-GVVQ
Cynocephalus        EVGPSGENIQAELGRNRGPKLSAMLRLGLMQPEVYKQNLPLGNCKHPEI-RQEENEGIVQ
Tupaia              EVGSSGENIQAELGKKRGSKLNAVLRLGLMQPEVYKQSLPLSNHNDPEMKRQEKNEGGVQ
Lepus               EVGSSGENMQAQPGRSRAPELNAVLRIGLLQPEVSEQSLPISNSELPKLQRQGENEGVVQ
Hystrix             EGGSSGEHIQAEPSRHQEPE----LRLGLTQPEVYQQSLPVGDCRHPEIQTRGENGVVAQ
Pedetes             EVGSSGENMQVELGRNRGPKLNSVQRLGHIQPEVCKQSLPVSS-KHPEMKKQQENEGVVQ
Aplodontia          EVGSSGENIQAEXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Sciurus             EVGSSGENIQAELGRNRGPKLNAVLRLGLMQPEACKQNLL-SNCKYPEIKRQGEDE-VVQ
Glaucomys           EVGSSGENIQAELGRNRGPKLNAVLRLGLMQPEACKQNLL-SNCKYPEIKRQGEDE-VVQ
Graphiurus          KRFQGGENIQAELARKRGPKLNAVLRLGLMQPEAYKQSLPVSNCEHPEIKRQGEDE-VVQ
Oryzomys            EVYSSGETVQGQQGRKRGTKLNTVLSLGLMKPEVCQQGFPVSDYKYLEMKKQ-EDE----
Meriones            EVCSSSENFQGQRDRNRGSKVNTVLPLDLLQPEVCKQ----SDYKYLEMKKQ-EGK----
Mus                 EVCSTGDSFPGQLGRNRGPKVNTVPPLDSMQPGVCQQSVPVSD-KYLEIKKQ-EGE----
Rattus              EVHSTGENVQGQLDRNRGPKVNTVSLLDSTQPGVSKQSAPVSD-KYLEIK-Q-ESK----
Scalopus            EVGSSGENIQAELDGSRGPKLNAMLRLGLMQPEVYKQSLPKSTCKHPEVKRQGENEGIVQ
Erinaceus           EVGSSSENIQAKLCRNRGPRLNATLRASLMQPEVFEQCLLMSNCKHSEMKRQGENEGVIQ
Myotis              EVGSSGENIHAELDINKGSKLTAMLRLGLMQPEVYKPSLPVSNCKHPEVKRQGDNEGLVQ
Tadarida            EVGSSGENIQAELGRNRGSKINAMLRSGLMQPEVYKPSLSVSNCEHPEIKRQGENEGVVQ
Taphozous           EAGSSGKNIGAELDRNRGSKLSAVLRLGLMQPEVYKPSLPISNCKHSEIERQGENEVVVQ
Tonatia             EVGSSGENGQAEPGTNRASKLSALLRSGLMQPEVCKPSLPLSNCEDPEIKRQ-EDGGVVQ
Megaderma           EVSSSGENIQTELGRNQGPKLNAVLRLGLMQPQVYVQSLPVSNCEHSEIKRQGENEGVVE
Pteropus            EVGSSGENIQAELSRNRGPQLNAVLQLGLMQPEVYKQSLPLSNCKHPEIKRQGENEGVVQ
Hipposideros        EVGSSGENIQAELGRNRGPKLNAVLGLGLVQPEVYRQSLPVSNCQHPEIKRQGENEGIVQ
Cynopterus          EVGSSGENIQAELSRNRGPKLNAVLQLGLMQPEVYEQSLPLSNCKHSEIKRQGENEGVVQ
Equus               EVGSSGEHIQAELGRNRGPKLNAILRLGLMQPEVYKQSLPISNCKHLEIKRQGEKE-VVQ
Diceros             EVGSSGENIEAELGRNRGPKLNAILRLGLMQPEVYKQSLPISNCKHPEIKRRGENEGVVQ
Manis               EVGSSGEKIQAELGRNRGPKLSAVLRLGLMQPEAYKQNLLIGNRKHPEIKRQGEKEGVVQ
Canis               EVGSSGENIQAELGRNRGPKLNAMLRLGLMQPEVCKQSLSLSNCKHPEMKWQGQSEGAVL
Felis               EVGSSGENIQTELGRNRGPKLSAMLRLGLMQPEVYEQSLPISNCKCPEMKRQGENEGVVQ
Sus                 EVGSSGENVRAEPGRNRGPKLSAMLRLGLMQPEVYKQSLPVSNCNHTEIKRQGENEGIFQ
Lama                EVGSSGENIQAELGRNMGPKLNAMLRLGLLQPEVCKQSLPVSNCKQPEIKRQGENEGIFQ
Bos                 EVGSSGENIQAEPGRNREPKLRALLGLGLTQPEVYKQSLPVSNCHHPEIKRQGENEDMPQ
Hippopotamus        EVGSSGGNIQAELDRKRGPKLSALLRLGLMQPEVYKQSLPVSNCQHPEIKRQGENEGILQ
Megaptera           EVGSSGENIQAKLXRNRGPKLSALLRLGLMQPEVYKQSLPISNCQLPEIKRQGESEGTLQ
Physeter            EVGSSGENIQAKLDRNRGPKLSALLRLGLMQPEVYKQSLPVSNCQLPEIKRQGENEGTLQ
Tamandua            EVGSSGENVQAELGRNR-PKLNAMLRLGLMQPEVYEQNLPITNFKLSEIKKQGENEEVVQ
Bradypus            EVGSSGENTQAELGRNRGSKLSAMLRLSLMQPEVYKQSLPITNCKHPEIKKQGENEEVVQ
Dasypus             EVGSSDENIQAEVGRNRAPKLNAMLRLGLMQPEVYKQSLPITNCKYPEIKSQGENEEAIR
Chaetophractus      EVGSSGENIQAELGRNRAPKLNAMLRLGLMQPEVYKQSLPITSCKHPEIKRQGENEEAIQ
Loxodonta           EVGSSGENIQAEISRKRGPKLNAVLRLGLMQPEVYKQSLPISDCKHPGIKTQGENEGVVQ
Elephas             EVGSSGENIQAEISRKRGPKLNAVLRLGLMQPEVYKQSLPISDCKHPGIKTQGENEGVVQ
Dugong              EVGSSGENIRAELGRNRGPKLNAVLRLGLMQPEVYKQSLPVSNCKRPEIKRQGENEGVVQ
Trichechus          EVGSSGENIEAELGRNRGPKLNAVLRLGLMQPEVYKQSLPVSNCKHPEIKRQGENEGVVE
Procavia            EVGSSSENIQAEISRNREPRLNAVLRLGVMQPEVYKQSLSISNCKQPEIKKRGENEGVVQ
Dendrohyrax         EVGSSSENIQAEISRNREPRLNAVLRLGVMQPEVYKQSLSISNCKQPEIKKQGENEGVVQ
Orycteropus         EIGSSGENIQAELGKNRGPKLNAVLKLCLMQPEEYKQSPPISNCKHPSIKTQGQNEGVVQ
Tenrec              EVGSSSENIQAELARNREPKLDAVLRLGLVQPEGCKESLPLRKCKHPEVRRQKGNGGLVP
Echinops            EVGSSSENIQAELARNREPKLDAVLRLGLVQPEVCKESLPMRKCKHSEVKRQKGNGGLVP
Elephantulus        EVGSSGENIQAELDRNRGPALNAVLRLGLVQPEVYEQSLPAGNCKHPEMTRPGDSEGEKK
Rhynchocyon         EVCSSDENIQAELDRNRRPELNAVLRLGLMQPEVYQPSLPTNNCEYLEISGPGKNEGIIQ
Amblysomus          EVGSSNENIQAEVGRNRGPKLNAMLTLGFMQPEVYKQNLTLSNCKHPEITKQGDNEERVQ
Vombatus            SIGSSGEGSQAQKGENKESELNTQPKLKLVQPQICQQSFPQDNCKESKRKGKGGNGKLAQ
                    .    .     :
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                    1119                              1152
Homo                TVNTDFSPYLISDNLEQPMGSSHASQVCSETPDD
Pan                 TVNTDFSPCLISDNLEQPMGSSHASQVCSETPDD
Gorilla             TVNTDFSPCLISDNLEQPMGSSHASQVCSETPDD
Pongo               TVNTDFSPCLISDNLEQPMRSSHASQVCSETPND
Macaca              TVNTDFSPCLISDNLEQPMGSSHASEVCSETPDD
Alouatta            TVNTDVSLCLISYNLEQHMGSSHTSQVCSETPDN
Otolemur            PVNPDFSSCLISDNLEQPTRSSHASQLCSETPDD
Cynocephalus        AVNTNLSLCLISHNLEQPMESSHASQVCSETPDD
Tupaia              AIK-DLPPCLISDNQEH-MGSSHASQICSETPDD
Lepus               AVNRDFSSYLVPDSQEQSMGGRHASQICSETPDD
Hystrix             AVHADFSPCLILDNVEQPMGNNPASQICSETPDD
Pedetes             AVDADFSPCLTSNSLEQPMRSGCVSQICSETPDD
Aplodontia          XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Sciurus             VVNTDFSPCLISDDLEQPMGNSHVTQVCSETPDD
Glaucomys           VVNADFSPCLISDDLEQPMGNSHVTQVCSETPDD
Graphiurus          AVDTDFSPYLISDNLEHPMGNTHASQICSETPDD
Oryzomys            AVDADFSSCLFSDKLKQPMGSGNIFQVCSETPDD
Meriones            AVGTDFSPCLFSDHLEQSMRSGNIFQVCSETPDD
Mus                 AVCADFSPCLFSDHLEQSM-SGKVFQVCSETPDD
Rattus              AVSADFSPCLFSDHLEKPMRSDKTFQVCSETPDD
Scalopus            AVHTDFFPCLISDNQEQPMGSSHASQVCSETPED
Erinaceus           TVNIESDSCPRPDNLEQPVETSH---VCSETPDD
Myotis              AVNADFPPCQISDNLEQPMGSSPVSQVCSATPDD
Tadarida            AVNADFSPCQISDNLEQSMGSTPASQVCSETPDD
Taphozous           AVNA----CQISDNLEQPMGSSPVSQACSETPDD
Tonatia             AVNADFSPCQILDNLEQPLGSSPASRVCSETPDD
Megaderma           AVNAEFSPCQTSDNLEQPMGSSHASQICSETPDD
Pteropus            AVNADVSLRQISDNLEQPMGNSNASQVCSETPDD
Hipposideros        AVSADFSPCQISDNLEQPTGSSHASQVCPETPDD
Cynopterus          AVNADVSPXQISDNLEQPMGNSNISQVCSETPDD
Equus               AVNADFSPCLISDNLEQPMGSSCASQVCSETPDD
Diceros             PVNADFSPCPISDNLEQPVGISCASQVCSETPDD
Manis               VVNADFSPCLISDNLEQPMGSSHASQVCSETPED
Canis               SVSADFSPCLISDNPEQPMGSSRSSQVCSETPDD
Felis               SVNADFSPCLISDNVEQPMESSRASQVCSETPND
Sus                 AVNADFSPYLISDNPEQPMGSSHASQICSETPDD
Lama                AVNTDFSPCLISDNLEQPMGSSHASQVCSETPDD
Bos                 AVKADFSPCLISDNLEQPTGSRHASQVCSETPDN
Hippopotamus        AVNADFSPCLISDNLEQPMGSSHASQVCSETPDD
Megaptera           AVNADFSPSLISDNLEQPMGRSHASQVCSETSDE
Physeter            AVNADFSPCLVSDNLEQPMGRSHASQVCSETSDE
Tamandua            AVNTDFSPCLISDNLELPMGSSRVSQICSETPDD
Bradypus            AVKT----CLISDNLELPMGSSHASQICSETPDD
Dasypus             AVDIDFSPCLISDNLQLPMGNSCASQICSETPDD
Chaetophractus      AVDTDFSPHLISDNLELPMGNSHVSQICSETPDD
Loxodonta           AVNTDFSPCLISDNLEQPVGTSRASQVCSETPDD
Elephas             AVNTDFSPCLISDNLEQPVGTSRASQVCSETPDD
Dugong              DVNMDFSPCLISDNLEQPMGSSRASQICSETPDD
Trichechus          DVNMDFSPCLISDNLEQPMGSSRASQICSETPDD
Procavia            AVSTDFSACPISENLEQPVRSSHTSQVCSQTPDN
Dendrohyrax         AVSTDFSACPISENLEQPVRSSHTSQVCSQTPDN
Orycteropus         AVNTGFSSCLISDNLGQPMGSSHASQICSETPDD
Tenrec              AVNPDLSRYLMSRNPEQPMESN-GSQICSETPED
Echinops            AVHPDFSRYLMSHNPEQPMEDN-DPQICSETPED
Elephantulus        TVNPDFSPCLLSDNLEQPRGSCHASQICSETPDD
Rhynchocyon         AVNPDFTPCLISDNLEQPMGSNHASQICSETPDD
Amblysomus          AADPGFSPCLISDNLEPPMGSNHASQICSETPDD
Vombatus            AISTDSSPCL-----EQTKESTHSSQVCSETPDD
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Appendix C: BRCA1 exon 11 nucleotide alignment of eight marsupial sequences and human

Sequences from Wombat Red_Kangaroo_GB, Echymipera, Phascogale, Shrew_Opossum and Human were obtained from GenBank (Table 2.2).

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                      846                                              895
Wombat                TCATTACTTCCTAAAACCAGCAGTTTATTGCCCAACACAGACAGAATGAA
'Red_Kangaroo__GB_'   TCATTACTTCCTGAAACCACCAGCTTATCACCCAACACAGACCGAATGAA
'Red_Kangaroo__CJR_'  TCATTACTTCCTGAAACCACCAGCTTATCGCCCAACACAGACCGAATGAA
Wallaroo              TCATTACTTCCTGAAACCACCAGCTTATCGCCCAACACAGACCGAATGAA
Tree_kangaroo         TCATTACTTCCTGAAACCACCAGCTTATCGCCCAACACATTCCAAATGAA
Echymipera            TCATTAATGCTTGAAACCAGCAGTTTATTGTCCAACATAGACAGAATGAC
Phascogale            TCATTACTGCCTGAAACCTCCAGTTTATTGCCCAACACAGACAGAATGTC
Shrew_Opossum         TCATTACTGCCTGAGATCACCAGTTTATTGCCCAACACAGACAGAATGAA
Virginia_Opossum      TCATTACTGCCTGACATCACCAGTGTATTGCCTAACACAGACAGCATGAA
Human                 TCATTACAGCATGAGAACAGCAGTTTATTACTCACTAAAGACAGAATGAA

                       896                                             945
Wombat                TGTAGAAAAGGCTGAACTCTGCCATAAAAACAAACAGCCTGCCTTAGGAA
'Red_Kangaroo__GB_'   TGTAGAAAAGGCTGAACTCTGTAATAAAAGCAAACAGCCAGGCTTAGCAA
'Red_Kangaroo__CJR_'  TGTAGAAAAGGCTGAACTCTGTAATAAAAGCAAACAGCCTGGCTTAGCAA
Wallaroo              TGTAGAAAAGGCTGAACTCTGTAATAAAAGCAAACAGCCTGGCTTAGCAA
Tree_kangaroo         TGTAGAAAAGGCTGAACTCTGTAATAAAAGCAAACAGCCTGGCTTAGCAA
Echymipera            TACAAAAAAGGCTGAACTCTGTAATAAAAGTAAAGATCCTGGCTTAGCAA
Phascogale            T---GAAAAAGCTGAGCTCAGTAATAAAAGCAAACAGTCTGGCTTAGCAA
Shrew_Opossum         TGTAGAAAAGGCTGAACTCTGTAATAAAAGCAAACAGCCTGGCTTAGCAA
Virginia_Opossum      TGTAGAAAAGGCTGAACTCTGTGATAAAAGCAAAAGGCCTGATTTAGCAT
Human                 TGTAGAAAAGGCTGAATTCTGTAATAAAAGCAAACAGCCTGGCTTAGCAA

                      946                                              995
Wombat                GGAACCAAGAGAGCAGTCTCGATGAAAGTAAGGAAATATGTAGCCCTGGG
'Red_Kangaroo__GB_'   AAAACCAACAGAGCAGCCTGGATGAAAGTAAGGAAATATGTAGTGCTGGA
'Red_Kangaroo__CJR_'  AAAACCAACAGAGCAGTCTGGATGAAAGTAAGGAAATATGTAGTGCTGGA
Wallaroo              AAAACCAACAGAGCAGTCTGGATGAAAGTAAGGAAATATGTAGTGCTGGA
Tree_kangaroo         AAAACCAACAGAGCAGTCTGGATGAAAGTAAGGAAATATGTAGTGCTGGA
Echymipera            GGAACCAACAGGACTGTTTGGGTGAAAGTAAAGAAATAAGTAGCACTGTG
Phascogale            GGAACCAACAGAGCAGACTGGATGAAAGTAAGGGAATATGTAGTACTGGG
Shrew_Opossum         GCAACCAGCAGAGCAATCTGGATGAAAGTAAGGAAATATGTAGTGCTAGC
Virginia_Opossum      GGAGCCAGCAGATCAGTCAGGATGAAAGTAAGGAAAAATGTATTGCTGGG
Human                 GGAGCCAACATAACAGATGGGCTGGAAGTAAGGAAACATGTAATGATAGG

                      996                                             1045
Wombat                AAGACCCCAGGTGCCTGTGAGCGGCATGAGCTGAATGACCATCATCTGTG
'Red_Kangaroo__GB_'   AAGACCCTGGGTGCC---------CATGAGCTGAATGCCCATCATCCATG
'Red_Kangaroo__CJR_'  AAGACCCTGGGTGCC---------CATGAGCTGAATGCCCATCATCCATG
Wallaroo              AAGACCCTGGGTGCC---------CATGAGCTGAATGCCCATCATCCATG
Tree_kangaroo         AAGACCCTGGGTGCC---------CATGAGCTGAATGCCCATCATCCATG
Echymipera            AAGACCCCAGCTGCAGGGGAGCAGCATAAGCTGAATGCCCACCATCTGTG
Phascogale            AAGACCCCCAGTGTAGGAGAGCAGCCTGAGTTGAATGCCCATCATCTGTG
Shrew_Opossum         AAGACCCCAGGTGCAGAGGAACAGCCTGAGCTGAATGCCAATCATCTGTG
Virginia_Opossum      AAGACCTCAGATGCAAAGGAGTTACATGAGCTAAATGCCCATCATCTGTA
Human                 CGGACTCCCAGCACAGAAAAAAAGGTAGATCTGAATGCTGATCCCCTGTG

                      1046                                            1095
Wombat                TGAGAGGCAAGGCCTAGAG---GAGAAGCCGCAGCACCCTGAGAGCCCTA
'Red_Kangaroo__GB_'   TGAGAGGAAAGAACTAGAG---GATGAGCCACAGCACCCTGAGAGCCCCA
'Red_Kangaroo__CJR_'  CGAGAGGAAAGAACTAGAG---GATGAGCCACAGCACCCTGAGAGCCCCA
Wallaroo              TGAGAGGAAAGAACTAGAG---GATGAGCCACAGCACCCTGAGAGCCCCA
Tree_kangaroo         TGAGAGGAAAGAACTAGAG---GATGAGCCACAGCACCCTGAGAGCCCCA
Echymipera            TGAGAAGCAAGAACTAGAG---GTAAAGTCACAGCACCCTGAGAGCCCCA
Phascogale            TGAGAAGCAAGAACTAAAG---GAGAAGCCACAAGGTCCTGAAGGCCCCA
Shrew_Opossum         TGAGAGGAAAGAACTAGAG---GAGAAGCTGCAGTGCCCTGAGAGCCCCA
Virginia_Opossum      TGAGAGGCAAGAACTAGAA---GAGCAGCCAGAGTGCCCCAACTACCCCA
Human                 TGAGAGAAAAGAATGGAATAAGCAGAAACTGCCATGCTCAGAGAATCCTA
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                         1096                                        1139
Wombat                   GAGGTAATCCTCAGAACTGCCTGTCTGGAACCAAACTGAAAAGCAGCATT
'Red_Kangaroo__GB_'      GAGGTAATCCTCAGAACTGCCAGTCTGGAACCAAACTGAAAAGTAGTATT
'Red_Kangaroo__CJR_'     GAGGTAATCCTCAGAACTGCCAGTCTGGAACCAAACTGAAAAGTAGTATT
Wallaroo                 GAGGTAATCCTCAGAACTGCCAGTCTGGAACCAAACTGAAAAGTAGTATT
Tree_kangaroo            GAGGTAATCCTCAGAACTGCCAGTCTGGAACCAAACTGAAAAGTAGTATT
Echymipera               AAGGTAGTCCTCGGAGGTGCCGGTCTGGAACCAAACTGAAAAGCAGTATT
Phascogale               GAGGAAATCCTCAGAATTGCCTATCTGGAACCAAACTGAAAAGCAGTATT
Shrew_Opossum            GAGGTGATTCTGGGGACTGCCTGTCTGGAACCAAAGTGAAAAACAGTATT
Virginia_Opossum         GAGGAAATTCTCAAAACTGCTTGTCTGGAACCAAACTGAAA---AGTATT
Human                    GAGATACTGAAGAT------GTTCCTTGGATAACACTAAATAGCAGCATT

                         1140                                              1189
Wombat                   CAGAAAGTTAATGAGTGGTTATCCAGAAGTAGTGACATTTTAGCCTCTGA
'Red_Kangaroo__GB_'      CAGAAAGTTAATGAGTGGTTATCCAGGAGTAATGATATTTTAACTTCTGA
'Red_Kangaroo__CJR_'     CAGAAAGTTAATGAGTGGTTATCCAGGAGTAATGATATTTTAACTTCTGA
Wallaroo                 CAGAAAGTTAATGAGTGGTTATCCAGGAGTAATGATATTTTAACTTCTGA
Tree_kangaroo            CAGAAAGTTAATGAGTGGTTATCCAGGAGTAATGATATTTTAATTTCTGA
Echymipera               CAGAAAGTCAGTGAGTGGTTGTCTAGAAGTAATGACATTTTAAACTCTGA
Phascogale               CAGAAAGTTAATGAGTGGTTATCCAGGAGTAATGACATTTTAGCCTCCGA
Shrew_Opossum            CAGAAAGTTAATGAGTGGTTATTCAGAAGTAATGACGTTTTAGCCCCAGA
Virginia_Opossum         CAGAAAGTTAATGACTGGTTATCCAAAAGTAATGACATTTTAGTCTCTGA
Human                    CAGAAAGTTAATGAGTGGTTTTCCAGAAGTGATGAACTGTTAGGTTCTGA

                         1190                                              1239
Wombat                   TAACTCCAACGGTAGGAGCCATGAGCAGAGCGCAGAGGTGCCTAGTGCCT
'Red_Kangaroo__GB_'      TAACTCCTGTAGTAGGAACCATGAGCAGAATGTAGAGATGCCNAGTGCCT
'Red_Kangaroo__CJR_'     TAACTCCTATAGTAGGAACCATGAGCAGAATGCAGAGATGCCTAGTGCCT
Wallaroo                 TAACTCCTATAGTAGGAACCATGAGCAGAATGCAGAGATGCCTAGTGCCT
Tree_kangaroo            TAACTCCTATAGTAGGAACCATGAGCAGAATGCAGAGATGCCTAGTGCCT
Echymipera               TTATTCCCATGAGAGAAGCCAGGAGCAGAATGCAGAGATTGCTATTGCCT
Phascogale               TTGCTCCCTTGACAAGAATCATAAGCAGAATGCAGAGATAGCTAGTGCCT
Shrew_Opossum            TTACTCAAGTGTTAGGAGCCATGAACAGAATGCAGAGGCAACCAATGCTT
Virginia_Opossum         TTACTCCTCTGGTAGGATCCATGAACAGAATGCAGAGATGGATAGTGTCT
Human                    TGACTCACATGATGGGGAGTCTGAATCAAATGCCAAAGTAGCTGATGTAT

                         1240                                        1283
Wombat                   TAGAAGATGGGCATCCAGATACCGCAGAGGGAAATTCTAGCGTTTCTGAG
'Red_Kangaroo__GB_'      TAGAAGATGGGTATCCAGATACTGCAGATGGAAATTCTAACATTTCTGAG
'Red_Kangaroo__CJR_'     TAAAAGATGGGTATCCAGATACTGCAGATGCAAATTCTAACATTTCTGAG
Wallaroo                 TAGAAGATGGGTATCCAGATACTGCAGATGCAAATTCTAACATTTCTGAG
Tree_kangaroo            TAGAAGATGGGTATCCAGATACTGCAGATGGAAATTCTAACATTTCTGAG
Echymipera               TAGAAGATGGGCATCTGAATACTGCTGATGGAAATTCTAGCATTTCTGAG
Phascogale               TAGAAGATGGGCATCCAGATAACTCTGATGGAAATTCTAGCATTTCTGAG
Shrew_Opossum            TAGAATATGGGCATGTAGAGACA---GATGGAAATTCTAGCATTTCTGAA
Virginia_Opossum         TAGAAGATGGGCATCCAGATGTTACAGATGGAAATTCTAGCATTTCTGGG
Human                    TGGACGTT------CTAAATGAGGTAGATGAATATTCTGGTTCTTCAGAG

                         1284                                           1330
Wombat                   AAGACTGACCCAGTGGCTGACAGC---ACTGATGATGCCTGGCTACATGT
'Red_Kangaroo__GB_'      AAGACTGACCCAGTGGCTGACATC---ACTTATGATCCCTGGCCACATGT
'Red_Kangaroo__CJR_'     AAGACTGACCCAGTGGCTGACATC---ACTTATGATCCCTGGCCACATGT
Wallaroo                 AAGACTGACCCAGTGGCTGACATC---ACTTATGATCCCTGGCCACATGT
Tree_kangaroo            AAGACTGACCCAGTGGCTGACAACAACACTTATGATCCCTGGCCACATGT
Echymipera               AAGACTGNCCTGGTGGCTGNC------ACCACTGAT------------GT
Phascogale               AAGACTGACGTTGTGGCTGACACT---GCCGATGGAGCCTGGCTACATGT
Shrew_Opossum            AAGACTGATATGGTGGCTGACAGT---ACTGATGGTTCCTGGCTACATGC
Virginia_Opossum         AAGACTGACTTGGTGGCTGACTCC---ACCGATGGTGCCTGGCTACATAT
Human                    AAAATAGACTTACTGGCCAGTGAT---CCTCATGAGGCTTTAATATGTAA
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                      1331                                            1377
Wombat                GCCTAAAAGAAGCTGTCTCAGGCCTGCAGAAAACAAT---ATTGAAGATA
'Red_Kangaroo__GB_'   GCCTGAAAGAAGCTGCCCCAGGCCAGCAGAAAACAATAACATTGAAGATA
'Red_Kangaroo__CJR_'  GCCTGAAAGAAGCTGCCCCAGGCCAGCAGAAAACAATAACATTGAAGATA
Wallaroo              GCCTGAAAGAAGCTGCCCCAGGCCAGCAGAAAACAATAACATTGAAGATA
Tree_kangaroo         GCCTGAAAGAAGCTGCCCCAGGCCAGCAGAAAACAATAACATTGAAGATA
Echymipera            GCTGGAAACTAGCTTNTCCAGGCCAGCTAAAAGCAAT---ATTGAAGATA
Phascogale            GCCTAAAAGAACTTACACCAGGCCAGCAGAAAACAACAATATTAAAGATA
Shrew_Opossum         ACCTGAAAAAAACTGCCCCAGACCGGCAGAGAGCAACAATATTGAAGATA
Virginia_Opossum      GTCTGAAAGAAGCTGCTCCAGGAAGGCAGAGAGCAACAATATTGAAGACA
Human                 AAGTGAAAGAGTTCACTCCAAATCAGTAGAGAGTAAT---ATTGAAGACA

                      1378                                            1427
Wombat                AAATATTTGGAAAAAACCTATCGGAGAAAGTCAGGTCACCCTAATTTGAAT
'Red_Kangaroo__GB_'   AAATATTTGGAAAAAACCTATCGGAGAAAATCAGGTCACCCTCATTTGAAT
'Red_Kangaroo__CJR_'  AAATATTTGGAAAAAACCTATCGGAGAAAATCAGGTCACCCTCATTTGAAT
Wallaroo              AAATATTTGGAAAAAACCTATCGGAGAAAATCAGGTCACTCTCATTTGAAT
Tree_kangaroo         AAATATTTGGAAAAAACCTATCGGAGAAAATCAGGTCACCCTCATTTGAAT
Echymipera            AAATATTTGGGAAGACCTATCGGAGAAAGTCANGTCACTCTAATTTGAAT
Phascogale            AAATATTTGGAAAAAACCTATCGGAGAAAGTCGGGTCACCCTAATTTGAAT
Shrew_Opossum         AAATATTTGGAAAAAACCTATCGAAGAAAGTCGGTTCACCCTGTTTTGAAT
Virginia_Opossum      AAATCTTCGGCAAGACCTACCATAGAAAATCAGTTCACATTAATTTGAAT
Human                 AAATATTTGGGAAAACCTATCGGAAGAAGGCAAGCCTCCCCAACTTAAGC

                      1428                                            1474
Wombat                TATGTAACTGAAAACTTGTTTGCTGAAGCTGTG---GCTCCTGATTCCTT
'Red_Kangaroo__GB_'   TGTATGACTGAAAACTTGTTTGCTGGAGCTGTTGTTGCTCCTGATTCTTT
'Red_Kangaroo__CJR_'  TGTATAACTGAAAACTTGTTTGCTGGAGCTGTTGTTGCTCCTGATTCTTT
Wallaroo              TGTATAACTGAAAACTTGTTTGCTGGAGCTGTTGTTGCTCCTGATTCTTT
Tree_kangaroo         TGTATAACTGAAAACTTGTTTGCTGGAGCTGTTGTTGCTCCTGATTCTTT
Echymipera            TATCTAACTGAAAACCTCCTTGTTGAAACTATT---GCTCCTGATTCTTT
Phascogale            CACATAACTGAAAATTTGATTGTTGAGACAGTT---GTTCCTGATTCTTT
Shrew_Opossum         TACGTAACTGAAAACTTGATTGTTGAAACCATT---GCTCCTGATTCTGT
Virginia_Opossum      TATGTGACTGAAAACTTGATTGTTGGAGCTGTT---GATTCTGATTCTTT
Human                 CATGTAACTGAAAATCTAATTATAGGAGCATTT---GTTACTGAGCCACA

                      1475                                            1524
Wombat                GATCCCTCTAGAGGCTCCCAAAAACACCAGGTTAAAGCGTAAAGGAAGGA
'Red_Kangaroo__GB_'   GATCCCTCCAGAGCCTCCAAAAACAACCAAGTTAAAGCGTAAAAGAAAAA
'Red_Kangaroo__CJR_'  GATCCCTCCAGAGCCTCCAAAAACAACCAAGTTAAAGCG
Wallaroo              GATCCCTCCAGAGCCTCCAAAAACAACCAAGTTAAAGCGTAAAAGAAAAA
Tree_kangaroo         GATCCCTCCAGAGCCTCCAAAAACAACCAAGTTAAAGCATAAAAGAAAAA
Echymipera            GATCCCTCCAGAATCTCTCAAGAACATCAAGTTAAAGCGAAAAAGAAAAA
Phascogale            GGTTCCTCCAGAACCTCTGAAAAATACCAAGTTAAAGCGTAAAAGAAAGA
Shrew_Opossum         GATCCCTCCAGAGCCTCTCAAAAAAAACCAAATTAAAGCGTAAAAGAAAGA
Virginia_Opossum      GATCCCTCCAGAGCCTGTCAAAAAAACCCGGTTAAAGCGTAAAAGGAAGA
Human                 GATAATACAAGAGCGTCCCCTCACAAATAAATTAAAGCGTAAAAGGAGAC

                      1525                                            1574
Wombat                GCATAGCTGACCTGCAGCCTGAGGATTTCATCAGGAAGACGGACGTTCCA
'Red_Kangaroo__GB_'   CCATATCTAACCTGCAGCCTGAGGATTTCATCAAGAGGACAGACATTCCA
Wallaroo              CCATATCTAACCTGCAGCCTGAG
Tree_kangaroo         CCATATCTAACCTGCAGCCTGAGGATTTC
Echymipera            CTATATCTGACCTGCAGCCTGAAGATTTCATCAGGAAGACAGATGTTCCA
Phascogale            CTATATGTGACTTGCAGCCTGAGGATTTCATTAAGAAGACG---GTTCCA
Shrew_Opossum         CCATATGTRACCTGCAGCCTGAGGATTTCATCAAAAAGACAAACATTCCA
Virginia_Opossum      CCGTCTCTGACCTACAGCCG
Human                 CTACATCAGGCCTTCATCCTGAGGATTTTATCAAGAAAGCAGATTTGGCA
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                       1575                                         1619
Wombat                 GTTATTCACAAAACCCCTGAAAAGAAAAATCACTCTGTTGACCAAATTCT
'Red_Kangaroo__GB_'    GTTGTTCACAAAACCCCTGAAAGGAAAAATCATGCTGTTGACCAAATTCT
Echymipera             GTTAGTCACAAAACCCCTGAAAAGAAAAATCCTGCTGTTGACCAGATTCT
Phascogale             GTTACTCACAAAACCCCTGAAAAGAAACATCACGCTGCTGACCAAACCCT
Shrew_Opossum          GTTATTCCCAAAACCCCTGAAAAGAAAAATCACCCTGTTGACCAGATCCT
Human                  GTT---CAAAAGACTCCTGAAATGATAAATCAGGGAACTAACCAAACG--

                       1620                                            1662
Wombat                 CAAAAGAGAACAAAGTGACCAAGTGATGAACACGGCTAACAGTCTTCCTG
'Red_Kangaroo__GB_'    TGAAAAAGAACAAAATGAC------------ACGGCTAACAGTCATCTTG
Echymipera             TGAAAGAGAACAAAATGACCAAGTGATGAACACAGCTAATGGTCATCTTA
Phascogale             TGAAAGAGAACAAAATGACCAAGTGATGAACATGGATAATGGTCATCCTG
Shrew_Opossum          TGAAAAAGAACAAAATGGCCAGGTGATGAGCACAGCTGATGGTCAGTCCA
Human                  -------GAGCAGAATGGTCAAGTGATGAATATTACTAATAGTGGTCATG

                       1663                                            1706
Wombat                 AGCAGAAAGCCCTAGGTGGTCATGTAGGGGAAGTGAAAGATGTTCAGGTA
'Red_Kangaroo__GB_'    AACAGAAAGCATTAGATGGTCATGCAGGGGAAGTGAAAGATGCTCAGGCA
Echymipera             AACAGAAAGCACTGGGTGATCATGTCAAGGAAGTGAAAGATGCTCAGGCA
Phascogale             AACAGAAAGCACTAAATGGTCATGTAGGGGAAATTAAAGAAGCTCAGACA
Shrew_Opossum          AGCAGAAAGCACCCGGTTGTCATGTGGGGGAACTGAAAGAGGCTCAGGCA
Human                  AGAATAAAACAAAAGGTGATTCTATTCAG------AATGAGAAAAATCCT

                       1707                                            1756
Wombat                 TTAGAGCTGTTCTCTGCGGAGAAAGAATCCACTTTCAGAACTGGAACAGA
'Red_Kangaroo__GB_'    TCAGAACTGTTCTCTGCGGAGAAAGAATCCACTTTCAGAACTGGAACAGA
Echymipera             GCAGAACTGTTCTCTACAGAGAAAGAATCAACATTCAGGACTAGAACAGA
Phascogale             TCGGAACTGTTCTCTGCAGAGAAAGAATCCACTTTCAGAACTGGAACAGA
Shrew_Opossum          TCAGAACCATCCTCTGTAGAGAAAGGATCCACTTTCAAAACTGGATCCGA
Human                  AACCCAATAGAATCACTCGAAAAAGAATCTGCTTTCAAAACGAAAGCTGA

                       1757                                            1806
Wombat                 GCCTGTAGCTGGCAGCACAAACCATGGGGAGCTTGAATTAAATAGTAGAA
'Red_Kangaroo__GB_'    GCCTACAGCTGACAGTACAAACCACAGGGAACTTGAATTAAATGGTAGAG
Echymipera             GCCTAAAGCTGGCAGCATAGTCCACGGGGAGCTCGAATTAAATGGGAGAG
Phascogale             GCCTGCAGCTAGC------------------------TTAAATGGTGAAG
Shrew_Opossum          GCCTGCAGCTGGTAGCACAAACCAGAGGGAACTTGAATTAAATGGTAGAG
Human                  ACCTATAAGCAGCAGTATAAGCAATATGGAACTCGAATTAAATATCCACA

                       1807                                            1856
Wombat                 ATGCCAAAATGACAAGAAAAGACAGGCTGAGGAAGAAGCCTTCAGCCAGG
'Red_Kangaroo__GB_'    ATGTCAAAATGACAAAAAAAGA
Echymipera             GTGCCAAAATGACAAAAAAGGACAGGTTGAGGAAAAAGCCTTCAGCCAGG
Phascogale             AAACCAACATAACAAAAAAAGACAAGCTGAGGAAGCAGCCTTCATTCAAG
Shrew_Opossum          ATGCAAAAATGACAAAAAAAGACAGACCAAGGAAGAGGCCTTCAGTTAGG
Human                  ATTCAAAAGCACCTAAAAAGAATAGGCTGAGGAGGAAGTCTTCTACCAGG

                       1857                                            1906
Wombat                 ATCGTCCGTGCTCTTGAGCTCGTAGTTGATAGAAACCCAAGCTCTTCTAA
Echymipera             ATTGTCCGTGCTCTTGAGCTTGTGGCTGATAAAAACTCAGGCTCTTCTAA
Phascogale             ATTGTCTGTGCTCTTGAGCTTGGAGTTGATGGAAGCCCAAGCTCTTCTAA
Shrew_Opossum          ACTGTCTGTGCTCTGGAGCTCGTGACTGATAGACACCCAGGCTCTTCTAA
Human                  CATATTCATGCGCTTGAACTAGTAGTCAGTAGAAATCTAAGCCCACCTAA

                       1907                                            1956
Wombat                 TGAGAGTGAACTGCAGATCGATAGCTATCCCAGCAGTGAAGAGATAAGGA
Echymipera             TGAGGCTGAATTACAGATCGATAGTTATCCCAGCAGTGATGAGATAAGGA
Phascogale             TGAGACTGAACTACAGATCGATAGCTATCCCAGCAGTGAAGAGATAAGGA
Shrew_Opossum          TGAGACAGAACTACAGATCGATAGCTATCCCAGCAGTGAAGAGATAAGGA
Human                  TTGTACTGAATTGCAAATTGATAGTTGTTCTAGCAGTGAAGAGATAAAGA
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               1957                                              2003
Wombat         AAGGAACTAATTCTGAACAGAAGCAAATCAGACGCAGCAGAAGGCTTCGG
Echymipera     AAGGAAATAATTCTGAACAGAAGCAAATCAGACGCAGCAGAAGACTTCAG
Phascogale     GAAAAAATAATTCTGAACAGAAGCAACTTAGACGCAGCAGAAGACTTCAG
Shrew_Opossum  AAGGAAATAATTCTGAGCAAAAGCAAGTCAGACGCAGCAGAAGACTTCAG
Human          AA---AAAAAGTACAACCAAATGCCAGTCAGGCACAGCAGAAACCTACAA

               2004                                              2053
Wombat         CTGCTATCAGAA---GAAATTGTGGTTGGAGCCAAGAAGGCCCATAAGCC
Echymipera     CTACTGTCAGAA---GAAATTGCAGTTGGAACCAAGAAGGCCCATGAGCC
Phascogale     CAGGTGTCAGAA---GAGATTGCAATTGGAGCCAAGAAAGCCCATAAGCC
Shrew_Opossum  ATGCTGTCAGAA---GAAATTGCAGCAGGAGCCAAGAAGGCCCATAAGCC
Human          CTCATGGAAGGTAAAGAACCTGCAACTGGAGCCAAGAAGAGTAACAAGCC

               2054                                              2103
Wombat         AGATGACCAAGCAGAAGAAAGTTGTATCAGTGAAGTTTTCCCAGAACTAA
Echymipera     ATATGACCAAGCAGAAGAAAGATGTGTCAAGAAGGTTTTCCCAGAATTGG
Phascogale     AGATGATCAAGCAGAAGAAAGTTGTATCACTGAAGTTGTCTCAGAACTAA
Shrew_Opossum  AGATGAAGAAGTGGAAGAGAATTGTGTCAATGAAGTTTCCCCAGAACTAA
Human          AAATGAACAGACAAGTAAAAGACATGACAGCGATACTTTCCCAGAGCTGA

               2104                                              2153
Wombat         AAATAGGAAACGTGCCTGCCTGTGCTACTGACAGTCTAACTACTGATAGG
Echymipera     AAATGGGAACTGTGTCTGCTGGTGCTACTGACAGCCTATCTACTGATAGG
Phascogale     AATTAGGAAATCTACCTGCCTGTGCTCCTGACAATGTCAGTACTGATAAG
Shrew_Opossum  AAATAGGAAAAGTATCTGCCTGTTCTACTGACAGTCTAGCTACTGATAGT
Human          AGTTAACAAATGCACCTGGTTCTTTTACTAAGTGTTCAAATACCAGTGAA

               2154                                              2203
Wombat         GATCAAGTGTTAGCTAGCTGCAGTTTCACAGAAGAAAGAGATGAAAGGAG
Echymipera     GATGAAGTGTTAGCTAGTTGCAGTTTCACAGAT---GGAGAGGAAAGGAA
Phascogale     GATCAAGTATTAGCTAGTTGCAGTTTCACA------GGAGATGAAAGGAG
Shrew_Opossum  GATCTGGTATTAGCTAGCTGCAGTTTCACAGAA---GGAGATGAAAAGAG
Human          CTTAAAGAATTTGTCAATCCTAGCCTTCCAAGAGAAGAAAAAGAAGAGAA

               2204                                              2250
Wombat         CCTGGAAGCAATCCCAAGCAGCAAA---------GACCAAGAT------C
Echymipera     CCTGGAAGTAATCCCAAGCAGCAAA---------GACCAAGACCAAGATC
Phascogale     TCTGGAAGTAATCCCTAGCAGCCAA---------GACCAAGAT------T
Shrew_Opossum  CCTGGAAGCCTTCCAGCCCAGCAGA---------GACCAAGACAGC---C
Human          ACTAGAAACAGTTAAAGTGTCTAATAATGCTGAAGACCCCAAA---GATC

               2251                                              2300
Wombat         TGCCCTTGAATGGAGGGGAGGGGTTGCAAGGTGAAAGAGCCCCAGGAAGC
Echymipera     TGGCATTAAGTGAAAGGGAAAGGTTGCAAGAAAAAAGAACCCAAGGAAAC
Phascogale     TGGCATTGAGTGGAAAGGAAGGGTTGCAAGGTGAAATATCTCAAGGAAGC
Shrew_Opossum  TGGCAGTAAGCAGAGGAGAGAAGTTGCAAGGGAAAAGAACCAAAGGAAAC
Human          TCATGTTAAGTGGAGAAAGGGTTTTGCAAACTGAAAGATCTGTAGAGAGT

               2301                                              2350
Wombat         CTGGAGGCTTTGGAGGTTCCTGATACTGATTGGGACACTCAGGACAGTAC
Echymipera     CTGGAGCTTCTGGAGGTTCCAGATACTTATTGGGAAACTCAAGACAGTAC
Phascogale     CTGGGGACTGTGGAGGTTCCTGATACTGCTTGGGACACTCAGGACAGTAC
Shrew_Opossum  ATGGAGGTTTTGGAGGTTGCCAGTACTGATTGGGACACTCAGGACAGCAC
Human          AGCAGTATTTCATTGGTACCTGGTACTGATTATGGCACTCAGGAAAGTAT

               2351                                              2400
Wombat         CTCATTGTTTCCAGCTGATACTCCCCAAAATTCAAAAGCAGGACCCAGTC
Echymipera     TTCACTGTTTCCAGCTGAAACTCCCCAGAATTCAAAAGCAGGACCCAGTC
Phascogale     CTCGTTGTTTCCAGCTGATACTCCTCAAAATTCAAAACCAGGTCCCAGTC
Shrew_Opossum  CTCATTGTTTCCAACCGATGTTCCCCCAAATCCAACAGCAGACTCTGGCC
Human          CTCGTTACTGGAAGTTAGCACTCTAGGGAAGGCAAAAACAGAACCAAATA
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                         2401                                            2450
Wombat                   CTCACAGAAGCCACAGTGAAATAATGGAAACCCCCAAGGAACTCTTAGAT
Echymipera               CTCACAGAAGTAACTGTGAAATAATGGAATCCTCCAAAGAACTCTTCGAT
Phascogale               CTCACAGAAATCACTGTGAAATAATGGAAACCCCCAAGGAACTCTTAGAA
Shrew_Opossum            CACACAGAAATCAACATGAGGTCATAGAAACCCCCAAGGAACTCTTTGAT
Human                    AATGTGTGAGTCAGTGTGCAGCATTTGAAAACCCCAAGGGACTAATTCAT

                         2451                                            2497
Wombat                   GGTTGTTCATCCAAAAACACTGAAAGTGACGAAGAAGATTTGAGGAGCCT
Echymipera               GCTTATTCATCCAAAAACACTGACAGTGGCACTGAAGGT---------TT
Phascogale               AGTAGTTCATCCAAAAACACTGAAAGTAGTGTAGAAGATTTAAGGAGCCT
Shrew_Opossum            GATTGCTCATCCAAAAACACCGGAAGTGGTAAAGAAGAT---------TT
Human                    GGTTGT---TCCAAAGATAATAGAAATGACACAGAAGGCTTTAAGTATCC

                         2498                                            2547
Wombat                   GATGAGACAGGAAGTTAAAAATGCCTCCAAGACAACCACAGAAATGGAGG
Echymipera               GATAAGACAGGAAATTAAATATGGCTCTGAGACATCTTCAGTAATGGAGG
Phascogale               GATGAAACAAGAAGTTAAAAATGCCTCCAAGACAATCACAGAAATGGAGG
Shrew_Opossum            GACAAGACAAGAAGTCAAAAATACCTCAGAGACAACCACAGAGATAGAGG
Human                    ATTGGGACATGAAGTTAACCACAGTCGGGAAACAAGCATAGAAATGGAAG

                         2548                                            2597
Wombat                   ATAGTGAACTCGACACCCAGTATTTACAAAATACCTTCAAACGTTCAAAG
Echymipera               ATAGTGAACTTGACACCCAGTATTTGCAGAATACCTTCAAACGTTCTAAG
Phascogale               ATAGTGAACTTGACACCCAGTATTTACAGAATACTTTCAAGCGTTCAAAG
Shrew_Opossum            ACAGTGAACTTGATACCCAATATTTACAGAATACCTTCAAACGTTCAAAA
Human                    AAAGTGAACTTGATGCTCAGTATTTGCAGAATACATTCAAGGTTTCAAAG

                        2598                                             2647
Wombat                   CGCCAGTCATTTGCTCTGCGTTCTAGCCCA---------AGGCAGGAATG
'Red_Kangaroo__GB_'      --------------------------------------------------
'Red_Kangaroo__CJR_'     --------------------------------------------------
Wallaroo                 --------------------------------------------------
Tree_kangaroo            --------------------------------------------------
Echymipera               CGCCAAACATTTGCTCTGTGTTCCAACCCA---------AAGCAGGAACA
Phascogale               CGCCAGTCATTTGCACTGTGTTCTAGCCCA---------AGGCAAGAATA
Shrew_Opossum            CGCCAATCATTTGCTCTGTGTCCCAGTCCA---------AGGCAGACAAG
Virginia_Opossum         --------------------------------------------------
Human                    CGCCAGTCATTTGCTCCGTTTTCAAATCCAGGAAATGCAGAAGAGGAATG

                         2648                                            2697
Wombat                   TAGGAAACCCTCTGCTGTCCCTGGGACTGTAAATCAGCAGAGTCCAGATA
Echymipera               GATAAAACCCTGCTCTGTTCCTAGGGCTGTCAGCCACCAGAGTTCAGATA
Phascogale               TGTGAAAACCTGTGCTGTCCCTGGGGCTATAAGTCAGCAAAGT-------
Shrew_Opossum            TATGAAACTCCGGTCCATCCCTAGAGCTCTAAGTCATCAGAGCCCAGATA
Virginia_Opossum         --------------------------------------------------
Human                    TGCAACATTCTCTGCCCACTCTGGGTCCTTAAAGAAACAAAGTCCAAAAG

                         2698                                            2744
Wombat                   ACACCACAGATTGTGGGGGCCAGGAAAAAGAAAAGCAGGGAAACAGAGAA
Echymipera               ATGCCTCAGACTGTGGGGGCCAAGAAAAAGAAAAGCAAGGAAACAGAGAA
Phascogale               -----ACAGTTCGTAGGTACCAGGAAAAAGAAAAGCAAGAAAACAGAGAA
Shrew_Opossum            AAGCCACGAATCATGGGGGGCAGGAAAAAAAAAAGCAGGGAAGCAGAGAA
Virginia_Opossum         --------------------------------------------------
Human                    TCACTTTTGAATGTGAACAAAAGGAAGAAAAT---CAAGGAAAGAATGAG

                        2745                                             2794
Wombat                   TCAAACAAGCCTGTGTGGCCAAAGTCTGCAGTCATGAGCTTAGCTGCGGC
Echymipera               TCAAATAAACCTGGCCAACTAGCATCTGCAGTCAGGAGCTCAGCTGCCAC
Phascogale               TCAAACAAGCCTGTGCAGCCAAAGCCTGCTGTTGTG--------------
Shrew_Opossum            TCAGACAAGGCTGTGCAGCCAGAACTTGCAGTCATGAGTTCAGCTGCGGT
Human                    TCTAATATCAAGCCTGTACAGACAGTTAATATCACTGCAGGCTTTCCTGT
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                2795                                           2841
Wombat          TTGTCAGACAGAGGAGAGGAAGCCAGGTGTTTATGCCAAATGTAGCACCA
Echymipera      TTGTCAGACAGAG---AGGAAGCCAGGTGATCCTGACAAATGTAGCGCCA
Phascogale      -------ATAGAGAAGGGGAAGCCAGGTGATCATGCCAAATGGAGCACCA
Shrew_Opossum   TTGTCAGACAAAGGAGAAAAAGCCAGGTGATTATGCCAAATGTAGCACA-
Human           GGTTGGTCAGAAAGAT---AAGCCAGTTGATAATGCCAAATGTAGTATCA

                2842                                           2888
Wombat          CAGAAGTGTCCAGGCTTTGTCACATAGCTCCATTACATGGTGTCATTGAC
Echymipera      CAGGAGTTTCCAGACTTTGTCACATAGCTCCATTACAAGAAGGCAATGAC
Phascogale      GAGAAGTCTCCAGGCTTTGTCACATAGCTTCATTAAATAGTGGCAATGAC
Shrew_Opossum   -----GTCTCTAGGCTTTGTCACATAGCTCCATTACATGATGACAATGAC
Human           AAGGAGGCTCTAGGTTTTGTCTATCATCTCAGTTC---AGAGGCAACGAA

                2889                                           2938
Wombat          TGTGAACACATTGCTGGAAACAACCAGGGAATTTCGCAAGTTCCTGATCA
Echymipera      TGTGAATACATTGCTGGAAAAAAACAGGGAATTTCACAAGTTCCTAATCA
Phascogale      TGTGAACCCATTGCTGAAATCAACCAGGGAATTTCACAAGTTCCTGATCA
Shrew_Opossum   TGTGACCACAGTGCTGAAAACAACAAGGGAATTTCACAAGTTCCTGATCA
Human           ACTGGACTCATTACTCCAAATAAACATGGACTTTTACAAAACCCATATCG

                2939                                           2985
Wombat          AAAACCATCAGTTTCTCCAGCAAGGTCATCTGCTAGTAAAACTATAAATA
Echymipera      AAAACAATCAGTTTCTCCGACAAGGTCATCAGTTAGTAAA---ATATATA
Phascogale      AAACCAATCAGTTTCTCCAGCAAGGTCATCTGATAGTAAAACCATATATG
Shrew_Opossum   AAAGCAATCTGTCTCTCCAGCAAAGTCATCAGCTGGTAGATCTATATACA
Human           TATACCACCACTTTTTCCCATCAAGTCATTTGTT---AAAACTAAATGTA

                2986                                           3035
Wombat          CAAAAAACCTCCTGGAGGAAAGGCTTGATGAACAGACCACATGTCCTGAA
Echymipera      CAAAAAACCTCTTGAAAGATAGACTT---GAACAGACCACATGCCCTGAA
Phascogale      CAAAAAACTTCCTGGAGGAAAGGCTTGATGAGCAAACCACGTGCCCTGAA
Shrew_Opossum   CAAAAAGCCTCCTGGAGGAAAGACTTGATGAACAGACCACATGTCCCGAA
Human           AGAAAAATCTGCTAGAGGAAAACTTTGAGGAACATTCAATGTCACCTGAA

                3036                                           3082
Wombat          ACAGCTATGGGAAATGAAAGCTTAGCCCAAAGCAGCTTAAGTCCAGTAAG
Echymipera      ACAGTTATGGGAAATGAAAGCTTAGGCCAAAGCAGCTTAAGTCCAGTTAG
Phascogale      ACAACTATGGGAAATGAAAGCTTAGCCCAAAGCAGCATTAGTTTAGTTAG
Shrew_Opossum   ACAGTGATGGGAAATGAAAGCTTAGTCCACAGTAGCTTAAGCCTGGTTAG
Human           AGAGAAATGGGAAATGAGAACATT---CCAAGTACAGTGAGCACAATTAG

                3083                                           3132
Wombat          CCAAAGTAATAGCAGAGAATATATTTCTAAAGCAACTGACTTAAATAGAT
Echymipera      CCAAAATAACAGCAGAGAATATATTTCTAAAGCAACTGACTTAAATAGAT
Phascogale      TCAAAGTAATAGCAGAGAATATGTTTCTAACCCAATTGACTTA------A
Shrew_Opossum   CCAAAGTAACAGCGGAGAATATATTTCTAAAGCAACTGACTCAAACAGAT
Human           CCGTAATAACATTAGAGAAAATGTTTTTAAAGAAGCCAGCTCAAGCAATA

                3133                                           3182
Wombat          TT------------------------------------------ATCAGC
Echymipera      TT------------------------------------------ATTAGC
Phascogale      TT------------------------------------------ATCAGC
Shrew_Opossum   TT------------------------------------------GTTGGT
Human           TTAATGAAGTAGGTTCCAGTACTAATGAAGTGGGCTCCAGTATTAATGAA

                3183                                           3232
Wombat          ATAGGCTCTAGTGGAGAAGGCAGTCAGGCACAAAAAGGTGAAAACAAAGA
Echymipera      AGGGACTCTAGTGGAGAAGACAGTCGGGCAGAAAAAGGTAAAATCAAAGA
Phascogale      GTAGGCTCCAGTGGAGAAGGCACTCAGGCAGAAAAAAGTGAAAACAAAGA
Shrew_Opossum   GTAGACTCTAGCGGAGAAGGTAGTCAGGAAGAAAAAGGTGAAAACAAA--
Human           ATAGGTTCCAGTGATGAAAACATTCAAGCAGAACTAGGTAGAAACAGAGG
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                 3233                                            3282
Wombat           ATCTGAATTAAATACACAACCCAAATTAAAGCTTGTGCAACCCCAAATCT
Echymipera       ATCTGAATTAAATACACCAACCAAATTCAAACTTGTGCAACCACAAGTAT
Phascogale       ATCTGAATTAAATACACCACCCAAATTAAAGCTTATGCAACCCCAAGTCT
Shrew_Opossum    -------TTAAAT------------------------CAGTCCCAAGTCT
Human            GCCAAAATTGAATGCTATGCTTAGATTAGGGGTTTTGCAACCTGAGGTCT

                 3283
Wombat           GTCAACAAAGCTTTCCTCAGGATAATTGC
Echymipera       GTCAACTAAGCTTTTCTCAGGATAATTGC
Phascogale       CTCAACAGACCTTTCCTCAGAATAATTGC
Shrew_Opossum    GTCAACAAAGC
Human            ATAAACAAAGTCTTCCTGGAAGTAATTGT
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Appendix D: Mammal Alignment of BRCA1 exon 11 amino acids 282 to 1162 from 36 eutherian ancestral sequences and eight marsupials

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                         282                                              331
HPG                      SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQHNRWAGSKETCNDR
Great_Apes               SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQHNRWAGSKETCNDR
OWMonkeys                SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQHNRWAGSKETCNDR
Monkeys                  SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQHNRWAESKETCNDR
Primates                 SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDR
'+Tupaia'                SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDR
Tamadua_Bradypus         SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDR
Armadillos               LLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARRQQSRWAESKETCNDR
EuarchLauraXen           SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDR
Elephants                SLQHKNSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDR
Hyraxes                  SLQHENSSLLLTKDRMDVEKAEFCSKSKQPGLARSQQSRWAESTETCNDR
Sirenia                  SLQHENSSLLLTKDRMNVEKAEFCHKSKQPGLARSQQSRWAESKETCNDR
TE_Amblysomus            SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDK
Macroscelidae            SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDR
Orycteropus_TEAM         SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDR
'+Cynocephalus'          SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDR
Myotis_Tadarida          SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDR
Taphozous_Tonatia        SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDR
Pteropus_Cynopterus      SLQHENSSLLYTKDRMNVEKTDFCNKSKQPGLARSQQNRWVETKETCNDR
Megaderma_Hipposideros   SLQHENSSLLLTEDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDR
Manis_C                  SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDR
Carnivores               SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDR
Cetacea                  SLQHENSSLLLTKDRMNVEKAEFCNKSKQPVLAKSQQSRWAESKDTCNDR
BHC                      SLQHENSSLLLTKDRMNVEKAEFCNKSKQPVLAKSQQSRWAESKDTCNDR
Sus_BHC                  SLQHENSSLLLTKDRMNVEKAEFCNKSKQPVLAKSQQSRWAESKDTCNDR
Perissodactyla           SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLAKSQQSRWAESKETCNDR
Insectivores             SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDR
Glires                   SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDR
Sciurus_Glaucomys        SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAKSKETCNDR
Aplodontia_SG            SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAKSKETCNDR
ASG_Graphiurus           SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDR
Hystrix_OMMR             SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDR
Pedetes_OMMR             SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDR
Mus_Rattus               SLQHETSSLLLTEDRMNAEKAEFCNKSKQSGVAVSQQSRWAESKETCNDR
Meriones_MR              SLQHENSSLLLTEDRMNVEKAEFCNKSKQSGLARSQQSRWAESKETCNDR
Oryzomys_MMR             SLQHENSSLLLTEDRMNVEKAEFCNKSKQSGLARSQQSRWAESKETCNDR
Tenrec_Echinops          SLQRENCSLLLTKDRLNVEKAGFCNESKQPGLARSQHSRWAESKETCNDK
Wombat                   SLLPKTSSLLPNTDRMNVEKAELCHKNKQPALGRNQESSLDESKEICSPG
Phascogale               SLLPETSSLLPNTDRMS-EKAELSNKSKQSGLARNQQSRLDESKGICSTG
Echymipera               SLMLETSSLLSNIDRMTTKKAELCNKSKDPGLARNQQDCLGESKEISSTV
Shrew_Opossum            SLLPEITSLLPNTDRMNVEKAELCNKSKQPGLASNQQSNLDESKEICSAS
Red_Kangaroo             SLLPETTSLSPNTDRMNVEKAELCNKSKQPGLAKNQQSSLDESKEICSAG
Wallaroo                 SLLPETTSLSPNTDRMNVEKAELCNKSKQPGLAKNQQSSLDESKEICSAG
Tree_Kangaroo            SLLPETTSLSPNTFQMNVEKAELCNKSKQPGLAKNQQSSLDESKEICSAG
Possum                   SLLPDITSVLPNTDSMNVEKAELCDKSKRPDLAWSQQISQDESKEKCIAG
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                          332                                            379
HPG                       RTPSTEKKVDLNADPLCERKEWNKQKLPCSENPRDTED--VPWITLNSSI
Great_Apes                QTPSTEKKVDLNADPLCERKEWNKQKLPCSENPRDTED--VPWITLNSSI
OWMonkeys                 QTPSTEKKVDLNADPLYERKEWNKQKLPCSENPRDTED--VPWITLNSSI
Monkeys                   QTPSTEKKVDLNADPLYGRKEWNKQKPPCSENPRDTED--VPWITLNSSI
Primates                  QTPSTEKKVDLNADPLYGRKERNKQKPPCSENPRDTQD--VPWITLNSSI
'+Tupaia'                 QTPSTEKKVDLNADPLYGRKERNKQKPPCSESPRDTQD--VPWITLNSSI
Tamadua_Bradypus          QTPSTEKKVDVDADPLYGRKELNKQKPPCSESPRDTQD--IPWITLNSSI
Armadillos                QTPSTEKKVDVDADPLYGRKELNKQKPPCSESPRDTQD--IPWITLNSSI
EuarchLauraXen            QTPSTEKKVDLNADPLYGRKELNKQKPPCSESPRDTQD--IPWITLNSSI
Elephants                 QTPSTEKKVDVNADPLYERKEVNKQKPPRSENLRDTQD--IPWITLNSSI
Hyraxes                   QILRTEKKVDTNADPLYGKKEGNKQKPPCSESRTDTQD--IPWVTLNNSI
Sirenia                   QTPSTEKKVDMNANPLYERKEVNKQKPPCSESVRDTQD--IPWLTLNSSI
TE_Amblysomus             QTPSTEKKVDMNADPLYGRKEVNKQKPPCSESPRDTQD--IPWITLNSSI
Macroscelidae             QTPSTEKKVDMNADPFYGRKEVNKQKSPCSESPKDTQD--IPWMTLNSSI
Orycteropus_TEAM          QTPSTEKKVDMNADPLYGRKEVNKQKPPCSESPRDTQD--IPWITLNSSI
'+Cynocephalus'           QTPSTEKKVDLNADPLYGRKERNKQKPPCSESPRDTQD--VPWITLNSSI
Myotis_Tadarida           QTPSTEKRVVLNADPLNGRKE-----PPCSDYPRDSQD--VPWITRSSSI
Taphozous_Tonatia         QTPSTEKRVVLNADPLNGRKE-----PPCSDCPRDSQD--VPWITRNSSI
Pteropus_Cynopterus       QTSSTEKKVVLNADPLNGRIELNKQKPPCSDSPRDSQD--IPWITRNSSI
Megaderma_Hipposideros    QTPSTEKKVVLNADPLNGRKELNKQKPPCSDSPRDSQD--VPWITRNSSI
Manis_C                   QTPSTEKKVVLNADPLCGRKELNKQKPPCSDSPRDSQD--VPWITLNSSI
Carnivores                QTPSTEKKVVLNADPLCGRKELNKQKPPCSDSPRDSQD--VPWITLNSSI
Cetacea                   QTPSTEKKVVLNADPLYGRKELNKQKPACSDSPRDSQE--FPWITVNSSI
BHC                       QTPSTEKKVVLNADPLYGRKELNKQKPACSDSPRDSQD--VPWITLNSSI
Sus_BHC                   QTPSTEKKVVLNADPLYGRKELNKQKPACSDSPRDSQD--VPWITLNSSI
Perissodactyla            QTPNSEKKLVLNADPLYGRKELNKQKPPCSDSPRDSQD--VPWITLNSSI
Insectivores              QTPSPEKKVDLNADPLYGRKELNKQKPPCSDSPRDSQD--VPWITLNSSI
Glires                    QTPSTEKKVDLNADPLYGRKERNKQKPPCSENPRDTQD--VPWITLNSSI
Sciurus_Glaucomys         QTPSTEKKVDLNADPQYERKEPSKQKPPCSENSRDTQD--VPWITLNSSI
Aplodontia_SG             QTPSTEKKVDLNADPLYERKEPSKQKPPCSENPRDTQD--VPWITLNSSI
ASG_Graphiurus            QTPSTEKKVDLNADPLYGRKERNKQKPPCSENPRDTQD--VPWITLNSSI
Hystrix_OMMR              QTPSTEKKVDLNADPLYGRKERNKQKPPCSENPRDTQD--VPWITLNSSI
Pedetes_OMMR              QTPSTEKKVDLNADPLYGRKERNKQKPPCSENPRDTQD--VPWITLNSSI
Mus_Rattus                QVPSTEEKVDPNADSLCGRKKWNHPKSLCPENSGATTD--VPWITLNSSI
Meriones_MR               QIPSTEKKVDPNADSLCGRKKWNNQKSLCPENSGATQD--VPWITLNSSI
Oryzomys_MMR              QIPSTEKKVDLNADSLCGRKKWNNQKSLCPENSRATQD--VPWITLNSSI
Tenrec_Echinops           PTPSTEKKVDMNADPVHGRKGVPKQKPPCHESPRKSHD--VPWKTRKSSI
Wombat                    KTPGACERHELNDHHLCERQGLE-EKPQHPESPRGNPQNCLSGTKLKSSI
Phascogale                KTPSVGEQPELNAHHLCEKQELK-EKPQGPEGPRGNPQNCLSGTKLKSSI
Echymipera                KTPAAGEQHKLNAHHLCEKQELE-VKSQHPESPKGSPRRCRSGTKLKSSI
Shrew_Opossum             KTPGAEEQPELNANHLCERKELE-EKLQCPESPRGDSGDCLSGTKVKNSI
Red_Kangaroo              KTLGA---HELNAHHPCERKELE-DEPQHPESPRGNPQNCQSGTKLKSSI
Wallaroo                  KTLGA---HELNAHHPCERKELE-DEPQHPESPRGNPQNCQSGTKLKSSI
Tree_Kangaroo             KTLGA---HELNAHHPCERKELE-DEPQHPESPRGNPQNCQSGTKLKSSI
Possum                    KTSDAKELHELNAHHLYERQELE-EQPECPNYPRGNSQNCLSGTKLK-SI
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                        380                                             427
HPG                     QKVNEWFSRSDELLGSDDSHDGGSESNAKVADVLDV--LNEVDEYSGSSE
Great_Apes              QKVNEWFSRSDELLGSDDSHDGGSESNAKVADVLDV--LNEVDEYSGSSE
OWMonkeys               QKVNEWFSRSDELLSSDDSHDGGSESNAKVADVLDV--LNEVDEYSGSSE
Monkeys                 QKVNEWFSRSDELLTSDDSHDGGSESNAKVADALEV--LNEVDGYSGSSE
Primates                QKVNEWFSRSDEMLTSDDSHDGGSESNAEVAGALEV--PNEVDGYSGSSE
'+Tupaia'               QKVNEWFSRSDEMLTSDDSHDGGSESNAEVAGALEV--PNEVDGYSGSSE
Tamadua_Bradypus        QKVNEWFSRSDDILTSDDSHNGGSESNAEVAGALKV--PNEVDGYSGSSE
Armadillos              QKVNEWFSRSDDILTSDDSHDGGSESNAEVAGALKV--PNEVDGYSSSSE
EuarchLauraXen          QKVNEWFSRSDDMLTSDDSHDGGSESNAEVAGALEV--PNEVDGYSGSSE
Elephants               QKVNEWFFRSDGL---DVLNDEGPESSAEVAGALEV--PNEVH--SNSSE
Hyraxes                 QKVNEWFSRSDNL---SDSPSEGSELNGKVAGPVKL--PGEVHRYSSFPE
Sirenia                 QKVNEWFFRSDGL---DDLHDKGSESNAEVAGALEV--PEEVHGYSSSSE
TE_Amblysomus           QKVNEWFSRSDGL---DDSHDEGSESNAEVAGAFEV--PNEVHGYSSSSE
Macroscelidae           QKVNEWFSRSDGL---DDSHDEGSESNAAIAGALEV--PNEVHGYSSSSE
Orycteropus_TEAM        QKVNEWFSRSDGL---DDSHDEGSESNAEVAGALEV--PNEVHGYSSSSE
'+Cynocephalus'         QKVNEWFSRSDEMLTSDDSHDGGSESNAEVAGALEV--PNEVDGYSGSSE
Myotis_Tadarida         QKVNEWFSRRDEILTSDGSHNGRSESNAEVAGAVEV--PNEVDGYSGSPE
Taphozous_Tonatia       QKVNEWFSRRDEILTSDGSHDGRSESNTEVAGAVEV--PNEVDGYSGSPE
Pteropus_Cynopterus     QKVNEWFSRRDEILTSDVSPDGRSESN-----VVEV--PNEVDGYSGASE
Megaderma_Hipposideros  QKVNEWFSRRDEILTSHGSHDGRAESNTEVAGAVEV--PNEVDGYSGSSE
Manis_C                 QKVNEWFSRSDEMLTSDDSHDGGSESNTEVAGAVEV--PNEVDGYSGSSE
Carnivores              QKVNEWFSRSDEMLTSDDSHDGGSESNTEVAGAVEV--PNEVDGYSGSSE
Cetacea                 QKVNEWFSRSDEMLTSNDSRDGGFESNTEVACAVEV--PKEVDGYLGSSE
BHC                     QKVNEWFSRSDEMLTSDDSRDGGSESNTEVAGAVEV--PNEVDGYLGSSE
Sus_BHC                 QKVNEWFSRSDEMLTSDDSHDGGSESNTEVAGAVEV--PNEVDGYLGSSE
Perissodactyla          QKVNEWFSRSDEMLTSDDSHDGGPESNTEVAGAVEV--PNEVDGYSGSSE
Insectivores            QKVNEWFSRSDEMLTSDDSHDGGSESNTEVAGAVEV--PNAVDGFSGSSE
Glires                  QKVNEWFSRSDEMLTSDDSHDGGSESNAEVAGALEV--PNEVDGYSGSSE
Sciurus_Glaucomys       RKVNEWFSRSDEMLTSDDSDDGGSESNAEVAGVLEI--PNEVDGFSGSSE
Aplodontia_SG           QKVNEWFSRSDEMLTSDDSHDGGSESNAEVAGVLEI--PNEVDGFSGSSE
ASG_Graphiurus          QKVNEWFSRSDEMLTSDDSHDGGSESNAEVAGALEV--PNEVDGYSGSSE
Hystrix_OMMR            QKVNEWFSRSDEMLTSDDSHDGGSESNAEVAGALEV--PNEVDGYSGSSE
Pedetes_OMMR            QKVNEWFSRSDEMLTSDDSHDGGSESNAEVAGALEV--PNEVDGYSGSSE
Mus_Rattus              QKVNEWFSRTGEMLTSDSASDRRPASNAEAAVVLEV--SNEVDGCFSSSK
Meriones_MR             QKVNEWFSRTGEMLTSDSASDRRPASNAEAAVALEV--SNEVDGCFSSSK
Oryzomys_MMR            QKVNEWFSRTGEMLTSDGASDRRPESNAEAAVALEV--SNEVDGCSSSSK
Tenrec_Echinops         WKVNEWFSKSDGL---GDSHDERPESDADVAGAFEV--PDEARESSSSPE
Wombat                  QKVNEWLSRSSDILASDNSNGRSHEQSAEVPSALEDGHPDTAEGNSSVSE
Phascogale              QKVNEWLSRSNDILASDCSLDKNHKQNAEIASALEDGHPDNSDGNSSISE
Echymipera              QKVSEWLSRSNDILNSDYSHERSQEQNAEIAIALEDGHLNTADGNSSISE
Shrew_Opossum           QKVNEWLFRSNDVLAPDYSSVRSHEQNAEATNALEYGHVET-DGNSSISE
Red_Kangaroo            QKVNEWLSRSNDILTSDNSCSRNHEQNVEMPSALEDGYPDTADGNSNISE
Wallaroo                QKVNEWLSRSNDILTSDNSYSRNHEQNAEMPSALEDGYPDTADANSNISE
Tree_Kangaroo           QKVNEWLSRSNDILISDNSYSRNHEQNAEMPSALEDGYPDTADGNSNISE
Possum                  QKVNDWLSKSNDILVSDYSSGRIHEQNAEMDSVLEDGHPDVTDGNSSISG
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                          428                                            475
HPG                       KIDLLAS-DPHEALICKSERVHSKSVESN-IEDKIFGKTYRRKASLPNLS
Great_Apes                KIDLLAS-DPHEALICKSERVHSKSVESN-IEDKIFGKTYRRKASLPNLS
OWMonkeys                 KIDLLAS-DPHEPLICKSERVHSKSVESN-IEDKIFGKTYRRKASLPNLS
Monkeys                   KIDLLAS-DPHDPLICKSERVHSKSVESN-IEDKIFGKTYRRKASLPNLS
Primates                  KIDLLAS-DPHDPLICKSERVHSKPVESN-IEDKIFGKTYRRKASLPNLS
'+Tupaia'                 KIDLMAS-DPHDALICKSERVHSKPVESN-IEDKIFGKTYRRKASLPNLS
Tamadua_Bradypus          KIDLIAS-DPHNALIFASERVQSKPTESN-IEDKIFGKTYHRKASLPNLS
Armadillos                KIDLMAS-DPHNALIFASERVQSKPAESN-IKDKIFGKTYHRKASLPNLS
EuarchLauraXen            KIDLMAS-DPHDALICESERVHSKPAESN-IEDKIFGKTYRRKASLPNLS
Elephants                 KIDLMAS-DLHGALICESERVPSKPAESN-IEDKIFGKTYRRKAGISHLS
Hyraxes                   NIDLMAS-GPPGDLICESERIPCKPPKSN-IKDKIFGKTYQRKGSLPHLS
Sirenia                   KIDLMAS-DPHSALICESERVLSKPAESN-IEDKIFGKTYRRKAILPHLS
TE_Amblysomus             KIDLMAS-DPHDALICESERVLSKPAESN-IEDKIFGKTYRRKASLPNLS
Macroscelidae             KIDLMAS-DPHDASICESERVLSKPAENN-IEDKIFGKTYRRKASLPNLS
Orycteropus_TEAM          KIDLMAS-DPHDALICESERVLSKPAESN-IEDKIFGKTYRRKASLPNLS
'+Cynocephalus'           KIDLMAS-DPHDALICKSERVHSKPVESN-IEDKIFGKTYRRKASLPNLS
Myotis_Tadarida           KIALMAS-DPHGALICESERVHSKPVESN-IEDKIFGKTYRRKASLPNLS
Taphozous_Tonatia         KIALMAS-DPHGALICESERVHSKPVESN-IEDKIFGKTYRRKASLPNLS
Pteropus_Cynopterus       KIALKAS-DPHGALIC--ERVHSKLVESN-IEDKIFGKTYRRKASLPNLS
Megaderma_Hipposideros    KIALMAS-DPHGALICESERVHSKPVESN-IEDKIFGKTYRRKASLPNLS
Manis_C                   KIDLMAS-DPHDALICESERVHSKPVESN-IEDKIFGKTYRRKASLPNLS
Carnivores                KIDLMAS-DPHDALICESERVHTKPVESN-IEDKIFGKTYRRKASLPNLS
Cetacea                   KIDLMAS-DPHGALIRESERVHSKPVESN-IEDKIFGKTYRRKASLPNLS
BHC                       KIDLMAS-DPHGALIRESERVHSKPVESN-IEDKIFGKTYRRKASLPNLS
Sus_BHC                   KIDLMAS-DPHGALIRESERVHSKPVESN-IEDKIFGKTYRRKASLPNLS
Perissodactyla            KIDLMAS-DPPGALICESERVHSKPVENN-IEDKIFGKTYRRKASLPNLS
Insectivores              KIDLMAS-DPHGALICESERVHSKPVESN-IEDKIFGKTYRRKASLPNLS
Glires                    KIDLLAS-DPHNALICKSERVHSKPVESN-IEDKIFGKTYRRKASLPNLS
Sciurus_Glaucomys         KIDLLAT-DPHNALISKCERVCSKAVESN-IEDKIFGKTYRRKASLPNLS
Aplodontia_SG             KIDLLAT-DPHNALISKCERVCSKAVESN-IEDKIFGKTYRRKASLPNLS
ASG_Graphiurus            KIDLLAS-DPHNALICKSERVCSKPVESN-IEDKIFGKTYRRKASLPNLS
Hystrix_OMMR              KIDLLAS-DPHNALICKSERVCSKPVESN-IEDKIFGKTYRRKASLPNLS
Pedetes_OMMR              KIDLLAS-DPHNALICKSERVCSKPVESN-IEDKIFGKTYRRKASLPNLS
Mus_Rattus                KTDLVAP-DPHNALMCKSGRDFSKPVENN-INDKIFGKTYQRKGSRPHLN
Meriones_MR               KTDLVAP-DPHNALMCKSERDFSKPVENN-IKDKIFGKTYQRKGSLPHLN
Oryzomys_MMR              KTDLVAT-DPHNALMCKSERDCSKPVENN-IKDKIFGKTYQRKGSLPHLN
Tenrec_Echinops           KTDLMAS-DPHVPLLHKSERVLSKPVESN-IEDKIFGKTYRRKSSLLNSS
Wombat                    KTDPVAD-STDDAWLHVPKRSCLRPAENN-IEDKIFGKTYRRKSGHPNLN
Phascogale                KTDVVAD-TADGAWLHVPKRTYTRPAENNNIKDKIFGKTYRRKSGHPNLN
Echymipera                KT-LVA--TTD-----VLETS-SRPAKSN-IEDKIFGKTYRRKS-HSNLN
Shrew_Opossum             KTDMVAD-STDGSWLHAPEKNCPRPAESNNIEDKIFGKTYRRKSVHPVLN
Red_Kangaroo              KTDPVAD-ITYDPWPHVPERSCPRPAENNNIEDKIFGKTYRRKSGHPHLN
Wallaroo                  KTDPVAD-ITYDPWPHVPERSCPRPAENNNIEDKIFGKTYRRKSGHSHLN
Tree_Kangaroo             KTDPVADNNTYDPWPHVPERSCPRPAENNNIEDKIFGKTYRRKSGHPHLN
Possum                    KTDLVAD-STDGAWLHMSERSCSRKAESNNIEDKIFGKTYHRKSVHINLN
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                          476                                             524
HPG                       HVTENLIIGAFV-TEPQIIQERPLTNKLKRKRRATSGLHPEDFIKKADLA
Great_Apes                HVTENLIIGAFV-TEPQIIQERPLTNKLKRKRRATSGLHPEDFIKKADLA
OWMonkeys                 HVTENLIIGAFV-TEPQIIQERPLTNKLKRKRRATSGLHPEDFIKKADLA
Monkeys                   HVTENLIIGAFV-TEPQIIQERPLTNKLKRKRRATSGLHPEDFIKKADLA
Primates                  HVTENLIIGAFA-TEPQITQERPLTNKLKRKRRTTSGLHPEDFIKKADLA
'+Tupaia'                 HVTEDLIIGAFA-TEPQITQERPLTNKLKRKRRTTSGLHPEDFIKKADLA
Tamadua_Bradypus          HIAEDLFIGAIA-TEPKITQEHPLTNKIKRKRRTTSGLHPEDFIKKVDLT
Armadillos                HITEDLFIGAIA-TEPKITQEHSLTNKIKRKRRTTSGLHPEDFIKKVDLT
EuarchLauraXen            HVTEDLIIGAVA-TEPQITQERPLTNKLKRKRRTTSGLHPEDFIKKVDLA
Elephants                 HITEDLIMGAIA-SEPQIAREHPFTNKLKRKRR-TSGLHPEDFIKKVDLA
Hyraxes                   HITEDLVKGAIA-TQPQIAREHPLTNKLQHKRR-TSGLHPEDFIKKADLT
Sirenia                   HVTEDLIIGAVA-TEPQIAQERPLTNKLKRKRR-TSGLHPEDFIKKVDLA
TE_Amblysomus             HVTEDLMIGAVA-TEPQIAQERPLTNKLKRKRR-TSGLHPEDFIKKVDLA
Macroscelidae             HVTQDLIIGAVA-TEPQTAQERPLTNKLKRKRR-TSGLHPEDFIKKVDLT
Orycteropus_TEAM          HVTEDLIIGAVA-TEPQIAQERPLTNKLKRKRR-TSGLHPEDFIKKVDLA
'+Cynocephalus'           HVTEDLIIGAFA-TEPQITQERPLTNKLKRKRRTTSGLHPEDFIKKADLA
Myotis_Tadarida           HITENLIIGASA-IEPQITQECPLTNKLKRKRRTTSGLHPEDFIKKVDLA
Taphozous_Tonatia         HITENLIIGASA-IEPQITQECPLTNKLKRKRRTTSGLHPEDFIKKVDLA
Pteropus_Cynopterus       HITENLITGASA-IEPQITQECPLTNKLKRKRRTTSGLHPEDFIKKIDLA
Megaderma_Hipposideros    HITENLIIGASA-VEPQITQECPLTNKLKRKRRTTSGLHPEDFIKKVDLA
Manis_C                   HITEDLIIGASA-IEPQITQERPLTNKVKRKRRTTSGLHPEDFIKKVDLA
Carnivores                HTTEDLIIGACA-IEPQITQAHPLTNKAKRKRRTTSGLHPEDFIKKVDLA
Cetacea                   HIAENLIIGAST-VEPQITQERPLTNKLKRKRRSTSGLHPEDFIKKVDLA
BHC                       HIAEDLIIGASA-VEPQITQERPLTNKLKRKRRSTSGLHPEDFIKKVDLA
Sus_BHC                   HIAEDLIIGASA-VEPQITQERPLTNKLKRKRRSTSGLHPEDFIKKVDLA
Perissodactyla            HITEDLIIGASA-IEPQITQERPLTNKLKHKRRTTSGLHPEDFIKKVDLA
Insectivores              HVTEDLIIGASA-TEPQITQERPLTNKLKRKRRTTSGLYPEDFIKKVDLA
Glires                    HVTEDLIIGAFA-TEPQITQERPLTNKLKRKRRTTSGLHPEDFIKKADLA
Sciurus_Glaucomys         HITENLIIGAFA-TEPQITQERPLTNKLKRKRRTTSCLHPEDFIKKTDLA
Aplodontia_SG             HVTENLIIGAFA-TEPQITQERPLTNKLKRKRRTTSCLHPEDFIKKTDLT
ASG_Graphiurus            HVTENLIIGAFA-TEPQITQERPLTNKLKRKRRTTSCLHPEDFIKKTDLT
Hystrix_OMMR              HVTENLIIGAFA-TEPQITQERPLTNKLKRKRRTTSCLHPEDFIKKADLT
Pedetes_OMMR              HVTENLIIGAFA-TEPQITQERPLTNKLKRKRRTTSCLHPEDFIKKADLT
Mus_Rattus                HVTE--IIGTFT-TEPQITQEQPFTNKLKRKRR-T-CLHPEDFIKKADLT
Meriones_MR               HVTE--IIGTFT-TEPQITQEQPFTNKLKRKRRST-CLHPEDFIKKADLT
Oryzomys_MMR              HVTE--IIGTFT-TEPQITQEHPFTNKLKRKRRTT-CLHPEDFIKKADLT
Tenrec_Echinops           HVTEDLMVGAAA-AVPPIAQEHLLTSKLKRKRR-SSVLHPEDFIKKADLA
Wombat                    YVTENLFAEAV-APDSLIPLEAPKNTRLKRKGRSIADLQPEDFIRKTDVP
Phascogale                HITENLIVETV-VPDSLVPPEPLKNTKLKRKRKTICDLQPEDFIKKT-VP
Echymipera                YLTENLLVETI-APDSLIPPESLKNIKLKRKRKTISDLQPEDFIRKTDVP
Shrew_Opossum             YVTENLIVETI-APDSVIPPEPLKKTKLKRKRKTICBLQPEDFIKKTNIP
Red_Kangaroo              CMTENLFAGAVVAPDSLIPPEPPKTTKLKRKRKTISNLQPEDFIKRTDIP
Wallaroo                  CITENLFAGAVVAPDSLIPPEPPKTTKLKRKRKTISNLQPE---------
Tree_Kangaroo             CITENLFAGAVVAPDSLIPPEPPKTTKLKHKRKTISNLQPEDF-------
Possum                    YVTENLIVGAV-DSDSLIPPEPVKKTRLKRKRKTVSDLQP----------
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                          525                                        568
HPG                       V-QKTPEMINQGTNQM---EQNGQVMNITNSGHENKTKGDSIQ--NEKNP
Great_Apes                V-QKTPEMINQGTNQM---EQNGQVMNITNSGHENKTKGDSIQ--NEKNP
OWMonkeys                 V-QKTPEMINQGTNQM---EQNGQVMNITNSGHENKTKGDSIQ--NEKNP
Monkeys                   V-QKTPEKINQGTNQM---EQNGQVMNITNSGHENKTKGDSIQ--NEKNP
Primates                  VVQKTPEKINQGTNQM---EQNGQVMNITNSGHENETKGDYVQ--NEKNA
'+Tupaia'                 VVQKTPEKINQGTDQM---EQNGQVMNITNSGHENETKGDYVQ--KEKNA
Tamadua_Bradypus          VVQKTPEKINQGTDQM---EQNGQVMNIANSGHENETKGDYVQ--KEKNA
Armadillos                VVQKTPEKINQGTDQM---EQNDQVMNIANSGHENETKGDYVQ--KEKNA
EuarchLauraXen            VVQKTPEKINQGTDQM---EQNGQVMNIANSGHENETKGDYVQ--KEKNA
Elephants                 VVQKIPEKINQETDHV---EQNGQVMNIANGGRENETKGDYVQ--KEKNA
Hyraxes                   VVQKASEKINQETDKV---EQSGQVINIANGGHENETKDDYVL--KEKNG
Sirenia                   VVQKTPEKINQETDQV---EQNGQVMNIANGGHENETKDDYVQ--KEKNA
TE_Amblysomus             VVQKTPEKINQETDQM---EQNGQVKNIADGGHENETKGDYVQ--KEKNA
Macroscelidae             VVQKTPEKINQETDQM---EQNGQVKNIAGGGHENETKGDYVQ--KEKNA
Orycteropus_TEAM          VVQKTPEKINQETDQM---EQNGQVKNIADGGHENETKGDYVQ--KEKNA
'+Cynocephalus'           VVQKTPEKINQGTDQM---EQNGQVMNITNSGHENETKGDYVQ--KEKNA
Myotis_Tadarida           VVQKTPEKIIEGTDQI---EQNGHVMNITNNGHENETKGDYVQ--KEKNA
Taphozous_Tonatia         VVQKTPEKIIEGTDQI---EQNGHVMNITNNGHENETKGDYVQ--KEKNA
Pteropus_Cynopterus       VVQKTPENIIEGTDQI---EQNGHVMNSTNNGHENETKGDYVQ--KKKNT
Megaderma_Hipposideros    VVQKTPEKIIEGTDQI---EQNGHVMNITNNGHENETKGDYVQ--KEKNA
Manis_C                   VVQKTPEKIIEGTDQI---EQNGHVMNITNNGHENETKGDYVQ--KEKNA
Carnivores                IVQKTPEKLIEGTDQI---EQNGHVMNITNNGPENETKGDYVQ--KEKNA
Cetacea                   VIPKTPEKIIEGTDQT---EQNGHGMNITSNGHETEMKGDYVQ--KEKNA
BHC                       VVPKTPEKIIEGTDQT---EQNGHGMNITSNGHENETKGDYVQ--KEKNA
Sus_BHC                   VVPKTPEKIIEGTDQT---EQNGHGMNITSNGHENETKGDYVQ--KEKNA
Perissodactyla            VVQKTPEKIIEGTDQI---EQNGHVMNITNNGHENETKGDYVQ--KEKNA
Insectivores              VVQKTPEKIIEGTDQM---DQNGQVMNIANNGHENETKGDYVQ--KEKNA
Glires                    VVQKTPEKINQGTDQM---EQNGQVMNITNSGHENETKGDYVQ--KEKNA
Sciurus_Glaucomys         VVQKTPEKINQGTDQM---EQNDQVMNITNSGQENETKVDYVQ--KEKNA
Aplodontia_SG             VVQKTPEKINQGTDQM---EQNDQVMNITNSGQENETKVDYVQ--KEKNA
ASG_Graphiurus            VVQKTPEKINQGTDQM---EQNDQVMNITNSGHENETKGDYVQ--KEKNA
Hystrix_OMMR              VVQKTPEKINQGTDQM---EQNGQVMNITNSGHENETKGDYVQ--KEKNA
Pedetes_OMMR              VVQKTPEKINQGTDQM---EQNGQVMNITNNGHENETKGDYVQ--KEKNA
Mus_Rattus                VVQRTPENINQGTDQM---EPNDQAMSITSNGQENETTGNDLQ--KEKNA
Meriones_MR               VVQKTPENINQGTDQM---EPNDQAMSITSNGQENETKGNDLQ--KEKNA
Oryzomys_MMR              VVQKTPENINQGTDQM---EPNGQAMSITSNGQENETKGNDLQ--KEKNA
Tenrec_Echinops           VVQKTPEKINQGTDQM---QPKGQVENIPDGGHGHGTKGDCVQ--KEKSA
Wombat                    VIHKTPEKKNHSVDQILKREQSDQVMNTANSLPEQKALGGHVGEVKDVQV
Phascogale                VTHKTPEKKHHAADQTLEREQNDQVMNMDNGHPEQKALNGHVGEIKEAQT
Echymipera                VSHKTPEKKNPAVDQILEREQNDQVMNTANGHLKQKALGDHVKEVKDAQA
Shrew_Opossum             VIPKTPEKKNHPVDQILEKEQNGQVMSTADGQSKQKAPGCHVGELKEAQA
Red_Kangaroo              VVHKTPERKNHAVDQILEKEQND----TANSHLEQKALDGHAGEVKDAQA
Wallaroo                  --------------------------------------------------
Tree_Kangaroo             --------------------------------------------------
Possum                    --------------------------------------------------
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                        569                                              618
HPG                     NPIESLEKESAFKTKAEPISSSISNMELELNIHNSKAPKKNRLRRKSSTR
Great_Apes              NPIESLEKESAFKTKAEPISSSISNMELELNIHNSKAPKKNRLRRKSSTR
OWMonkeys               NPIESLEKESAFKTKAEPISSSISNMELELNIHNSKAPKKNRLRRKSSTR
Monkeys                 NPIESLEKESAFKTKAEPISSSISNMELELNIHNSKAPKKNRLRRKSSTR
Primates                NPTESLEKESAFRTKAEPISSSISNMELELNIHNSKAPKKNRLRRKSSTR
'+Tupaia'               NPTESLEKESAFRTKAEPISSSISNMELELNIHNSKAPKKNRLRRKSSTR
Tamadua_Bradypus        NPTESLEKESAFRTKGEPISSSISNMELELNIYNSKASKKNRLRRMSSTR
Armadillos              NPTESLEKESAFRTKGEPISSSISNMELELNIYNSKASKKNRLRRMSSTR
EuarchLauraXen          NPTESLEKESAFRTKAEPISSSISNMELELNIHNSKAPKKNRLRRKSSTR
Elephants               IPTESLAKESAFRTKAEPISSSISNMELELNMHNSKAPKKNRLRRKSSTR
Hyraxes                 NPAESLKKESVFKTKAEPISNSISNMELELNTHNSKSLKKNRLRKKSSSR
Sirenia                 NPTESLTKESAFRTKAEPISSSISNMELELNMHNSKAPKKNRLRRKSSTR
TE_Amblysomus           NPTESLAKESAFRTKAEPISSSISNMELELNMHNSKAPKKNRLRRKSSTR
Macroscelidae           NPTESLAKESAFRTKAEPISSSISNMELELNMHSSIAPKKNRLRRKSSTR
Orycteropus_TEAM        NPTESLAKESAFRTKAEPISSSISNMELELNMHNSKAPKKNRLRRKSSTR
'+Cynocephalus'         NPTESLEKESAFRTKAEPISSSISNMELELNIHNSKAPKKNRLRRKSSTR
Myotis_Tadarida         NPTESLEKESAFTTKAEPISSSISNMELELNIHSSKAPKKNRLKRKSSTR
Taphozous_Tonatia       NPTESLEKESAFRTKAEPISSSISNMELELNIHSSKAPKKNRLRRKSSTR
Pteropus_Cynopterus     NPTESLEKESAFRTKAEPICSSISNMELELNIHSSKALKKNRLRRKSSTR
Megaderma_Hipposideros  NPTESLEKESAFRTKAEPISSSISNMELELNIHSSKAPKKNRLRRKSSTR
Manis_C                 NPTESLEKESAFRTKAEPISSSISNMELELNIHSSKAPKKNRLRRKSSTR
Carnivores              NPTESLEKESAFRTKAEPISSSISNMELELNSHSSKAPKKNRLRRKSSTR
Cetacea                 NLTESLEKESAFRTKAEPISSSISNMELELNIHSSKAPK-NRLRRKSSTR
BHC                     NPTESLEKESAFRTKAEPISSSISNMELELNIHSSKAPK-NRLRRKSSTR
Sus_BHC                 NPTESLEKESAFRTKAEPISSSISNMELELNIHSSKAPK-NRLRRKSSTR
Perissodactyla          NPTESLEKESAFRTKAEPISSSISNLELELNIHSSKAPKKNRLRRKSSTR
Insectivores            NPTESLEKESAFRTKAEPISSSISNMELELNIHSSKAPKKNRLRRKSSTR
Glires                  NPTESLEKESAFRTKAEPISSSISNMELELNIHNSKAPKKNRLRRKSSTR
Sciurus_Glaucomys       NPVESLEKESAFRTKAEPISSSISNMELELNIHNSKAPKKNRLRRKSSTR
Aplodontia_SG           NPIESLEKESAFRTKAEPISSSISNMELELNIHNSKAPKKNRLRRKSSTR
ASG_Graphiurus          NPIESLEKESAFRTKAEPISSSISNMELELNIHNSKAPKKNRLRRKSSTR
Hystrix_OMMR            NPIESLEKESAFRTKAEPISSSISNMELELNIHNSKAPKKNRLRRKSSTR
Pedetes_OMMR            NPIESLEKESAFRTKAEPISSSISNMELELNIHNSKAPKKNRLRRKSSTR
Mus_Rattus              HPIESLRKEPAFTAKAKSISNSISDLEVELNVHSSKAPKKNRLRRKSSTR
Meriones_MR             NPIESLGKESAFTAKAKPISNSISDLEVELNVHNSKAPKKNRLRRKSSTR
Oryzomys_MMR            NPIESLGKESAFTTKAKPISSSISNLELELNVHNSKAPKKNRLRRKSSTR
Tenrec_Echinops         NLAESSAKESAFRTVAEPLSSRKSSMELELTVFNSKAQK-NRLRRKPSAR
Wombat                  LELFSAEKESTFRTGTEPVAGSTNHGELELNSRNAKMTRKDRLRKKPSAR
Phascogale              SELFSAEKESTFRTGTEPAAS--------LNGEETNITKKDKLRKQPSFK
Echymipera              AELFSTEKESTFRTRTEPKAGSIVHGELELNGRGAKMTKKDRLRKKPSAR
Shrew_Opossum           SEPSSVEKGSTFKTGSEPAAGSTNQRELELNGRDAKMTKKDRPRKRPSVR
Red_Kangaroo            SELFSAEKESTFRTGTEPTADSTNHRELELNGRDVKMTKK----------
Wallaroo                --------------------------------------------------
Tree_Kangaroo           --------------------------------------------------
Possum                  --------------------------------------------------
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                          619                                             667
HPG                       HIHALELVVSRNLSPPNCTELQIDSCSSSEEIKK-KKYNQMPVRHSRNLQ
Great_Apes                HIHALELVVSRNLSPPNCTELQIDSCSSSEEIKK-KKYNQMPVRHSRNLQ
OWMonkeys                 HIHALELVVSRNLSPPNCTELQIDSCSSSEEIKK-KNYNQMPVRHSRNLQ
Monkeys                   HIHALELVVSRNLSPPNYTELQIDSCSSSEEIKK-KNYNQMPVRHSRKLQ
Primates                  HIHALELVVNRNPSPPNHTELQIDSCSSSEEIKK-KNSDQMPVRHSRKLQ
'+Tupaia'                 HIHALELVVNRNPSPPNHTELQIDSCSSSEEIKK-KNSDQMPVRHSRKLQ
Tamadua_Bradypus          HIHALELVANRNPSQPNHTELQIDSCSSSEEIKK-KNSDQKPIRHSRMLQ
Armadillos                HIHALELVGNRNPSPPNHTELQIDSCSSTEEIEK-INSNQKPIRHNRMLQ
EuarchLauraXen            HIHALELVVNRNPSPPNHTELQIDSCSSSEEIKK-KNSDQKPVRHSRKLQ
Elephants                 HIHALELVVNRNPSPPTHTELQIDSWSSSEETKK-KSSEQKPIRHNRNLQ
Hyraxes                   HVHALELVVNRNPSSPPHTGLQIDSWSGSEEMKK-TSSEQKPVRHNINLQ
Sirenia                   HIHALELVVNRNPSPPTHTELQIDSWSSSEEIKK-KSSEQKPVRHNRNLQ
TE_Amblysomus             HIHALELVVNRNPSPPTHTELQIDSWPSSEEIKK-KSSEQKPVRHSRNLQ
Macroscelidae             HIHALELVVNRNPSSPTHTELQIDSWPSSEEIKK-KRSEHKPVRHSRNLQ
Orycteropus_TEAM          HIHALELVVNRNPSPPTHTELQIDSWPSSEEIKK-KSSEQKPVRHSRNLQ
'+Cynocephalus'           HIHALELVVNRNPSPPNHTELQIDSCSSSEEIKK-KNSDQMPVRHSRKLQ
Myotis_Tadarida           HIYALELVVNRNPSPPNHTELQIDSCSSSEEVKE-KNSDQIPVRHSKKLQ
Taphozous_Tonatia         HIYALELVVNRNPSPPNHTELQIDSCSSSEEVKK-KNSDQIPVRHSKKLQ
Pteropus_Cynopterus       HIHALELVVNRNPSPPNHTELQIDSCSSSEELKE-KNSDQMPVRHSKKLQ
Megaderma_Hipposideros    HIHALELVVSRNPSPPNHTELQIDSCSSSEEVKK-KNSDQMPVRHSKKLQ
Manis_C                   HIHALELVVNRNPSPPNHTELQIDSCSSSEEMKK-KNSDQMPVRHSKKLQ
Carnivores                HIRALELVVNRNPSPPDHTELQIDSCSSSEEMKK-KNSDQMPVRHSKTLQ
Cetacea                   KIHALELVVSRNPSPPNHTELQIDSCSSSEEMKK-KHSSQMPVRHGKKLQ
BHC                       QIHALELVVSRNPSPPNHTELQIDSCSSSEEMKK-KHSSQMPVRHSKKLQ
Sus_BHC                   QIHALELVVSRNPSPPNHTELQIDSCSSSEEMKK-KHSDQMPVRHSKKLQ
Perissodactyla            HIHALELVVSRNPSPPNHTELQIDSCSSSEEMKK-KNSDQMPVRHSKKLQ
Insectivores              HIHALELVVNRNPSPPNHTELQIDSCSSSEEMKK-KNSDQMPVRHSKKLQ
Glires                    HIHALELVVNRNPSPPNHTELQIDSCTSSEEIKK-KNSDQMPVRHSRKLQ
Sciurus_Glaucomys         HIHVLEPVVNRNTSPPHHTELQIDSCTSSEEIKT-RNSNQMPVRHGRKLQ
Aplodontia_SG             HIHALELVVNRNTSPPHHTELQIDSCTSSEEIKK-RNSNQMPVRHGRKLQ
ASG_Graphiurus            HIHALELVVNRNTSPPNHTELQIDSCTSSEEIKK-KNSNQMPVRHGRKLQ
Hystrix_OMMR              HIHALELVVNRNPSPPNHTELQIDSCTSSEEIKK-KNSDQMPVRHSRKLQ
Pedetes_OMMR              HIHALELVVNRNPSPPNHTELQIDSCSSSEEIKK-KNSDQMPVRHSRKLQ
Mus_Rattus                CVLPLEPIV-RNPSPPTCAELQIDSCGSSEETKK-NNSNQTPAGHIREPQ
Meriones_MR               CVLALEPVV-RNPSPPTCAELQIDSCSSSEETKK-NNSNQTPVRHIRKPQ
Oryzomys_MMR              CVLALELVV-RNPSPPTCTELQIDSCSSSEETKK-NNSNQMPVRHIRKPQ
Tenrec_Echinops           HIHPLELVVNRQPSPTTHTELQISSWPSSEELKK-EESEPKPVRRSRNLQ
Wombat                    IVRALELVVDRNPSSSNESELQIDSYPSSEEIRKGTNSEQKQIRRSRRLR
Phascogale                IVCALELGVDGSPSSSNETELQIDSYPSSEEIRRKNNSEQKQLRRSRRLQ
Echymipera                IVRALELVADKNSGSSNEAELQIDSYPSSDEIRKGNNSEQKQIRRSRRLQ
Shrew_Opossum             TVCALELVTDRHPGSSNETELQIDSYPSSEEIRKGNNSEQKQVRRSRRLQ
Red_Kangaroo              -------------------------------------------------
Wallaroo                  -------------------------------------------------
Tree_Kangaroo             -------------------------------------------------
Possum                    -------------------------------------------------
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                         668                                              717
HPG                      LMEDKEPATGAKKSNKPNEQTSKRHDSDTFPELKLTNAPGSFTNCSNTSE
Great_Apes               LMEDKEPATGAKKSNKPNEQTSKRHDSDTFPELKLTNAPGSFTNCSNTSE
OWMonkeys                LMEDKEPATGAKKSNKPNEQTSKRHASDTFPELKLTNVPGSFTNCSNTSE
Monkeys                  LMEDKEPATGAKKSNKPNEQTSKRHASDTFPELKLTNIPGSFTNCSNTNE
Primates                 LMEDKEPATGAKKSNKPNEQISKRHASDTFPELKLTNIPGFFTNCSSSNK
'+Tupaia'                LMEDKEPATGAKKSNKPNEQISKRHASDAFPELKLTNIPGFFTNCSSSNK
Tamadua_Bradypus         LMKDKETATGAKKSNKRNEQISKRHASDAFPELNLTNVTGFLTKCSSSDK
Armadillos               LMKEKETTTGAKKNNKPNEQISERHASDAFPELKLTNVTDFLPKCSSSDK
EuarchLauraXen           LMKDKETATGAKKSNKPNEQISKRHASDAFPELNLTNITGFFTNCSSSDK
Elephants                LMKNQETATGAKKSNKPKEQISKRHGADSYPELHLTTTAGFITKCSSSDN
Hyraxes                  LMKNQETTTGAKKSNKPKEQINKRHTSNPYPELNLTSTAGFITACSSSDN
Sirenia                  LMKNQETTTGAKKSNKPKEQISKRHASDTYPELNLTSTTGLITNCSSSHN
TE_Amblysomus            LMKDQETATGAKKSNKPNEQISKRHATDTFPELNLTNITGFITNCSSSDN
Macroscelidae            LMKDQETETGAKKNNKPNEQISKRHATDTSPERNITG---FITNCSNTDN
Orycteropus_TEAM         LMKDQETATGAKKSNKPNEQISKRHATDTFPELNLTNITGFITNCSSSDN
'+Cynocephalus'          LMEDKEPATGAKKSNKPNEQISKRHASDAFPELKLTNIPGFFTNCSSSNK
Myotis_Tadarida          LMEGKEPATGAKKSNKSNEQINKKLASDAFPELNLTNIPGFFTNGSSSNK
Taphozous_Tonatia        LMEGKEPATGAKKSNKSNEQINKRLASDAFPELNLTNIPGFFTNGSSSNK
Pteropus_Cynopterus      FIEDKESATGAKKNNKPNETINKRLASDAFPELNITNIPGFFTNGSSSNK
Megaderma_Hipposideros   LIEDKEPATGAKKSNKPNEQINKRLTSDAFPELNLTNIPGFFTNGSSSNK
Manis_C                  LMEDKEPATGAKKSNKPNEQINKRLASDAFPELNLTNIPGFFTNCSSSNK
Carnivores               LMEDKEPATGAKKSNKPSEQINKRLASDAFPELNLTNIPGFFTNCSSSNK
Cetacea                  FMGDKEPTTGAKKSNKPHEQINKRLASDAYPELNLTNIPGFFTHCSSSNK
BHC                      LMGDKEPTTGAKKSNKPHEQINKRLASDAFPELNLTNIPGFFTNCSSSNK
Sus_BHC                  LMGDKEPTTGAKKSNKPHEQINKRLASDAFPELNLTNIPGFFTNCSSSNK
Perissodactyla           LMEDKEPATGAKKSNKPNEQINKRLASDAFPELKLTNIPGFFTNCSSSNK
Insectivores             LMEDKEPATGAMKSNKPNEQISKRLASDAFPELNLTNIPGFFTNCSSSNK
Glires                   LMEDTEPATGAKKSNKPNEQISKRHASDAFPELKLTNIPGFFTNCSSSNK
Sciurus_Glaucomys        LMEDAEPATEVRKSNKPNEQINKRHTNDAFPGLKLTGISGLFTNCSSSSK
Aplodontia_SG            LMEDAEPATGVKKSNKPNEQINKRHTNDAFPELKLTGISGLFTNCSSSSK
ASG_Graphiurus           LMEDAEPATGVKKSNKPNEQISKRHTNDAFPELKLTNIPGLFTNCSSSNK
Hystrix_OMMR             LMEDAEPATGAKKSNKPNEQISKRHASDAFPELKLTNIPGFFTNCSSSNK
Pedetes_OMMR             LMEDAEPATGAKKSNKPNEQISKRHASDAFPEVKLTNIPGFLTNCSSSNK
Mus_Rattus               LIEDTEPAADAKKN-EPNEHIRKRSASDAFPEEKLMNKAGLLTSCSSPRK
Meriones_MR              LIEDTEPAPDAKKN-EPNEQIRKRSASDAFPEEKLTNIPGLLTSCSSPSK
Oryzomys_MMR             LIEDTEPAPDAKKNNEPNEQIRKRSASDAFPEEKLTNIPGLLTSCSSSNK
Tenrec_Echinops          LTKDQEMAIGAKKNDKPNEERGKKHAPDTFPERNLTNTTDLITNCSVSGN
Wombat                   LLSE-EIVVGAKKAHKPDDQAEESCISEVFPELKIGNVPACATDSLTTDR
Phascogale               QVSE-EIAIGAKKAHKPDDQAEESCITEVVSELKLGNLPACAPDNVSTDK
Echymipera               LLSE-EIAVGTKKAHEPYDQAEERCVKKVFPELEMGTVSAGATDSLSTDR
Shrew_Opossum            MLSE-EIAAGAKKAHKPDEEVEENCVNEVSPELKIGKVSACSTDSLATDS
Red_Kangaroo             --------------------------------------------------
Wallaroo                 --------------------------------------------------
Tree_Kangaroo            --------------------------------------------------
Possum                   --------------------------------------------------
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                        718                                             766
HPG                     LKEFVNPSLPREEKEEKLETVKVSNNAEDPK-DLMLSGERVLQTERSVES
Great_Apes              LKEFVNPSLPREEKEEKLETVKVSNNAKDPK-DLMLSGERVLQTERSVES
OWMonkeys               LKEFVNPSLPREEKEEKLETVKVSNNAKDPK-DLMLSGERVLQTERSVES
Monkeys                 LKEFVNPSLPREETEEKLETVKVSNNAKDPK-DLMLSGERVLQTERSVES
Primates                LKEFVNPSLQREEIEENLETIQVSNSTKDPK-DLVLSGERVLQTERSVES
'+Tupaia'               LQEFVNPSLQREEIEENLETIQVSNSTKDPK-DLVLSGERGLQTERSVES
Tamadua_Bradypus        LQEFVNSSLQGEVAE-NLETIQVSDSTRDPE-DLVLSGGKGLQTERSVES
Armadillos              LQEFVNSSLQGEVAE-NLETIQVSDSTRDPE-DLVLSGGKSLQTERSAES
EuarchLauraXen          LQEFVNPSLQGEEIEENLETIQVSNSTKDPE-DLVLSGGRGLQTERSVES
Elephants               LQEFVNPSLQGEKTEENLETIQVSNITKEPK-DLVLNGGRDLQTKKSIES
Hyraxes                 LQEPVNPSLQGEEIEENLATVQMSNTAKEPE-DLELNGGRVLQTKRSVES
Sirenia                 YQEFVNPSLQGEEIEENLGTIQVSNRTRDPE-DLVLNGGRGLQTEISVES
TE_Amblysomus           LQEFVNPSLQGEEIEENLGTMQVSNSTKDPE-DQVLSGGRGLQTERSVES
Macroscelidae           LQEFVNPRLQGEEIEENLGPIQVSNSTKDPE-DQVLSRGRGLHTGKCVES
Orycteropus_TEAM        LQEFVNPSLQGEEIEENLGTIQVSNSTKDPE-DQVLSGGRGLQTERSVES
'+Cynocephalus'         LQEFVNPSLQREEIEENLETIQVSNSTKDPK-DLVLSGERGLQTERSVES
Myotis_Tadarida         LKEFVNPNLQREEIEENLGTVQMSNSTKDLK-DLILSGGRSLQTDRSMES
Taphozous_Tonatia       LQEFVDPNLQREEIEENLGTIQVSNSTKDLK-DLILSGGRSLQTDRSMES
Pteropus_Cynopterus     LQEFVNPSLQREEIKENLGTIQVSNSTKDPK-ILIFGEGRGSQTDRSTES
Megaderma_Hipposideros  LQEFVNPSLQREEIEENLGTIQVSNSTKDPK-DLILSGGRGLQTDRSMES
Manis_C                 LQEFVNPSLQREEIEENLGTIQVSNSTKDPK-DLILSGGRGLQTERSVES
Carnivores              LQEFVNPGLQREEIEESRGTIQVSDSTRDPK-ELVLSGGRGLQTERSVES
Cetacea                 LQEFVNPSLQREE---NLGTIQVSNSTKDPK-DLTLSGGKGLQIERSVES
BHC                     LQEFVNPSLQREE---NLGTIQVSNSTKDPK-DLILSGGKGLQIERSVES
Sus_BHC                 LQEFVNPSLQREE---NLGTIQVSNSTKDPK-DLILSGGKGLQIERSVES
Perissodactyla          LQEFVNPSLQREEIEQNLGAIQVSNSTKDPK-DLILSGGRGLQAERSVES
Insectivores            LQEFVNPSLQREEIEENLGTIQVSNSTKDPK-DLILSGERGLQTERSVES
Glires                  LQEFVNPSLQREEIEENLETIQVSNSTKDPK-DLVLSGERGLQTERSAES
Sciurus_Glaucomys       VEEFVNPNLQKEETEENLEIIQVSNNTKDPK-DMVLSGERVLQTERSAES
Aplodontia_SG           LKEFVNPNLQKEETEENLEIIQVSNSTKDPK-DMVLSGERGLQTERSAES
ASG_Graphiurus          LKEFVNPSLQKEEIEENLETIQVSNSTKDPK-DLVLSGERGLQTERSAES
Hystrix_OMMR            LKEFVNPSLQREEIEENLETIQVSNSTKDPK-DLVLSGERGLQTERSAES
Pedetes_OMMR            LKEFVNPSLQREEIEENLETIQVSNSTKDPK-DLVLSGERGLPTERSAES
Mus_Rattus              PQGPVNPSPQRKGIE-QLETRQMSDSTKELG-DLVLGGEPGKPTERSEES
Meriones_MR             PQGPVNPSPQRKEIE-KLETSQMSDSTKELK-DLVLGGERGLSTERSEES
Oryzomys_MMR            PQGPVNPSPQRKEIE-KLETSQMSDSTKDLK-DLVLGGERGLSTERSEES
Tenrec_Echinops         LQGSVCPSLPGAKLKEKLGTVQVSNSTRDPK-DEVLGRARGLQTARSVES
Wombat                  DQVLASCSFTEERDERSLEAIPSSK---DQD--LPLNGGEGLQGERAPGS
Phascogale              DQVLASCSFT--GDERSLEVIPSSQ---DQD--LALSGKEGLQGEISQGS
Echymipera              DEVLASCSFTD-GEERNLEVIPSSK---DQDQDLALSERERLQEKRTQGN
Shrew_Opossum           DLVLASCSFTE-GDEKSLEAFQPSR---DQDS-LAVSRGEKLQGKRTKGN
Red_Kangaroo            -------------------------------------------------
Wallaroo                -------------------------------------------------
Tree_Kangaroo           -------------------------------------------------
Possum                  -------------------------------------------------
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                         767                                              816
HPG                      SSISLVPGTDYGTQESISLLEVSTLGKAKTEPNKCVSQCAAFENPKGLIH
Great_Apes               SSISLVPGTDYGTQESISLLEVSTLGKAKTEPNKCVSQCAAFENPKELIH
OWMonkeys                SSISLVPGTDYGTQESISLLEVSTLGKAKTEPNKCVSQCAAFENPKELIH
Monkeys                  SSISLVPGTDYGTQESISLLEVSTLGKAKTEPNKCVSQCAAFENPKELIH
Primates                 TSISLVPDTDYGTQDSISLLEVNTLGKAKTAPNKRVSQCAAIENPKELIH
'+Tupaia'                TSISLVPDTDYGTQDSISLLEANTLGKAKTAPNQRVSQCAAIENPKELIH
Tamadua_Bradypus         TSISVVPDTDYGTQDSISLLEADTLGKAKAAPNQHVSQYAAIGNATELFH
Armadillos               TSISVVPDTDYGTQDSISLLEADTLGKAKTALNQHVSQYAAIRNATELSH
EuarchLauraXen           TSISVVPDTDYGTQDSISLLEADTLGKAKTAPNQRASQCAAIENPNELIH
Elephants                TNISVIPDTVYGTQDSVSLLGADTPGKAKTAPNQCASQCTAIENPSELTN
Hyraxes                  TSTSVIPDADCGAQDSISLLEADTLGKAKTAPNQGAGQCSAIENPNELIH
Sirenia                  TSISVIPDTDYGSQNSISLLEADTLRKAKTAPNQCASQCAAIENPNELIH
TE_Amblysomus            TSISVIPDTDYGTQDSISLLEAGTLGKAETAPNQCASQCAAIENPNKLIH
Macroscelidae            TSISVIPDTDYGTQNSISLLEAGTLGKAETAPNQCASHCAAIENPNKHVH
Orycteropus_TEAM         TSISVIPDTDYGTQDSISLLEADTLGKAKTAPNQCASQCAAIENPNKLIH
'+Cynocephalus'          TSISLVPDTDYGTQDSISLLEANTLGKAKTAPNQRVSQCAAIENPKELIH
Myotis_Tadarida          TNILLVPETDYGTQDSISLLEPDTPGKAKTAPNQCAGLCAAIKNPKELIH
Taphozous_Tonatia        TNILLVPETDYGTQDSISLLEPDTPGKAKTAPNQRAGLCAAIENPKELIH
Pteropus_Cynopterus      TSILLVPETDYGTQDSISLLEPDIPGRAKTAPNQHADLCAAIENPRELIH
Megaderma_Hipposideros   TSILLVPDTDYGTQDSMSLLEPDTPGKAKTAPNQRAGVCAAIENPKELIH
Manis_C                  TSISLVPDTDYGTQDSISLLEADTLGKAKTAPNQRASLCAAIENPKELIH
Carnivores               TSISLVPDTDYGTQDSISLLEADTLGKAKTAPNQRASLCAAIENPKEPIH
Cetacea                  TSISLVPDTDYGTQDSISLLEADTLGKAKTAPNQHVSLCAAIESPKELIH
BHC                      TSISLVPDTDYGTQDSISLLEADTLGKAKTAPNQRVSLCAATENPKELIH
Sus_BHC                  TSISLVPDTDYGTQDSISLLEADTLGKAKTAPNQRVSLCAATENPKELIH
Perissodactyla           TSISLVPDTDYGTQDSISLLEADTLGKAKTAPNQRASLCAAIENPKELIH
Insectivores             TSISLVPDTDYGSQDSISLLEADTLGKAKKAPNQCASLCAAIENPKELIH
Glires                   TSISLVPDTDYGTQDSISLLEANTLGKAKTAPNQRVSQCAAIENPKELIH
Sciurus_Glaucomys        TSISLVPDTDYGTQDSISLLEANTFGKARTASNQHVTQYVAIENPKEFIH
Aplodontia_SG            TSISLVPDTDYGTQDSISLLEANTFGKARTASNQHVTQYVAIENPKEFIH
ASG_Graphiurus           TSISLVPDTDYGTQDSISLLEANTLGKARTASNQCVTQYVAIENPKELIH
Hystrix_OMMR             TSISLVPDTDYGTQDSISLLEANTLGKAKTASNQCVTQYVAIENPKELIH
Pedetes_OMMR             TSVSLVPDTDYGTQDSISLLEANTLRKAKTASNQCVTQYVAIENPKELIH
Mus_Rattus               TSVSLVPDTDYDTQNSVSVLEANTVRYARTGSVQCMTQFVASENPKELVH
Meriones_MR              TSVSLVPDTDYDTQNSVSVLEANTVRYAKTGSIQCMTQFVASENPKELVH
Oryzomys_MMR             TSVSLVPDTDYDTQNSVSLLEANTVRYAKTGSIQCMTQFVASENPKELVH
Tenrec_Echinops          TSVSLIPDADDGTQGSISIMEAGNRGEAQTAPDQCARQCAATENPNKSVH
Wombat                   LEALEVPDTDWDTQDSTSLFPADTPQNSKAGPSPHRSHSEIMETPKELLD
Phascogale               LGTVEVPDTAWDTQDSTSLFPADTPQNSKPGPSPHRNHCEIMETPKELLE
Echymipera               LELLEVPDTYWETQDSTSLFPAETPQNSKAGPSPHRSNCEIMESSKELFD
Shrew_Opossum            MEVLEVASTDWDTQDSTSLFPTDVPPNPTADSGPHRNQHEVIETPKELFD
Red_Kangaroo             --------------------------------------------------
Wallaroo                 --------------------------------------------------
Tree_Kangaroo            --------------------------------------------------
Possum                   --------------------------------------------------
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                            817                                             865
HPG                         GC-SKDTRNDTEGFKYPLGHEVNHSRETSIEMEESELDAQYLQNTFKVSK
Great_Apes                  GC-SKDTRNDTEGFKYPLGHEVNHSQETSIEMEESELDTQYLQNTFKVSK
OWMonkeys                   GC-SKDTRNDTEGFKYPLGREVNHSQETSIEMEESELDTQYLQNTFKVSK
Monkeys                     GC-SKDTRNDTEGFKYPLGREVNHSQETSIEMEESELDTQYLQNTFKVSK
Primates                    GC-SKDTRNDTEGFKDPLRREVNHIQETSIEMEESELDTQYLQNTFKVSK
'+Tupaia'                   GC-SKDTRNDTEGFKDPLRREVNHIQETSIEMEESELDTQYLQNTFKVSK
Tamadua_Bradypus            GC-SKDTRNDTEDFKDPLRHEVNHTQETIVEMEESELDTQYLQNTFKISK
Armadillos                  GC-SKDTRNDTEDFKDPLRHEVNHTQETSVEMEESELDTQYLQNTFKISK
EuarchLauraXen              GC-SKDTRNDTEGFKDPLRREVNHIQETSIEMEESELDTQYLQNTFKVSK
Elephants                   SC-PKDTRNDTEGFKDLLRCEASHIQETCIEIEESELDTQYLQSTFKVSK
Hyraxes                     GS-PKDTRNDIEGFKDPLRCEVNPIQEICVEMDENELDTQYIQSTFKVSK
Sirenia                     GC-PKDTRNDTEDFKDLLRCEVNHIQETCIEMEDSELDTQYLQSTFKVSK
TE_Amblysomus               GF-PKDTRNDTEGFKDLLRREVNHIQETCIEMEESELDIQYLQNTFKVSK
Macroscelidae               GF-PKDTGNDTEGFKDLLKCDANHIQDTCIEMEDSELDTQYLQNTFKVSK
Orycteropus_TEAM            GF-PKDTRNDTEGFKDLLRREVNHIQETCIEMEESELDTQYLQNTFKVSK
'+Cynocephalus'             GC-SKDTRNDTEGFKDPLRREVNHIQETSIEMEESELDTQYLQNTFKVSK
Myotis_Tadarida             GC-SKDTRNDREGFKDLLRREVNHTQETSIEMEESELDTQYLQNTFKVSK
Taphozous_Tonatia           GC-SKDTRNDTEGVKDLLRCEVNHTQETSIEMEESELDTQYLQNTFKVSK
Pteropus_Cynopterus         GC-SKDTRNDTEGFKDPLRREVNYTQETSIEMEESELDTQYLQNTFKVSK
Megaderma_Hipposideros      GC-SKDTRNDTEGFKDPLRREVNHTQETSIEMEESELDTQYLQNTFKVSK
Manis_C                     GC-SKDTRNDTEGFKDPLRREDNHTQETSIEMEESELDTQYLQNTFKVSK
Carnivores                  GC-SKDTRNDTEGFTDPLRREDNHTQETSIEMEESELDTQCLHNTFKVSK
Cetacea                     GC-SKDIRNDTEDFQDPLGHHVNHIQEASTEMEENELDTQYLQNMFKVSK
BHC                         GC-SKDTRNDTEGFQDPLGHDVNHTQEASIEMEESELDTQYLQNTFKVSK
Sus_BHC                     GC-SKDTRNDTEGFKDPLGHDVNHTQEASIEMEESELDTQYLQNTFKVSK
Perissodactyla              DC-SKDTRNDTEGFKDPLRREVNHTQETSIEMEESELDTQYLQNTFKVSK
Insectivores                GC-SKDTRNDTEGFKDPLRREVNHTQETSIEMEESELDTQYLQNTFKVSK
Glires                      GC-SKDTRNDTEGFKDPLRREVNHIQETSIEMEESELDTQYLQNTFKVSK
Sciurus_Glaucomys           GH-SKDTRNDPEGFKDSLRCEVNHIQETNVEMEESELDTQYLENTFQVSK
Aplodontia_SG               GH-SKDTRNDTEGFKDSLRREVNHIQETNVEMEESELDTQYLENTFQVSK
ASG_Graphiurus              GC-SKDTRNDTEGFKDSLRREVNHIQETNIEMEESELDTQYLQNTFQVSK
Hystrix_OMMR                GC-SKDTRNDTEGFKDPLRREVNHIQETNIEMEESELDTQYLQNTFQVSK
Pedetes_OMMR                GC-SKDTRNDTEGFKDPLRREVNHIQETNIEMEESELDTQYLQNTFQVSK
Mus_Rattus                  G--SNNAGSGTECFKHPLRHELNHSQET-VEMEDSELDTQYLQNTFQVSK
Meriones_MR                 G--SNNAGSGTECFKHPLRHELNHIQET-VEMEESELDTQYLQNTFQVSK
Oryzomys_MMR                G--SNNAGSGTECFKHPLRHELNHIQET-VEMEESELDTQYLQNTFQVSK
Tenrec_Echinops             GL-SKDTRNNTEGFEDLLTHDVNHIQETCTEMEESELDIQSLQNTFKVSK
Wombat                      GCSSKNTESDEEDLRSLMRQEVKNASKTTTEMEDSELDTQYLQNTFKRSK
Phascogale                  SSSSKNTESSVEDLRSLMKQEVKNASKTITEMEDSELDTQYLQNTFKRSK
Echymipera                  AYSSKNTDSGTEG---LIRQEIKYGSETSSVMEDSELDTQYLQNTFKRSK
Shrew_Opossum               DCSSKNTGSGKED---LTRQEVKNTSETTTEIEDSELDTQYLQNTFKRSK
Red_Kangaroo                --------------------------------------------------
Wallaroo                    --------------------------------------------------
Tree_Kangaroo               --------------------------------------------------
Possum                      --------------------------------------------------
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                        866                                             914
HPG                     RQSFALFSNPGNPEEECATFSAHSRSLKKQSPKVTFECEQKEEN-QGKNE
Great_Apes              RQSFALFSNPGNPEEECATFSAHSRSLKKQSPKVTFECEQKEEN-QGKNE
OWMonkeys               RQSFALFSNPGNPEEECATFSAHSRSLKKQSPKVTFECEQKEEN-QGKKE
Monkeys                 RQSFALFSNPGNPEKECATFSAHSRSLKKQSPKVTLECEQKEEN-QGKKE
Primates                RQSFALFSNPGNPEKECATVCAHSRSLRKQSPKVTLECEQKEEN-QGKKE
'+Tupaia'               RQSFALFSNPGNPEKECATVCAHSRSLRKQSPKVTLECEQKEEN-QGKKE
Tamadua_Bradypus        RQSFALFSNP---EKECATVCAHSRSLGKQSPKVTFDCRQKEEN-QGKKE
Armadillos              RQSFALFSNP---ENECATVCAHSRFLGKQSPKVTFECRQKEEN-QGKKE
EuarchLauraXen          RQSFALFSNP---EKECATVCAHSRSLRKQSPKVTLECGQKEEN-QGKKE
Elephants               RQSFALFSNP---EKKCATICAHSKSLRKQSPKVTLVCGEKEEN-QGNRE
Hyraxes                 RHSFALFSNP---EKECATSYTHSKSLRKENPKVTLQRGEEEEN-QGNKE
Sirenia                 RQSFALFSNP---EKECATICAHSKSLRKQSPKVTPEYGEKEEN-QGNKE
TE_Amblysomus           RQSFALFSNP---EKECATVCAHSRSLRKQSPKVTLECGEKEEN-QGNKE
Macroscelidae           RQSFALFPNP---EKECTTVCAHSRSLRKQSPKVTLECGEKEEN-QGNKE
Orycteropus_TEAM        RQSFALFSNP---EKECATVCAHSRSLRKQSPKVTLECGEKEEN-QGNKE
'+Cynocephalus'         RQSFALFSNPGNPEKECATVCAHSRSLRKQSPKVTLECEQKEEN-QGKKE
Myotis_Tadarida         RQSFALFSN---PEKECATVYAHSRSLRKQSPKVTLECGQKEEN-QGEKE
Taphozous_Tonatia       RQSFALFSNPGNPEKECATVYAHSRSLRKQSPKVTLECGQKEEN-QGEKE
Pteropus_Cynopterus     RQS---FSNPGNLEKECATGYAHSRSLRKQSPKVTLECDRKEGN-QGKKE
Megaderma_Hipposideros  RQSFALFSNPGNPEKECATVYAHSRSLRKQSPKVTLECGQKEEN-QGKKE
Manis_C                 RQSFALFSNPGNPEKECATVCAHSRSLRKQSPKVTLECGQKEEN-QGKKE
Carnivores              RQSFALFSNPGNPEKECATVCARSRSLRKQSPKVTLECGQKEEN-QGKKE
Cetacea                 RQTFALFSNPENPEKECATVCAHSGSLREQSPRVPLECRQKEEN-QGKSE
BHC                     RQTFALFSNPGNPEKECATVCAHSGSLREQSPRVPLECGQKEEN-QGKSE
Sus_BHC                 RQTFALFSNPGNPEKECATVCAHSGSLREQSPKVTLECGQKEEN-QGKSE
Perissodactyla          RQSFALFSNPGNPEKECATVCAHSRSLRKQSPKVTLECGQKEEN-QGKKE
Insectivores            RQSFALFSNPGNSEKECATVSAHSRSLRKQSPKVTLECEQKEEN-QGKKE
Glires                  RQSFALFSNPGNPEKECATVCAHSKSLRKQSPKVTLECEQKEEN-QGKKE
Sciurus_Glaucomys       RQSFALFSNPGNLEKECAAIYTPSKSLRKQSPEVTLECEQKEEN-WGKKE
Aplodontia_SG           RQSFALFSNPGNPEKECAAVCTPSKSLRKQSPEVTLECEQKEEN-QGKKE
ASG_Graphiurus          RQSFALFSNPGNPEKECATVCAPSKSLRKQSPKVTLECEQKEEN-QGKKE
Hystrix_OMMR            RQSFALFSNPGNPEKECATVCAHSKSLRKQSPKVTLECEQKEEN-QGKKE
Pedetes_OMMR            RQSFALFSNPGNPEKECATVCAHSKSLRKQSPKVTLECEQKEEN-QGKEE
Mus_Rattus              RQSFALFSKPRSPQKDCTAVCAHS---RELSPKVTSKGEQKER--QGQEE
Meriones_MR             RQSFALFSKPRSPQKECAAVCAHSNSFRELSPKVTSKGEQKEG--QGQEE
Oryzomys_MMR            RQSFALFSKPGNPQKECAAVCAHSNSFRELSPKVTSKGEQKEGI-QGQEE
Tenrec_Echinops         RQSFALSSNP---EKECATLCAHPSAFRKQNPNVALECGEKEGT-QENKE
Wombat                  RQSFALRSSP---RQECRKPSAVPGTVNQQSPDNTTDCGGQEKEKQGNRE
Phascogale              RQSFALCSSP---RQEYVKTCAVPGAISQQS----TVRRYQEKEKQENRE
Echymipera              RQTFALCSNP---KQEQIKPCSVPRAVSHQSSDNASDCGGQEKEKQGNRE
Shrew_Opossum           RQSFALCPSP---RQTSMKLRSIPRALSHQSPDKATNHGGQEKKKQGSRE
Red_Kangaroo            --------------------------------------------------
Wallaroo                --------------------------------------------------
Tree_Kangaroo           --------------------------------------------------
Possum                  --------------------------------------------------
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                         915                                            962
HPG                      SNIKPVQTVNITAGFPVVCQKD-KPVDYAKCSIKGGSRFCLSSQF-RGNE
Great_Apes               SNIKPVQTVNITAGFPVVCQKD-KPVDYAKCSIKGGSRFCLSSQF-RGNE
OWMonkeys                SNIKPVQTVNITAGFPVVCQKD-KPVDYAKCSIKGGSRFCLSSQF-RGNE
Monkeys                  SNIKPVQTVNTTAGFPVVCQKD-KPVDYAKCSIKGGSRLCLSSQF-RGNE
Primates                 SKIKHVQAVNTTAGFPVVCQKD-KPGDYAKCSIKGVSRLCLSSQF-RGNE
'+Tupaia'                SKIKHVQAVNTTAGFPVVCQKD-KPGDYAKCSIKGVSRLCPSSQF-RGNE
Tamadua_Bradypus         SKIKHVQAVHTTAGFPVVCQKD-KPGDYAKCSIQGVSKLCQSSQF-RGNE
Armadillos               SKIKHVQAVHTTAGFPVVCQKD-KPGDYAKCSIQGVSRLCQSSQF-RGNE
EuarchLauraXen           SKIKHVQAVHTTAGFPVVCQKD-KPGDYAKCSIKGVSRLCQSSQF-RGNE
Elephants                PKIKHEQAVHMPAGYPEACQKE-KPSDYTKYSIKGVSGLCQSSQF-RGSE
Hyraxes                  SKIKH---VHTTASCPEVCQED-TPSDRTNCSVKGLPRLCHSSQF-KGSE
Sirenia                  SKIKHEQAVHTTAGYPEDCQKE-KPSDYTKCSIKGVSRLCQSSQF-RGSE
TE_Amblysomus            SKIKHVQAVHTTAGYPGVCQKE-KPSDYTKCSIQGVSRLCQSSQF-RGNE
Macroscelidae            SKIKHVQVVHTTAGYPGVCEEE-KPNDYTKCSIKGVSRLCQSSPF-RGNE
Orycteropus_TEAM         SKIKHVQAVHTTAGYPGVCQKE-KPSDYTKCSIKGVSRLCQSSQF-RGNE
'+Cynocephalus'          SKIKHVQAVNTTAGFPVVCQKD-KPGDYAKCSIKGVSRLCPSSQF-RGNE
Myotis_Tadarida          SKIKHVQAVHTTAGFPVVCEKD-KPGEYAKYSIKGTSRLCQSSQF-RGNE
Taphozous_Tonatia        SKIKHVQAVHTTAGFPVVCEKD-KPGEYAKYSIKGISRLCQSSQF-RGNE
Pteropus_Cynopterus      SNIKHVQAVYTTVGFPVVCEKD-KPGDYAKYGIKEVSRLCQSFQF-RGNE
Megaderma_Hipposideros   SKIKHVQAVHTTAGFPVVCEKD-KPGDYAKYSIKGVSRLCQSSQF-RGNE
Manis_C                  SEIKHVQAVHTTAGFPVVSQKD-KPGDYAKCSIKGVSRLCQSSQF-RGNE
Carnivores               SEIKHVQAVHTTAGFSAVSQKV-KPGDYAKCSIKGVSRLCQSSQF-RGNE
Cetacea                  SKIKHVRAINTTVDFPVAGQKD-KPSDHAKRSPKRVTRLCQSSQF-RSNK
BHC                      SKIKHVQAIYTTVDFPVAGQKD-KPSDYAKCSTKGVTRLCQSSQF-RGNK
Sus_BHC                  SKIKHVQAVHTTVDFPVVGQKD-KPSDYAKCSTKGVTRLCQSSQF-RGNK
Perissodactyla           SKIKHVQSVHTTVGFPVVCQKD-KPGDYVKCSIKEVSRLCQSSQF-RGNE
Insectivores             SKIKHVQAVHTTAGFPVVCQKD-KPGDYAKCSIKGVSRLCQSSQF-RGNE
Glires                   SKIKHVQAVNTTVGFPVVCQKD-KPGDYAKCSIKGVSRLCPSSQF-RGNE
Sciurus_Glaucomys        SKIRHVQAVNATMGF--VCQKD-KPDDDAQCSITEVSRICPSFQF-RGNE
Aplodontia_SG            SKIRHVQAVNATMGFPVVCQKD-KPGDDAKCSITEVSRLCPSFQF-RGNE
ASG_Graphiurus           SKIRHVQAVNTTMGFPVVCQKD-KPGDDAKCSITGVSRLCPSFQF-RGNE
Hystrix_OMMR             SKIRHVQAVNTTVGFPVVCQKD-KPGADAKCSITGVSRLCPSSQF-RGNE
Pedetes_OMMR             SKIRHVQAVNTTVGFPVVCQED-KPGADAKCSITGVSRLCPSSQF-RGNE
Mus_Rattus               SEISHVQAVTATVGLPVLCQEG-KPGADTMCA--GVSRLCPSSHY-RSGE
Meriones_MR              SEISHVQAVTATVGLPVLCQEG-KPGADTMCA--GVSRLCPSSQY-RSNE
Oryzomys_MMR             SEISHVQAVTATVGFPVLCQEG-KPGADTMCAITGVSRLCPSSQY-RSNE
Tenrec_Echinops          STIKPVQAVHTTVGGAGGSPTE-KPSDYTKSSLQGVSRLGQASQF-RGSE
Wombat                   SNKPVWPKSAVMSLAAACQTEERKPGVYAKCSTTEVSRLCHIAPLHGVID
Phascogale               SNKPVQPKPAVV-------IEKGKPGDHAKWSTREVSRLCHIASLNSGND
Echymipera               SNKPGQLASAVRSSAATCQTE-RKPGDPDKCSATGVSRLCHIAPLQEGND
Shrew_Opossum            SDKAVQPELAVMSSAAVCQTKEKKPGDYAKCST--VSRLCHIAPLHDDND
Red_Kangaroo             --------------------------------------------------
Wallaroo                 --------------------------------------------------
Tree_Kangaroo            --------------------------------------------------
Possum                   --------------------------------------------------
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                           963                                           1011
HPG                        TGLITPNKHGLLQNPYHIPPLFPIKSFV-KTKCKKNLLEENFEEHSMSPE
Great_Apes                 TGLITPNKHGLLQNPYHIPPLFPIKSFV-KTKCKKNLLEENSEEHSMSPE
OWMonkeys                  TGLITPNKHGLLQNPYHIPPLFPIKSFV-KTKCKKNLLEENSEEHSMSPE
Monkeys                    TGLITPNKHGLLQNPYHMPPLFPIRSFV-KTKCKKNLLEENSEEHSMSPE
Primates                   TELITANKHGILQNPYHMPPLSPIRSFV-KTKCKKNLLEERFEEHSVSPE
'+Tupaia'                  TELITANKHGISQNPYHMPSLSPIRSSV-KTKCKKNLSEERFEEHSVSPE
Tamadua_Bradypus           SELITANEHEISQNPDQMPSLSPIRSSV-KTKCKENLSEERFEEHTVSLE
Armadillos                 SELITANEHEISQNPDQMPSLSHIRSSV-KTKCKENLSEEKFEELTVSLE
EuarchLauraXen             SELITANEHGISQNPDQMPSLSPIRSSV-KTKCKKNLSEERFEEHTVSLE
Elephants                  SELITADGHGISQNPDQIPSLSPTRSSV-KTKCKTNLLEERFEEHTISLE
Hyraxes                    SELITEGEHGIAQNPDQMPSSSPIRSSV-NSKCNKNLSEERFKEHKILLE
Sirenia                    SEHITAGEHGISQNPDQMPLLSPIRASV-KS--KKNLSEERFEEHTISLE
TE_Amblysomus              SELITANEHGISQSPDQTPSLSPIRSSV-KTKCKKNLSEERFEEHTISLE
Macroscelidae              SELITANEHEMSHSPDQTPSLSPTKSSV-KTKCKKNLSEEKFEEHTISLE
Orycteropus_TEAM           SELITANEHGISQNPDQTPSLSPIRSSV-KTKCKKNLSEERFEEHTISLE
'+Cynocephalus'            TELITANKHGISQNPYHMPSLSPIRSSV-KTKCKKNLSEERFEEHSVSPE
Myotis_Tadarida            TELTIANKHGISQNPYHIPSISPIRSFV-KTISKKNLSEEKFEEHSVSPE
Taphozous_Tonatia          TELTIANKHGISQNPYHIPSISPIRSSV-KTISKKNLSEEKFEEHSVSPE
Pteropus_Cynopterus        TELTIANKLGISQNPYHMPSISPIKSSV-KTICKKNLSEEKFEEHSISPE
Megaderma_Hipposideros     TELTIANKHGISQNPYHIPPISPIRSSV-KTICKKNLSEENFEEYSVSPE
Manis_C                    TELIIANKHGISQNPYHIPSLSPIRSSV-KTICKKNLSEEKFEEHSMSPE
Carnivores                 TELFIANNHGISQNPYHIPPLSPIRSSV-KTICKKNLSEEKFEQHSMSPE
Cetacea                    TELIIANKHGISQNPYLIPSLSPIRSSV-KTICKKNLSEEKFEEPVMSPE
BHC                        TELIIANKHGISQNPYLIPSLSPIRSSV-KTICKKNLSEEKFEEPVMSPE
Sus_BHC                    TELIIANKHGISQNPYLIPSLSPIRSSV-KTICKKNLSEEKFEEPVMSPE
Perissodactyla             TELITANKHGISQNPYYIPSLSPIRSSV-KTICKKNLSEEKLEEHSVSPE
Insectivores               TELIIANKHLISQNPYHIPSLSPIRSSV-KSICKKNLSEEKFEEHSVSPE
Glires                     TELITANKHGISQNPYHMPSISPIRSSV-KTKCKKNLSEERFEEHSVSPE
Sciurus_Glaucomys          TKLITADKHGISQNPYHMPSISPIRSSV-NTKCKKNLSEEKFEKHSRSPE
Aplodontia_SG              TKLITADKHGISQNPYHMPSISPIRSSV-KTKCKKNLSEEKFEKHSRSPE
ASG_Graphiurus             TELITADKHGISQNPYHMPSISPIRSSV-KTKCKKNLSEERFEKHSVSPE
Hystrix_OMMR               TELITADKHGISQNPYHMPSISPIRSSV-KTKCKKNLSEERFEKHSVSPE
Pedetes_OMMR               TELSTADKHGISQNPYLMPSISPIRSSV-KTKCKKNLSEERFEKHSVSPE
Mus_Rattus                 NGLSTTGKSGISQNSHFKQSVSPIRSSI-KTDNRKTLTEGRFEKHTLSTE
Meriones_MR                NELSTAGKPGISQNSHLKQSVSPIRSSV-KTDHRKTLSEGRFEKHTLSTE
Oryzomys_MMR               NELSTAGKPGISQNSHLKQSVSPIRSSV-KTDHRKTLSEGRFEKHTLSTE
Tenrec_Echinops            SDPSTSVEHGILQTSEHTPPLSPIRSSV-KSKCKEKLSEERLEDHAESLE
Wombat                     CEHIAGNNQGISQVPDQKPSVSPARSSASKTINTKNLLEERLDEQTTCPE
Phascogale                 CEPIAEINQGISQVPDQNQSVSPARSSDSKTIYAKNFLEERLDEQTTCPE
Echymipera                 CEYIAGKKQGISQVPNQKQSVSPTRSSVSK-IYTKNLLKDRL-EQTTCPE
Shrew_Opossum              CDHSAENNKGISQVPDQKQSVSPAKSSAGRSIYTKSLLEERLDEQTTCPE
Red_Kangaroo               --------------------------------------------------
Wallaroo                   --------------------------------------------------
Tree_Kangaroo              --------------------------------------------------
Possum                     --------------------------------------------------
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                         1012                                             1060
HPG                      REMGNENI-PSTVSTISRNNIRENVFKEASSSNINEVGSSTNEVGSSINE
Great_Apes               REMGNENI-PSTVSTISRNNIRENVFKEASSSNINEVGSSTNEVGSSINE
OWMonkeys                RAMGNENIIPSTVSTISHNNIRENAFKEASSSNINEVGSSTNEVGSSINE
Monkeys                  RAMGNENIIPSTVSTISHNNIRENAFKEASSSSINEVGSSTNEVGSSINE
Primates                 RAMGNENIIPSTVYTISQNNIRESAFKEASSSSINEVGSSTNEVGSSINE
'+Tupaia'                RAMGNESIIQSTVSTISQNNIRESAFKEASSSSINEVGSSTNEVGSSINE
Tamadua_Bradypus         RAVGNENIIQSTVSTISQNNIRESAFKEASSSSINEVGSSINEVGSSINE
Armadillos               RTVGNENIIQSTVSTISHNNIRENAFKEASSSI--------------NE
EuarchLauraXen           RAMGNESIIQSTVSTISQNNIRESAFKEASSSSINEVGSSTNEVGSSINE
Elephants                RAMRNENVIQSTVSTVSQNNIRESASKEASSSI-------NEVCSSINE
Hyraxes                  RTTGNETIVQSTVSTGSQDNIRGSASKETSSSI--------------NE
Sirenia                  RAVGNESIVQSTVSTVSQNNIKESASKEASSSI-------NEVGSSVNE
TE_Amblysomus            RAMGNESIIQSTVSTVSQNNIRESAFKEASSSI-------NEVGSSINE
Macroscelidae            RAMGNESIIHSTVSTVSQNNIRGSAFKEASSSSINEVGSSTNEVGSSINE
Orycteropus_TEAM         RAMGNESIIQSTVSTVSQNNIRESAFKEASSSSINEVGSSTNEVGSSINE
'+Cynocephalus'          RAMGNESIIQSTVSTISQNNIRESAFKEASSSSINEVGSSTNEVGSSINE
Myotis_Tadarida          RAMGNENI-QSTVSPISLNNIRESTFKEGSSST-------NEVGSSINE
Taphozous_Tonatia        RAMGNENIIQSTVSTISQNNIRESAVKEGSSST-------NEVGSSINE
Pteropus_Cynopterus      RAIGNETIIQSTVGTISQNNIRESTFKEGSSSSIYEAGSSTNELGSSVNE
Megaderma_Hipposideros   RAMGNESIIQSTVSTISQNNIRESTFKEGSSSNIYEADSSTNEVGSSINE
Manis_C                  RAVGNESIIQSTVSTISQNNIRESTFKEVSSSSINEVGSSTNEVGSSINE
Carnivores               RAVGNESVIQSTVSTISQNNIRESTFKEVSSSSVNEVGSSTNEVGSSINE
Cetacea                  RAMENESIIQSTVSTISQNNIRESTFKEVSSSSINEVGSSTNEVGSSINE
BHC                      RAMGNESIIQSTVSTISQNNIRESTFKEVSSSSINEVGSSTNEVGSSINE
Sus_BHC                  RAMGNESIIQSTVSTISQNNIRESTFKEVSSSSINEVGSSTNEVGSSINE
Perissodactyla           RAMGNESIIQSTVSTISQNNIRESTFKEVSSSSINEVGSSTNEVGSSINE
Insectivores             RAMGNESIIQSTVSTISQNNIRESAFKEVSSSSINEVGSSTNEVGSSINE
Glires                   RAMGNESIIQSTVSTISQNNIRESAFKEASSSSINEVGSSTNEVGSSINE
Sciurus_Glaucomys        KAVGYKRIIQSTVSTISQNNIRQSAFKEANSGSINEVGSSTNEVGSSINE
Aplodontia_SG            KAVGYKRIIQSTVSTISQNNIRESAFKEANSGSINEVGSSTNEVGSSINE
ASG_Graphiurus           KAVGYERIIQSTVSTISQNNIRESAFKEANSGSINEVGSSTNEVGSSINE
Hystrix_OMMR             KAMGNESIIQSTVSTISQNNIRESAFKEASSGSINEVGSSTNEVGSSINE
Pedetes_OMMR             KAMGNESIIQSTVYTISQNNIRESAFKEASSGSINEVGSSTNEVGSSINE
Mus_Rattus               RAMGNETVVQSTVHTISLNN-RGNACQEASSGSI--------------NE
Meriones_MR              RAMGNETVVQSTVHTISQNN-RGNACQEASSGSI--------------NE
Oryzomys_MMR             RAMGNETVVQSTVHTISQNN-RENACQEASSGSI--------------NE
Tenrec_Echinops          RASGNESIIQSTVSTISQNTLRENAFKGTSSSSL--------------NE
Wombat                   TAMGNESLAQSSLSPVSQSNSREYISKATDLNRF--------------IS
Phascogale               TTMGNESLAQSSISLVSQSNSREYVSNPIDL--I--------------IS
Echymipera               TVMGNESLGQSSLSPVSQNNSREYISKATDLNRF--------------IS
Shrew_Opossum            TVMGNESLVHSSLSLVSQSNSGEYISKATDSNRF--------------VG
Red_Kangaroo             --------------------------------------------------
Wallaroo                 --------------------------------------------------
Tree_Kangaroo            --------------------------------------------------
Possum                   --------------------------------------------------
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                          1061                                                      1120
HPG                       VGSSDENIQAELGRNRGPKLNAMLRLGVLQPEVYKQSLPGSNCKHPEIKK
Great_Apes                VGSSDENIQAELGRNRGPKLNAMLRLGVLQPEVYKQSLPGSNCKHPEIKK
OWMonkeys                 VGSSDENIQAELGRNRGPKLNAMLRLGLLQPEVYKQSLPISNCKHPEIKK
Monkeys                   VGSSDENIQAELGRNRGPKLNAMLRLGLLQPEVYKQSLPISNCKHPEIKK
Primates                  VGSSGENIQAELGRNRGPKLNAVLRLGLMQPEVYKQSLPISNCKHPEIKR
'+Tupaia'                 VGSSGENIQAELGRNRGPKLNAVLRLGLMQPEVYKQSLPISNCKHPEIKR
Tamadua_Bradypus          VGSSGENIQAELGRNRGPKLNAMLRLGLMQPEVYKQSLPITNCKHPEIKK
Armadillos                VGSSGENIQAELGRNRAPKLNAMLRLGLMQPEVYKQSLPITNCKHPEIKR
EuarchLauraXen            VGSSGENIQAELGRNRGPKLNAVLRLGLMQPEVYKQSLPISNCKHPEIKR
Elephants                 VGSSGENIQAEISRKRGPKLNAVLRLGLMQPEVYKQSLPISDCKHPGIKT
Hyraxes                   VGSSSENIQAEISRNREPRLNAVLRLGVMQPEVYKQSLSISNCKQPEIKK
Sirenia                   VGSSGENIQAELGRNRGPKLNAVLRLGLMQPEVYKQSLPVSNCKHPEIKR
TE_Amblysomus             VGSSGENIQAELGRNRGPKLNAVLRLGLMQPEVYKQSLPISNCKHPEIKR
Macroscelidae             VGSSGENIQAELDRNRGPELNAVLRLGLMQPEVYKQSLPTSNCKHPEIKR
Orycteropus_TEAM          VGSSGENIQAELGRNRGPKLNAVLRLGLMQPEVYKQSLPISNCKHPEIKR
'+Cynocephalus'           VGSSGENIQAELGRNRGPKLNAVLRLGLMQPEVYKQSLPISNCKHPEIKR
Myotis_Tadarida           VGSSGENIQAELGRNRGSKLNAMLRLGLMQPEVYKPSLPVSNCKHPEIKR
Taphozous_Tonatia         VGSSGENIQAELGRNRGSKLNAVLRLGLMQPEVYKPSLPVSNCKHPEIKR
Pteropus_Cynopterus       VGSSGENIQAELSRNRGPKLNAVLQLGLMQPEVYKQSLPLSNCKHPEIKR
Megaderma_Hipposideros    VGSSGENIQAELGRNRGPKLNAVLRLGLMQPEVYKQSLPVSNCKHPEIKR
Manis_C                   VGSSGENIQAELGRNRGPKLNAMLRLGLMQPEVYKQSLPISNCKHPEIKR
Carnivores                VGSSGENIQAELGRNRGPKLNAMLRLGLMQPEVYKQSLPISNCKHPEMKR
Cetacea                   VGSSGENIQAKLDRNRGPKLSALLRLGLMQPEVYKQSLPVSNCQLPEIKR
BHC                       VGSSGENIQAELGRNRGPKLSALLRLGLMQPEVYKQSLPVSNCQHPEIKR
Sus_BHC                   VGSSGENIQAELGRNRGPKLSAMLRLGLMQPEVYKQSLPVSNCKHPEIKR
Perissodactyla            VGSSGENIQAELGRNRGPKLNAILRLGLMQPEVYKQSLPISNCKHPEIKR
Insectivores              VGSSGENIQAELGRNRGPKLNAMLRLGLMQPEVYKQSLPISNCKHPEIKR
Glires                    VGSSGENIQAELGRNRGPKLNAVLRLGLMQPEVYKQSLPISNCKHPEIKR
Sciurus_Glaucomys         VGSSGENIQAELGRNRGPKLNAVLRLGLMQPEACKQNLL-SNCKYPEIKR
Aplodontia_SG             VGSSGENIQAELGRNRGPKLNAVLRLGLMQPEACKQNLLVSNCKYPEIKR
ASG_Graphiurus            VGSSGENIQAELGRNRGPKLNAVLRLGLMQPEAYKQSLPVSNCKHPEIKR
Hystrix_OMMR              VGSSGENIQAELGRNRGPKLNAVLRLGLMQPEVYKQSLPVSNCKHPEIKR
Pedetes_OMMR              VGSSGENIQAELGRNRGPKLNAVLRLGLMQPEVCKQSLPVSNCKHPEIKR
Mus_Rattus                VCSTGENVQGQLGRNRGPKVNTVPPLDSMQPGVCKQSVPVSD-KYLEIKK
Meriones_MR               VCSSGENVQGQLGRNRGPKVNTVLPLDLMQPEVCKQSVPVSDYKYLEMKK
Oryzomys_MMR              VCSSGENVQGQLGRNRGPKLNTVLPLGLMQPEVCKQSLPVSDYKYLEMKK
Tenrec_Echinops           VGSSSENIQAELARNREPKLDAVLRLGLVQPEVCKESLPIRKCKHPEVKR
Wombat                    IGSSGEGSQAQKGENKESELNTQPKLKLVQPQICQQSFPQDNCKESKRKG
Phascogale                VGSSGEGTQAEKSENKESELNTPPKLKLMQPQVSQQTFPQNNCK
Echymipera                RDSSGEDSRAEKGKIKESELNTPTKFKLVQPQVCQLSFSQDNCKEPKRKG
Shrew_Opossum             VDSSGEGSQEEKGENK---LN--------QSQVCQQS
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                         1121                                      1162
HPG                      QG-YEEVVQTVNTDFSPCLISDNLEQPMGSSHASQVCSETPDD
Great_Apes               QG-YEEVVQTVNTDFSPCLISDNLEQPMGSSHASQVCSETPDD
OWMonkeys                QG-HEEVVQTVNTDFSPCLISDNLEQPMGSSHASQVCSETPDD
Monkeys                  QG-HEEVVQTVNTDFSPCLISDNLEQPMGSSHASQVCSETPDD
Primates                 QGENEGVVQAVNTDFSPCLISDNLEQPMGSSHASQVCSETPDD
'+Tupaia'                QGENEGVVQAVNTDFSPCLISDNLEQPMGSSHASQVCSETPDD
Tamadua_Bradypus         QGENEEVVQAVNTDFSPCLISDNLELPMGSSHASQICSETPDD
Armadillos               QGENEEAIQAVDTDFSPCLISDNLELPMGNSHASQICSETPDD
EuarchLauraXen           QGENEGVVQAVNTDFSPCLISDNLEQPMGSSHASQICSETPDD
Elephants                QGENEGVVQAVNTDFSPCLISDNLEQPVGTSRASQVCSETPDD
Hyraxes                  QGENEGVVQAVSTDFSACPISENLEQPVRSSHTSQVCSQTPDN
Sirenia                  QGENEGVVQDVNMDFSPCLISDNLEQPMGSSRASQICSETPDD
TE_Amblysomus            QGDNEGVVQAVNPDFSPCLISDNLEQPMGSSHASQICSETPDD
Macroscelidae            PGENEGVIQAVNPDFSPCLISDNLEQPMGSSHASQICSETPDD
Orycteropus_TEAM         QGENEGVVQAVNTDFSPCLISDNLEQPMGSSHASQICSETPDD
'+Cynocephalus'          QGENEGVVQAVNTDFSPCLISDNLEQPMGSSHASQVCSETPDD
Myotis_Tadarida          QGENEGVVQAVNADFSPCQISDNLEQPMGSSPASQVCSETPDD
Taphozous_Tonatia        QGENEGVVQAVNADFSPCQISDNLEQPMGSSPASQVCSETPDD
Pteropus_Cynopterus      QGENEGVVQAVNADVSPRQISDNLEQPMGNSNASQVCSETPDD
Megaderma_Hipposideros   QGENEGVVQAVNADFSPCQISDNLEQPMGSSHASQVCSETPDD
Manis_C                  QGENEGVVQAVNADFSPCLISDNLEQPMGSSHASQVCSETPDD
Carnivores               QGENEGVVQSVNADFSPCLISDNLEQPMGSSRASQVCSETPDD
Cetacea                  QGENEGTLQAVNADFSPCLISDNLEQPMGRSHASQVCSETSDE
BHC                      QGENEGILQAVNADFSPCLISDNLEQPMGSSHASQVCSETPDD
Sus_BHC                  QGENEGIFQAVNADFSPCLISDNLEQPMGSSHASQVCSETPDD
Perissodactyla           QGENEGVVQAVNADFSPCLISDNLEQPMGSSCASQVCSETPDD
Insectivores             QGENEGVVQAVNTDFSPCLISDNLEQPMGSSHASQVCSETPDD
Glires                   QGENEGVVQAVNTDFSPCLISDNLEQPMGSSHASQVCSETPDD
Sciurus_Glaucomys        QGE-EGVVQVVNTDFSPCLISDDLEQPMGNSHVTQVCSETPDD
Aplodontia_SG            QGE-EGVVQVVNTDFSPCLISDDLEQPMGNSHVTQVCSETPDD
ASG_Graphiurus           QGE-EGVVQAVNTDFSPCLISDNLEQPMGNSHASQVCSETPDD
Hystrix_OMMR             QGENEGVVQAVNTDFSPCLISDNLEQPMGSSHASQVCSETPDD
Pedetes_OMMR             QGENEGVVQAVDADFSPCLISDNLEQPMGSGHVSQVCSETPDD
Mus_Rattus               Q-E-EG---AVSADFSPCLFSDHLEQPMRSGKIFQVCSETPDD
Meriones_MR              Q-E-EG---AVGADFSPCLFSDHLEQPMRSGNIFQVCSETPDD
Oryzomys_MMR             Q-E-EG---AVDADFSPCLFSDNLEQPMGSGNIFQVCSETPDD
Tenrec_Echinops          QKGNGGLVPAVNPDFSRYLMSHNPEQPMESNH-SQICSETPED
Wombat                   KGGNGKLAQAISTDSSPCL
Echymipera               KGGNGILALATSTDSSPCL
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Appendix E: Three class alignment of BRCA1 exon 11 amino acids 282-1152

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                        282                                              331
HPG                     SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQHNRWAGSKETCNDR
Great_Apes              SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQHNRWAGSKETCNDR
OWMonkeys               SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQHNRWAGSKETCNDR
Monkeys                 SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQHNRWAESKETCNDR
Primates                SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDR
'+Tupaia'               SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDR
Tamadua_Bradypus        SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDR
Armadillos              LLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARRQQSRWAESKETCNDR
EuarchLauraXen          SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDR
Elephants               SLQHKNSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDR
Hyraxes                 SLQHENSSLLLTKDRMDVEKAEFCSKSKQPGLARSQQSRWAESTETCNDR
Sirenia                 SLQHENSSLLLTKDRMNVEKAEFCHKSKQPGLARSQQSRWAESKETCNDR
TE_Amblysomus           SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDK
Macroscelidae           SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDR
Orycteropus_TEAM        SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDR
'+Cynocephalus'         SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDR
Myotis_Tadarida         SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDR
Taphozous_Tonatia       SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDR
Pteropus_Cynopterus     SLQHENSSLLYTKDRMNVEKTDFCNKSKQPGLARSQQNRWVETKETCNDR
Megaderma_Hipposideros  SLQHENSSLLLTEDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDR
Manis_C                 SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDR
Carnivores              SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDR
Cetacea                 SLQHENSSLLLTKDRMNVEKAEFCNKSKQPVLAKSQQSRWAESKDTCNDR
BHC                     SLQHENSSLLLTKDRMNVEKAEFCNKSKQPVLAKSQQSRWAESKDTCNDR
Sus_BHC                 SLQHENSSLLLTKDRMNVEKAEFCNKSKQPVLAKSQQSRWAESKDTCNDR
Perissodactyla          SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLAKSQQSRWAESKETCNDR
Insectivores            SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDR
Glires                  SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDR
Sciurus_Glaucomys       SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAKSKETCNDR
Aplodontia_SG           SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAKSKETCNDR
ASG_Graphiurus          SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDR
Hystrix_OMMR            SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDR
Pedetes_OMMR            SLQHENSSLLLTKDRMNVEKAEFCNKSKQPGLARSQQSRWAESKETCNDR
Mus_Rattus              SLQHETSSLLLTEDRMNAEKAEFCNKSKQSGVAVSQQSRWAESKETCNDR
Meriones_MR             SLQHENSSLLLTEDRMNVEKAEFCNKSKQSGLARSQQSRWAESKETCNDR
Oryzomys_MMR            SLQHENSSLLLTEDRMNVEKAEFCNKSKQSGLARSQQSRWAESKETCNDR
Tenrec_Echinops         SLQRENCSLLLTKDRLNVEKAGFCNESKQPGLARSQHSRWAESKETCNDK
Wombat                  SLLPKTSSLLPNTDRMNVEKAELCHKNKQPALGRNQESSLDESKEICSPG
Phascogale              SLLPETSSLLPNTDRMS-EKAELSNKSKQSGLARNQQSRLDESKGICSTG
Echymipera              SLMLETSSLLSNIDRMTTKKAELCNKSKDPGLARNQQDCLGESKEISSTV
Shrew_Opossum           SLLPEITSLLPNTDRMNVEKAELCNKSKQPGLASNQQSNLDESKEICSAS
Red_Kangaroo            SLLPETTSLSPNTDRMNVEKAELCNKSKQPGLAKNQQSSLDESKEICSAG
Wallaroo                SLLPETTSLSPNTDRMNVEKAELCNKSKQPGLAKNQQSSLDESKEICSAG
Tree_Kangaroo           SLLPETTSLSPNTFQMNVEKAELCNKSKQPGLAKNQQSSLDESKEICSAG
Possum                  SLLPDITSVLPNTDSMNVEKAELCDKSKRPDLAWSQQISQDESKEKCIAG
Gallus                  SPLKNDTSFLKNAEEMDVEETQCSHKNQELDLEDSSEGRLDKIKEKDICV
Xenopus_Prot_FASTA      EQFPNDHHCSFKQNIADAEQNKRNQHCGNVPFAPMGKSNLDE-KETVETD
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                          332                                            379
HPG                       RTPSTEKKVDLNADPLCERKEWNKQKLPCSENPRDTED--VPWITLNSSI
Great_Apes                QTPSTEKKVDLNADPLCERKEWNKQKLPCSENPRDTED--VPWITLNSSI
OWMonkeys                 QTPSTEKKVDLNADPLYERKEWNKQKLPCSENPRDTED--VPWITLNSSI
Monkeys                   QTPSTEKKVDLNADPLYGRKEWNKQKPPCSENPRDTED--VPWITLNSSI
Primates                  QTPSTEKKVDLNADPLYGRKERNKQKPPCSENPRDTQD--VPWITLNSSI
'+Tupaia'                 QTPSTEKKVDLNADPLYGRKERNKQKPPCSESPRDTQD--VPWITLNSSI
Tamadua_Bradypus          QTPSTEKKVDVDADPLYGRKELNKQKPPCSESPRDTQD--IPWITLNSSI
Armadillos                QTPSTEKKVDVDADPLYGRKELNKQKPPCSESPRDTQD--IPWITLNSSI
EuarchLauraXen            QTPSTEKKVDLNADPLYGRKELNKQKPPCSESPRDTQD--IPWITLNSSI
Elephants                 QTPSTEKKVDVNADPLYERKEVNKQKPPRSENLRDTQD--IPWITLNSSI
Hyraxes                   QILRTEKKVDTNADPLYGKKEGNKQKPPCSESRTDTQD--IPWVTLNNSI
Sirenia                   QTPSTEKKVDMNANPLYERKEVNKQKPPCSESVRDTQD--IPWLTLNSSI
TE_Amblysomus             QTPSTEKKVDMNADPLYGRKEVNKQKPPCSESPRDTQD--IPWITLNSSI
Macroscelidae             QTPSTEKKVDMNADPFYGRKEVNKQKSPCSESPKDTQD--IPWMTLNSSI
Orycteropus_TEAM          QTPSTEKKVDMNADPLYGRKEVNKQKPPCSESPRDTQD--IPWITLNSSI
'+Cynocephalus'           QTPSTEKKVDLNADPLYGRKERNKQKPPCSESPRDTQD--VPWITLNSSI
Myotis_Tadarida           QTPSTEKRVVLNADPLNGRKE-----PPCSDYPRDSQD--VPWITRSSSI
Taphozous_Tonatia         QTPSTEKRVVLNADPLNGRKE-----PPCSDCPRDSQD--VPWITRNSSI
Pteropus_Cynopterus       QTSSTEKKVVLNADPLNGRIELNKQKPPCSDSPRDSQD--IPWITRNSSI
Megaderma_Hipposideros    QTPSTEKKVVLNADPLNGRKELNKQKPPCSDSPRDSQD--VPWITRNSSI
Manis_C                   QTPSTEKKVVLNADPLCGRKELNKQKPPCSDSPRDSQD--VPWITLNSSI
Carnivores                QTPSTEKKVVLNADPLCGRKELNKQKPPCSDSPRDSQD--VPWITLNSSI
Cetacea                   QTPSTEKKVVLNADPLYGRKELNKQKPACSDSPRDSQE--FPWITVNSSI
BHC                       QTPSTEKKVVLNADPLYGRKELNKQKPACSDSPRDSQD--VPWITLNSSI
Sus_BHC                   QTPSTEKKVVLNADPLYGRKELNKQKPACSDSPRDSQD--VPWITLNSSI
Perissodactyla            QTPNSEKKLVLNADPLYGRKELNKQKPPCSDSPRDSQD--VPWITLNSSI
Insectivores              QTPSPEKKVDLNADPLYGRKELNKQKPPCSDSPRDSQD--VPWITLNSSI
Glires                    QTPSTEKKVDLNADPLYGRKERNKQKPPCSENPRDTQD--VPWITLNSSI
Sciurus_Glaucomys         QTPSTEKKVDLNADPQYERKEPSKQKPPCSENSRDTQD--VPWITLNSSI
Aplodontia_SG             QTPSTEKKVDLNADPLYERKEPSKQKPPCSENPRDTQD--VPWITLNSSI
ASG_Graphiurus            QTPSTEKKVDLNADPLYGRKERNKQKPPCSENPRDTQD--VPWITLNSSI
Hystrix_OMMR              QTPSTEKKVDLNADPLYGRKERNKQKPPCSENPRDTQD--VPWITLNSSI
Pedetes_OMMR              QTPSTEKKVDLNADPLYGRKERNKQKPPCSENPRDTQD--VPWITLNSSI
Mus_Rattus                QVPSTEEKVDPNADSLCGRKKWNHPKSLCPENSGATTD--VPWITLNSSI
Meriones_MR               QIPSTEKKVDPNADSLCGRKKWNNQKSLCPENSGATQD--VPWITLNSSI
Oryzomys_MMR              QIPSTEKKVDLNADSLCGRKKWNNQKSLCPENSRATQD--VPWITLNSSI
Tenrec_Echinops           PTPSTEKKVDMNADPVHGRKGVPKQKPPCHESPRKSHD--VPWKTRKSSI
Wombat                    KTPGACERHELNDHHLCERQGLE-EKPQHPESPRGNPQNCLSGTKLKSSI
Phascogale                KTPSVGEQPELNAHHLCEKQELK-EKPQGPEGPRGNPQNCLSGTKLKSSI
Echymipera                KTPAAGEQHKLNAHHLCEKQELE-VKSQHPESPKGSPRRCRSGTKLKSSI
Shrew_Opossum             KTPGAEEQPELNANHLCERKELE-EKLQCPESPRGDSGDCLSGTKVKNSI
Red_Kangaroo              KTLGA---HELNAHHPCERKELE-DEPQHPESPRGNPQNCQSGTKLKSSI
Wallaroo                  KTLGA---HELNAHHPCERKELE-DEPQHPESPRGNPQNCQSGTKLKSSI
Tree_Kangaroo             KTLGA---HELNAHHPCERKELE-DEPQHPESPRGNPQNCQSGTKLKSSI
Possum                    KTSDAKELHELNAHHLYERQELE-EQPECPNYPRGNSQNCLSGTKLK-SI
Gallus                    PSVEDVEMCEPMDDSLLE-KEPPVEKPLQPKIPHCPTLNEVSTKGLNQSI
Xenopus_Prot_FASTA        FDNQHNDSNPENNDPLG----------------------KVTKLMRR-ST
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                         380                                            427
HPG                      QKVNEWFSRSDELLGSDDSHDGGSESNAKVADVLDV--LNEVDEYSGSSE
Great_Apes               QKVNEWFSRSDELLGSDDSHDGGSESNAKVADVLDV--LNEVDEYSGSSE
OWMonkeys                QKVNEWFSRSDELLSSDDSHDGGSESNAKVADVLDV--LNEVDEYSGSSE
Monkeys                  QKVNEWFSRSDELLTSDDSHDGGSESNAKVADALEV--LNEVDGYSGSSE
Primates                 QKVNEWFSRSDEMLTSDDSHDGGSESNAEVAGALEV--PNEVDGYSGSSE
'+Tupaia'                QKVNEWFSRSDEMLTSDDSHDGGSESNAEVAGALEV--PNEVDGYSGSSE
Tamadua_Bradypus         QKVNEWFSRSDDILTSDDSHNGGSESNAEVAGALKV--PNEVDGYSGSSE
Armadillos               QKVNEWFSRSDDILTSDDSHDGGSESNAEVAGALKV--PNEVDGYSSSSE
EuarchLauraXen           QKVNEWFSRSDDMLTSDDSHDGGSESNAEVAGALEV--PNEVDGYSGSSE
Elephants                QKVNEWFFRSDGL---DVLNDEGPESSAEVAGALEV--PNEVH--SNSSE
Hyraxes                  QKVNEWFSRSDNL---SDSPSEGSELNGKVAGPVKL--PGEVHRYSSFPE
Sirenia                  QKVNEWFFRSDGL---DDLHDKGSESNAEVAGALEV--PEEVHGYSSSSE
TE_Amblysomus            QKVNEWFSRSDGL---DDSHDEGSESNAEVAGAFEV--PNEVHGYSSSSE
Macroscelidae            QKVNEWFSRSDGL---DDSHDEGSESNAAIAGALEV--PNEVHGYSSSSE
Orycteropus_TEAM         QKVNEWFSRSDGL---DDSHDEGSESNAEVAGALEV--PNEVHGYSSSSE
'+Cynocephalus'          QKVNEWFSRSDEMLTSDDSHDGGSESNAEVAGALEV--PNEVDGYSGSSE
Myotis_Tadarida          QKVNEWFSRRDEILTSDGSHNGRSESNAEVAGAVEV--PNEVDGYSGSPE
Taphozous_Tonatia        QKVNEWFSRRDEILTSDGSHDGRSESNTEVAGAVEV--PNEVDGYSGSPE
Pteropus_Cynopterus      QKVNEWFSRRDEILTSDVSPDGRSESN-----VVEV--PNEVDGYSGASE
Megaderma_Hipposideros   QKVNEWFSRRDEILTSHGSHDGRAESNTEVAGAVEV--PNEVDGYSGSSE
Manis_C                  QKVNEWFSRSDEMLTSDDSHDGGSESNTEVAGAVEV--PNEVDGYSGSSE
Carnivores               QKVNEWFSRSDEMLTSDDSHDGGSESNTEVAGAVEV--PNEVDGYSGSSE
Cetacea                  QKVNEWFSRSDEMLTSNDSRDGGFESNTEVACAVEV--PKEVDGYLGSSE
BHC                      QKVNEWFSRSDEMLTSDDSRDGGSESNTEVAGAVEV--PNEVDGYLGSSE
Sus_BHC                  QKVNEWFSRSDEMLTSDDSHDGGSESNTEVAGAVEV--PNEVDGYLGSSE
Perissodactyla           QKVNEWFSRSDEMLTSDDSHDGGPESNTEVAGAVEV--PNEVDGYSGSSE
Insectivores             QKVNEWFSRSDEMLTSDDSHDGGSESNTEVAGAVEV--PNAVDGFSGSSE
Glires                   QKVNEWFSRSDEMLTSDDSHDGGSESNAEVAGALEV--PNEVDGYSGSSE
Sciurus_Glaucomys        RKVNEWFSRSDEMLTSDDSDDGGSESNAEVAGVLEI--PNEVDGFSGSSE
Aplodontia_SG            QKVNEWFSRSDEMLTSDDSHDGGSESNAEVAGVLEI--PNEVDGFSGSSE
ASG_Graphiurus           QKVNEWFSRSDEMLTSDDSHDGGSESNAEVAGALEV--PNEVDGYSGSSE
Hystrix_OMMR             QKVNEWFSRSDEMLTSDDSHDGGSESNAEVAGALEV--PNEVDGYSGSSE
Pedetes_OMMR             QKVNEWFSRSDEMLTSDDSHDGGSESNAEVAGALEV--PNEVDGYSGSSE
Mus_Rattus               QKVNEWFSRTGEMLTSDSASDRRPASNAEAAVVLEV--SNEVDGCFSSSK
Meriones_MR              QKVNEWFSRTGEMLTSDSASDRRPASNAEAAVALEV--SNEVDGCFSSSK
Oryzomys_MMR             QKVNEWFSRTGEMLTSDGASDRRPESNAEAAVALEV--SNEVDGCSSSSK
Tenrec_Echinops          WKVNEWFSKSDGL---GDSHDERPESDADVAGAFEV--PDEARESSSSPE
Wombat                   QKVNEWLSRSSDILASDNSNGRSHEQSAEVPSALEDGHPDTAEGNSSVSE
Phascogale               QKVNEWLSRSNDILASDCSLDKNHKQNAEIASALEDGHPDNSDGNSSISE
Echymipera               QKVSEWLSRSNDILNSDYSHERSQEQNAEIAIALEDGHLNTADGNSSISE
Shrew_Opossum            QKVNEWLFRSNDVLAPDYSSVRSHEQNAEATNALEYGHVET-DGNSSISE
Red_Kangaroo             QKVNEWLSRSNDILTSDNSCSRNHEQNVEMPSALEDGYPDTADGNSNISE
Wallaroo                 QKVNEWLSRSNDILTSDNSYSRNHEQNAEMPSALEDGYPDTADANSNISE
Tree_Kangaroo            QKVNEWLSRSNDILISDNSYSRNHEQNAEMPSALEDGYPDTADGNSNISE
Possum                   QKVNDWLSKSNDILVSDYSSGRIHEQNAEMDSVLEDGHPDVTDGNSSISG
Gallus                   QKVNEWFSKSSRILSSSSSQND-HAEATDASG---EGDISLSDKDSCISE
Xenopus_Prot_FASTA       ERVNEWLLKTNQDFSTLSAEED------PILDALALQNKETSDKRSCSSD
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                          428                                       473
HPG                       KIDLLAS-DPHEALICKSERVHSKSVESN-IEDKIFGKTY--RRKASLPN
Great_Apes                KIDLLAS-DPHEALICKSERVHSKSVESN-IEDKIFGKTY--RRKASLPN
OWMonkeys                 KIDLLAS-DPHEPLICKSERVHSKSVESN-IEDKIFGKTY--RRKASLPN
Monkeys                   KIDLLAS-DPHDPLICKSERVHSKSVESN-IEDKIFGKTY--RRKASLPN
Primates                  KIDLLAS-DPHDPLICKSERVHSKPVESN-IEDKIFGKTY--RRKASLPN
'+Tupaia'                 KIDLMAS-DPHDALICKSERVHSKPVESN-IEDKIFGKTY--RRKASLPN
Tamadua_Bradypus          KIDLIAS-DPHNALIFASERVQSKPTESN-IEDKIFGKTY--HRKASLPN
Armadillos                KIDLMAS-DPHNALIFASERVQSKPAESN-IKDKIFGKTY--HRKASLPN
EuarchLauraXen            KIDLMAS-DPHDALICESERVHSKPAESN-IEDKIFGKTY--RRKASLPN
Elephants                 KIDLMAS-DLHGALICESERVPSKPAESN-IEDKIFGKTY--RRKAGISH
Hyraxes                   NIDLMAS-GPPGDLICESERIPCKPPKSN-IKDKIFGKTY--QRKGSLPH
Sirenia                   KIDLMAS-DPHSALICESERVLSKPAESN-IEDKIFGKTY--RRKAILPH
TE_Amblysomus             KIDLMAS-DPHDALICESERVLSKPAESN-IEDKIFGKTY--RRKASLPN
Macroscelidae             KIDLMAS-DPHDASICESERVLSKPAENN-IEDKIFGKTY--RRKASLPN
Orycteropus_TEAM          KIDLMAS-DPHDALICESERVLSKPAESN-IEDKIFGKTY--RRKASLPN
'+Cynocephalus'           KIDLMAS-DPHDALICKSERVHSKPVESN-IEDKIFGKTY--RRKASLPN
Myotis_Tadarida           KIALMAS-DPHGALICESERVHSKPVESN-IEDKIFGKTY--RRKASLPN
Taphozous_Tonatia         KIALMAS-DPHGALICESERVHSKPVESN-IEDKIFGKTY--RRKASLPN
Pteropus_Cynopterus       KIALKAS-DPHGALIC--ERVHSKLVESN-IEDKIFGKTY--RRKASLPN
Megaderma_Hipposideros    KIALMAS-DPHGALICESERVHSKPVESN-IEDKIFGKTY--RRKASLPN
Manis_C                   KIDLMAS-DPHDALICESERVHSKPVESN-IEDKIFGKTY--RRKASLPN
Carnivores                KIDLMAS-DPHDALICESERVHTKPVESN-IEDKIFGKTY--RRKASLPN
Cetacea                   KIDLMAS-DPHGALIRESERVHSKPVESN-IEDKIFGKTY--RRKASLPN
BHC                       KIDLMAS-DPHGALIRESERVHSKPVESN-IEDKIFGKTY--RRKASLPN
Sus_BHC                   KIDLMAS-DPHGALIRESERVHSKPVESN-IEDKIFGKTY--RRKASLPN
Perissodactyla            KIDLMAS-DPPGALICESERVHSKPVENN-IEDKIFGKTY--RRKASLPN
Insectivores              KIDLMAS-DPHGALICESERVHSKPVESN-IEDKIFGKTY--RRKASLPN
Glires                    KIDLLAS-DPHNALICKSERVHSKPVESN-IEDKIFGKTY--RRKASLPN
Sciurus_Glaucomys         KIDLLAT-DPHNALISKCERVCSKAVESN-IEDKIFGKTY--RRKASLPN
Aplodontia_SG             KIDLLAT-DPHNALISKCERVCSKAVESN-IEDKIFGKTY--RRKASLPN
ASG_Graphiurus            KIDLLAS-DPHNALICKSERVCSKPVESN-IEDKIFGKTY--RRKASLPN
Hystrix_OMMR              KIDLLAS-DPHNALICKSERVCSKPVESN-IEDKIFGKTY--RRKASLPN
Pedetes_OMMR              KIDLLAS-DPHNALICKSERVCSKPVESN-IEDKIFGKTY--RRKASLPN
Mus_Rattus                KTDLVAP-DPHNALMCKSGRDFSKPVENN-INDKIFGKTY--QRKGSRPH
Meriones_MR               KTDLVAP-DPHNALMCKSERDFSKPVENN-IKDKIFGKTY--QRKGSLPH
Oryzomys_MMR              KTDLVAT-DPHNALMCKSERDCSKPVENN-IKDKIFGKTY--QRKGSLPH
Tenrec_Echinops           KTDLMAS-DPHVPLLHKSERVLSKPVESN-IEDKIFGKTY--RRKSSLLN
Wombat                    KTDPVAD-STDDAWLHVPKRSCLRPAENN-IEDKIFGKTY--RRKSGHPN
Phascogale                KTDVVAD-TADGAWLHVPKRTYTRPAENNNIKDKIFGKTY--RRKSGHPN
Echymipera                KT-LVA--TTD-----VLETS-SRPAKSN-IEDKIFGKTY--RRKS-HSN
Shrew_Opossum             KTDMVAD-STDGSWLHAPEKNCPRPAESNNIEDKIFGKTY--RRKSVHPV
Red_Kangaroo              KTDPVAD-ITYDPWPHVPERSCPRPAENNNIEDKIFGKTY--RRKSGHPH
Wallaroo                  KTDPVAD-ITYDPWPHVPERSCPRPAENNNIEDKIFGKTY--RRKSGHSH
Tree_Kangaroo             KTDPVADNNTYDPWPHVPERSCPRPAENNNIEDKIFGKTY--RRKSGHPH
Possum                    KTDLVAD-STDGAWLHMSERSCSRKAESNNIEDKIFGKTY--HRKSVHIN
Gallus                    KTNPIVD-SVEFAVIERNKRWTKQTTYS--IEDKIFGKTY--ERGRK-SN
Xenopus_Prot_FASTA        DSELMPV-LHKHAEKGISGGGFDKPAVG--VKDKIFCKVYKRERKAMPPN
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                        474                                          518
HPG                     LSHVTENLII--GAFV---TEPQIIQERPLTNKLKRKRRATSGLHPEDFI
Great_Apes              LSHVTENLII--GAFV---TEPQIIQERPLTNKLKRKRRATSGLHPEDFI
OWMonkeys               LSHVTENLII--GAFV---TEPQIIQERPLTNKLKRKRRATSGLHPEDFI
Monkeys                 LSHVTENLII--GAFV---TEPQIIQERPLTNKLKRKRRATSGLHPEDFI
Primates                LSHVTENLII--GAFA---TEPQITQERPLTNKLKRKRRTTSGLHPEDFI
'+Tupaia'               LSHVTEDLII--GAFA---TEPQITQERPLTNKLKRKRRTTSGLHPEDFI
Tamadua_Bradypus        LSHIAEDLFI--GAIA---TEPKITQEHPLTNKIKRKRRTTSGLHPEDFI
Armadillos              LSHITEDLFI--GAIA---TEPKITQEHSLTNKIKRKRRTTSGLHPEDFI
EuarchLauraXen          LSHVTEDLII--GAVA---TEPQITQERPLTNKLKRKRRTTSGLHPEDFI
Elephants               LSHITEDLIM--GAIA---SEPQIAREHPFTNKLKRKRR-TSGLHPEDFI
Hyraxes                 LSHITEDLVK--GAIA---TQPQIAREHPLTNKLQHKRR-TSGLHPEDFI
Sirenia                 LSHVTEDLII--GAVA---TEPQIAQERPLTNKLKRKRR-TSGLHPEDFI
TE_Amblysomus           LSHVTEDLMI--GAVA---TEPQIAQERPLTNKLKRKRR-TSGLHPEDFI
Macroscelidae           LSHVTQDLII--GAVA---TEPQTAQERPLTNKLKRKRR-TSGLHPEDFI
Orycteropus_TEAM        LSHVTEDLII--GAVA---TEPQIAQERPLTNKLKRKRR-TSGLHPEDFI
'+Cynocephalus'         LSHVTEDLII--GAFA---TEPQITQERPLTNKLKRKRRTTSGLHPEDFI
Myotis_Tadarida         LSHITENLII--GASA---IEPQITQECPLTNKLKRKRRTTSGLHPEDFI
Taphozous_Tonatia       LSHITENLII--GASA---IEPQITQECPLTNKLKRKRRTTSGLHPEDFI
Pteropus_Cynopterus     LSHITENLIT--GASA---IEPQITQECPLTNKLKRKRRTTSGLHPEDFI
Megaderma_Hipposideros  LSHITENLII--GASA---VEPQITQECPLTNKLKRKRRTTSGLHPEDFI
Manis_C                 LSHITEDLII--GASA---IEPQITQERPLTNKVKRKRRTTSGLHPEDFI
Carnivores              LSHTTEDLII--GACA---IEPQITQAHPLTNKAKRKRRTTSGLHPEDFI
Cetacea                 LSHIAENLII--GAST---VEPQITQERPLTNKLKRKRRSTSGLHPEDFI
BHC                     LSHIAEDLII--GASA---VEPQITQERPLTNKLKRKRRSTSGLHPEDFI
Sus_BHC                 LSHIAEDLII--GASA---VEPQITQERPLTNKLKRKRRSTSGLHPEDFI
Perissodactyla          LSHITEDLII--GASA---IEPQITQERPLTNKLKHKRRTTSGLHPEDFI
Insectivores            LSHVTEDLII--GASA---TEPQITQERPLTNKLKRKRRTTSGLYPEDFI
Glires                  LSHVTEDLII--GAFA---TEPQITQERPLTNKLKRKRRTTSGLHPEDFI
Sciurus_Glaucomys       LSHITENLII--GAFA---TEPQITQERPLTNKLKRKRRTTSCLHPEDFI
Aplodontia_SG           LSHVTENLII--GAFA---TEPQITQERPLTNKLKRKRRTTSCLHPEDFI
ASG_Graphiurus          LSHVTENLII--GAFA---TEPQITQERPLTNKLKRKRRTTSCLHPEDFI
Hystrix_OMMR            LSHVTENLII--GAFA---TEPQITQERPLTNKLKRKRRTTSCLHPEDFI
Pedetes_OMMR            LSHVTENLII--GAFA---TEPQITQERPLTNKLKRKRRTTSCLHPEDFI
Mus_Rattus              LNHVTE--II--GTFT---TEPQITQEQPFTNKLKRKRR-T-CLHPEDFI
Meriones_MR             LNHVTE--II--GTFT---TEPQITQEQPFTNKLKRKRRST-CLHPEDFI
Oryzomys_MMR            LNHVTE--II--GTFT---TEPQITQEHPFTNKLKRKRRTT-CLHPEDFI
Tenrec_Echinops         SSHVTEDLMV--GAAA---AVPPIAQEHLLTSKLKRKRR-SSVLHPEDFI
Wombat                  LNYVTENLFA--EAV-A--PDSLIPLEAPKNTRLKRKGRSIADLQPEDFI
Phascogale              LNHITENLIV--ETV-V--PDSLVPPEPLKNTKLKRKRKTICDLQPEDFI
Echymipera              LNYLTENLLV--ETI-A--PDSLIPPESLKNIKLKRKRKTISDLQPEDFI
Shrew_Opossum           LNYVTENLIV--ETI-A--PDSVIPPEPLKKTKLKRKRKTICBLQPEDFI
Red_Kangaroo            LNCMTENLFA--GAVVA--PDSLIPPEPPKTTKLKRKRKTISNLQPEDFI
Wallaroo                LNCITENLFA--GAVVA--PDSLIPPEPPKTTKLKRKRKTISNLQPE
Tree_Kangaroo           LNCITENLFA--GAVVA--PDSLIPPEPPKTTKLKHKRKTISNLQPEDF
Possum                  LNYVTENLIV--GAV-D--SDSLIPPEPVKKTRLKRKRKTVSDLQP
Gallus                  PSTILRDILP--ATKKEDAAAEEGCLNNSRKDRLKRKRKSACILQPEDFI
Xenopus_Prot_FASTA      NITCVAEVHHDSALETG--KENMTLEYGTGMSHLMSKRKMVYSLNPENTS
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                        519                                         563
HPG                     KKADLAV-QKTPEMINQGTNQM---EQNGQVMNITNSGHENKTKGDSIQ-
Great_Apes              KKADLAV-QKTPEMINQGTNQM---EQNGQVMNITNSGHENKTKGDSIQ-
OWMonkeys               KKADLAV-QKTPEMINQGTNQM---EQNGQVMNITNSGHENKTKGDSIQ-
Monkeys                 KKADLAV-QKTPEKINQGTNQM---EQNGQVMNITNSGHENKTKGDSIQ-
Primates                KKADLAVVQKTPEKINQGTNQM---EQNGQVMNITNSGHENETKGDYVQ-
'+Tupaia'               KKADLAVVQKTPEKINQGTDQM---EQNGQVMNITNSGHENETKGDYVQ-
Tamadua_Bradypus        KKVDLTVVQKTPEKINQGTDQM---EQNGQVMNIANSGHENETKGDYVQ-
Armadillos              KKVDLTVVQKTPEKINQGTDQM---EQNDQVMNIANSGHENETKGDYVQ-
EuarchLauraXen          KKVDLAVVQKTPEKINQGTDQM---EQNGQVMNIANSGHENETKGDYVQ-
Elephants               KKVDLAVVQKIPEKINQETDHV---EQNGQVMNIANGGRENETKGDYVQ-
Hyraxes                 KKADLTVVQKASEKINQETDKV---EQSGQVINIANGGHENETKDDYVL-
Sirenia                 KKVDLAVVQKTPEKINQETDQV---EQNGQVMNIANGGHENETKDDYVQ-
TE_Amblysomus           KKVDLAVVQKTPEKINQETDQM---EQNGQVKNIADGGHENETKGDYVQ-
Macroscelidae           KKVDLTVVQKTPEKINQETDQM---EQNGQVKNIAGGGHENETKGDYVQ-
Orycteropus_TEAM        KKVDLAVVQKTPEKINQETDQM---EQNGQVKNIADGGHENETKGDYVQ-
'+Cynocephalus'         KKADLAVVQKTPEKINQGTDQM---EQNGQVMNITNSGHENETKGDYVQ-
Myotis_Tadarida         KKVDLAVVQKTPEKIIEGTDQI---EQNGHVMNITNNGHENETKGDYVQ-
Taphozous_Tonatia       KKVDLAVVQKTPEKIIEGTDQI---EQNGHVMNITNNGHENETKGDYVQ-
Pteropus_Cynopterus     KKIDLAVVQKTPENIIEGTDQI---EQNGHVMNSTNNGHENETKGDYVQ-
Megaderma_Hipposideros  KKVDLAVVQKTPEKIIEGTDQI---EQNGHVMNITNNGHENETKGDYVQ-
Manis_C                 KKVDLAVVQKTPEKIIEGTDQI---EQNGHVMNITNNGHENETKGDYVQ-
Carnivores              KKVDLAIVQKTPEKLIEGTDQI---EQNGHVMNITNNGPENETKGDYVQ-
Cetacea                 KKVDLAVIPKTPEKIIEGTDQT---EQNGHGMNITSNGHETEMKGDYVQ-
BHC                     KKVDLAVVPKTPEKIIEGTDQT---EQNGHGMNITSNGHENETKGDYVQ-
Sus_BHC                 KKVDLAVVPKTPEKIIEGTDQT---EQNGHGMNITSNGHENETKGDYVQ-
Perissodactyla          KKVDLAVVQKTPEKIIEGTDQI---EQNGHVMNITNNGHENETKGDYVQ-
Insectivores            KKVDLAVVQKTPEKIIEGTDQM---DQNGQVMNIANNGHENETKGDYVQ-
Glires                  KKADLAVVQKTPEKINQGTDQM---EQNGQVMNITNSGHENETKGDYVQ-
Sciurus_Glaucomys       KKTDLAVVQKTPEKINQGTDQM---EQNDQVMNITNSGQENETKVDYVQ-
Aplodontia_SG           KKTDLTVVQKTPEKINQGTDQM---EQNDQVMNITNSGQENETKVDYVQ-
ASG_Graphiurus          KKTDLTVVQKTPEKINQGTDQM---EQNDQVMNITNSGHENETKGDYVQ-
Hystrix_OMMR            KKADLTVVQKTPEKINQGTDQM---EQNGQVMNITNSGHENETKGDYVQ-
Pedetes_OMMR            KKADLTVVQKTPEKINQGTDQM---EQNGQVMNITNNGHENETKGDYVQ-
Mus_Rattus              KKADLTVVQRTPENINQGTDQM---EPNDQAMSITSNGQENETTGNDLQ-
Meriones_MR             KKADLTVVQKTPENINQGTDQM---EPNDQAMSITSNGQENETKGNDLQ-
Oryzomys_MMR            KKADLTVVQKTPENINQGTDQM---EPNGQAMSITSNGQENETKGNDLQ-
Tenrec_Echinops         KKADLAVVQKTPEKINQGTDQM---QPKGQVENIPDGGHGHGTKGDCVQ-
Wombat                  RKTDVPVIHKTPEKKNHSVDQILKREQSDQVMNTANSLPEQKALGGHVGE
Phascogale              KKT-VPVTHKTPEKKHHAADQTLEREQNDQVMNMDNGHPEQKALNGHVGE
Echymipera              RKTDVPVSHKTPEKKNPAVDQILEREQNDQVMNTANGHLKQKALGDHVKE
Shrew_Opossum           KKTNIPVIPKTPEKKNHPVDQILEKEQNGQVMSTADGQSKQKAPGCHVGE
Red_Kangaroo            KRTDIPVVHKTPERKNHAVDQILEKEQND----TANSHLEQKALDGHAGE
Gallus                  KKKDLEEADRCPQGIKSSLGDAE----KEKCDE-NSAVKENPLLE-----
Xenopus_Prot_FASTA      KKNDLANINGSINVFPDCISDAN-----LELED-KSEADSNSADA-----
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                         564                                        609
HPG                      -NEKNPNPIESLEKESAFKTKAEPISSSISNMELELNIHNSKAPK---KN
Great_Apes               -NEKNPNPIESLEKESAFKTKAEPISSSISNMELELNIHNSKAPK---KN
OWMonkeys                -NEKNPNPIESLEKESAFKTKAEPISSSISNMELELNIHNSKAPK---KN
Monkeys                  -NEKNPNPIESLEKESAFKTKAEPISSSISNMELELNIHNSKAPK---KN
Primates                 -NEKNANPTESLEKESAFRTKAEPISSSISNMELELNIHNSKAPK---KN
'+Tupaia'                -KEKNANPTESLEKESAFRTKAEPISSSISNMELELNIHNSKAPK---KN
Tamadua_Bradypus         -KEKNANPTESLEKESAFRTKGEPISSSISNMELELNIYNSKASK---KN
Armadillos               -KEKNANPTESLEKESAFRTKGEPISSSISNMELELNIYNSKASK---KN
EuarchLauraXen           -KEKNANPTESLEKESAFRTKAEPISSSISNMELELNIHNSKAPK---KN
Elephants                -KEKNAIPTESLAKESAFRTKAEPISSSISNMELELNMHNSKAPK---KN
Hyraxes                  -KEKNGNPAESLKKESVFKTKAEPISNSISNMELELNTHNSKSLK---KN
Sirenia                  -KEKNANPTESLTKESAFRTKAEPISSSISNMELELNMHNSKAPK---KN
TE_Amblysomus            -KEKNANPTESLAKESAFRTKAEPISSSISNMELELNMHNSKAPK---KN
Macroscelidae            -KEKNANPTESLAKESAFRTKAEPISSSISNMELELNMHSSIAPK---KN
Orycteropus_TEAM         -KEKNANPTESLAKESAFRTKAEPISSSISNMELELNMHNSKAPK---KN
'+Cynocephalus'          -KEKNANPTESLEKESAFRTKAEPISSSISNMELELNIHNSKAPK---KN
Myotis_Tadarida          -KEKNANPTESLEKESAFTTKAEPISSSISNMELELNIHSSKAPK---KN
Taphozous_Tonatia        -KEKNANPTESLEKESAFRTKAEPISSSISNMELELNIHSSKAPK---KN
Pteropus_Cynopterus      -KKKNTNPTESLEKESAFRTKAEPICSSISNMELELNIHSSKALK---KN
Megaderma_Hipposideros   -KEKNANPTESLEKESAFRTKAEPISSSISNMELELNIHSSKAPK---KN
Manis_C                  -KEKNANPTESLEKESAFRTKAEPISSSISNMELELNIHSSKAPK---KN
Carnivores               -KEKNANPTESLEKESAFRTKAEPISSSISNMELELNSHSSKAPK---KN
Cetacea                  -KEKNANLTESLEKESAFRTKAEPISSSISNMELELNIHSSKAPK----N
BHC                      -KEKNANPTESLEKESAFRTKAEPISSSISNMELELNIHSSKAPK----N
Sus_BHC                  -KEKNANPTESLEKESAFRTKAEPISSSISNMELELNIHSSKAPK----N
Perissodactyla           -KEKNANPTESLEKESAFRTKAEPISSSISNLELELNIHSSKAPK---KN
Insectivores             -KEKNANPTESLEKESAFRTKAEPISSSISNMELELNIHSSKAPK---KN
Glires                   -KEKNANPTESLEKESAFRTKAEPISSSISNMELELNIHNSKAPK---KN
Sciurus_Glaucomys        -KEKNANPVESLEKESAFRTKAEPISSSISNMELELNIHNSKAPK---KN
Aplodontia_SG            -KEKNANPIESLEKESAFRTKAEPISSSISNMELELNIHNSKAPK---KN
ASG_Graphiurus           -KEKNANPIESLEKESAFRTKAEPISSSISNMELELNIHNSKAPK---KN
Hystrix_OMMR             -KEKNANPIESLEKESAFRTKAEPISSSISNMELELNIHNSKAPK---KN
Pedetes_OMMR             -KEKNANPIESLEKESAFRTKAEPISSSISNMELELNIHNSKAPK---KN
Mus_Rattus               -KEKNAHPIESLRKEPAFTAKAKSISNSISDLEVELNVHSSKAPK---KN
Meriones_MR              -KEKNANPIESLGKESAFTAKAKPISNSISDLEVELNVHNSKAPK---KN
Oryzomys_MMR             -KEKNANPIESLGKESAFTTKAKPISSSISNLELELNVHNSKAPK---KN
Tenrec_Echinops          -KEKSANLAESSAKESAFRTVAEPLSSRKSSMELELTVFNSKAQK----N
Wombat                   VKDVQVLELFSAEKESTFRTGTEPVAGSTNHGELELNSRNAKMTR---KD
Phascogale               IKEAQTSELFSAEKESTFRTGTEPAAS--------LNGEETNITK---KD
Echymipera               VKDAQAAELFSTEKESTFRTRTEPKAGSIVHGELELNGRGAKMTK---KD
Shrew_Opossum            LKEAQASEPSSVEKGSTFKTGSEPAAGSTNQRELELNGRDAKMTK---KD
Red_Kangaroo             VKDAQASELFSAEKESTFRTGTEPTADSTNHRELELNGRDVKMTK---K-
Gallus                   -KRKGSTLAEFKERGLQWKNAAEKVSGKCSDGQLELNNSDQKSTKNACST
Xenopus_Prot_FASTA       ---CQSDIVHSSNTQIKQQCVESLANAGETRKKQELSCERSQEEK-----
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                         610                                             658
HPG                      RLRRKSSTRHIHALELVVSRNLSPPNCTELQIDSCSSSEEIKK-KKYNQM
Great_Apes               RLRRKSSTRHIHALELVVSRNLSPPNCTELQIDSCSSSEEIKK-KKYNQM
OWMonkeys                RLRRKSSTRHIHALELVVSRNLSPPNCTELQIDSCSSSEEIKK-KNYNQM
Monkeys                  RLRRKSSTRHIHALELVVSRNLSPPNYTELQIDSCSSSEEIKK-KNYNQM
Primates                 RLRRKSSTRHIHALELVVNRNPSPPNHTELQIDSCSSSEEIKK-KNSDQM
'+Tupaia'                RLRRKSSTRHIHALELVVNRNPSPPNHTELQIDSCSSSEEIKK-KNSDQM
Tamadua_Bradypus         RLRRMSSTRHIHALELVANRNPSQPNHTELQIDSCSSSEEIKK-KNSDQK
Armadillos               RLRRMSSTRHIHALELVGNRNPSPPNHTELQIDSCSSTEEIEK-INSNQK
EuarchLauraXen           RLRRKSSTRHIHALELVVNRNPSPPNHTELQIDSCSSSEEIKK-KNSDQK
Elephants                RLRRKSSTRHIHALELVVNRNPSPPTHTELQIDSWSSSEETKK-KSSEQK
Hyraxes                  RLRKKSSSRHVHALELVVNRNPSSPPHTGLQIDSWSGSEEMKK-TSSEQK
Sirenia                  RLRRKSSTRHIHALELVVNRNPSPPTHTELQIDSWSSSEEIKK-KSSEQK
TE_Amblysomus            RLRRKSSTRHIHALELVVNRNPSPPTHTELQIDSWPSSEEIKK-KSSEQK
Macroscelidae            RLRRKSSTRHIHALELVVNRNPSSPTHTELQIDSWPSSEEIKK-KRSEHK
Orycteropus_TEAM         RLRRKSSTRHIHALELVVNRNPSPPTHTELQIDSWPSSEEIKK-KSSEQK
'+Cynocephalus'          RLRRKSSTRHIHALELVVNRNPSPPNHTELQIDSCSSSEEIKK-KNSDQM
Myotis_Tadarida          RLKRKSSTRHIYALELVVNRNPSPPNHTELQIDSCSSSEEVKE-KNSDQI
Taphozous_Tonatia        RLRRKSSTRHIYALELVVNRNPSPPNHTELQIDSCSSSEEVKK-KNSDQI
Pteropus_Cynopterus      RLRRKSSTRHIHALELVVNRNPSPPNHTELQIDSCSSSEELKE-KNSDQM
Megaderma_Hipposideros   RLRRKSSTRHIHALELVVSRNPSPPNHTELQIDSCSSSEEVKK-KNSDQM
Manis_C                  RLRRKSSTRHIHALELVVNRNPSPPNHTELQIDSCSSSEEMKK-KNSDQM
Carnivores               RLRRKSSTRHIRALELVVNRNPSPPDHTELQIDSCSSSEEMKK-KNSDQM
Cetacea                  RLRRKSSTRKIHALELVVSRNPSPPNHTELQIDSCSSSEEMKK-KHSSQM
BHC                      RLRRKSSTRQIHALELVVSRNPSPPNHTELQIDSCSSSEEMKK-KHSSQM
Sus_BHC                  RLRRKSSTRQIHALELVVSRNPSPPNHTELQIDSCSSSEEMKK-KHSDQM
Perissodactyla           RLRRKSSTRHIHALELVVSRNPSPPNHTELQIDSCSSSEEMKK-KNSDQM
Insectivores             RLRRKSSTRHIHALELVVNRNPSPPNHTELQIDSCSSSEEMKK-KNSDQM
Glires                   RLRRKSSTRHIHALELVVNRNPSPPNHTELQIDSCTSSEEIKK-KNSDQM
Sciurus_Glaucomys        RLRRKSSTRHIHVLEPVVNRNTSPPHHTELQIDSCTSSEEIKT-RNSNQM
Aplodontia_SG            RLRRKSSTRHIHALELVVNRNTSPPHHTELQIDSCTSSEEIKK-RNSNQM
ASG_Graphiurus           RLRRKSSTRHIHALELVVNRNTSPPNHTELQIDSCTSSEEIKK-KNSNQM
Hystrix_OMMR             RLRRKSSTRHIHALELVVNRNPSPPNHTELQIDSCTSSEEIKK-KNSDQM
Pedetes_OMMR             RLRRKSSTRHIHALELVVNRNPSPPNHTELQIDSCSSSEEIKK-KNSDQM
Mus_Rattus               RLRRKSSTRCVLPLEPIV-RNPSPPTCAELQIDSCGSSEETKK-NNSNQT
Meriones_MR              RLRRKSSTRCVLALEPVV-RNPSPPTCAELQIDSCSSSEETKK-NNSNQT
Oryzomys_MMR             RLRRKSSTRCVLALELVV-RNPSPPTCTELQIDSCSSSEETKK-NNSNQM
Tenrec_Echinops          RLRRKPSARHIHPLELVVNRQPSPTTHTELQISSWPSSEELKK-EESEPK
Wombat                   RLRKKPSARIVRALELVVDRNPSSSNESELQIDSYPSSEEIRKGTNSEQK
Phascogale               KLRKQPSFKIVCALELGVDGSPSSSNETELQIDSYPSSEEIRRKNNSEQK
Echymipera               RLRKKPSARIVRALELVADKNSGSSNEAELQIDSYPSSDEIRKGNNSEQK
Shrew_Opossum            RPRKRPSVRTVCALELVTDRHPGSSNETELQIDSYPSSEEIRKGNNSEQK
Gallus                   AKGCRHSTRTRCAIHLV-DRNPGSFDLAEPLINSYPSNEEPSK-ADCERR
Xenopus_Prot_FASTA       DFTQS--G----ALGPKTRSQKSPYGHSELHIESSQISNEPS--NVTKQV
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                         659                                             707
HPG                      PVRHSRNLQLMEDKEPATGAKKSN-KPNEQTSKRHDSDTFPELKLTNAPG
Great_Apes               PVRHSRNLQLMEDKEPATGAKKSN-KPNEQTSKRHDSDTFPELKLTNAPG
OWMonkeys                PVRHSRNLQLMEDKEPATGAKKSN-KPNEQTSKRHASDTFPELKLTNVPG
Monkeys                  PVRHSRKLQLMEDKEPATGAKKSN-KPNEQTSKRHASDTFPELKLTNIPG
Primates                 PVRHSRKLQLMEDKEPATGAKKSN-KPNEQISKRHASDTFPELKLTNIPG
'+Tupaia'                PVRHSRKLQLMEDKEPATGAKKSN-KPNEQISKRHASDAFPELKLTNIPG
Tamadua_Bradypus         PIRHSRMLQLMKDKETATGAKKSN-KRNEQISKRHASDAFPELNLTNVTG
Armadillos               PIRHNRMLQLMKEKETTTGAKKNN-KPNEQISERHASDAFPELKLTNVTD
EuarchLauraXen           PVRHSRKLQLMKDKETATGAKKSN-KPNEQISKRHASDAFPELNLTNITG
Elephants                PIRHNRNLQLMKNQETATGAKKSN-KPKEQISKRHGADSYPELHLTTTAG
Hyraxes                  PVRHNINLQLMKNQETTTGAKKSN-KPKEQINKRHTSNPYPELNLTSTAG
Sirenia                  PVRHNRNLQLMKNQETTTGAKKSN-KPKEQISKRHASDTYPELNLTSTTG
TE_Amblysomus            PVRHSRNLQLMKDQETATGAKKSN-KPNEQISKRHATDTFPELNLTNITG
Macroscelidae            PVRHSRNLQLMKDQETETGAKKNN-KPNEQISKRHATDTSPERNITG---
Orycteropus_TEAM         PVRHSRNLQLMKDQETATGAKKSN-KPNEQISKRHATDTFPELNLTNITG
'+Cynocephalus'          PVRHSRKLQLMEDKEPATGAKKSN-KPNEQISKRHASDAFPELKLTNIPG
Myotis_Tadarida          PVRHSKKLQLMEGKEPATGAKKSN-KSNEQINKKLASDAFPELNLTNIPG
Taphozous_Tonatia        PVRHSKKLQLMEGKEPATGAKKSN-KSNEQINKRLASDAFPELNLTNIPG
Pteropus_Cynopterus      PVRHSKKLQFIEDKESATGAKKNN-KPNETINKRLASDAFPELNITNIPG
Megaderma_Hipposideros   PVRHSKKLQLIEDKEPATGAKKSN-KPNEQINKRLTSDAFPELNLTNIPG
Manis_C                  PVRHSKKLQLMEDKEPATGAKKSN-KPNEQINKRLASDAFPELNLTNIPG
Carnivores               PVRHSKTLQLMEDKEPATGAKKSN-KPSEQINKRLASDAFPELNLTNIPG
Cetacea                  PVRHGKKLQFMGDKEPTTGAKKSN-KPHEQINKRLASDAYPELNLTNIPG
BHC                      PVRHSKKLQLMGDKEPTTGAKKSN-KPHEQINKRLASDAFPELNLTNIPG
Sus_BHC                  PVRHSKKLQLMGDKEPTTGAKKSN-KPHEQINKRLASDAFPELNLTNIPG
Perissodactyla           PVRHSKKLQLMEDKEPATGAKKSN-KPNEQINKRLASDAFPELKLTNIPG
Insectivores             PVRHSKKLQLMEDKEPATGAMKSN-KPNEQISKRLASDAFPELNLTNIPG
Glires                   PVRHSRKLQLMEDTEPATGAKKSN-KPNEQISKRHASDAFPELKLTNIPG
Sciurus_Glaucomys        PVRHGRKLQLMEDAEPATEVRKSN-KPNEQINKRHTNDAFPGLKLTGISG
Aplodontia_SG            PVRHGRKLQLMEDAEPATGVKKSN-KPNEQINKRHTNDAFPELKLTGISG
ASG_Graphiurus           PVRHGRKLQLMEDAEPATGVKKSN-KPNEQISKRHTNDAFPELKLTNIPG
Hystrix_OMMR             PVRHSRKLQLMEDAEPATGAKKSN-KPNEQISKRHASDAFPELKLTNIPG
Pedetes_OMMR             PVRHSRKLQLMEDAEPATGAKKSN-KPNEQISKRHASDAFPEVKLTNIPG
Mus_Rattus               PAGHIREPQLIEDTEPAADAKKN--EPNEHIRKRSASDAFPEEKLMNKAG
Meriones_MR              PVRHIRKPQLIEDTEPAPDAKKN--EPNEQIRKRSASDAFPEEKLTNIPG
Oryzomys_MMR             PVRHIRKPQLIEDTEPAPDAKKNN-EPNEQIRKRSASDAFPEEKLTNIPG
Tenrec_Echinops          PVRRSRNLQLTKDQEMAIGAKKND-KPNEERGKKHAPDTFPERNLTNTTD
Wombat                   QIRRSRRLRLLSE-EIVVGAKKAH-KPDDQAEESCISEVFPELKIGNVPA
Phascogale               QLRRSRRLQQVSE-EIAIGAKKAH-KPDDQAEESCITEVVSELKLGNLPA
Echymipera               QIRRSRRLQLLSE-EIAVGTKKAH-EPYDQAEERCVKKVFPELEMGTVSA
Shrew_Opossum            QVRRSRRLQMLSE-EIAAGAKKAH-KPDEEVEENCVNEVSPELKIGKVSA
Gallus                   QVRRSRRLQLLSEEITKETGKMRVIKEAKNSDSGPEGSVFGVER--NVLV
Xenopus_Prot_FASTA       EVRRSRRLLMLP---KGPGNKSNS-NAVKEMNEQENIAQIPEFR------
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                           708                                            756
HPG                        SFTNCSNTSELKEFVNPSLPREEKEEKLETVKVSNNAEDPK-DLMLSGER
Great_Apes                 SFTNCSNTSELKEFVNPSLPREEKEEKLETVKVSNNAKDPK-DLMLSGER
OWMonkeys                  SFTNCSNTSELKEFVNPSLPREEKEEKLETVKVSNNAKDPK-DLMLSGER
Monkeys                    SFTNCSNTNELKEFVNPSLPREETEEKLETVKVSNNAKDPK-DLMLSGER
Primates                   FFTNCSSSNKLKEFVNPSLQREEIEENLETIQVSNSTKDPK-DLVLSGER
'+Tupaia'                  FFTNCSSSNKLQEFVNPSLQREEIEENLETIQVSNSTKDPK-DLVLSGER
Tamadua_Bradypus           FLTKCSSSDKLQEFVNSSLQGEVAE-NLETIQVSDSTRDPE-DLVLSGGK
Armadillos                 FLPKCSSSDKLQEFVNSSLQGEVAE-NLETIQVSDSTRDPE-DLVLSGGK
EuarchLauraXen             FFTNCSSSDKLQEFVNPSLQGEEIEENLETIQVSNSTKDPE-DLVLSGGR
Elephants                  FITKCSSSDNLQEFVNPSLQGEKTEENLETIQVSNITKEPK-DLVLNGGR
Hyraxes                    FITACSSSDNLQEPVNPSLQGEEIEENLATVQMSNTAKEPE-DLELNGGR
Sirenia                    LITNCSSSHNYQEFVNPSLQGEEIEENLGTIQVSNRTRDPE-DLVLNGGR
TE_Amblysomus              FITNCSSSDNLQEFVNPSLQGEEIEENLGTMQVSNSTKDPE-DQVLSGGR
Macroscelidae              FITNCSNTDNLQEFVNPRLQGEEIEENLGPIQVSNSTKDPE-DQVLSRGR
Orycteropus_TEAM           FITNCSSSDNLQEFVNPSLQGEEIEENLGTIQVSNSTKDPE-DQVLSGGR
'+Cynocephalus'            FFTNCSSSNKLQEFVNPSLQREEIEENLETIQVSNSTKDPK-DLVLSGER
Myotis_Tadarida            FFTNGSSSNKLKEFVNPNLQREEIEENLGTVQMSNSTKDLK-DLILSGGR
Taphozous_Tonatia          FFTNGSSSNKLQEFVDPNLQREEIEENLGTIQVSNSTKDLK-DLILSGGR
Pteropus_Cynopterus        FFTNGSSSNKLQEFVNPSLQREEIKENLGTIQVSNSTKDPK-ILIFGEGR
Megaderma_Hipposideros     FFTNGSSSNKLQEFVNPSLQREEIEENLGTIQVSNSTKDPK-DLILSGGR
Manis_C                    FFTNCSSSNKLQEFVNPSLQREEIEENLGTIQVSNSTKDPK-DLILSGGR
Carnivores                 FFTNCSSSNKLQEFVNPGLQREEIEESRGTIQVSDSTRDPK-ELVLSGGR
Cetacea                    FFTHCSSSNKLQEFVNPSLQREE---NLGTIQVSNSTKDPK-DLTLSGGK
BHC                        FFTNCSSSNKLQEFVNPSLQREE---NLGTIQVSNSTKDPK-DLILSGGK
Sus_BHC                    FFTNCSSSNKLQEFVNPSLQREE---NLGTIQVSNSTKDPK-DLILSGGK
Perissodactyla             FFTNCSSSNKLQEFVNPSLQREEIEQNLGAIQVSNSTKDPK-DLILSGGR
Insectivores               FFTNCSSSNKLQEFVNPSLQREEIEENLGTIQVSNSTKDPK-DLILSGER
Glires                     FFTNCSSSNKLQEFVNPSLQREEIEENLETIQVSNSTKDPK-DLVLSGER
Sciurus_Glaucomys          LFTNCSSSSKVEEFVNPNLQKEETEENLEIIQVSNNTKDPK-DMVLSGER
Aplodontia_SG              LFTNCSSSSKLKEFVNPNLQKEETEENLEIIQVSNSTKDPK-DMVLSGER
ASG_Graphiurus             LFTNCSSSNKLKEFVNPSLQKEEIEENLETIQVSNSTKDPK-DLVLSGER
Hystrix_OMMR               FFTNCSSSNKLKEFVNPSLQREEIEENLETIQVSNSTKDPK-DLVLSGER
Pedetes_OMMR               FLTNCSSSNKLKEFVNPSLQREEIEENLETIQVSNSTKDPK-DLVLSGER
Mus_Rattus                 LLTSCSSPRKPQGPVNPSPQRKGIE-QLETRQMSDSTKELG-DLVLGGEP
Meriones_MR                LLTSCSSPSKPQGPVNPSPQRKEIE-KLETSQMSDSTKELK-DLVLGGER
Oryzomys_MMR               LLTSCSSSNKPQGPVNPSPQRKEIE-KLETSQMSDSTKDLK-DLVLGGER
Tenrec_Echinops            LITNCSVSGNLQGSVCPSLPGAKLKEKLGTVQVSNSTRDPK-DEVLGRAR
Wombat                     CATDSLTTDRDQVLASCSFTEERDERSLEAIPSSK---DQD--LPLNGGE
Phascogale                 CAPDNVSTDKDQVLASCSFT--GDERSLEVIPSSQ---DQD--LALSGKE
Echymipera                 GATDSLSTDRDEVLASCSFTD-GEERNLEVIPSSK---DQDQDLALSERE
Shrew_Opossum              CSTDSLATDSDLVLASCSFTE-GDEKSLEAFQPSR---DQDS-LAVSRGE
Gallus                     HNSQCKDLRKQQDILSYMSLADRNGADLEANGIQISSKNSD-D--MAKNR
Xenopus_Prot_FASTA         -VKDTNKNNEISDTVPSQLKKKDTY-------------------------
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                          757                                             805
HPG                       VLQTE-RSVESSSISLVPGTDYGTQESISLLEVSTLGKAKTEPNKCVSQC
Great_Apes                VLQTE-RSVESSSISLVPGTDYGTQESISLLEVSTLGKAKTEPNKCVSQC
OWMonkeys                 VLQTE-RSVESSSISLVPGTDYGTQESISLLEVSTLGKAKTEPNKCVSQC
Monkeys                   VLQTE-RSVESSSISLVPGTDYGTQESISLLEVSTLGKAKTEPNKCVSQC
Primates                  VLQTE-RSVESTSISLVPDTDYGTQDSISLLEVNTLGKAKTAPNKRVSQC
'+Tupaia'                 GLQTE-RSVESTSISLVPDTDYGTQDSISLLEANTLGKAKTAPNQRVSQC
Tamadua_Bradypus          GLQTE-RSVESTSISVVPDTDYGTQDSISLLEADTLGKAKAAPNQHVSQY
Armadillos                SLQTE-RSAESTSISVVPDTDYGTQDSISLLEADTLGKAKTALNQHVSQY
EuarchLauraXen            GLQTE-RSVESTSISVVPDTDYGTQDSISLLEADTLGKAKTAPNQRASQC
Elephants                 DLQTK-KSIESTNISVIPDTVYGTQDSVSLLGADTPGKAKTAPNQCASQC
Hyraxes                   VLQTK-RSVESTSTSVIPDADCGAQDSISLLEADTLGKAKTAPNQGAGQC
Sirenia                   GLQTE-ISVESTSISVIPDTDYGSQNSISLLEADTLRKAKTAPNQCASQC
TE_Amblysomus             GLQTE-RSVESTSISVIPDTDYGTQDSISLLEAGTLGKAETAPNQCASQC
Macroscelidae             GLHTG-KCVESTSISVIPDTDYGTQNSISLLEAGTLGKAETAPNQCASHC
Orycteropus_TEAM          GLQTE-RSVESTSISVIPDTDYGTQDSISLLEADTLGKAKTAPNQCASQC
'+Cynocephalus'           GLQTE-RSVESTSISLVPDTDYGTQDSISLLEANTLGKAKTAPNQRVSQC
Myotis_Tadarida           SLQTD-RSMESTNILLVPETDYGTQDSISLLEPDTPGKAKTAPNQCAGLC
Taphozous_Tonatia         SLQTD-RSMESTNILLVPETDYGTQDSISLLEPDTPGKAKTAPNQRAGLC
Pteropus_Cynopterus       GSQTD-RSTESTSILLVPETDYGTQDSISLLEPDIPGRAKTAPNQHADLC
Megaderma_Hipposideros    GLQTD-RSMESTSILLVPDTDYGTQDSMSLLEPDTPGKAKTAPNQRAGVC
Manis_C                   GLQTE-RSVESTSISLVPDTDYGTQDSISLLEADTLGKAKTAPNQRASLC
Carnivores                GLQTE-RSVESTSISLVPDTDYGTQDSISLLEADTLGKAKTAPNQRASLC
Cetacea                   GLQIE-RSVESTSISLVPDTDYGTQDSISLLEADTLGKAKTAPNQHVSLC
BHC                       GLQIE-RSVESTSISLVPDTDYGTQDSISLLEADTLGKAKTAPNQRVSLC
Sus_BHC                   GLQIE-RSVESTSISLVPDTDYGTQDSISLLEADTLGKAKTAPNQRVSLC
Perissodactyla            GLQAE-RSVESTSISLVPDTDYGTQDSISLLEADTLGKAKTAPNQRASLC
Insectivores              GLQTE-RSVESTSISLVPDTDYGSQDSISLLEADTLGKAKKAPNQCASLC
Glires                    GLQTE-RSAESTSISLVPDTDYGTQDSISLLEANTLGKAKTAPNQRVSQC
Sciurus_Glaucomys         VLQTE-RSAESTSISLVPDTDYGTQDSISLLEANTFGKARTASNQHVTQY
Aplodontia_SG             GLQTE-RSAESTSISLVPDTDYGTQDSISLLEANTFGKARTASNQHVTQY
ASG_Graphiurus            GLQTE-RSAESTSISLVPDTDYGTQDSISLLEANTLGKARTASNQCVTQY
Hystrix_OMMR              GLQTE-RSAESTSISLVPDTDYGTQDSISLLEANTLGKAKTASNQCVTQY
Pedetes_OMMR              GLPTE-RSAESTSVSLVPDTDYGTQDSISLLEANTLRKAKTASNQCVTQY
Mus_Rattus                GKPTE-RSEESTSVSLVPDTDYDTQNSVSVLEANTVRYARTGSVQCMTQF
Meriones_MR               GLSTE-RSEESTSVSLVPDTDYDTQNSVSVLEANTVRYAKTGSIQCMTQF
Oryzomys_MMR              GLSTE-RSEESTSVSLVPDTDYDTQNSVSLLEANTVRYAKTGSIQCMTQF
Tenrec_Echinops           GLQTA-RSVESTSVSLIPDADDGTQGSISIMEAGNRGEAQTAPDQCARQC
Wombat                    GLQGE-RAPGSLEALEVPDTDWDTQDSTSLFPADTPQNSKAGPSPHRSHS
Phascogale                GLQGE-ISQGSLGTVEVPDTAWDTQDSTSLFPADTPQNSKPGPSPHRNHC
Echymipera                RLQEK-RTQGNLELLEVPDTYWETQDSTSLFPAETPQNSKAGPSPHRSNC
Shrew_Opossum             KLQGK-RTKGNMEVLEVASTDWDTQDSTSLFPTDVPPNPTADSGPHRNQH
Gallus                    SFFNPTFSCQLSNFN-SPSSKAGSQEG-EMLGKLFLP---QSPSKTVLHA
Xenopus_Prot_FASTA        -------------FPPCTSEDTGELEN---------G---IPVRKISDQN
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                        806                                       848
HPG                     AAFENPKGLIHGC-------SKDTRNDTEGFKYPLGHEVNHSRETSIEME
Great_Apes              AAFENPKELIHGC-------SKDTRNDTEGFKYPLGHEVNHSQETSIEME
OWMonkeys               AAFENPKELIHGC-------SKDTRNDTEGFKYPLGREVNHSQETSIEME
Monkeys                 AAFENPKELIHGC-------SKDTRNDTEGFKYPLGREVNHSQETSIEME
Primates                AAIENPKELIHGC-------SKDTRNDTEGFKDPLRREVNHIQETSIEME
'+Tupaia'               AAIENPKELIHGC-------SKDTRNDTEGFKDPLRREVNHIQETSIEME
Tamadua_Bradypus        AAIGNATELFHGC-------SKDTRNDTEDFKDPLRHEVNHTQETIVEME
Armadillos              AAIRNATELSHGC-------SKDTRNDTEDFKDPLRHEVNHTQETSVEME
EuarchLauraXen          AAIENPNELIHGC-------SKDTRNDTEGFKDPLRREVNHIQETSIEME
Elephants               TAIENPSELTNSC-------PKDTRNDTEGFKDLLRCEASHIQETCIEIE
Hyraxes                 SAIENPNELIHGS-------PKDTRNDIEGFKDPLRCEVNPIQEICVEMD
Sirenia                 AAIENPNELIHGC-------PKDTRNDTEDFKDLLRCEVNHIQETCIEME
TE_Amblysomus           AAIENPNKLIHGF-------PKDTRNDTEGFKDLLRREVNHIQETCIEME
Macroscelidae           AAIENPNKHVHGF-------PKDTGNDTEGFKDLLKCDANHIQDTCIEME
Orycteropus_TEAM        AAIENPNKLIHGF-------PKDTRNDTEGFKDLLRREVNHIQETCIEME
'+Cynocephalus'         AAIENPKELIHGC-------SKDTRNDTEGFKDPLRREVNHIQETSIEME
Myotis_Tadarida         AAIKNPKELIHGC-------SKDTRNDREGFKDLLRREVNHTQETSIEME
Taphozous_Tonatia       AAIENPKELIHGC-------SKDTRNDTEGVKDLLRCEVNHTQETSIEME
Pteropus_Cynopterus     AAIENPRELIHGC-------SKDTRNDTEGFKDPLRREVNYTQETSIEME
Megaderma_Hipposideros  AAIENPKELIHGC-------SKDTRNDTEGFKDPLRREVNHTQETSIEME
Manis_C                 AAIENPKELIHGC-------SKDTRNDTEGFKDPLRREDNHTQETSIEME
Carnivores              AAIENPKEPIHGC-------SKDTRNDTEGFTDPLRREDNHTQETSIEME
Cetacea                 AAIESPKELIHGC-------SKDIRNDTEDFQDPLGHHVNHIQEASTEME
BHC                     AATENPKELIHGC-------SKDTRNDTEGFQDPLGHDVNHTQEASIEME
Sus_BHC                 AATENPKELIHGC-------SKDTRNDTEGFKDPLGHDVNHTQEASIEME
Perissodactyla          AAIENPKELIHDC-------SKDTRNDTEGFKDPLRREVNHTQETSIEME
Insectivores            AAIENPKELIHGC-------SKDTRNDTEGFKDPLRREVNHTQETSIEME
Glires                  AAIENPKELIHGC-------SKDTRNDTEGFKDPLRREVNHIQETSIEME
Sciurus_Glaucomys       VAIENPKEFIHGH-------SKDTRNDPEGFKDSLRCEVNHIQETNVEME
Aplodontia_SG           VAIENPKEFIHGH-------SKDTRNDTEGFKDSLRREVNHIQETNVEME
ASG_Graphiurus          VAIENPKELIHGC-------SKDTRNDTEGFKDSLRREVNHIQETNIEME
Hystrix_OMMR            VAIENPKELIHGC-------SKDTRNDTEGFKDPLRREVNHIQETNIEME
Pedetes_OMMR            VAIENPKELIHGC-------SKDTRNDTEGFKDPLRREVNHIQETNIEME
Mus_Rattus              VASENPKELVHG--------SNNAGSGTECFKHPLRHELNHSQET-VEME
Meriones_MR             VASENPKELVHG--------SNNAGSGTECFKHPLRHELNHIQET-VEME
Oryzomys_MMR            VASENPKELVHG--------SNNAGSGTECFKHPLRHELNHIQET-VEME
Tenrec_Echinops         AATENPNKSVHGL-------SKDTRNNTEGFEDLLTHDVNHIQETCTEME
Wombat                  EIMETPKELLDGCS------SKNTESDEEDLRSLMRQEVKNASKTTTEME
Phascogale              EIMETPKELLESSS------SKNTESSVEDLRSLMKQEVKNASKTITEME
Echymipera              EIMESSKELFDAYS------SKNTDSGTEG---LIRQEIKYGSETSSVME
Shrew_Opossum           EVIETPKELFDDCS------SKNTGSGKED---LTRQEVKNTSETTTEIE
Gallus                  ASILTEEKRSWSCTVFSQDKGCCSRNVPKDFRIGKSPMAKNASEFTMEAE
Xenopus_Prot_FASTA      ASLDNP---IDPCK-----------D--EYSDTLLHVAGDNVQPDYMETE
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                        849                                              898
HPG                     ESELDAQYLQNTFKVSKRQSFALFSNPGNPEEECATFSAHSRSLKKQSPK
Great_Apes              ESELDTQYLQNTFKVSKRQSFALFSNPGNPEEECATFSAHSRSLKKQSPK
OWMonkeys               ESELDTQYLQNTFKVSKRQSFALFSNPGNPEEECATFSAHSRSLKKQSPK
Monkeys                 ESELDTQYLQNTFKVSKRQSFALFSNPGNPEKECATFSAHSRSLKKQSPK
Primates                ESELDTQYLQNTFKVSKRQSFALFSNPGNPEKECATVCAHSRSLRKQSPK
'+Tupaia'               ESELDTQYLQNTFKVSKRQSFALFSNPGNPEKECATVCAHSRSLRKQSPK
Tamadua_Bradypus        ESELDTQYLQNTFKISKRQSFALFSNP---EKECATVCAHSRSLGKQSPK
Armadillos              ESELDTQYLQNTFKISKRQSFALFSNP---ENECATVCAHSRFLGKQSPK
EuarchLauraXen          ESELDTQYLQNTFKVSKRQSFALFSNP---EKECATVCAHSRSLRKQSPK
Elephants               ESELDTQYLQSTFKVSKRQSFALFSNP---EKKCATICAHSKSLRKQSPK
Hyraxes                 ENELDTQYIQSTFKVSKRHSFALFSNP---EKECATSYTHSKSLRKENPK
Sirenia                 DSELDTQYLQSTFKVSKRQSFALFSNP---EKECATICAHSKSLRKQSPK
TE_Amblysomus           ESELDIQYLQNTFKVSKRQSFALFSNP---EKECATVCAHSRSLRKQSPK
Macroscelidae           DSELDTQYLQNTFKVSKRQSFALFPNP---EKECTTVCAHSRSLRKQSPK
Orycteropus_TEAM        ESELDTQYLQNTFKVSKRQSFALFSNP---EKECATVCAHSRSLRKQSPK
'+Cynocephalus'         ESELDTQYLQNTFKVSKRQSFALFSNPGNPEKECATVCAHSRSLRKQSPK
Myotis_Tadarida         ESELDTQYLQNTFKVSKRQSFALFSN---PEKECATVYAHSRSLRKQSPK
Taphozous_Tonatia       ESELDTQYLQNTFKVSKRQSFALFSNPGNPEKECATVYAHSRSLRKQSPK
Pteropus_Cynopterus     ESELDTQYLQNTFKVSKRQS---FSNPGNLEKECATGYAHSRSLRKQSPK
Megaderma_Hipposideros  ESELDTQYLQNTFKVSKRQSFALFSNPGNPEKECATVYAHSRSLRKQSPK
Manis_C                 ESELDTQYLQNTFKVSKRQSFALFSNPGNPEKECATVCAHSRSLRKQSPK
Carnivores              ESELDTQCLHNTFKVSKRQSFALFSNPGNPEKECATVCARSRSLRKQSPK
Cetacea                 ENELDTQYLQNMFKVSKRQTFALFSNPENPEKECATVCAHSGSLREQSPR
BHC                     ESELDTQYLQNTFKVSKRQTFALFSNPGNPEKECATVCAHSGSLREQSPR
Sus_BHC                 ESELDTQYLQNTFKVSKRQTFALFSNPGNPEKECATVCAHSGSLREQSPK
Perissodactyla          ESELDTQYLQNTFKVSKRQSFALFSNPGNPEKECATVCAHSRSLRKQSPK
Insectivores            ESELDTQYLQNTFKVSKRQSFALFSNPGNSEKECATVSAHSRSLRKQSPK
Glires                  ESELDTQYLQNTFKVSKRQSFALFSNPGNPEKECATVCAHSKSLRKQSPK
Sciurus_Glaucomys       ESELDTQYLENTFQVSKRQSFALFSNPGNLEKECAAIYTPSKSLRKQSPE
Aplodontia_SG           ESELDTQYLENTFQVSKRQSFALFSNPGNPEKECAAVCTPSKSLRKQSPE
ASG_Graphiurus          ESELDTQYLQNTFQVSKRQSFALFSNPGNPEKECATVCAPSKSLRKQSPK
Hystrix_OMMR            ESELDTQYLQNTFQVSKRQSFALFSNPGNPEKECATVCAHSKSLRKQSPK
Pedetes_OMMR            ESELDTQYLQNTFQVSKRQSFALFSNPGNPEKECATVCAHSKSLRKQSPK
Mus_Rattus              DSELDTQYLQNTFQVSKRQSFALFSKPRSPQKDCTAVCAHS---RELSPK
Meriones_MR             ESELDTQYLQNTFQVSKRQSFALFSKPRSPQKECAAVCAHSNSFRELSPK
Oryzomys_MMR            ESELDTQYLQNTFQVSKRQSFALFSKPGNPQKECAAVCAHSNSFRELSPK
Tenrec_Echinops         ESELDIQSLQNTFKVSKRQSFALSSNP---EKECATLCAHPSAFRKQNPN
Wombat                  DSELDTQYLQNTFKRSKRQSFALRSSP---RQECRKPSAVPGTVNQQSPD
Phascogale              DSELDTQYLQNTFKRSKRQSFALCSSP---RQEYVKTCAVPGAISQQS--
Echymipera              DSELDTQYLQNTFKRSKRQTFALCSNP---KQEQIKPCSVPRAVSHQSSD
Shrew_Opossum           DSELDTQYLQNTFKRSKRQSFALCPSP---RQTSMKLRSIPRALSHQSPD
Gallus                  DSELDMQYLRNIFRSSKRQSFSLYPTP---MKACTTDDVAS---EKLN--
Xenopus_Prot_FASTA      ESELETQHIVKMFKTSKRTSFILESKE-----------------------
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                         899                                             946
HPG                      VTFECEQKEEN-QGKNESNIKPVQTVNITAGFPVVCQKD-KPVDYAKCSI
Great_Apes               VTFECEQKEEN-QGKNESNIKPVQTVNITAGFPVVCQKD-KPVDYAKCSI
OWMonkeys                VTFECEQKEEN-QGKKESNIKPVQTVNITAGFPVVCQKD-KPVDYAKCSI
Monkeys                  VTLECEQKEEN-QGKKESNIKPVQTVNTTAGFPVVCQKD-KPVDYAKCSI
Primates                 VTLECEQKEEN-QGKKESKIKHVQAVNTTAGFPVVCQKD-KPGDYAKCSI
'+Tupaia'                VTLECEQKEEN-QGKKESKIKHVQAVNTTAGFPVVCQKD-KPGDYAKCSI
Tamadua_Bradypus         VTFDCRQKEEN-QGKKESKIKHVQAVHTTAGFPVVCQKD-KPGDYAKCSI
Armadillos               VTFECRQKEEN-QGKKESKIKHVQAVHTTAGFPVVCQKD-KPGDYAKCSI
EuarchLauraXen           VTLECGQKEEN-QGKKESKIKHVQAVHTTAGFPVVCQKD-KPGDYAKCSI
Elephants                VTLVCGEKEEN-QGNREPKIKHEQAVHMPAGYPEACQKE-KPSDYTKYSI
Hyraxes                  VTLQRGEEEEN-QGNKESKIKH---VHTTASCPEVCQED-TPSDRTNCSV
Sirenia                  VTPEYGEKEEN-QGNKESKIKHEQAVHTTAGYPEDCQKE-KPSDYTKCSI
TE_Amblysomus            VTLECGEKEEN-QGNKESKIKHVQAVHTTAGYPGVCQKE-KPSDYTKCSI
Macroscelidae            VTLECGEKEEN-QGNKESKIKHVQVVHTTAGYPGVCEEE-KPNDYTKCSI
Orycteropus_TEAM         VTLECGEKEEN-QGNKESKIKHVQAVHTTAGYPGVCQKE-KPSDYTKCSI
'+Cynocephalus'          VTLECEQKEEN-QGKKESKIKHVQAVNTTAGFPVVCQKD-KPGDYAKCSI
Myotis_Tadarida          VTLECGQKEEN-QGEKESKIKHVQAVHTTAGFPVVCEKD-KPGEYAKYSI
Taphozous_Tonatia        VTLECGQKEEN-QGEKESKIKHVQAVHTTAGFPVVCEKD-KPGEYAKYSI
Pteropus_Cynopterus      VTLECDRKEGN-QGKKESNIKHVQAVYTTVGFPVVCEKD-KPGDYAKYGI
Megaderma_Hipposideros   VTLECGQKEEN-QGKKESKIKHVQAVHTTAGFPVVCEKD-KPGDYAKYSI
Manis_C                  VTLECGQKEEN-QGKKESEIKHVQAVHTTAGFPVVSQKD-KPGDYAKCSI
Carnivores               VTLECGQKEEN-QGKKESEIKHVQAVHTTAGFSAVSQKV-KPGDYAKCSI
Cetacea                  VPLECRQKEEN-QGKSESKIKHVRAINTTVDFPVAGQKD-KPSDHAKRSP
BHC                      VPLECGQKEEN-QGKSESKIKHVQAIYTTVDFPVAGQKD-KPSDYAKCST
Sus_BHC                  VTLECGQKEEN-QGKSESKIKHVQAVHTTVDFPVVGQKD-KPSDYAKCST
Perissodactyla           VTLECGQKEEN-QGKKESKIKHVQSVHTTVGFPVVCQKD-KPGDYVKCSI
Insectivores             VTLECEQKEEN-QGKKESKIKHVQAVHTTAGFPVVCQKD-KPGDYAKCSI
Glires                   VTLECEQKEEN-QGKKESKIKHVQAVNTTVGFPVVCQKD-KPGDYAKCSI
Sciurus_Glaucomys        VTLECEQKEEN-WGKKESKIRHVQAVNATMGF--VCQKD-KPDDDAQCSI
Aplodontia_SG            VTLECEQKEEN-QGKKESKIRHVQAVNATMGFPVVCQKD-KPGDDAKCSI
ASG_Graphiurus           VTLECEQKEEN-QGKKESKIRHVQAVNTTMGFPVVCQKD-KPGDDAKCSI
Hystrix_OMMR             VTLECEQKEEN-QGKKESKIRHVQAVNTTVGFPVVCQKD-KPGADAKCSI
Pedetes_OMMR             VTLECEQKEEN-QGKEESKIRHVQAVNTTVGFPVVCQED-KPGADAKCSI
Mus_Rattus               VTSKGEQKER--QGQEESEISHVQAVTATVGLPVLCQEG-KPGADTMCA-
Meriones_MR              VTSKGEQKEG--QGQEESEISHVQAVTATVGLPVLCQEG-KPGADTMCA-
Oryzomys_MMR             VTSKGEQKEGI-QGQEESEISHVQAVTATVGFPVLCQEG-KPGADTMCAI
Tenrec_Echinops          VALECGEKEGT-QENKESTIKPVQAVHTTVGGAGGSPTE-KPSDYTKSSL
Wombat                   NTTDCGGQEKEKQGNRESNKPVWPKSAVMSLAAACQTEERKPGVYAKCST
Phascogale               --TVRRYQEKEKQENRESNKPVQPKPAVV-------IEKGKPGDHAKWST
Echymipera               NASDCGGQEKEKQGNRESNKPGQLASAVRSSAATCQTE-RKPGDPDKCSA
Shrew_Opossum            KATNHGGQEKKKQGSRESDKAVQPELAVMSSAAVCQTKEKKPGDYAKCST
Gallus                   --TSCPDQVEE-RNSKYLKTENLQEEKTTAENLSSVCEK--FETCESACV
Xenopus_Prot_FASTA       -----AENEN----R-VNSAVEISQVETSNELPNVAE-------------
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                          947                                            994
HPG                       KGGSRFCLSSQF-RGNETGLITPNKHGLLQNPYHIPPLFPIKSFV-KTKC
Great_Apes                KGGSRFCLSSQF-RGNETGLITPNKHGLLQNPYHIPPLFPIKSFV-KTKC
OWMonkeys                 KGGSRFCLSSQF-RGNETGLITPNKHGLLQNPYHIPPLFPIKSFV-KTKC
Monkeys                   KGGSRLCLSSQF-RGNETGLITPNKHGLLQNPYHMPPLFPIRSFV-KTKC
Primates                  KGVSRLCLSSQF-RGNETELITANKHGILQNPYHMPPLSPIRSFV-KTKC
'+Tupaia'                 KGVSRLCPSSQF-RGNETELITANKHGISQNPYHMPSLSPIRSSV-KTKC
Tamadua_Bradypus          QGVSKLCQSSQF-RGNESELITANEHEISQNPDQMPSLSPIRSSV-KTKC
Armadillos                QGVSRLCQSSQF-RGNESELITANEHEISQNPDQMPSLSHIRSSV-KTKC
EuarchLauraXen            KGVSRLCQSSQF-RGNESELITANEHGISQNPDQMPSLSPIRSSV-KTKC
Elephants                 KGVSGLCQSSQF-RGSESELITADGHGISQNPDQIPSLSPTRSSV-KTKC
Hyraxes                   KGLPRLCHSSQF-KGSESELITEGEHGIAQNPDQMPSSSPIRSSV-NSKC
Sirenia                   KGVSRLCQSSQF-RGSESEHITAGEHGISQNPDQMPLLSPIRASV-KS--
TE_Amblysomus             QGVSRLCQSSQF-RGNESELITANEHGISQSPDQTPSLSPIRSSV-KTKC
Macroscelidae             KGVSRLCQSSPF-RGNESELITANEHEMSHSPDQTPSLSPTKSSV-KTKC
Orycteropus_TEAM          KGVSRLCQSSQF-RGNESELITANEHGISQNPDQTPSLSPIRSSV-KTKC
'+Cynocephalus'           KGVSRLCPSSQF-RGNETELITANKHGISQNPYHMPSLSPIRSSV-KTKC
Myotis_Tadarida           KGTSRLCQSSQF-RGNETELTIANKHGISQNPYHIPSISPIRSFV-KTIS
Taphozous_Tonatia         KGISRLCQSSQF-RGNETELTIANKHGISQNPYHIPSISPIRSSV-KTIS
Pteropus_Cynopterus       KEVSRLCQSFQF-RGNETELTIANKLGISQNPYHMPSISPIKSSV-KTIC
Megaderma_Hipposideros    KGVSRLCQSSQF-RGNETELTIANKHGISQNPYHIPPISPIRSSV-KTIC
Manis_C                   KGVSRLCQSSQF-RGNETELIIANKHGISQNPYHIPSLSPIRSSV-KTIC
Carnivores                KGVSRLCQSSQF-RGNETELFIANNHGISQNPYHIPPLSPIRSSV-KTIC
Cetacea                   KRVTRLCQSSQF-RSNKTELIIANKHGISQNPYLIPSLSPIRSSV-KTIC
BHC                       KGVTRLCQSSQF-RGNKTELIIANKHGISQNPYLIPSLSPIRSSV-KTIC
Sus_BHC                   KGVTRLCQSSQF-RGNKTELIIANKHGISQNPYLIPSLSPIRSSV-KTIC
Perissodactyla            KEVSRLCQSSQF-RGNETELITANKHGISQNPYYIPSLSPIRSSV-KTIC
Insectivores              KGVSRLCQSSQF-RGNETELIIANKHLISQNPYHIPSLSPIRSSV-KSIC
Glires                    KGVSRLCPSSQF-RGNETELITANKHGISQNPYHMPSISPIRSSV-KTKC
Sciurus_Glaucomys         TEVSRICPSFQF-RGNETKLITADKHGISQNPYHMPSISPIRSSV-NTKC
Aplodontia_SG             TEVSRLCPSFQF-RGNETKLITADKHGISQNPYHMPSISPIRSSV-KTKC
ASG_Graphiurus            TGVSRLCPSFQF-RGNETELITADKHGISQNPYHMPSISPIRSSV-KTKC
Hystrix_OMMR              TGVSRLCPSSQF-RGNETELITADKHGISQNPYHMPSISPIRSSV-KTKC
Pedetes_OMMR              TGVSRLCPSSQF-RGNETELSTADKHGISQNPYLMPSISPIRSSV-KTKC
Mus_Rattus                -GVSRLCPSSHY-RSGENGLSTTGKSGISQNSHFKQSVSPIRSSI-KTDN
Meriones_MR               -GVSRLCPSSQY-RSNENELSTAGKPGISQNSHLKQSVSPIRSSV-KTDH
Oryzomys_MMR              TGVSRLCPSSQY-RSNENELSTAGKPGISQNSHLKQSVSPIRSSV-KTDH
Tenrec_Echinops           QGVSRLGQASQF-RGSESDPSTSVEHGILQTSEHTPPLSPIRSSV-KSKC
Wombat                    TEVSRLCHIAPLHGVIDCEHIAGNNQGISQVPDQKPSVSPARSSASKTIN
Phascogale                REVSRLCHIASLNSGNDCEPIAEINQGISQVPDQNQSVSPARSSDSKTIY
Echymipera                TGVSRLCHIAPLQEGNDCEYIAGKKQGISQVPNQKQSVSPTRSSVSK-IY
Shrew_Opossum             --VSRLCHIAPLHDDNDCDHSAENNKGISQVPDQKQSVSPAKSSAGRSIY
Gallus                    SPVSCFVSSAACVHTVENQDVSKVAN--HGNLTTLLRICAARNED-GNRP
Xenopus_Prot_FASTA        ------CR--H--------------------T----SL------------
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                         995                                             1042
HPG                      KKN-LLEENFEEHSMSPEREMGNENI-PSTVSTISRNNIRENVFKEASSS
Great_Apes               KKN-LLEENSEEHSMSPEREMGNENI-PSTVSTISRNNIRENVFKEASSS
OWMonkeys                KKN-LLEENSEEHSMSPERAMGNENIIPSTVSTISHNNIRENAFKEASSS
Monkeys                  KKN-LLEENSEEHSMSPERAMGNENIIPSTVSTISHNNIRENAFKEASSS
Primates                 KKN-LLEERFEEHSVSPERAMGNENIIPSTVSTISQNNIRESAFKEASSS
'+Tupaia'                KKN-LSEERFEEHSVSPERAMGNESIIQSTVSTISQNNIRESAFKEASSS
Tamadua_Bradypus         KEN-LSEERFEEHTVSLERAVGNENIIQSTVSTISQNNIRESAFKEASSS
Armadillos               KEN-LSEEKFEELTVSLERTVGNENIIQSTVSTISHNNIRENAFKEASSS
EuarchLauraXen           KKN-LSEERFEEHTVSLERAMGNESIIQSTVSTISQNNIRESAFKEASSS
Elephants                KTN-LLEERFEEHTISLERAMRNENVIQSTVSTVSQNNIRESASKEASSS
Hyraxes                  NKN-LSEERFKEHKILLERTTGNETIVQSTVSTGSQDNIRGSASKETSSS
Sirenia                  KKN-LSEERFEEHTISLERAVGNESIVQSTVSTVSQNNIKESASKEASSS
TE_Amblysomus            KKN-LSEERFEEHTISLERAMGNESIIQSTVSTVSQNNIRESAFKEASSS
Macroscelidae            KKN-LSEEKFEEHTISLERAMGNESIIHSTVSTVSQNNIRGSAFKEASSS
Orycteropus_TEAM         KKN-LSEERFEEHTISLERAMGNESIIQSTVSTVSQNNIRESAFKEASSS
'+Cynocephalus'          KKN-LSEERFEEHSVSPERAMGNESIIQSTVSTISQNNIRESAFKEASSS
Myotis_Tadarida          KKN-LSEEKFEEHSVSPERAMGNENI-QSTVSPISLNNIRESTFKEGSSS
Taphozous_Tonatia        KKN-LSEEKFEEHSVSPERAMGNENIIQSTVSTISQNNIRESAVKEGSSS
Pteropus_Cynopterus      KKN-LSEEKFEEHSISPERAIGNETIIQSTVGTISQNNIRESTFKEGSSS
Megaderma_Hipposideros   KKN-LSEENFEEYSVSPERAMGNESIIQSTVSTISQNNIRESTFKEGSSS
Manis_C                  KKN-LSEEKFEEHSMSPERAVGNESIIQSTVSTISQNNIRESTFKEVSSS
Carnivores               KKN-LSEEKFEQHSMSPERAVGNESVIQSTVSTISQNNIRESTFKEVSSS
Cetacea                  KKN-LSEEKFEEPVMSPERAMENESIIQSTVSTISQNNIRESTFKEVSSS
BHC                      KKN-LSEEKFEEPVMSPERAMGNESIIQSTVSTISQNNIRESTFKEVSSS
Sus_BHC                  KKN-LSEEKFEEPVMSPERAMGNESIIQSTVSTISQNNIRESTFKEVSSS
Perissodactyla           KKN-LSEEKLEEHSVSPERAMGNESIIQSTVSTISQNNIRESTFKEVSSS
Insectivores             KKN-LSEEKFEEHSVSPERAMGNESIIQSTVSTISQNNIRESAFKEVSSS
Glires                   KKN-LSEERFEEHSVSPERAMGNESIIQSTVSTISQNNIRESAFKEASSS
Sciurus_Glaucomys        KKN-LSEEKFEKHSRSPEKAVGYKRIIQSTVSTISQNNIRQSAFKEANSG
Aplodontia_SG            KKN-LSEEKFEKHSRSPEKAVGYKRIIQSTVSTISQNNIRESAFKEANSG
ASG_Graphiurus           KKN-LSEERFEKHSVSPEKAVGYERIIQSTVSTISQNNIRESAFKEANSG
Hystrix_OMMR             KKN-LSEERFEKHSVSPEKAMGNESIIQSTVSTISQNNIRESAFKEASSG
Pedetes_OMMR             KKN-LSEERFEKHSVSPEKAMGNESIIQSTVYTISQNNIRESAFKEASSG
Mus_Rattus               RKT-LTEGRFEKHTLSTERAMGNETVVQSTVHTISLNN-RGNACQEASSG
Meriones_MR              RKT-LSEGRFEKHTLSTERAMGNETVVQSTVHTISQNN-RGNACQEASSG
Oryzomys_MMR             RKT-LSEGRFEKHTLSTERAMGNETVVQSTVHTISQNN-RENACQEASSG
Tenrec_Echinops          KEK-LSEERLEDHAESLERASGNESIIQSTVSTISQNTLRENAFKGTSSS
Wombat                   TKN-LLEERLDEQTTCPETAMGNESLAQSSLSPVSQSNSREYISKATDLN
Phascogale               AKN-FLEERLDEQTTCPETTMGNESLAQSSISLVSQSNSREYVSNPIDL-
Echymipera               TKN-LLKDRL-EQTTCPETVMGNESLGQSSLSPVSQNNSREYISKATDLN
Shrew_Opossum            TKS-LLEERLDEQTTCPETVMGNESLVHSSLSLVSQSNSGEYISKATDSN
Gallus                   QKGEQGSEKTLSTGIGVESKLRLSPVRSNRSQS-DQSNTEEHAFQRTGLN
Xenopus_Prot_FASTA       ----LSSAKEQSGALLKQGSPSSEPKKTSPIHMLKKTESKHSKMSRNRRG
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                         1043                                            1092
HPG                      NINEVGSSTNEVGSSINEVGSSDENIQAELGRNRGPKLNAMLRLGVLQPE
Great_Apes               NINEVGSSTNEVGSSINEVGSSDENIQAELGRNRGPKLNAMLRLGVLQPE
OWMonkeys                NINEVGSSTNEVGSSINEVGSSDENIQAELGRNRGPKLNAMLRLGLLQPE
Monkeys                  SINEVGSSTNEVGSSINEVGSSDENIQAELGRNRGPKLNAMLRLGLLQPE
Primates                 SINEVGSSTNEVGSSINEVGSSGENIQAELGRNRGPKLNAVLRLGLMQPE
'+Tupaia'                SINEVGSSTNEVGSSINEVGSSGENIQAELGRNRGPKLNAVLRLGLMQPE
Tamadua_Bradypus         SINEVGSSINEVGSSINEVGSSGENIQAELGRNRGPKLNAMLRLGLMQPE
Armadillos               SI--------------NEVGSSGENIQAELGRNRAPKLNAMLRLGLMQPE
EuarchLauraXen           SINEVGSSTNEVGSSINEVGSSGENIQAELGRNRGPKLNAVLRLGLMQPE
Elephants                SI-------NEVCSSINEVGSSGENIQAEISRKRGPKLNAVLRLGLMQPE
Hyraxes                  SI--------------NEVGSSSENIQAEISRNREPRLNAVLRLGVMQPE
Sirenia                  SI-------NEVGSSVNEVGSSGENIQAELGRNRGPKLNAVLRLGLMQPE
TE_Amblysomus            SI-------NEVGSSINEVGSSGENIQAELGRNRGPKLNAVLRLGLMQPE
Macroscelidae            SINEVGSSTNEVGSSINEVGSSGENIQAELDRNRGPELNAVLRLGLMQPE
Orycteropus_TEAM         SINEVGSSTNEVGSSINEVGSSGENIQAELGRNRGPKLNAVLRLGLMQPE
'+Cynocephalus'          SINEVGSSTNEVGSSINEVGSSGENIQAELGRNRGPKLNAVLRLGLMQPE
Myotis_Tadarida          ST-------NEVGSSINEVGSSGENIQAELGRNRGSKLNAMLRLGLMQPE
Taphozous_Tonatia        ST-------NEVGSSINEVGSSGENIQAELGRNRGSKLNAVLRLGLMQPE
Pteropus_Cynopterus      SIYEAGSSTNELGSSVNEVGSSGENIQAELSRNRGPKLNAVLQLGLMQPE
Megaderma_Hipposideros   NIYEADSSTNEVGSSINEVGSSGENIQAELGRNRGPKLNAVLRLGLMQPE
Manis_C                  SINEVGSSTNEVGSSINEVGSSGENIQAELGRNRGPKLNAMLRLGLMQPE
Carnivores               SVNEVGSSTNEVGSSINEVGSSGENIQAELGRNRGPKLNAMLRLGLMQPE
Cetacea                  SINEVGSSTNEVGSSINEVGSSGENIQAKLDRNRGPKLSALLRLGLMQPE
BHC                      SINEVGSSTNEVGSSINEVGSSGENIQAELGRNRGPKLSALLRLGLMQPE
Sus_BHC                  SINEVGSSTNEVGSSINEVGSSGENIQAELGRNRGPKLSAMLRLGLMQPE
Perissodactyla           SINEVGSSTNEVGSSINEVGSSGENIQAELGRNRGPKLNAILRLGLMQPE
Insectivores             SINEVGSSTNEVGSSINEVGSSGENIQAELGRNRGPKLNAMLRLGLMQPE
Glires                   SINEVGSSTNEVGSSINEVGSSGENIQAELGRNRGPKLNAVLRLGLMQPE
Sciurus_Glaucomys        SINEVGSSTNEVGSSINEVGSSGENIQAELGRNRGPKLNAVLRLGLMQPE
Aplodontia_SG            SINEVGSSTNEVGSSINEVGSSGENIQAELGRNRGPKLNAVLRLGLMQPE
ASG_Graphiurus           SINEVGSSTNEVGSSINEVGSSGENIQAELGRNRGPKLNAVLRLGLMQPE
Hystrix_OMMR             SINEVGSSTNEVGSSINEVGSSGENIQAELGRNRGPKLNAVLRLGLMQPE
Pedetes_OMMR             SINEVGSSTNEVGSSINEVGSSGENIQAELGRNRGPKLNAVLRLGLMQPE
Mus_Rattus               SI--------------NEVCSTGENVQGQLGRNRGPKVNTVPPLDSMQPG
Meriones_MR              SI--------------NEVCSSGENVQGQLGRNRGPKVNTVLPLDLMQPE
Oryzomys_MMR             SI--------------NEVCSSGENVQGQLGRNRGPKLNTVLPLGLMQPE
Tenrec_Echinops          SL--------------NEVGSSSENIQAELARNREPKLDAVLRLGLVQPE
Wombat                   RF--------------ISIGSSGEGSQAQKGENKESELNTQPKLKLVQPQ
Phascogale               -I--------------ISVGSSGEGTQAEKSENKESELNTPPKLKLMQPQ
Echymipera               RF--------------ISRDSSGEDSRAEKGKIKESELNTPTKFKLVQPQ
Shrew_Opossum            RF--------------VGVDSSGEGSQEEKGENK---LN--------QSQ
Gallus                   AV-----------SETYFSSESNQVEKAEVVDDK-GLMQHFQPSPMLCPT
Xenopus_Prot_FASTA       KV-----------------KPSSNSAKNTTGQPDN--LNNPTQ-G-VTGS
```

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                            1093                                            1133
HPG                         VYKQSLPGSNC---KHPEIKK-----QG-YEEVVQTVNTDFSPCLISDNL
Great_Apes                  VYKQSLPGSNC---KHPEIKK-----QG-YEEVVQTVNTDFSPCLISDNL
OWMonkeys                   VYKQSLPISNC---KHPEIKK-----QG-HEEVVQTVNTDFSPCLISDNL
Monkeys                     VYKQSLPISNC---KHPEIKK-----QG-HEEVVQTVNTDFSPCLISDNL
Primates                    VYKQSLPISNC---KHPEIKR-----QGENEGVVQAVNTDFSPCLISDNL
'+Tupaia'                   VYKQSLPISNC---KHPEIKR-----QGENEGVVQAVNTDFSPCLISDNL
Tamadua_Bradypus            VYKQSLPITNC---KHPEIKK-----QGENEEVVQAVNTDFSPCLISDNL
Armadillos                  VYKQSLPITNC---KHPEIKR-----QGENEEAIQAVDTDFSPCLISDNL
EuarchLauraXen              VYKQSLPISNC---KHPEIKR-----QGENEGVVQAVNTDFSPCLISDNL
Elephants                   VYKQSLPISDC---KHPGIKT-----QGENEGVVQAVNTDFSPCLISDNL
Hyraxes                     VYKQSLSISNC---KQPEIKK-----QGENEGVVQAVSTDFSACPISENL
Sirenia                     VYKQSLPVSNC---KHPEIKR-----QGENEGVVQDVNMDFSPCLISDNL
TE_Amblysomus               VYKQSLPISNC---KHPEIKR-----QGDNEGVVQAVNPDFSPCLISDNL
Macroscelidae               VYKQSLPTSNC---KHPEIKR-----PGENEGVIQAVNPDFSPCLISDNL
Orycteropus_TEAM            VYKQSLPISNC---KHPEIKR-----QGENEGVVQAVNTDFSPCLISDNL
'+Cynocephalus'             VYKQSLPISNC---KHPEIKR-----QGENEGVVQAVNTDFSPCLISDNL
Myotis_Tadarida             VYKPSLPVSNC---KHPEIKR-----QGENEGVVQAVNADFSPCQISDNL
Taphozous_Tonatia           VYKPSLPVSNC---KHPEIKR-----QGENEGVVQAVNADFSPCQISDNL
Pteropus_Cynopterus         VYKQSLPLSNC---KHPEIKR-----QGENEGVVQAVNADVSPRQISDNL
Megaderma_Hipposideros      VYKQSLPVSNC---KHPEIKR-----QGENEGVVQAVNADFSPCQISDNL
Manis_C                     VYKQSLPISNC---KHPEIKR-----QGENEGVVQAVNADFSPCLISDNL
Carnivores                  VYKQSLPISNC---KHPEMKR-----QGENEGVVQSVNADFSPCLISDNL
Cetacea                     VYKQSLPVSNC---QLPEIKR-----QGENEGTLQAVNADFSPCLISDNL
BHC                         VYKQSLPVSNC---QHPEIKR-----QGENEGILQAVNADFSPCLISDNL
Sus_BHC                     VYKQSLPVSNC---KHPEIKR-----QGENEGIFQAVNADFSPCLISDNL
Perissodactyla              VYKQSLPISNC---KHPEIKR-----QGENEGVVQAVNADFSPCLISDNL
Insectivores                VYKQSLPISNC---KHPEIKR-----QGENEGVVQAVNTDFSPCLISDNL
Glires                      VYKQSLPISNC---KHPEIKR-----QGENEGVVQAVNTDFSPCLISDNL
Sciurus_Glaucomys           ACKQNLL-SNC---KYPEIKR-----QGE-EGVVQVVNTDFSPCLISDDL
Aplodontia_SG               ACKQNLLVSNC---KYPEIKR-----QGE-EGVVQVVNTDFSPCLISDDL
ASG_Graphiurus              AYKQSLPVSNC---KHPEIKR-----QGE-EGVVQAVNTDFSPCLISDNL
Hystrix_OMMR                VYKQSLPVSNC---KHPEIKR-----QGENEGVVQAVNTDFSPCLISDNL
Pedetes_OMMR                VCKQSLPVSNC---KHPEIKR-----QGENEGVVQAVDADFSPCLISDNL
Mus_Rattus                  VCKQSVPVSD----KYLEIKK-----Q-E-EG---AVSADFSPCLFSDHL
Meriones_MR                 VCKQSVPVSDY---KYLEMKK-----Q-E-EG---AVGADFSPCLFSDHL
Oryzomys_MMR                VCKQSLPVSDY---KYLEMKK-----Q-E-EG---AVDADFSPCLFSDNL
Tenrec_Echinops             VCKESLPIRKC---KHPEVKR-----QKGNGGLVPAVNPDFSRYLMSHNP
Wombat                      ICQQSFPQDNC---KESKRKG-----KGGNGKLAQAISTDSSPCL-----
Phascogale                  VSQQTFPQNNC---K-----------------------------------
Echymipera                  VCQLSFSQDNC---KEPKRKG-----KGGNGILALATSTDSSPCL-----
Shrew_Opossum               VCQQS---------------------------------------------
Gallus                      ACQQNPAEFNCELTEKKIITRERSLVKGNEERVIQTVSTGLSEFSVREAL
Xenopus_Prot_FASTA          LYN-KQVMSDFP--MRLNVD----------EEHTNASAKGSQSSVADKST
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                         1134             1152
HPG                      EQ-PMGSSHASQVCSETPDD
Great_Apes               EQ-PMGSSHASQVCSETPDD
OWMonkeys                EQ-PMGSSHASQVCSETPDD
Monkeys                  EQ-PMGSSHASQVCSETPDD
Primates                 EQ-PMGSSHASQVCSETPDD
'+Tupaia'                EQ-PMGSSHASQVCSETPDD
Tamadua_Bradypus         EL-PMGSSHASQICSETPDD
Armadillos               EL-PMGNSHASQICSETPDD
EuarchLauraXen           EQ-PMGSSHASQICSETPDD
Elephants                EQ-PVGTSRASQVCSETPDD
Hyraxes                  EQ-PVRSSHTSQVCSQTPDN
Sirenia                  EQ-PMGSSRASQICSETPDD
TE_Amblysomus            EQ-PMGSSHASQICSETPDD
Macroscelidae            EQ-PMGSSHASQICSETPDD
Orycteropus_TEAM         EQ-PMGSSHASQICSETPDD
'+Cynocephalus'          EQ-PMGSSHASQVCSETPDD
Myotis_Tadarida          EQ-PMGSSPASQVCSETPDD
Taphozous_Tonatia        EQ-PMGSSPASQVCSETPDD
Pteropus_Cynopterus      EQ-PMGNSNASQVCSETPDD
Megaderma_Hipposideros   EQ-PMGSSHASQVCSETPDD
Manis_C                  EQ-PMGSSHASQVCSETPDD
Carnivores               EQ-PMGSSRASQVCSETPDD
Cetacea                  EQ-PMGRSHASQVCSETSDE
BHC                      EQ-PMGSSHASQVCSETPDD
Sus_BHC                  EQ-PMGSSHASQVCSETPDD
Perissodactyla           EQ-PMGSSCASQVCSETPDD
Insectivores             EQ-PMGSSHASQVCSETPDD
Glires                   EQ-PMGSSHASQVCSETPDD
Sciurus_Glaucomys        EQ-PMGNSHVTQVCSETPDD
Aplodontia_SG            EQ-PMGNSHVTQVCSETPDD
ASG_Graphiurus           EQ-PMGNSHASQVCSETPDD
Hystrix_OMMR             EQ-PMGSSHASQVCSETPDD
Pedetes_OMMR             EQ-PMGSGHVSQVCSETPDD
Mus_Rattus               EQ-PMRSGKIFQVCSETPDD
Meriones_MR              EQ-PMRSGNIFQVCSETPDD
Oryzomys_MMR             EQ-PMGSGNIFQVCSETPDD
Tenrec_Echinops          EQ-PMESNH-SQICSETPED
Gallus                   EESLKGHSDFTDL-SETPDG
Xenopus_Prot_FASTA       AHSNVNTDFISDINSATPDG
```

Appendix F Eutherian full-length BRCA1 amino acid alignment and conservation.

Marks above the human residues represent identical (*), weakly conservative (.), and strongly conservative (:) sites [40]

```
                  1                                                          60
                  ***** :::*****::**************************************:*****
Human             MDLSALRVEEVQNVINAMQKILECPICLELIKEPVSTKCDHIFCKFCMLKLLNQKKGPSQ
Cow               MDLSADHVEEVQNVLNAMQKILECPICLELIKEPVSTKCDHIFCKFCMLKLLNQKKGPSQ
Dog               MDLSADRVEEVQNVLNAMQKILECPICLELIKEPVSTKCDHIFCKFCMLKLLNQRKGPSQ
Mouse             MDLSAVQIQEVQNVLHAMQKILECPICLELIKEPVSTKCDHIFCKFCMLKLLNQKKGPSQ

                  61                                                        120
                  ******:******* *******.****:*: **:****:: ::.:.*::*.:** *:*::
Human             CPLCKNDITKRSLQESTRFSQLVEELLKIICAFQLDTGLEYANSYNFAKKENNSPEHLKD
Cow               CPLCKNDITKRSLQESTRFSQLVEELLKIIHAFELDTGLQFANSYNFSRKEDNSPEHLKE
Dog               CPLCKNDITKRSLQESTRFSQLVEELLKIIHAFELDTGLQFADSYNFSKKENNSPEHLKE
Mouse             CPLCKNEITKRSLQGSTRFSQLAEELLRIMAAFELDTGMQLTNGFSFSKKRNNSCERLNE

                  121                                                       180
                  *.*****:*****.:** * ** *.:* : ** *:***** **:::.::: *.::.****
Human             EVSIIQSMGYRNRAKRLLQSEPENPSLQETSLSVQLSNLGTVRTLRTKQRIQPQKTSVYI
Cow               EVSIIQSMGYRNRAKRLWQSEPENPTLQETSLTVELSNLGIVRSLRTKQQTQSQNKSVYI
Dog               EVSIIQSMGYRNRAKRLRQSEPENPTL-ETSLSVQLSNLGIVRSLRTKQQIQPQNKSVYI
Mouse             EASIIQSVGYRNRVRRLPQVEPGNATL-KDSLGVQLSNLGIVRSVKKNRQTQPRKKSVYI

                  181                                                       240
                  **.*****:**.*.   ** *.* *: :.* :  : .*..*::******  .: * ****
Human             ELGSDSSEDTVNKATYCSVGDQELLQITPQGTRDEISLDSAKKAACEFSETDVTNTEHHQ
Cow               ELGSDSSEDTVNKASYFSVGDHELLEITPQGAKAKTNLNPAEKAACEFSEKDITNTEHHQ
Dog               ELGSDSSEDTVNKASSCSVGDDE-LEITSQGARAEASLNPAKKAACEFSG-DITNIEHHQ
Mouse             ELDSDSSEETVTKPGDCSVRDQELLQTAPQEAGDEGKLHSAEEAACEFSE-GIRNIEHHQ

                  241                                                       300
                   * .** .*:::*:: **** *. *:*:. ******::****** *.***** :.*:*.*
Human             PSNNDLNTTEKRAAERHPEKYQGSSVSNLHVEPCGTNTHASSLQHENSSLLLTKDRMNVE
Cow               LSIKDLITTQKHATETHPEKYQGISVSDFHVEPCGTDTHASSLQHENSSLLLTENRLNVE
Dog               SSNKDLTTTEKHATKKHPEKYQGISVSNLHVEPCGTNTHASSLQHENSSLLLTKHRMNVE
Mouse             CS-DDLNPTENHATERHPEKCQSISISNVCVEPCGTDAHASSLQPETSSLLLIEDRMNAE

                  301                                                       360
                  ***:**:**** :. **:.*** ** **:**: *** :*:  *:* *  *::  : :
Human             KAEFCNKSKQPGLARSQHNRWAGSKETCNDRRTPSTEKKVDLNADPLCERKEWNKQKLPC
Cow               KAEFCNKSKQPVLVKSQQSRWAESKGTCKDRQIPSTEKKIVLNTDPLYRRKELRKQKPAC
Dog               KAEICNNSKQPGLARSQQSRWAESKETCNDRQIPSTEKKVVVNADLLCGRKELNKQKPPH
Mouse             KAEFCNKSKQPGIAVSQQSRWAASKGTCNDRQVPSTGEKVGPNADSLSDREKWTHPQSLC

                  361                                                       420
                  .:..  : ****:***.*::***:****:.*:* **.:     * * :.. .::: *:*.
Human             SENPRDTEDVPWITLNSSIQKVNEWFSRSDELLGSDDSHDGESESNAKVADVLDVLNEVD
Cow               PDSPGDSQDVPWVTLNNSIQKVNDWFSRSDEILTSDDSCDGGSESNNEVAGAVEIPNKVD
Dog               SDSPRDSQDVPWITLNSSIRKVNEWFSRSDEILTSDDSHDRGSELNTEVGGAVEVPNEVG
Mouse             PENSGATTDVPWITLNSSVQKVNEWFSRTGEMLTSDSASARRHESNAEAAVVLEVSNEVD

                  421                                                       480
                     .**.* :*::.**: :::    * .:*.* .**.******:*::*.* *:..* :*
Human             EYSGSSEKIDLLASDPHEALICKSERVHSKSVESNIEDKIFGKTYRKKASLPNLSHVTEN
Cow               GYSGSSEKINLMASDPHGTLIH--ERVHSKPVESNIEDKIFGKTYRRKSSLPNFSHIAED
Dog               EYSGSSEKIDLMASDPQDAFICESERVHTKPVGGNIEDKIFGKTYRRKASLPKVSHTTEV
Mouse             GGFSSSRKTDLVTPDPHHTLMCKSGRDFSKPVEDNISDKIFGKSYQRKGSRPHLNHVTE-
```

```
                 481                                                        539
                    :*:   ***  * :*: ** : **  ::.*:*******.:   * :**: : :* :
Human            LIIGAFVTEPQIIQERPLTNKLKRKRRPTSGLHPEDFIKKADL-AVQKTPEMINQGTNQT
Cow              LILGAFTVEPQITQEQPLTNKLKCKRRGTSGLQPEDFIKKVDLTIVPKTPEKMTEGTDQT
Dog              LTIGACAIEPQTMQTHPFMNKAEHKRRTTSSLHPEDFIKKVELGIVPKTPEKLIEGINQI
Mouse            -IIGTFITEPQITQEQPFTNKLKRKR--STSLQPEDFIKKADSAGVQRTPDNINQGTDLM

                 540                                                        599
                 : . : :. *..  **:    . :*:*:..:* ***.**..  : ::.:*  :*::*:***
Human            EQNGQVMNITNSGHENKTKGDSIQNEKNPNPIESLEKESAFKTKAEPISSSISNMELELN
Cow              EQKCHGMNITSDGHENKTKRDYVQKEQNANPAESLEKESVFRTEAEPISISISNMELELN
Dog              KRDGHVINITNNGPENETEGDYVQKEKNANPTESLEKESAFRTKTEPMSSRISNMELELN
Mouse            EPNEQAVSTTSNCQENKIAGSNLQKEKSAHPTESLRKEPASTAGAKSISNSVSDLEVELN

                 600                                                        659
                  ***** ***:**** *    ** :  ** . *  :** *:*..*.** **:: .* *
Human            IHNSKAPKKNRLRRKSSTRHIHALELVVSRNLSPPNCTELQIDSCSSSEEIKKKKYNQMP
Cow              IHRSKAPK-NRLKRKSSTRKIPELELVVSRNPSLPNHTELPIDSSSSNEEMKKKHSSQMP
Dog              SSSSKAPKKNRLRRKSSARHTCALEFVVNRNLNPPDHSELQIESCSSSEEMKKQHLDQVP
Mouse            VHSSKAPKKNRLRRKSSIRCALPLEPIS-RNPSPPTCAELQIDSCGSSEETKKNHSNQQP

                 660                                                        719
                 . : :  **: ..* :  ** ..:. *:  **  *.:*** .* * .* ::. *.  : :
Human            VRHSRNLQLMEGKEPATGAKKSNKPNEQTSKRHDSDTFPELKLTNAPGSFTKCSNTSELK
Cow              VRQSQKLQLIGDKELTAGAK-NNKTYEQINKRLASDAFPELKLTNTPGYFTNCSS--KPE
Dog              VRHNKTLQLMQDKEPAGRAKKSSKPGEQINKRLASHAFPELTLTNVSGFFANYSSSSKPQ
Mouse            AGHLREPQLIEDTEPAADAK-KNEPNEHIRKRRASDAFPEEKLMNKAGLLTSCSSPRKSQ

                 720                                                        778
                  ::*.  *    *.    ::*:.:.: : :*           :** **:.:*** .***.
Human            EFVNPSLPREEKEEKLETVKVSNNAEDPKDLMLSGE-RVLQTERSVESSSISLVPGTDYG
Cow              EFVHPSLQR---EENLGTIQVSNSTKDPKDLILREG-KALQIERSVESTNISLVPDTDYS
Dog              ECINPGLRREEIEESRRMTQVSDSTRDPKELVLSGG-RGLQTERSVESTSISLVLDTDYG
Mouse            GPVNPSPQRTG-TEQLETRQMSDSAKELGDRVLGGEPSGKTTDRSEESTSVSLVSDTDYD

                 779                                                        838
                 **:*:*:*:. *   *:* .     .  .: :* *  :*   ::  ..***:   *    *
Human            TQESISLLEVSTLGKAKTEPNKCVSQCAAFENPKGLIHGCSKDNRNDTEGFKYPLGHEVN
Cow              TQDSISLLEAKTPEKAKTAPNPCVSLCTATKNLKELIHRDFKDTKNNTEGFQDLLGHDIN
Dog              TQDSISLLEADTLRKAKTVSNQQANLCATIENPKEPIHGCSKDTRNDTEGFVVPLTCKDN
Mouse            TQNSVSVLDAHTVRYARTGSAQCMTQFVASENPKELVHGS-NNAGSGTEGLKPPLRHALN

                 839                                                        897
                      : . ***:****:* *:* *:.****:** ** *  ..:::*.   .      . .*
Human            -HSRETSIEMEESELDAQYLQNTFKVSKRQSFAPFSNPGNAEEECATFSAHSGSLKKQSP
Cow              YVIQETSREMEDSELDTQYLQNTFKASKRQTFALFSNPGNPQKECATVFAHSGSLRDQSP
Dog              -HTQETSIEMEESELDTQCLRNMFKVSKRQSFALFSYPRDPEEDCVTVCPRSGAFGKQGP
Mouse            --LSQEKVEMEDSELDTQYLQNTFQVSKRQSFALFSKPRSPQKDCAHSVPS----KELSP

                 898                                                        956
                 : . :  ***  **:.* :   **::  .. :..  *: :     : *.     *.* **
Human            KVTFECEQKEENQGKNESNIKPVQTVNITAGFPVVGQKDK-PVDNAKCSIKGGSRFCLSS
Cow              RDPLKCRQKEDSQGKSESKSQHVQAICTTVHFPVADQQDRTPGDDAKCSAKEVTRVCQSS
Dog              KVTLECGQKEESQGKKESEIRHVQAVHTNAGFSAVSQKAKKPGDFAKCSIKGVSRLCLSS
Mouse            KVTAKGKQKE-RQGQEEFEISHVQAVAATVGLPVPCQEGK-LAADTMCDRG--CRLCPSS

                 957                                                       1016
                 : :. :. *   ..  *: ::.     .: **:* :**  ::   * .**.   *.*  :*.
Human            QFRGNETGLITPNKHGLLQNPYRIPPLFPIKSFVKTKCKKNLLEENFEEHSMSPEREMGN
Cow              QLRGHKTELVFANKQGVSEKPNLIPSLSPIKSSVKTICKKSPSE-KFEEPVTSPEKTLGS
Dog              QFKGKETELLIANYHGISQNPYHIPPLSPIRSCVKTLCQENLSEEKFEQHSMSPERAVGN
Mouse            HYRSGENGLSATGKSGISQNSHFKQSVSPIRSSIKTDNRKPLTEGRFERHTSSTEMAVGN
```

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             1017                                                        1075
              *  : *:* *:* ** :   . :*..*              .*::*: *:.:.: .: ***
Human         E-NIPSTVSTISRNNIRENVFKEASSSNINEVGSSTNEVGSSINEIGSSDENIQAELGRN
Cow           ESIIQSAVSTISQNNIQESTFKEVSSNSVNEVGSSTNEVGSSVNEVGSSGENIQAEPGRN
Dog           ERVIQSTVSTISQNNIRECASKEVGSSSVNEVVSSTNEVGSSVNEVGSSGENIQAELGRN
Mouse         ENILQSTVHTVSLNN-RGNACQEAGS--------------GSIHEVCSTGDSFPGQLGRN

             1076                                                        1134
              * **:.::  *.  ** * :**:. *  :: *:* * : *    :* :**** *:**: *
Human         RGPKLNAMLRLGVLQPEVYKQSLPGSNCKHPEIKKQ-EYEEVVQTVNTDFSPYLISDNLE
Cow           REPKLRALLGLGLTQPEVYKQSLPVSNCHHPEIKRQGENEDMPQAVKADFSPCLISDNLE
Dog           RGPKLNAMLRLGLMQPEVCKQSLSLSNCKHPEMKWQGQSEGAVLSVSADFSPCLISDNPE
Mouse         RGPKVNTVPPLDSMQPGVCQQSVPVS-DKYLEIKKQ-EGE----AVCADFSPCLFSDHLE

             1135                                                        1194
              *. .. :  ********:**:. :*: .  *.*.** * ****. *:   *   **.*
Human         QPMGSSHASQVCSETPDDLLDDGEIKEDTSFAENDIKESSAVFSKSVQKGELSRSPSPFT
Cow           QPTGSRHASQVCSETPDNLLNDDEIKENSHFAESDIKERSAVFSESVQKGEFRGSPGPFT
Dog           QPMGSSRSSQVCSETPDDLLNGDKIKGKVSFAESDIKEKSAVFSKSVQSGEFSRSPSPSD
Mouse         QSMSG-KVFQVCSETPDDLLDDVEIQGHTSFGEGDIMERSAVFNGSILRRESSRSPSPVT

             1195                                                        1254
              *:  :*. :*.: **** **. *:*:*:*****:*:  ::..      *   .:..:: :.:
Human         HTHLAQGYRRGAKKLESSEENLSSEDEELPCFQHLLFGKVNNIPSQSTRHSTVATECLSK
Cow           HTHLAQGHQRGAGKLES-EETVSSEDEELPCFQQLLFGKVTSTLSPSTGCNTVATEGLSK
Dog           HTRLAQGYQRGTKKLESSEENMSSEEEELPCFQHLIFGKVTNMPSQSTSHNAVAAEGLSN
Mouse         HASKSQSLHRASRKLESSEESDSTEDEDLPCFQHLLS-RISNTP-ELTRCSSAVTQRMPE

             1255                                                        1314
              ::* .   . *.. .* ..:*    :.****::.*:.:**.*:**** *   :. *.*:*:**
Human         NTEENLLSLKNSLNDCSNQVILAKASQEHHLSEETKCSASLFSSQCSELEDLTANTNTQD
Cow           ETEGNLESLKSGLNDCSGQVTSAKVSQEHHLNEEARCSGSLFSSQCSAMEDLTTNTNTQD
Dog           KTEENLDSLKNSLSDISNQVPSAKASQEHHLSEEARCSGSLFSSQCSALEDLTVNTNTQD
Mouse         KAEGTQAPWKGSSSDCNNEVIMIEASQEHQFSEDPRCSGSMFSSQHSAAQGSTANANSQD

             1315                                                        1370
              .  :   .***  :*. .   . *.****:**:: *   . ***:. ***:*: .:    .*
Human         PFLIG--SSKQMRHQSESQGVGLSDKELVSDDE-ERGTGLEENN-QEEQSMDSNLGEAAS
Cow           PFLMFERPSKQV-YQSESEEV-LSDKELVSDDE-ERETGLEEDSCQEEQSVDSDLGEAVS
Dog           PFSMFDPTSKQVRHQSENLDV-LNDKELVSDDDDEREPGLEEDSPQEEQSVDSDLGEVAS
Mouse         SNFIP--PSKQRSHQCGNEEAFLSDKELISDNE-EMATCLEEDNDQEEDSIIPDS--EAS

             1371                                                        1430
              .  ***.:***      ********** **: **:*******.******:: .***   .
Human         GCESETSVSEDCSGLSSQSDILTTQQRDTMQHNLIKLQQEMAELEAVLEQHGSQPSNSYP
Cow           DHVSETSLSEDGVGLSSQSDILTTQQRDTMQDNLLKLQQEMAELEAVLERHGSQPSHSSA
Dog           GYESETSLSEDCSRLSSQSDILTTQQRDTMQDNLIKLQQEMAELEAVLEQHESQPSNSSP
Mouse         GYESETNLSEDCS----QSDILTTQQRATMKYNLIKLQQEMAHLEAVLEQRGNQPSGHSP

             1431                                                        1489
              *: :*. . *.* : * . *   :***::  : . *** :. . *** :   :..*. :
Human         SIISDSSALEDLRNPEQSTSEKAVLTSQKSSEYPISQNPEGLSADKFEVS-ADSSTSKNK
Cow           SLTADSRGPEHLLNLEQDTSERAILTSEKSRDYSRSQNPESLSADKFPVS-LDSSTNKNK
Dog           SLIADSCSPEDLLNPEQNASER-VLTSEKSSDSPISQNPESLSTDKFQVF-LDSSTSKNG
Mouse         SLLADPCALEDLPDLEPNMSGAAILTSKNINENPVSQNLKSACDDKFQLQHLEGPTSGDD

             1490                                                        1549
              *.*: *.*. :       *    *..    **. * ***:*  : .. * .       .::
Human         EPGVERSSPSKCPSLDDRWYMHSCSGSLQNRNYPSQEELIKVVDVEEQQLEESGPHDLTE
Cow           EPGMERSSASKFQLSYNRWYMHSS-RSLQDRNCPSQKEPINVADMEEQQLAKREAQDLMG
Dog           EPGMIRSSPSQSRLLDTRWYVHSCPRSLQDTNCPSQKELTKVVSMEEQQPTESEARDLME
Mouse         ESGMGRPSPFKSPLAGSRGSAHGCSRHLQKRNSPSQEELLQPAGSEAS----SEPHNSTG
```

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                      1550                                                        1609
                       * *.* : **:*** *******     **... . * *:: . *.*:****:.* :*  
Human                 TSYLPRQDLEGTPYLESGISLFSDDPESDPSEDRAPESARVGNIPSSTSALKVPQLKVAE
Cow                   -SFLPRQDQEGTPYLKSGISLFSHEPESDPSEDRAAEPAHVHSMPPSASALKLSQFRVEE
Dog                   QSYLSRPDLEGAPYLESGISLFSDDPESDPSSHRASELAHVSSMPTSTSALKLPQFQVEE
Mouse                 QSCLPRRELEGTPYLGSGISLFSS---RDPESESPKEPAHIGTTPASTSALKIPQGQVAF

                      1610                                                        1669
                       :  .*... : .         :.  ***: :* .  .: :***.*****:*.* * ***
Human                 SAQSPAAAHTTDTAGYNAMEESVSREKPELTASTERVNKRMSMVVSGLTPEEFMLVYKFA
Cow                   STKNPAAAHIANTTRCNLREESMSKEKPEVISSTERSKKRLSMVASGLTPKELMLVQKFA
Dog                   SAKSTAAVHIASTAGYNKSEDSVGIEKPEVISSTRGVNKRISMVASGLTPKEFMLVHKFA
Mouse                 RSAAAAGADKAVVG-------IVSKIKPELTSSEERADRDISMVVSGLTPKEVMTVQKFA

                      1670                                                        1729
                      .*::::**: *:******::***.*******************:*** **.:**:* ::*
Human                 RKHHITLTNLITEETTHVVMKTDAEFVCERTLKYFLGIAGGKWVVSYFWVTQSIKERKML
Cow                   RKHHVTLTNLITEETTHVIMKTDPEFVCERTLKYFLGIAGGKWVVSYFWVTQSIKEGKML
Dog                   RKHHISLTNLISEETTHVIMKTDAEFVCERTLKYFLGIAGGKWVVSYFWVTQSIKERKIL
Mouse                 EKYRLTLTDAITEETTHVIIKTDAEFVCERTLKYFLGIAGGKWIVSYSWVVRSIQERRLL

                      1730                                                        1784
                      : *:***:****.*******:*:***:::      :*:**:: *  ******.*:** *:
Human                 NEHDFEVRGDVVNGRNHQGPKRARESQDR-----KIFRGLEICCYGPFTNMPTDQLEWMV
Cow                   DEHDFEVRGDVVNGRNHQGPKRARESRDK-----KIFKGLEICCYGPFTNMPTDQLEWMV
Dog                   DEHDFEVRGDVVNGRNHQGPKRARESQDRESQDRKIFRGLEICCYGPFTNMPTDQLEWMV
Mouse                 NVHEFEVKGDVVTGRNHQGPRRSRESREK------LFKGLQVYCCEPFTNMPKDELERML

                      1785                                                        1844
                      :********* . :* . *.* :*:***.***** .   ***:*:* :*  :*****::
Human                 QLCGASVVKELSSFTLGTGVHPIVVVQPDAWTEDNGFHAIGQMCEAPVVTREWVLDSVAL
Cow                   QLCGASVVKEPSSFTPDQGTHPVVVVQPDAWTEDAGFHVIGQMCEAPVVTREWVLDSVAL
Dog                   HLCGASVVKEPSLFTLSKGTHPVVVVQPDAWTEDSGFHAIGQMCEAPVVTREWVLDSVAL
Mouse                 QLCGASVVKELPSLTHDTGAHLVVIVQPSAWTEDSNCPDIGQLCKARLVMWDWVLDSLSS
```

Appendix G: Mammalian full-length BRCA1 amino acid alignment and conservation

Marks above the human residues represent identical (*), weakly conservative (.), and strongly conservative (:) sites [40]. The opossum sequence is not complete; therefore, long stretches of gaps are likely the result of incomplete sequence and not evolutionary divergence.

```
               1                                                          60
                ***.:  ::**:**: .*********                   *******.::*****
Human           MDLSALRVEEVQNVINAMQKILECPICLELIKEPVSTKCDHIFCKFCMLKLLNQKKGPSQ
Cow             MDLSADHVEEVQNVLNAMQKILECPICLELIKEPVSTKCDHIFCKFCMLKLLNQKKGPSQ
Dog             MDLSADRVEEVQNVLNAMQKILECPICLELIKEPVSTKCDHIFCKFCMLKLLNQRKGPSQ
Mouse           MDLSAVQIQEVQNVLHAMQKILECPICLELIKEPVSTKCDHIFCKFCMLKLLNQKKGPSQ
Opossum         MDLPTVTIEEVKNVLIGMQKILECPI-------------------FCMLKLLSKKKGPSQ

               61                                                        120
                ******:******: ****.**.* **: : **:****:: ::  .*:: . .: * *:.
Human           CPLCKNDITKRSLQESTRFSQLVEELLKIICAFQLDTGLEYANSYNFAKKENNSPEHLKD
Cow             CPLCKNDITKRSLQESTRFSQLVEELLKIIHAFELDTGLQFANSYNFSRKEDNSPEHLKE
Dog             CPLCKNDITKRSLQESTRFSQLVEELLKIIHAFELDTGLQFADSYNFSKKENNSPEHLKE
Mouse           CPLCKNEITKRSLQGSTRFSQLAEELLRIMAAFELDTGMQLTNGFSFSKKRNNSCERLNE
Opossum         CPLCKNNITKRSLRESTRFNQLVEGLLKTIRAFELDTGFQFSNTQDFSKWERRTPEPLKK

               121                                                       180
                *.: ***:***** :*:   *. *.:*
Human           EVSIIQSMGYRNRAKRLLQSEPENPSLQETSLSVQLSNLGTVRTLRTKQRIQPQKTSVYI
Cow             EVSIIQSMGYRNRAKRLWQSEPENPTLQETSLTVELSNLGIVRSLRTKQQTQSQNKSVYI
Dog             EVSIIQSMGYRNRAKRLRQSEPENPTL-ETSLSVQLSNLGIVRSLRTKQQIQPQNKSVYI
Mouse           EASIIQSVGYRNRVRRLPQVEPGNATL-KDSLGVQLSNLGIVRSVKKNRQTQPRKKSVYI
Opossum         EAATIQSIGYRNRSKRFKASESENSTL---------------------------------

               181                                                       240
                   *****: *.:.
Human           ELGSDSSEDTVNKATYCSVGDQELLQITPQGTRDEISLDSAKKAACEFSETDVTNTEHHQ
Cow             ELGSDSSEDTVNKASYFSVGDHELLEITPQGAKAKTNLNPAEKAACEFSEKDITNTEHHQ
Dog             ELGSDSSEDTVNKASSCSVGDDE-LEITSQGARAEASLNPAKKAACEFSG-DITNIEHHQ
Mouse           ELDSDSSEETVTKPGDCSVRDQELLQTAPQEAGDEGKLHSAEEAACEFSE-GIRNIEHHQ
Opossum         ---SDSSEDGVKNAICN-------------------------------------------

               241                                                       300
Human           PSNNDLNTTEKRAAERHPEKYQGSSVSNLHVEPCGTNTHASSLQHENSSLLLTKDRMNVE
Cow             LSIKDLITTQKHATETHPEKYQGISVSDFHVEPCGTDTHASSLQHENSSLLLTENRLNVE
Dog             SSNKDLTTTEKHATKKHPEKYQGISVSNLHVEPCGTNTHASSLQHENSSLLLTKHRMNVE
Mouse           CSD-DLNPTENHATERHPEKCQSISISNVCVEPCGTDAHASSLQPETSSLLLIEDRMNAE
Opossum         ------------------------------------------------------------

               301                                                       360
Human           KAEFCNKSKQPGLARSQHNRWAGSKETCNDRRTPSTEKKVDLNADPLCERKEWNKQKLPC
Cow             KAEFCNKSKQPVLVKSQQSRWAESKGTCKDRQIPSTEKKIVLNTDPLYRRKELRKQKPAC
Dog             KAEICNNSKQPGLARSQQSRWAESKETCNDRQIPSTEKKVVVNADLLCGRKELNKQKPPH
Mouse           KAEFCNKSKQPGIAVSQQSRWAASKGTCNDRQVPSTGEKVGPNADSLSDREKWTHPQSLC
Opossum         ------------------------------------------------------------

               361                                                       420
Human           SENPRDTEDVPWITLNSSIQKVNEWFSRSDELLGSDDSHDGESESNAKVADVLDVLNEVD
Cow             PDSPGDSQDVPWVTLNNSIQKVNDWFSRSDEILTSDDSCDGGSESNNEVAGAVEIPNKVD
Dog             SDSPRDSQDVPWITLNSSIRKVNEWFSRSDEILTSDDSHDRGSELNTEVGGAVEVPNEVG
Mouse           PENSGATTDVPWITLNSSVQKVNEWFSRTGEMLTSDSASARRHESNAEAAVVLEVSNEVD
Opossum         ------------------------------------------------------------

               421                                                       480
Human           EYSGSSEKIDLLASDPHEALICKSERVHSKSVESNIEDKIFGKTYRKKASLPNLSHVTEN
Cow             GYSGSSEKINLMASDPHGTLIH--ERVHSKPVESNIEDKIFGKTYRRKSSLPNFSHIAED
Dog             EYSGSSEKIDLMASDPQDAFICESERVHTKPVGGNIEDKIFGKTYRRKASLPKVSHTTEV
Mouse           GGFSSSRKTDLVTPDPHHTLMCKSGRDFSKPVEDNISDKIFGKSYQRKGSRPHLNHVTE-
Opossum         ------------------------------------------------------------
```

```
              481                                                        539
Human         LIIGAFVTEPQIIQERPLTNKLKRKRRPTSGLHPEDFIKKADLA-VQKTPEMINQGTNQT
Cow           LILGAFTVEPQITQEQPLTNKLKCKRRGTSGLQPEDFIKKVDLTIVPKTPEKMTEGTDQT
Dog           LTIGACAIEPQTMQTHPFMNKAEHKRRTTSSLHPEDFIKKVELGIVPKTPEKLIEGINQI
Mouse         -IIGTFITEPQITQEQPFTNKLKRKR--STSLQPEDFIKKADSAGVQRTPDNINQGTDLM
Opossum       ------------------------------------------------------------

              540                                                        599
Human         EQNGQVMNITNSGHENKTKGDSIQNEKNPNPIESLEKESAFKTKAEPISSSISNMELELN
Cow           EQKCHGMNITSDGHENKTKRDYVQKEQNANPAESLEKESVFRTEAEPISISISNMELELN
Dog           KRDGHVINITNNGPENETEGDYVQKEKNANPTESLEKESAFRTKTEPMSSRISNMELELN
Mouse         EPNEQAVSTTSNCQENKIAGSNLQKEKSAHPTESLRKEPASTAGAKSISNSVSDLEVELN
Opossum       ------------------------------------------------------------

              600                                                        659
Human         IHNSKAPKKNRLRRKSSTRHIHALELVVSRNLSPPNCTELQIDSCSSSEEIKKKKYNQMP
Cow           IHRSKAPK-NRLKRKSSTRKIPELELVVSRNPSLPNHTELPIDSSSSNEEMKKKHSSQMP
Dog           SSSSKAPKKNRLRRKSSARHTCALEFVVNRNLNPPDHSELQIESCSSSEEMKKQHLDQVP
Mouse         VHSSKAPKKNRLRRKSSIRCALPLEPI-SRNPSPPTCAELQIDSCGSSEETKKNHSNQQP
Opossum       ------------------------------------------------------------

              660                                                        719
Human         VRHSRNLQLMEGKEPATGAKKSNKPNEQTSKRHDSDTFPELKLTNAPGSFTKCSNTSELK
Cow           VRQSQKLQLIGDKELTAGAK-NNKTYEQINKRLASDAFPELKLTNTPGYFTNCSS--KPE
Dog           VRHNKTLQLMQDKEPAGRAKKSSKPGEQINKRLASHAFPELTLTNVSGFFANYSSSSKPQ
Mouse         AGHLREPQLIEDTEPAADAK-KNEPNEHIRKRRASDAFPEEKLMNKAGLLTSCSSPRKSQ
Opossum       ------------------------------------------------------------

              720                                                        778
Human         EFVNPSLPREEKEEKLETVKVSNNAEDPKDLMLSGE-RVLQTERSVESSSISLVPGTDYG
Cow           EFVHPSLQR---EENLGTIQVSNSTKDPKDLILREG-KALQIERSVESTNISLVPDTDYS
Dog           ECINPGLRREEIEESRRMTQVSDSTRDPKELVLSGG-RGLQTERSVESTSISLVLDTDYG
Mouse         GPVNPSPQRTG-TEQLETRQMSDSAKELGDRVLGGEPSGKTTDRSEESTSVSLVSDTDYD
Opossum       ------------------------------------------------------------

              779                                                        838
Human         TQESISLLEVSTLGKAKTEPNKCVSQCAAFENPKGLIHGCSKDNRNDTEGFKYPLGHEVN
Cow           TQDSISLLEAKTPEKAKTAPNPCVSLCTATKNLKELIHRDFKDTKNNTEGFQDLLGHDIN
Dog           TQDSISLLEADTLRKAKTVSNQQANLCATIENPKEPIHGCSKDTRNDTEGFVVPLTCKDN
Mouse         TQNSVSVLDAHTVRYARTGSAQCMTQFVASENPKELVHGS-NNAGSGTEGLKPPLRHALN
Opossum       ------------------------------------------------------------

              839                                                        897
Human         -HSRETSIEMEESELDAQYLQNTFKVSKRQSFAPFSNPGNAEEECATFSAHSGSLKKQSP
Cow           YVIQETSREMEDSELDTQYLQNTFKASKRQTFALFSNPGNPQKECATVFAHSGSLRDQSP
Dog           -HTQETSIEMEESELDTQCLRNMFKVSKRQSFALFSYPRDPEEDCVTVCPRSGAFGKQGP
Mouse         --LSQEKVEMEDSELDTQYLQNTFQVSKRQSFALFSKPRSPQKDCAHSVPS----KELSP
Opossum       ------------------------------------------------------------

              898                                                        956
Human         KVTFECEQKEENQGKNESNIKPVQTVNITAGFPVVGQKDK-PVDNAKCSIKGGSRFCLSS
Cow           RDPLKCRQKEDSQGKSESKSQHVQAICTTVHFPVADQQDRTPGDDAKCSAKEVTRVCQSS
Dog           KVTLECGQKEESQGKKESEIRHVQAVHTNAGFSAVSQKAKKPGDFAKCSIKGVSRLCLSS
Mouse         KVTAKGKQKE-RQGQEEFEISHVQAVAATVGLPVPCQEGK-LAADTMCDRG--CRLCPSS
Opossum       ------------------------------------------------------------

              957                                                       1016
Human         QFRGNETGLITPNKHGLLQNPYRIPPLFPIKSFVKTKCKKNLLEENFEEHSMSPEREMGN
Cow           QLRGHKTELVFANKQGVSEKPNLIPSLSPIKSSVKTICKKSPSE-KFEEPVTSPEKTLGS
Dog           QFKGKETELLIANYHGISQNPYHIPPLSPIRSCVKTLCQENLSEEKFEQHSMSPERAVGN
Mouse         HYRSGENGLSATGKSGISQNSHFKQSVSPIRSSIKTDNRKPLTEGRFERHTSSTEMAVGN
Opossum       ------------------------------------------------------------
```

```
                 1017                                                        1075
                                                                     :.:   . . *
Human            EN-IPSTVSTISRNNIRENVFKEASSSNINEVGSSTNEVGSSINEIGSSDENIQAELGRN
Cow              ESIIQSAVSTISQNNIQESTFKEVSSNSVNEVGSSTNEVGSSVNEVGSSGENIQAEPGRN
Dog              ERVIQSTVSTISQNNIRECASKEVGSSSVNEVVSSTNEVGSSVNEVGSSGENIQAELGRN
Mouse            ENILQSTVHTVSLNNRGNACQEAGS--------------GSIHEVCSTGDSFPGQLGRN
Opossum          ------------------------------------------------AENINIRSDFN

                 1076                                                        1134
                  *:          :* * :**.. .  :  * : : :      :: :* **         *
Human            RGPKLNAMLRLGVLQPEVYKQSLPGSNCKHPEIKKQ-EYEEVVQTVNTDFSPYLISDNLE
Cow              REPKLRALLGLGLTQPEVYKQSLPVSNCHHPEIKRQGENEDMPQAVKADFSPCLISDNLE
Dog              RGPKLNAMLRLGLMQPEVCKQSLSLSNCKHPEMKWQGQSEGAVLSVSADFSPCLISDNPE
Mouse            RGPKVNTVPPLDSMQPGVCQQSVPVS-DKYLEIKKQ-EGE----AVCADFSPCLFSDHLE
Opossum          TLPE-------KAVHPKVCQQSFPQDNCKDPEREEK-EDVKLTPAISADSSPC-----LE

                 1135                                                        1194
                 *.  . :  ** **** :**:. ::: .  *.*.** * ****. .     :    . .*
Human            QPMGSSHASQVCSETPDDLLDDGEIKEDTSFAENDIKESSAVFSKSVQKGELSRSPSPFT
Cow              QPTGSRHASQVCSETPDNLLNDDEIKENSHFAESDIKERSAVFSESVQKGEFRGSPGPFT
Dog              QPMGSSRSSQVCSETPDDLLNGDKIKGKVSFAESDIKEKSAVFSKSVQSGEFSRSPSPSD
Mouse            QSMSG-KVFQVCSETPDDLLDDVEIQGHTSFGEGDIMERSAVFNGSILRRESSRSPSPVT
Opossum          QTKENTHFTQVWSETP-DLLDDGELKENTSFAESDIKEQSAVFGKNAQVRKSRKNLSPLV

                 1195                                                        1254
                 *   :   :* : **** **  *:*: :**.**.*: .:  .     *  .: . :  .:
Human            HTHLAQGYRRGAKKLESSEENLSSEDEELPCFQHLLFGKVNNIPSQSTRHSTVATECLSK
Cow              HTHLAQGHQRGAGKLES-EETVSSEDEELPCFQQLLFGKVTSTLSPSTGCNTVATEGLSK
Dog              HTRLAQGYQRGTKKLESSEENMSSEEEELPCFQHLIFGKVTNMPSQSTSHNAVAAEGLSN
Mouse            HASKSQSLHRASRKLESSEESDSTEDEDLPCFQHLL-SRISNTP-ELTRCSSAVTQRMPE
Opossum          HRNLSWKSRRQARKLESSEEEASSEEGELPSFQDLIFGKAASTPFQPTKNKTIAKEFSAN

                 1255                                                        1314
                 ::: .    *.. .  . ::   :.**:*. .::..**.*:***: .  :. : ::* :*
Human            NTEENLLSLKNSLNDCSNQVILAKASQEHHLSEETKCSASLFSSQCSELEDLTANTNTQD
Cow              ETEGNLESLKSGLNDCSGQVTSAKVSQEHHLNEEARCSGSLFSSQCSAMEDLTTNTNTQD
Dog              KTEENLDSLKNSLSDISNQVPSAKASQEHHLSEEARCSGSLFSSQCSALEDLTVNTNTQD
Mouse            KAEGTQAPWKGSSSDCNNEVIMIEASQEHQFSEDPRCSGSMFSSQHSAAQGSTANANSQD
Opossum          EAKENLAFLKNNMSVNNLQIPSGEASQDHDSSQESECSGSLFSSHSNSLEDLAGKANDKD

                 1315                                                        1370
                 .  :   .*:*    :. .      ...*: **.: *   . *:*:  ::::.: .:    *
Human            PFLIG--SSKQMRHQSESQGVGLSDKELVSDDE-ERGTGLEENN-QEEQSMDSNLGEAAS
Cow              PFLMFERPSKQV-YQSESEEV-LSDKELVSDDE-ERETGLEEDSCQEEQSVDSDLGEAVS
Dog              PFSMFDPTSKQVRHQSENLDV-LNDKELVSDDDDEREPGLEEDSPQEEQSVDSDLGEVAS
Mouse            SNFIP--PSKQRSHQCGNEEAFLSDKELISDNE-EMATCLEEDNDQEEDSIIPDS--EAS
Opossum          SALV--GSSHQESSHSRTQEI-QSGSEMASDKE-ERETDLDEDH-HKDQGVDSNLG-EGS

                 1371                                                        1430
                 .  ***. . *       ********
Human            GCESETSVSEDCSGLSSQSDILTTQQRDTMQHNLIKLQQEMAELEAVLEQHGSQPSNSYP
Cow              DHVSETSLSEDGVGLSSQSDILTTQQRDTMQDNLLKLQQEMAELEAVLERHGSQPSHSSA
Dog              GYESETSLSEDCSRLSSQSDILTTQQRDTMQDNLIKLQQEMAELEAVLEQHESQPSNSSP
Mouse            GYESETNLSEDCS----QSDILTTQQRATMKYNLIKLQQEMAHLEAVLEQRGNQPSGHSP
Opossum          GYDSETSHPGDTSQLSFQSDILTTQ-----------------------------------
```

```
            1431                                                       1489
                                      :::  :   ***  :. . **      ..... :
Human       SIISDSSALEDLRNPEQSTSEKAVLTSQKSSEYPISQNPEGLSADKFEVS-ADSSTSKNK
Cow         SLTADSRGPEHLLNLEQDTSERAILTSEKSRDYSRSQNPESLSADKFPVS-LDSSTNKNK
Dog         SLIADSCSPEDLLNPEQNASER-VLTSEKSSDSPISQNPESLSTDKFQVF-LDSSTSKNG
Mouse       SLLADPCALEDLPDLEPNMSGAAILTSKNINENPVSQNLKSACDDKFQLQHLEGPTSGDD
Opossum     --------------------------AEENVDHHKSQNVQSFSADKSRAF-PSDSNSKNE

            1490                                                       1549
            *.*:  .*  :           .      . : **::
Human       EPGVERSSPSKCPSLDDRWYMHSCSGSLQNRNYPSQEELIKVVDVEEQQLEESGPHDLTE
Cow         EPGMERSSASKFQLSYNRWYMHSS-RSLQDRNCPSQKEPINVADMEEQQLAKREAQDLMG
Dog         EPGMIRSSPSQSRLLDTRWYVHSCPRSLQDTNCPSQKELTKVVSMEEQQPTESEARDLME
Mouse       ESGMGRPSPFKSPLAGSRGSAHGCSRHLQKRNSPSQEELLQPAGSEAS----SEPHNSTG
Opossum     EAGVEGSSFSKSQMPNRVWSPLSRSRTPWEGDSPSEE-----------------------

            1550                                                       1609
                       :.   **:.:       :* ..      .: . *.*:***: .*  :.
Human       TSYLPRQDLEGTPYLESGISLFSDDPESDPSEDRAPESARVGNIPSSTSALKVPQLKVAE
Cow         -SFLPRQDQEGTPYLKSGISLFSHEPESDPSEDRAAEPAHVHSMPPSASALKLSQFRVEE
Dog         QSYLSRPDLEGAPYLESGISLFSDDPESDPSSHRASELAHVSSMPTSTSALKLPQFQVEE
Mouse       QSCLPRRELEGTPYLGSGISLFSS---RDPESESPKEPAHIGTTPASTSALKIPQGQVAF
Opossum     ----------ITTEPESGVKVNLKNIKSNPHQNKDPALRNIFNLPTSTSALRSSQLQTIE

            1610                                                       1669
             :  .*    :                       .  .: :*:* *****:* * * ***
Human       SAQSPAAAHTTDTAGYNAMEESVSREKPELTASTERVNKRMSMVVSGLTPEEFMLVYKFA
Cow         STKNPAAAHIANTTRCNLREESMSKEKPEVISSTERSKKRLSMVASGLTPKELMLVQKFA
Dog         SAKSTAAVHIASTAGYNKSEDSVGIEKPEVISSTRGVNKRISMVASGLTPKEFMLVHKFA
Mouse       RSAAAAGADKAVVG-------IVSKIKPELTSSEERADRDISMVVSGLTPKEVMTVQKFA
Opossum     ATNTTAPCAPACNV-GQLKEDSAERL-------KRRDNRKISLVSSGLTPKENMLVQKFA

            1670                                                       1729
            .* : :::. *:* ****::***.*******************:**: **.:*::* ::*
Human       RKHHITLTNLITEETTHVVMKTDAEFVCERTLKYFLGIAGGKWVVSYFWVTQSIKERKML
Cow         RKHHVTLTNLITEETTHVIMKTDPEFVCERTLKYFLGIAGGKWVVSYFWVTQSIKEGKML
Dog         RKHHISLTNLISEETTHVIMKTDAEFVCERTLKYFLGIAGGKWVVSYFWVTQSIKERKIL
Mouse       EKYRLTLTDAITEETTHVIIKTDAEFVCERTLKYFLGIAGGKWIVSYSWVVRSIQERRLL
Opossum     RKTHSTVSHQITEGTTHVIMKTDAEFVCERTLKYFLGIAGGKWVVSFLWVVQSFKEGKML

            1730                                                       1784
               :***:***:.****:**.*:***:        :*:**:: *  ***:*..*:** *:
Human       NEHDFEVRGDVVNGRNHQGPKRARESQDR-----KIFRGLEICCYGPFTNMPTDQLEWMV
Cow         DEHDFEVRGDVVNGRNHQGPKRARESRDK-----KIFKGLEICCYGPFTNMPTDQLEWMV
Dog         DEHDFEVRGDVVNGRNHQGPKRARESQDRESQDRKIFRGLEICCYGPFTNMPTDQLEWMV
Mouse       NVHEFEVKGDVVTGRNHQGPRRSRESREK------LFKGLQVYCCEPFTNMPKDELERML
Opossum     PECDFEVRGDVINGRNHRGPERARESQGM-----KIFRGLEICCYGPFTDMSTDQLEWMV

            1785                                                       1844
            :********: . :                         ** :*:* :*  :*****::
Human       QLCGASVVKELSSFTLGTGVHPIVVVQPDAWTEDNGFHAIGQMCEAPVVTREWVLDSVAL
Cow         QLCGASVVKEPSSFTPDQGTHPVVVVQPDAWTEDAGFHVIGQMCEAPVVTREWVLDSVAL
Dog         HLCGASVVKEPSLFTLSKGTHPVVVVQPDAWTEDSGFHAIGQMCEAPVVTREWVLDSVAL
Mouse       QLCGASVVKELPSLTHDTGAHLVVIVQPSAWTEDSNCPDIGQLCKARLVMWDWVLDSLSS
Opossum     QLCGASVVKKPSSLRFRV---------------------IGLVCEAPVVTREWVLDSVAC
```

Appendix H: Eutherian full-length BRCA2 amino acid alignment and conservation

Marks above the human residues represent identical (*), weakly conservative (.), and strongly conservative (:) sites [40].

```
                 1855                                                1873
                 *: ::**:**:
Human            YQCQELDTYLIPQIPHSHY-----------------------------------------
Cow              YQCQELDTYLVP------------------------------------------------
Dog              YQCQELDTYLIPQIPRTAADSSQPCV----------------------------------
Mouse            YRCRDLDAYLVQNITCDSSEPQDSND----------------------------------
Opossum          YQRQELDTYLISQTSPSLC-----------------------------------------

                 1                                                     60
                 **:  *.****:***::**. *************. ****** **.*** :*   ***:

Human            MPIGSKERPTFFEIFKTRCNKADLGPISLNWFEELSSEAPPYNSEPAEESEHKNNNYEPN
Dog              MPVGCKERPTFFEIFKTRCNQADLGPISLNWFEELSLEAPPYNSEPTEESGYKIS-YEPN
Cat              MPIGCKERPTFFEIFRTRCNKADLGPISLNWFEELCLEAPPYNSEPTEESGYKIS-YEPN
Mouse            MPVEYKRRPTFWEIFKARCSTADLGPISLNWFEELSSEAPPYNFEPPEESEYKPHGYEPQ

                 61                                                   119
                 *******:*  :*:*****:*:*     *: * **.:**       *: :..*:*::  .
Human            LFKTPQRKPSYNQLASTPIIFKEQGLTLPLYQ-SPVKELDKFKLDLGRNVPNSRHKSLRT
Dog              LFKTPQRKP-YNQLASTPIVFRE-----PIYQQSPLKELDKYRLDSGKDITDSKHKSCCT
Cat              LFKTPQRKP-CHQLASTPIIFKEQGLIPPIYQQSPLKEL-------GKDITNSKHRSCCT
Mouse            LFKTPQRNPPYHQFASTPIMFKERSQTLPLDQ-SPFREL-------GKVVASSKHKTHSK

                 120                                                  179
                  *:*:* . **:.* *:* *****: *:.*:.. **:*.**.****:**:: :* ****
Human            VKTKMDQADDVSCPLLNSCLSESPVVLQCTHVTPQRDKSVVCGSLFHTPKFVKGRQTPKH
Dog              MKSKMDRANDVTSPPLNSYLSESPV-LRCTHVTPQREKSVVCGSLFHTPRLMKG-QTPKR
Cat              MKSKMDQTNDVTSPPLNSCLSESPL-LRSTHVTPQREKSVVCGSLFHTPKLTKG-QTPKR
Mouse            KKTKVDPVVDVASPPLKSCLSESPLTLRCTQAVLQREKPVVSGSLFYTPKLKEG-QTPKP

                 180                                                  219
                 ******.***.****:***********                    ****.*:**.  :
Human            ISESLGAEVDPDMSWSSSLATPPTLSS--------------------TVLIVRNEEASET
Dog              ISESLGAEVDSDMSWSSSLATPPTLSSRISESLGAEVDSDMSWSSSLTVLIVRDEEVSAA
Cat              ISESLGAEVDPDMSWSSSLATPPTLSS--------------------TVLIVRDEEASAA
Mouse            ISESLGVEVDPDMSWTSSLATPPTLSS--------------------TVLIARDEEARSS

                 220                                                  278
                 * * *:.* .** *.**:** :**** :..   ..**..*:** *:.:    *:*  * **
Human            VFPHDTTANVKSYFSNHDESLKKNDRFIASVTDSENTNQREAASHGFGKTSGNSF-KVNS
Dog              VFPNDTTAIFKSCFSNHDESLKKNDRFIPCGPGKENKNQREAKSQSL----GNSFGKVNS
Cat              VFPNDTTAIFKSYFCNHDESLKKNDRFIPSGPDSENKSQREAKSQGLGKMVGNSCDKVNS
Mouse            VTPADSPATLKSCFSNHNESPQKNDRSVPSVIDSENKNQQEAFSQGLGKMLGDSSGKRNS

                 279                                                  337
                  ** : :.  *:**.   * . *.*** ***.**..* :*:****:: .****:** *:
Human            CKDHIGKSMPNVLEDEVYETVVDTSEE-DSFSLCFSKCRTKNLQKVRTSKTRKKIFHEAN
Dog              TKDHFVKSTPNVLEGEVHEKVLDVSEEEDSFSLCVPKYKTRNLQKIKTSKTRKNIFNETK
Cat              CKDPFGNSTLNVLEDGVRERVADVSEE-DSFPLCVPKCKTRNLQKIKTSKTRKNIFNET-
Mouse            FKDCLRKPIPNILEDG--ETAVDTSEE-DSFSLCFPKRRTRNLQKMRMGKTRKKIFSETR

                 338                                                  395
                 :.* .::::.* .: * *:* *:* . :.*** .*: :*** . .::*.:* * .  .
Human            ADE-CEKSKNQVKE-KYSFVSEVEPNDTDPLDSNVAHQKPFESGSDKISKEVVPSLACEW
Dog              TSE-CEEAKKQMKENKHSLVSEMEPNDSHPLDWNVTHEKPFGNGTDKISKEIVLSSASGC
Cat              TDE-CKEAKKQMKENKHSFVSEMEANASDPLDSNVTNQKPFGNGSDKISKEVVLSSASES
Mouse            TDELSEEARRQPDD-KNSFVFEMELRESDPLDPGVTSQKPFYSQNEEICNEAVQCSDSRW
```

```
                396                                                      454
                .. .**.** ::  * .*   *  .** ** *::  .:: .   :  *.* *:**.:*:
Human           SQLTLSGLNGAQMEKIPLLHISSCDQNISEKDLLDTENKRKKDFLTSENSLPRISSLPK-
Dog             SDLTLSSLNGAQMEKTPLLHTS-YDQNNSEKDLIITDKECTN-FITLENSWPQISNVPKY
Cat             CHLTLSGLNGTHMEKLPLLCISSCDQNNSEKDLITTEKECTN-FIILEDSLPQISGVPKC
Mouse           SQSNLSGLNETQTGKITLPHISSHSQNISE-DFIDMKKEGTG-SITSEKSLPHISSLPE-

455                                                      514
                .** :.** **:* .* * :**  *.: : ** :  *:  *.   .*:****::**. .
Human           SEKPLNEETVVNKRDEEQHLESHTDCILAVKQAISGTSPVASSFQGIKKSIFRIRESPKE
Dog             SEKTLNEEIVVNKINEGQCLESHEDSVVSVKQAIYETTLIASPLQGIRKSIFRIRESPEG
Cat             TEKILNEEIVVNKIDEGQCLESHEDSILAVKQAVFETSLIASPLQGIRKSIFRIRESPEE
Mouse           PEKMFSEETVVDKEHEGQHFESLEDSI-AGKQMVSRTSQAACLSPSIRKSIFKMREPLDE

                515                                                      574
                  .: **. :*:..*. * *** . *   : ***:***:... :* ****:* ...*.::
Human           TFNASFSGHMTDPNFKKETEASESGLEIHTVCSQKEDSLCPNLIDNGSWPATTTQNSVAL
Dog             MSNAMFSNNMTNPNFK-EPEASESGLEKHTICSQKEDSLCTSSIDDGSWPATIKHTSVAL
Cat             TFSAVFSNNITDPNFKEEHEASESVLEKHSICSQKEDSLSTSSLDNGSWPATIKHTSVAL
Mouse           TLGTVFSDSMTNSTFTEEHEASACGLGILTACSQREDSICPSSVDTGSWPTTLTDTSATV

                575                                                      634
                ** ****:**:*..**** : *::  :* *  ..::  * * *:*:**..:* ****:*.
Human           KNAGLISTLKKKTNKFIYAIHDETFYKGKKIPKDQKSELINCSAQFEANAFEAPLTFANA
Dog             KNLGLISSLKKKTKKFIYVINDETSNQGLKTQKDQESRLINLSTQFEANAFEGPLTFTNA
Cat             KNSGLISTLKKKTKKFIYVVNDETSYQGLKTQKDQQSGLMNYSAQFEANVLEGPLTFANA
Mouse           KNAGLISTLKNKKRKFIYSVSDDASLQGKKLQTHRQLELTNLSAQLEASAFEVPLTFTNV

                635                                                      692
                :**: .**  *: *  **.::*  ***.****   *      .   : :**** : ***
Human           DSGLLHSS-VKRSCSQNDSEEPTLSLTSSFGTILRKCSRNETCS-NNTVISQDLDYKEAK
Dog             DSGLLHSSSIKKNCLQNDSEKPALSLTSSFGTILRKVSSNGASSPNNKIISQDPDYKEAK
Cat             DSGLLHSS-VKKTCLQNDSKEPILSLTNSFGTLLRKVSNKGSSSPNNKIISQDLDYKEAK
Mouse           NSGIPDSS-DKKRCLPNDPEEP--SLTNSFGTATSK----EISY-IHALISQDLNDKEAI

                693                                                      751
                  ::* : : : *:: * .* *   *:* *. :*:: **::* :.. *    * *: *.
Human           CNKEKLQLFITPEADSLSCLQEGQCENDPKSKKVSDIKEEVLAAACHP-VQHSKVEYSDT
Dog             INKKKLESFITTETDCLSSLQEKHWEDDAKKQRVSDIKEKVLPTVSHPPVPHSEVEGSDI
Cat             IKKEKLQSFISTETNCLSSLQEKHCEDDTKSQRVADRKEEILPAVSQPSVPYSEVEDSGI
Mouse           VIEEKPQPYTAREADFLLCLPERTCENDQKSPKVSNGKEKVLVSACLP----SAVQLSSI

                752                                                      811
                 *:: :.   * : :*   *** .:   *.   :** :   ::.:.*: :. : ..**:*
Human           DFQSQKSLLYDHENASTLILTPTSKDVLSNLVMISRGKESYKMSDKLKGNNYESDVELTK
Dog             HFQSPESFSFDCDNTS--LLTPSSRDSPSSLVVMSRGKESYKISEKLKCKNHETGFELTK
Cat             HFQTLKSFSSDPDKSS--QLTPHPRDPPSNPVGLSRGRESYEVSETLKCKNHEAGFELTK
Mouse           SFESQENPLGDHNGTSTLKLTPSSKLPLSKADMVSREK-MCKMPEKLQCESCKVNIELSK

                812                                                      871
                .  :* . ::  *. . *.  **.. : :  .:.* *  ****:::  ***:*: :. **
Human           NIPMEKNQDVCALNENYKNVELLPPEKYMRVASPSRKVQFNQNTNLRVIQKNQEETTSIS
Dog             NIPMEKNQDIHVLNADSKNAKLLSTEKHITVASSSVKVQFNQNANLTTIQKDQKETTLIS
Cat             T--MENSQEIHVLNEHAKKAKLLSTEKYVTEASPSMKVPFNQNAHLTIIQKDQKETTLIS
Mouse           NI-LEVN-EICILSENSKTPGLLPPGENIIEVASSMKSQFNQNAKI-VIQKDQKGSPFIS

                872                                                      931
                ::::* :*****.*. * *.:::::: *   **.  **:: :*  .. .  :**.*.:
Human           KITVNPDSEELFSDNENNFVFQVANERNNLALGNTKELHETDLTCVNEPIFKNSTMVLYG
Dog             KITVNPNSEELFPDDENNFVLKITNESNTPVLGNTKELHDSNLCCVRDSVPKNSTMVVCT
Cat             KITMNPNSEELFPDGDN-FVFKITKERNVPVLGSIKELQDSDLCCVKEPVLENSTMVVYT
Mouse           EVAVNMNSEELFPDSGNNFAFQVTNKCNKPDLGSSVELQEEDLSHTQGPSLKNSPMAVDE
```

```
            932                                                       986
            * .* ::::* * *.      :   :*..:..::*: : * .:* **: : :    .: *
Human       DTGDKQATQVSIKKD-----LVYVLAEENKNSVKQHIKMTLGQDLKSDISLNIDKIPEKN
Dog         DLDDKQTAKVSIMKD-CYSSSIDDLTERNRSTIKQQLKMTLDQDSKSDITSDIVRKSNGN
Cat         DMDDKQAAKVSITKG-FDSSNIDDLTEKDRNSIKQQLRMTLDQDSKSDITLDSDMKSNGN
Mouse       DVDDAHAAQVLITKDSDSLAVVHDYTEKSRNNIEQHQKGTEDKDFKSNSSLNM--KSDGN

            987                                                      1046
            .*  ::*: : .*: **.* ..*:***********:*::****:******:*** ***::
Human       NDYMNKWAGLLGPISNHSFGGSFRTASNKEIKLSEHNIKKSKMFFKDIEEQYPTSLACVE
Dog         SDYMDNWARLSDPISNHSFENGFKTASNKEIKLSENNIRKSKMLFKDIEEHYPTNLACLE
Cat         NDYMDNWARLSDPILNHNFGNGFRTASNKEIKLSEHNIKKSKMLFKDIEERYPTNLACIE
Mouse       SDCSDKWSEFLDPVLNHNFGGSFRTASNKEIKLSEHNVKKSKMFFKDIEEQYPTRLACID

            1047                                                     1101
            **** .* .*:* *:.     :*:. :*   :..  **. :. . :*  *  *:**.**
Human       IVNTLALDNQKKLSKP-----QSINTVSAHLQSSVVVSDCKNSHITPQMLFSKQDFNSNH
Dog         IVNTSSLESQKKPSKSHALDPQSINIISGFVQNSTYVSDSESGHTAPPTLSLKQDFDSNR
Cat         IVNT-PLESQEKLSKPHILDPQSINTVSGCVQSSAYVSDSENRHTTPPTLSLKRDFDSNH
Mouse       IVNTLPLANQKKLSEPHIFDLKSVTTVSTQSHNQSSVSH-EDTDTAPQMLSSKQDFHSN-

            1102                                                     1161
            ***.*****************************:: * .. *:* :::.: .::.:* :*
Human       NLTPSQKAEITELSTILEESGSQFEFTQFRKPSYILQKSTFEVPENQMTILKTTSEECRD
Dog         NLTPSQKAEITELSTILEESGSQFEFTQFRKPSHIIQKNPFEMPENQLTILNSTSKEWKD
Cat         NLTPSQKAEITELSTILEESGSQFEFTQFRKPSHLKQKNPCEMPEKHLTISNTTPEEQKD
Mouse       NLTTSQKAEITELSTILEESGSQFEFTQFRKPSHIAQ-NTSEVPGNQMVVLSTASKEWKD

            1162                                                     1221
             .*::  :  *:.* * **: **    *:.:. * .  **:.:* . .. **: * ** *
Human       ADLHVIMNAPSIGQVDSSKQFEGTVEIKRKFAGLLKNDCNKSASGYLTDENEVGFRGFYS
Dog         DDLHLTTNAPSISQVD-SKKSEGIIGGKQKFACLSRTSCNRSASGYSTDKNEVEFRGFYS
Cat         GHLRLTINALSISQGDSSKKFEGIIGGKQKLACLSKTSCNKSASGHLTGKNEVEFRGFYS
Mouse       TDLHLPVD-PSVGQTDHSKQFEGSAGVKQSFPHLLEDTCNKNTSCFLPNINEMEFGGFCS

            1222                                                     1280
            * ****.* .***:** *****:** .**.*.:*   .:***  :.** *::: :.  * :
Human       AHGTKLNVSTEALQKAVKLFSDIENISEETSAEVHPISLSSSKCHDSVVSMFKIENHN-D
Dog         ARGTKLNVGSEALQKAKKLFSDLENINEETSVEVD-RSFSSSKYNDSV-SMIQIEDCN-D
Cat         ARGTKLNVCSEALQKAKKLFSDLENISEETSVEVD-RSFSSSKCNGSV-SMFKKENCNNE
Mouse       ALGTKLSVSNEALRKAMKLFSDIEN-SEEPSAKVGPRGFSSSAHHDSVASVFKIKKQNTE

            1281                                                     1339
            *...**..* :: *********  ** . .* * :* ::: .  * : **  :  : ***
Human       KTVSEKNNKCQLILQNNIEMTTGTFVEEITENYKRNTENEDNKYTAASRNSHNL-EFDGS
Dog         KNLNEKNNKCRLILQNNIEMTTDIFVEEYTESYRRNTENEGNQCTDAGRNTCNS-ESDGS
Cat         KKLNEKNNKYRLILQNNIEMTTGIFVAEDTEGYKRNIENKANKYTDASRNVYNFREADGS
Mouse       KSFDEKSSKCQVTLQNNIEMTTCIFVGRNPEKYIKNTKHEDS-YTSSQRNNLE--NSDGS

            1340                                                     1399
             **....* **: :..*   **  .   :   *: :* ******.:**** **: **:*:
Human       DSSKNDTVCIHKDETDLLFTDQHNICLKLSGQFMKEGNTQIKEDLSDLTFLEVAKAQEAC
Dog         DSSKNDTVYIHEEENGLPCIDQHNIDLKLFSQFMKEGNTQIKEGLSDLTCLEVMKAEETS
Cat         DSSKNDTVYIHKEENGLPYIDQHDIDLKLSSQFIKEGNTQIKEGLSDLTCLEVVKAEETL
Mouse       MSSTSGPVYIHKGDSDLP-ADQGSKCPESCTQYAREENTQIKENISDLTCLEIMKAEETC

            1400                                                     1457
              . *:*::*.:    :  *:*:     ***** **  *:: *:**  .:::::   :**
Human       HGNTSNKEQLTATKTEQNIKDFETSDTFFQTASGKNISVAKESFNKIVNFFDQKP--EEL
Dog         HVTMSNKQQLTAN-TGQNIKDFDTFYLSFQTASRKNIRVSRESLNKARSLLNQKWTEEEL
Cat         HVNTSNKEHLTANTMGRITKDFDIFDVSFQTASGKNIRVSRASLNKVTNLLDQKCTEEEL
Mouse       -MKSSDKKQLPSDKMEQNIKEFNIS---FQTASGKNTRVSKESLNKSVNIFNRET--DEL
```

```
               1458                                                    1513
                 :  ****:: .*  .* .   :        .:  ::    * .     * :**.
Human          HNF--SLNSELHSDIRKNKMDILSYEETDIV--KHKILKESVPVGTGNQLVTFQGQPERD
Dog            NNFSDSLNSELLPGIDIKKTDISNHEVIENTERKDKITKESDLIGTENILLILQQRPESK
Cat            NNFADSLNSELLSGIDINKADISHHGEMEIL--KKRQMKESDLTGTENKSLTLQQRPEYE
Mouse          TVISDSLNSKILHGINKDKMHTSCHKKAISI---KKVFEDHFPIVTVSQLPA-QQHPEYE

               1514                                                    1572
                :. **.::*.*******:::* :**********:*  *   : :.** : :*  *  :
Human          -EKIKEPTLLGFHTASGKKVKIAKESLDKVKNLFDEKEQGTSEITSFSHQWAKTLKYREA
Dog            IKKIKESAVLGFHTASGKKIEITKESLDKVKNLFEEKEQDNSEITNFSHRGAKMSKDREE
Cat            IKKIKEPTILGFHTASGKRIEIAKESLDKVKNLFDEQEQDKSEMTNFSHRGTKMSKGREE
Mouse          IESTKEPTLLSFHTASGKKVKIMQESLDKVKNLFDET-QYVRKTASFS-QGSKPLKDSK-

               1573                                                    1630
                :    **  . *:* :.: :* :.       :** *     *:  . :: :****** .
Human          CKD-LELACETIEITAAPKCKEMQNSLNNDKNLVSIETVVP-PKLLSDNLCRQTENLKTS
Dog            CKDGRELACGTTEITTTPEYEETHSSLEK-KKLVSNEIAALRPRLLSDNLYKQTENLKIS
Cat            CEGGLRLACKTIEITPASKEEEMQKPLEK--NLVSNEIVVV-PRLLSDNLYKQTENLKIP
Mouse          -KE-LTLAYEKIEVT-ASKCEEMQN-------FVSKETEML-PQQ-NYHMYRQTENLKTS

               1631                                                    1690
               .    *  *:**  ::. *.*      **.*.. *:*.*::**  .** .* ::*: : :
Human          KSIFLKVKVHENVEKETAKSPATCYTNQSPYSVIENSALAFYTSCSRKTSVSQTSLLEAK
Dog            DHASQKVDVHENTEKETAKKPTM-YTNQSTYSAIENSPLTFYTGHGRKISVSEASLFEAK
Cat            NRASLKVKVHENTGKETAKKPTT-CTNQSTYSATENSALSFYTGHGRKISVSQSSILEVK

               1691                                                    1736
               ****
Human          KWLRE----------GIFDGQPERINTADYVGNYLYENNSNSTIAENDKNHLSEKQ----
Dog            KWLREGEWDDQSERINAAKVNCLKEYPDDYVENPSCGNSSNSAITENDKNHLSEKQ----
Cat            KWLRGGELDDQPEKT---------------------------------------------
Mouse          KWLRE--QGDKLGTRNTIKIECVKEHTEDFAGNASYEHSLVIIRTEIDTNHVSENQVSTL

               1737                                                    1788
                                         ::* * *: :.*:* *.: * ::*     .  .*
Human          --DTYLSNSSMSNSYSY-----HSDEVYNDSGYLSKNKLD-SGIEPVLKNVEDQKNTSFS
Dog            -GSTYLSNSTMSNSYSYHPGFCHSSEVYNKSEYLSRSKIDNSGIEPVIKNIRERKNIGFS
Cat            --------------------------VYNISEYLPKSKVDNSGIEPVVRNVGERENTSVS
Mouse          LSDPNVCHSYLSQSSFC-----HCDDMHNDSGYFLKNKID-SDVPPDMRNAE---GNTIS

               1789                                                    1838
                 :   :: :  **::**  **:.* *. *   :::.**.  : :*.*           :
Human          KVISNVKDANAYPQTVNEDICVEELVTSSSPCKNKNAAIKLSISNSNNF----------E
Dog            EIMSPGREADTDPQSVNEDICVEKLATNSS-CKNKNTAIKVAISDSNNFNTIQKLNSDSN
Cat            EIMFTVREADTDPQSVNEDICVQRLVTNFS-CKKENTAIKVTVSDSNNFDSTQKLNSDSN
Mouse          PRVSATKERNLHPQTINEY-CVQKLETNTSPHANKDVAIDPFLLDSRNC----------K

               1839                                                    1898
                .  .:       .  :::*  :. : .*:.     ::. :.*.        :.  :. *
Human          VGPPAFRIASGKIVCVSHETIKKVKDIFTDSFSKVIKENNENKSKICQTKIMAGCYEALD
Dog            NSVPAYSTVNSKRVFVAHQT--KVTEGFTDNCSMVTKQNTKSKSDTCHAEIVADYPKALD
Cat            DAVPVYTTASSERVLVAHET--KVAEGFTENCSMAIKQTTKSKPGK----IVAGYRKAPD
Mouse          VGSLVF------ITAHSQET-ERTKEIVTDNCYKIVEQNRQSKPDTCQ----TSCHKVLD

               1899                                                    1957
               **:  :  .* .  : .  *:*     :.*:  * **.: *::* :   .  :. :* *
Human          DSEDIL-HNSLDNDECSTHSHKVFADIQSEEILQHNQNMSGLEKVSKISPCDVSLETSDI
Dog            DSEAIF-PNSLGAIECS-PSHKVFADIQSEQTSQLNQSMSGLEKVSETPPCQINSKTSDR
Cat            DSEDTICPNSLDGAECSSPSHKDFAETQSEQTPQLNQSISGFKKRSEIPPHQINLKTSDI
Mouse          DSKDFICPSSSG--DVCINSRKDSFCPHNEQILQHNQSMFGLKKAA---TPPVGLETWDT
```

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                1958                                                        2017
                .: .  :  ::   :.: *********.:*****:::**:***:::..:**   . * ::
Human           CKCSIGKLHKSVSSANTCGIFSTASGKSVQVSDASLQNARQVFSEIEDSTKQVFSKVLFK
Dog             CELPRGKLPKSVSYTNACGIFSTASGKSVQVSDAAIQKAREVFSKLEDSAKQLFPEVSLK
Cat             CKLSTGKRLQSISYTNACGIFSTASGKCVQVSDAALQKARQVFSKVEDSAKQPFSKVSFK
Mouse           SK-SIREPPQAAHPSRTYGIFSTASGKAIQVSDASLEKARQVFSEMDGDAKQLSSMVSLE

                2018                                                        2076
                 ** :..: ...**: : :.: ::           **.**** **.** *.: **:* **
Human           SNE-HSDQLTREENTAIRTPEHLISQKGFSYNVVNSSAFSGFSTASGKQVSILESSLHKV
Dog             DNEEHSEKFTNEENTVIYTSQNLL-----------SSAFSGFRTASGKQVPVSESALCKV
Cat             HNEDHSDKFTREENTMIHTPQNLL-----------SSAFSGFSTASGKQVPVSESALCKV
Mouse           GNE-KPHHSVKRENSVVHSTQGVLSLPKPLPGNVNSSVFSGFSTAGGKLVTVSESALHKV

                2077                                                        2134
                **:****:::***   : *. . ::***: *      :.*::  **:::*: ..: *..
Human           KGVLEEFDLIRTEHSLHYSPTSRQNVSKILP--RVDKRNPEHCVNSEMEKTCSKEFKLSN
Dog             KGMLEEFNLIRTESCLQHSSTSRQDVSKMPPPSCIGKRTPEHSRNSKLDKACNKEFRLSS
Cat             KGILEEFDVMRTECGPQRSPTSRQDVSKMPPPSCVENKTPKHSVNSKLEKAYNKEFKLSS
Mouse           KGMLEEFDLIRTEHTLQHSPIP-EDVSKILPQPCAEIRTPEYPVNSKLQKTYNDKSSLPS

                2135                                                        2193
                * : :.*** * :*::**   **:::::  **: *.* *   :   : * ***: *:*:* :
Human           NLNVEGGSSENNHSIKVSPYLSQFQQDK-QQLVLGTKVSLVENIHVLGKEQASPKNVKME
Dog             NCNNQSGSSENHHSIKVSPCPSQLKRDK-PQLLVGSKGSLVENIHPLGKEQALPKNIKTE
Cat             NSKIENGSSEN-HSVQVSPYPSQFKQDK--QLIQGNKASLVENIHLLEKEQALPKNIKWK
Mouse           NYK-ESGSSGNTQSIEVSLQLSQMERNQDTQLVLGTKVSHSK-ANLLGKEQTLPQNIKVK

                2194                                                        2253
                     *.::*:**:        **:.*******:** *******.****:.   :**   :
Human           IGKTETFSDVPVKTNIEVCSTYSKDSENYFETEAVEIAKAFMEDDELTDSKLPSHATHSL
Dog             IGKAETFPNLPVKTNIEFCSTYSKDPENYFETETVEIAKAFMEDGELTDSELLSHAKHFV
Cat             LETEA-FPNLPLKTDTAIHSTDSKDPENYFETETVEIAKAFMEDGELTDADLLSHARHFL

                2254                                                        2313
                 ** ..:   : ***   ** *   :   **:*.***.*****.***:.: .**..*******
Human           FTCPENEEMVLSNSRIGKRRGEPLILVGEPSIKRNLLNEFDRIIENQEKSLKASKSTPDG
Dog             FTCQNTKEMVLLNSRIGKRRGDALVSVGEPPIKRNLLNEFGRIIKNQETSLKASKSTPDG
Cat             PTCQHSEETLVSNSRRGKRRGV-LVSVGEPPIKRNLLNEFDRIIKNQEKSLKASKSTPDG
Mouse           FTCPQNE--TLFNSRTRKRGGVTVDAVGQPPIKRSLLNEFDRIIESKGKSLTPSKSTPDG

                2314                                                        2373
                 :*** ** **:****::* ** ::::**   *.*::*:*.*::*.*.* :.* : ***.*
Human           TIKDRRLFMHHVSLEPITCVPFRTTKERQEIQNPNFTAPGQEFLSKSHLYEHLTLEKSSS
Dog             ILKDRSLFMHHISLEPISCGPFRTTEERQEIQNPNFTAPGQEFLPKSHFYEHLASEKSSS
Cat             IIKDRSLFMHHISLEPVTCGPFSTTKKRQEIQNPNFTAPGQKFLSKSHFYEHLALEKSSS
Mouse           TVKDRSLFTHHMSLEPVTCGPFCSSKERQGAQRPHLTSPAQELLSKGHPWRHSALEKSPS

                2374                                                        2432
                .  :*  *   *.** .*:  *    ..:..******** **:*    *:    :* ::* :.
Human           NLAVSGHPFYQVSATRNEKMRHLITTGRPTKVFVPPFKTKSHFHRVEQCV-RNINLEENR
Dog             NLSVSRQPFCMVPATGNEKRRHLIAPGKPVKVFVPPFKTKSHFHRDEQCISKNTKLEKNK
Cat             NVSISGQPFCTVPATRSEKRGHSITPSKPVKVFVPPFKTKSRFLQDEQHISKNTHVEENK
Mouse           SPIVSILPAHDVSATRTERTRH---SGKSTKVFVPPFKMKSQFHGDEHFNSKNVNLEGKN

                2433                                                        2491
                *:       .:....:. *:. ::*::*                    **::.**.***:*
Human           QK-QNIDGHGSDDSKNKINDNEIHQFNKNNSNQAAAVTFTKCEEEPLDLITSLQNARDIQ
Dog             QNSKDIDELGSGDSEKNINDSGIHQLKKNNSNQAATIIFTKNEKEPLDLITNLQNARDIQ
Cat             QKPNNIDEHSSGDSKNNINNSEIHQLNKNNSSQAATMVFTKCEKEPLDLIASLQNARDIQ
Mouse           QK-------STDGDREDGNDSHVRQFNK-------------------DLMSSLQSARDLQ
```

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                  2492                                                        2551
                  ****::*.::::  *****:*:*:**:*****: ** .:.***** **** *****.*::
Human             DMRIKKKQRQRVFPQPGSLYLAKTSTLPRISLKAAVGGQVPSACSHKQLYTYGVSKHCIK
Dog               DMRIKKKQRQHIFPQPGSLYLAKTSTLPRISLREAVEGRVPSACSHKQLYMYGVSKHCVK
Cat               DMRIREKRKQHIFPQPGSLFLAKTSTVPRISLRVAVEGRVPSACSHKQLYMYGVSKHCVK
Mouse             DMRIKNKERRHLRLQPGSLYLTKSSTLPRISLQAAVGDRAPSACSPKQLYIYGVSKECIN

                  2552                                                        2611
                  :****** ***. :*:****    : :*:**.************ ***************
Human             INSKNAESFQFHTEDYFGKESLWTGKGIQLADGGWLIPSNDGKAGKEEFYRALCDTPGVD
Dog               INSKNAESFQFHAQDYFGKEGLWSGEGIQLPDGGWLIPSNDGKIGKEEFYRALCDTPGVD
Cat               INSKNAESFQFHTQDYFGKEVQWAKEGIQLADGGWLIPSNDGKAGKEEFYRALCDTPGVD
Mouse             VNSKNAEYFQFDIQDHFGKEDLCAGKGFQLADGGWLIPSNDGKAGKEEFYRALCDTPGVD

                  2612                                                        2671
                  *: ** :** ******:******* ***********.*********** * ***.*:***
Human             PKLISRIWVYNHYRWIIWKLAAMECAFPKEFANRCLSPERVLLQLKYRYDTEIDRSRRSA
Dog               PNCISRVWVYNHYRWIIWKLAAMEFAFPKEFANRCLSPERVLLQLKYRCDVEIDKSRRSA
Cat               PNLISRIWVYNHYRWIIWKLAAMEFAFPKEFANRCLSPERVLLQLKYRYDMEIDRSKRSA
Mouse             PKLISSIWVANHYRWIVWKLAAMEFAFPKEFANRCLNPERVLLQLKYRYDVEIDNSRRSA


                  2672                                                        2731
                  :***:*************:*: ** *:.:****..***. .:::*  : *******::**
Human             IKKIMERDDTAAKTLVLCVSDIISLSANISETSSNKTSSADTQKVAIIELTDGWYAVKAQ
Dog               IKKIMERDDTAAKTLVLCISEIISSSADISETSSSKTSSVGTKKVGIIALTDGWYAIKAQ
Cat               IKKIMERDDTAAKTLVLCISETISSSTDLSETSGSKTSGVGTKNVGIVELTDGWYAIKAQ
Mouse             LKKILERDDTAAKTLVLCISDIISPSTKVSETSGGKTSGEDANKVDTIELTDGWYAVRAQ

                  2732                                                        2791
                  *****:*::*.*:****:**  :****.******:*****:** *********** *:::
Human             LDPPLLAVLKNGRLTVGQKIILHGAELVGSPDACTPLEAPESLMLKISANSTRPARWYTK
Dog               LDPPLLALVKNGRLTVGQKITIHGAELVGSPDACTPLEAPESLMLKISANSTRPACWYTK
Cat               LDPPLLALVKKGRLTVGHKIIIHGAELAGSPDACTPLEAPESLILKISANSTRPACWYAK
Mouse             LDPPLMALVKSGKLTVGQKIITQGAELVGSPDACAPLEAPDSLRLKISANSTRPARWHSR

                  2792                                                        2851
                  ***  ***********:***********:::**.**:**:*:* *** ***.*****:**
Human             LGFFPDPRPFPLPLSSLFSDGGNVGCVDVIIQRAYPIQWMEKTSSGLYIFRNEREEEKEA
Dog               LGFSPDPRPFPLPLSSLFSDGGNVGCVDVVVQRAYPIQWMERTPSGLCIFRNEREEEKEA
Cat               LGFFPDPRPFPLPLSSLFSDGGNVGCVDVVIQRTYPIQWMEKTPSGLCIFRNEREEEREA

                  2852                                                        2911
                   ::.* ***:**.**.*:: **:.::*: *:  :   :*****: ********* **  *
Human             AKYVEAQQKRLEALFTKIQEEFEEHEENTTKPYLPSRALTRQQVRALQDGAELYEAVKNA
Dog               TKYAEIQQKKLEVLFNKIQAEFEKNDENITKQCIPSCALTRQQICALQDGAELYEAVTNA
Cat               TKYAEAQQKKLEVLFNKIQAEFEKHDENITKRCVPLRALTRQQVCALQDGAELYEAVKNA
Mouse             LRFAEAQQKKLEALFTKVHTEFKDHEEDTTQRCVLSRTLTRQQVHALQDGAELYAAVQYA

                  2912                                                        2971
                  .**  **. *****:*****:**********:** *::**:****: *  *.********
Human             ADPAYLEGYFSEEQLRALNNHRQMLNDKKQAQIQLEIRKAMESAEQKEQGLSRDVTTVWK
Dog               PDPSDLEGYFSEEQLRALNNHRQMLNDKKQAQIQLEFKKAMESAEQGEQILPRDVTTVWK
Cat               PDPASLEAYFSEEQIRALNNHRQMLNDKKQAQIQLEFRKAMESAEQGEQMLPRDVTTVWK
Mouse             SDPDHLEACFSEEQLRALNNYRQMLNDKKQARIQSEFRKALESAEKEE-GLSRDVTTVWK

                  2972                                                        3031
                  :*: ** **** *. * *****.** *** ******** **.*:****  :.  **:***
Human             LRIVSYSKKEKDSVILSIWRPSSDLYSLLTEGKRYRIYHLATSKSKSKSERANIQLAATK
Dog               LRIISYRKKEKDSVTLSIWRPSPDLYSLLIEGKRYRIYHLAASQSKSKSGKANTQLTATK
Cat               MRIISYGKKEKDSVTLSIWRPSSDLYSLLTEGKRYRIYHLATSQSKSKSERAHIQLTATK
Mouse             LRVTSYKKKEK-SALLIIWRPSSDLSSLLTEGKRYRIYLLAVSKSKSKFERPSIQLTATK
```

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                 3032                                                   3091
                 :*******.*.* * *:*****.*:*.:: ** ***.*****::*.******  *:**.*
Human            KTQYQQLPVSDEILFQIYQPREPLHFSKFLDPDFQPSCSEVDLIGFVVSVVKKTGLAPFV
Dog              KTQYQQLPASDEILSQVYQPREPLYFNKLLDPDFQPPCSEVDLIGFVVSVVKKIGLAPVV
Cat              KTQYQQLPASDELLFQVYQPREPLYFNKLLDPDFQPPCSEVDLIGFVVSVVKKIGFAPLV
Mouse            RTQYQQLPVSSETLLQVYQPRESLHFSRLSDPAFQPPCSEVDVVGVVVSVVKPIGLAPLV

                 3092                                                   3151
                 ****** ***.:*.   *:**** **  ******** :**:.**: *****.** ******
Human            YLSDECYNLLAIKFWIDLNEDIIKPHMLIAASNLQWRPESKSGLLTLFAGDFSVFSASPK
Dog              YLSDECHNLLAIKFWTDFNEDIIKPYTLIAASNLQWRPEAKSGIPTLFAGDFSRFSASPK
Cat              YLSDECHNLLAIKVWTDLNEDIVKPHTLIAASNLQWRPESKSGIPTLFAGDFSRFSASPK
Mouse            YLSDECLNLLVVKFGIDLNEDI-KPRVLIAASNLQCQPESTSGVPTLFAGHFSIFSASPK

                3152                                                 3206
                 * :***..:::*:::**:   : ::**:**:*:*..:.** *** ** :  *::      .
Human            EGHFQETFNKMKNTVENIDILCNEAENKLMHILHANDPKWSTPTKDCTSGPYT-----AQ
Dog              EEHFQETFHKMKNTVENIGMFYNDAENKLVHILNANDPKLSTPTKDYASEPHT-----AQ
Cat              EGHFQETFHKMKNTIENVETFCNDAENKLVHILNANSPKVSTPMKDYASEPHT-----IQ
Mouse            EAYFQEKVNNLKHAIENIDTFYKEAEKKLIHVLEGDSPKWSTPNKDPTREPHAASTCCAS

                 3207                                                   3265
                  : * *.::    **. :   ****** *   * **:. . *:**::**   . *.*:** *.*
Human            IIPGTGNKLLMSSPNCEIYYQSPLSLCMAKRKSVSTPVSAQMTSKS-CKGEKEIDDQKNC
Dog              IVLGIGNKFLMSSPNNEMNYQSPLSLCKPKEKSVPIPGSTQMTSKSYCKEEKEMDDPKTC
Cat              TVLGLGNKLSMSSPNSEMNYQSPLSLCKPKAKSVPTPGSAQMTSKSCYKGERELDDPKTC
Mouse            DLLGSGGQFLRISPTGQQSYQSPLSHCTLKGKSMPLAHSAQMAAKS-WSGENEIDDPKTC

                 3266                                                   3324
                 :**:*******:***..**************.*********** * : ::: .**:  **
Human            KKRRALDFLSRLPLPPPVSPICTFVSPAAQKAFQPPRSCGTKYETPIKKKELNSPQM-TP
Dog              KKRRALDFLSRVPLPPSVSPICTFVSPAAQKAFQPPRSCGTKYETLM-KKELNSPQM-TP
Cat              KKRKALDFLSRLPLPPPVSPICTFVSPAAQKAFQPPRSCGTKYETPI-RRELNSPQM-TP
Mouse            RKRRALDFLSRLPLPSPVSPICTFVSPAAQKGFQPPRSCGTKYATPI-KKKPSSPRRKTP

                 3325                                                   3384
                   * .  ** :.:*:******::.****   .  * .:    .:*.*.. .:..
Human            FKKFNEISLLESNSIADEELALINTQALLSGSTGEKQFISVSESTRTAPTSSEDYLRLKR
Dog              -RKFNDLSLLESDSIADEELAMINTQALLLGSPGEHQLVSVSDSTRTAPTSSKDYLGLKR
Cat              -LKFNDTSLVESDSIADEELALINTQALLSGLAGEDQLMSLNDSPRTAPTSSKDYVRPKS
Mouse            FQKTSGVSLPDCDSVADEELALLSTQALTPDSVGGNEQAFPGDSTRNPQPAQRPDQQVGP

                 3385                                                   3418
                      ::  .. .: .   *
Human            RCTTSLIKEQESSQASTEECEKNKQDTITTKKYI--------------------------
Dog              HSTAPGVRGPESPQACTRKREPRVQNTSDLKRTISETAEATNTKMTMNW-----------
Cat              YPTAPGIRDCENPQASTEGGEPDVQDTDTVKRSSMRLQRRQQQT----------------
Mouse            RSRKESLRDCRGDSSEKLAVES--------------------------------------
```

Appendix I: Mammalian full-length BRCA2 amino acid alignment and conservation

Marks above the human residues represent identical (*), weakly conservative (.), and strongly conservative (:) sites [40]. The opossum sequence is not complete; therefore, long stretches of gaps are likely the result of incomplete sequence and not evolutionary divergence.

```
            1                                                         60
                                       ************  ****** * .*:.  *   ** :
Human       MPIGSKERPTFFEIFKTRCNKADLGPISLNWFEELSSEAPPYNSEPAEESEHKNNNYEPN
Cat         MPIGCKERPTFFEIFRTRCNKADLGPISLNWFEELCLEAPPYNSEPTEESGYKIS-YEPN
Dog         MPVGCKERPTFFEIFKTRCNQADLGPISLNWFEELSLEAPPYNSEPTEESGYKIS-YEPN
Mouse       MPVEYKRRPTFWEIFKARCSTADLGPISLNWFEELSSEAPPYNFEPPEESEYKPHGYEPQ
Opossum     -----------------------LGPISLNWFEELTSEAPPYNYEISEDPGSKT-NYEVN

            61                                                       119
             ******:*  :*:****::*:*     .: . **.          *:  ....  ::
Human       LFKTPQRKPSYNQLASTPIIFKEQGLTLPLYQ-SPVKELDKFKLDLGRNVPNSRHKSLRT
Cat         LFKTPQRKP-CHQLASTPIIFKEQGLIPPIYQQSPLKEL-------GKDITNSKHRSCCT
Dog         LFKTPQRKP-YNQLASTPIVFRE-----PIYQQSPLKELDKYRLDSGKDITDSKHKSCCT
Mouse       LFKTPQRNPPYHQFASTPIMFKERSQTLPLDQ-SPFREL-------GKVVASSKHKTHSK
Opossum     YFKTPQRKPSYNQLASTPLIFKEQNVNCSLNS-SPLSGPDHCKLDLGKDTANKELKSHCV

            120                                                      179
             *:*:. . **:.* *.: *****  *: :  . **:*.*. *.*::**:: :   . :
Human       VKTKMDQADDVSCPLLNSCLSESPVVLQCTHVTPQRDKSVVCGSLFHTPKFVKGRQTPKH
Cat         MKSKMDQTNDVTSPPLNSCLSESPL-LRSTHVTPQREKSVVCGSLFHTPKLTKG-QTPKR
Dog         MKSKMDRANDVTSPPLNSYLSESPV-LRCTHVTPQREKSVVCGSLFHTPRLMKG-QTPKR
Mouse       KKTKVDPVVDVASPPLKSCLSESPLTLRCTQAVLQREKPVVSGSLFYTPKLKEG-QTPKP
Opossum     LKTKLGQANDVTSPPLSTCLSESPAVLRGAYRTPQREKPVAYGNLLYTPKLMKFQTPKHI

            180                                                      219
             ..  .         :*  :.*.  *                     .::
Human       ISESLGAEVDPDMSWSSSLATPPTLSS--------------------TVLIVRNEEASET
Cat         ISESLGAEVDPDMSWSSSLATPPTLSS--------------------TVLIVRDEEASAA
Dog         ISESLGAEVDSDMSWSSSLATPPTLSSRISESLGAEVDSDMSWSSSLTVLIVRDEEVSAA
Mouse       ISESLGVEVDPDMSWTSSLATPPTLSS--------------------TVLIARDEEARSS
Opossum     SESLGAEVDPDMSWSSSLATPPTLSS--------------------TVLID---------

            220                                                      278
                      *    : :.. : :    .    .:   :  * ..      ..     *
Human       VFPHDTTANVKSYFSNHDESLKKNDRFIASVTDSENTNQREAASHGFGKTSGNSF-KVNS
Cat         VFPNDTTAIFKSYFCNHDESLKKNDRFIPSGPDSENKSQREAKSQGLGKMVGNSCDKVNS
Dog         VFPNDTTAIFKSCFSNHDESLKKNDRFIPCGPGKENKNQREAKSQSL----GNSFGKVNS
Mouse       VTPADSPATLKSCFSNHNESPQKNDRSVPSVIDSENKNQQEAFSQGLGKMLGDSSGKRNS
Opossum     --------LQKYLSQHGERPKRLDRSTSSVPNIENIHAEGYASQELEKMIDDSF-DGNNF

            279                                                      337
             ..        : *           *  *:          .  :     . :*
Human       CKDHIGKSMPNVLEDEVYETVVDTSEE-DSFSLCFSKCRTKNLQKVRTSKTRKKIFHEAN
Cat         CKDPFGNSTLNVLEDGVRERVADVSEE-DSFPLCVPKCKTRNLQKIKTSKTRKNIFNET-
Dog         TKDHFVKSTPNVLEGEVHEKVLDVSEEEDSFSLCVPKYKTRNLQKIKTSKTRKNIFNETK
Mouse       FKDCLRKPIPNILEDG--ETAVDTSEE-DSFSLCFPKRRTRNLQKMRMGKTRKKIFSETR
Opossum     KDHGGKMMPNIMEEEICDPIINTPVE-DDASFNFTGYIVGNLRKVKCDKTRKKYS-KTKT

            338                                                      395
             .   .  ..  .    *       .    :.     :.      : : .:   .
Human       ADE-CEKSKNQVKE-KYSFVSEVEPNDTDPLDSNVAHQKPFESGSDKISKEVVPSLACEW
Cat         TDE-CKEAKKQMKENKHSFVSEMEANASDPLDSNVTNQKPFGNGSDKISKEVVLSSASES
Dog         TSE-CEEAKKQMKENKHSLVSEMEPNDSHPLDWNVTHEKPFGNGTDKISKEIVLSSASGC
Mouse       TDELSEEARRQPDD-KNSFVFEMELRESDPLDPGVTSQKPFYSQNEEICNEAVQCSDSRW
Opossum     NE-YEDTKNQVKE-NYSSASETEL-NTDPLISKAENQKSIKNVNEEMLEDDVPSSATQWS
```

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                396                                                     454
                     .        .         .:  .: : :  . .     :
Human           SQLTLSGLNGAQMEKIPLLHISSCDQNISEKDLLDTENKRKKDFLTSENSLPRISSLPK-
Cat             CHLTLSGLNGTHMEKLPLLCISSCDQNNSEKDLITTEKECTN-FIILEDSLPQISGVPKC
Dog             SDLTLSSLNGAQMEKTPLLHTS-YDQNNSEKDLIITDKECTN-FITLENSWPQISNVPKY
Mouse           SQSNLSGLNETQTGKITLPHISSHSQNISE-DFIDMKKEGTG-SITSEKSLPHISSLPE-
Opossum         QLNLSGLDVTQIEKTPLPHISFCVQN-SEKDQQMKAKCSSL-STLK--------------

                455                                                     514
                    ..     :. .:    :.        :     :.  *      ...:   : . .
Human           SEKPLNEETVVNKRDEEQHLESHTDCILAVKQAISGTSPVASSFQGIKKSIFRIRESPKE
Cat             TEKILNEEIVVNKIDEGQCLESHEDSILAVKQAVFETSLIASPLQGIRKSIFRIRESPEE
Dog             SEKTLNEEIVVNKINEGQCLESHEDSVVSVKQAIYETTLIASPLQGIRKSIFRIRESPEG
Mouse           PEKMFSEETVVDKEHEGQHFESLEDSI-AGKQMVSRTSQAACLSPSIRKSIFKMREPLDE
Opossum         ---TVEIAAYKEDEEKITTPNKGSVM-LLKQISPEISPPNAISQDRKNSKFKMRQTSEET

                 515                                                      574
                     :.  :. .    * :.    *     *.::.. :...  . ** .:. . .*..:
Human           TFNASFSGHMTDPNFKKETEASESGLEIHTVCSQKEDSLCPNLIDNGSWPATTTQNSVAL
Cat             TFSAVFSNNITDPNFKEEHEASESVLEKHSICSQKEDSLSTSSLDNGSWPATIKHTSVAL
Dog             MSNAMFSNNMTNPNFK-EPEASESGLEKHTICSQKEDSLCTSSIDDGSWPATIKHTSVAL
Mouse           TLGTVFSDSMTNSTFTEEHEASACGLGILTACSQREDSICPSSVDTGSWPTTLTDTSATV
Opossum         VSMDFLDCTVNASIT-TEAKVFENKLENHIICPEKHGLLSPNTDGKGSCATVSKRNSAPL

                575                                                     633
                :. *:** :*:: .. :     *.:        ...   :   *     .  *
Human           KNAGLISTLKKK-TNKFIYAIHDETFYKGKKIPKDQKSELINCSAQFEANAFEAPLTFAN
Cat             KNSGLISTLKKK-TKKFIYVVNDETSYQGLKTQKDQQSGLMNYSAQFEANVLEGPLTFAN
Dog             KNLGLISSLKKK-TKKFIYVINDETSNQGLKTQKDQESRLINLSTQFEANAFEGPLTFTN
Mouse           KNAGLISTLKNK-KRKFIYSVSDDASLQGKKLQTHRQLELTNLSAQLEASAFEVPLTFTN
Opossum         NSTGIISHFKKRTKKFIYVVNNDSSYQGEKIQKTQEFGSVNCSSHLELNSFEEHHEFTNA

                634                                                     689
                 .. :  *   :: .  :  ::.      .                   .   .:    :
Human           ADSGLLHSS-VKRSCSQNDSEEPTLSLTSSFGTILRK--CSRNETCS-NNTVISQDLDYK
Cat             ADSGLLHSS-VKKTCLQNDSKEPILSLTNSFGTLLRK--VSNKGSSSPNNKIISQDLDYK
Dog             ADSGLLHSSSIKKNCLQNDSEKPALSLTSSFGTILRK--VSSNGASSPNNKIISQDPDYK
Mouse           VNSGIPDSS-DKKRCLPNDPEEP--SLTNSFGTATSK----EISY---IHALISQDLNDK
Opossum         ISDFLDSS-IRRKCSQFDPKEETAPLTECDKTMMEE--YFHESRFP-HNEVTSQDLGFRE

                690                                                     748
                      :  .   :   :   .  .   : . :.      :  :  :        .
Human           EAKCNKEKLQLFITPEADSLSCLQEGQCENDPKSKKVSDIKEEVLAAACHP-VQHSKVEY
Cat             EAKIKKEKLQSFISTETNCLSSLQEKHCEDDTKSQRVADRKEEILPAVSQPSVPYSEVED
Dog             EAKINKKKLESFITTETDCLSSLQEKHWEDDAKKQRVSDIKEKVLPTVSHPPVPHSEVEG
Mouse           EAIVIEEKPQPYTAREADFLLCLPERTCENDQKSPKVSNGKEKVLVSACLP----SAVQL
Opossum         VEMNKGELESDI-TETDNQSQSQERSYNDFSKRQRDSHVKECILTATCPP-RKHTEIELG

                749                                                     808
                .     . ..   . : :              .    .:        .  : :. .
Human           SDTDFQSQKSLLYDHENASTLILTPTSKDVLSNLVMISRGKESYKMSDKLKGNNYESDVE
Cat             SGIHFQTLKSFSSDPDKSS--QLTPHPRDPPSNPVGLSRGRESYEVSETLKCKNHEAGFE
Dog             SDIHFQSPESFSFDCDNTS--LLTPSSRDSPSSLVVMSRGKESYKISEKLKCKNHETGFE
Mouse           SSISFESQENPLGDHNGTSTLKLTPSSKLPLSKADMVSREK-MCKMPEKLQCESCKVNIE
Opossum         NIDFTTKNSTLHDSVDTSINSLTQLPQDPQELSVVIYGKKGLCKVKQKLRRRNSDSKVEL
```

```
               809                                                        868
                 .     .     .   .   * .        .        ::   :  ::.::: .
Human          LTKNIPMEKNQDVCALNENYKNVELLPPEKYMRVASPSRKVQFNQNTNLRVIQKNQEETT
Cat            LTKT--MENSQEIHVLNEHAKKAKLLSTEKYVTEASPSMKVPFNQNAHLTIIQKDQKETT
Dog            LTKNIPMEKNQDIHVLNADSKNAKLLSTEKHITVASSSVKVQFNQNANLTTIQKDQKETT
Mouse          LSKNI-LEVN-EICILSENSKTPGLLPPGENIIEVASSMKSQFNQNAKI-VIQKDQKGSP
Opossum        KESFGNKGNQETEVLNEILGDDRELSSEKCKEMTSVSLGAQVNKNAGLFVSLRDQENTNL

               869                                                        928
                 .     ..*:*. :   * :   : ::      ..   :        .    :.
Human          SISKITVNPDSEELFSDNENNFVFQVANERNNLALGNTKELHETDLTCVNEPIFKNSTMV
Cat            LISKITMNPNSEELFPDGDN-FVFKITKERNVPVLGSIKELQDSDLCCVKEPVLENSTMV
Dog            LISKITVNPNSEELFPDDENNFVLKITNESNTPVLGNTKELHDSNLCCVRDSVPKNSTMV
Mouse          FISEVAVNMNSEELFPDSGNNFAFQVTNKCNKPDLGSSVELQEEDLSHTQGPSLKNSPMA
Opossum        ITKTAIELYSEEDLHFNEENFIFQTIDKKNIRVTDSSEEFFATSFCYLEESIPKNS----

               929                                                   983
                   .  . :: :  .             :  .  .  ::        .. ...
Human          LYGDTGDKQATQVSIKKD-----LVYVLAEENKNSVKQHIKMTLGQDLKSDISLNIDKIP
Cat            VYTDMDDKQAAKVSITKG-FDSSNIDDLTEKDRNSIKQQLRMTLDQDSKSDITLDSDMKS
Dog            VCTDLDDKQTAKVSIMKD-CYSSSIDDLTERNRSTIKQQLKMTLDQDSKSDITSDIVRKS
Mouse          VDEDVDDAHAAQVLITKDSDSLAVVHDYTEKSRNNIEQHQKGTEDKDFKSNSSLNM--KS
Opossum        -TEIDYKQTVQELFMED-----LVPVFTRDSQDK-NQNSKLAQSKSSYSKSTIDTNMKPK

               984                                                       1043
                :.    .     :       :      .    ::.:: *   ..:  : . :: .  :   .:  :
Human          EKNNDYMNKWAGLLGPISNHSFGGSFRTASNKEIKLSEHNIKKSKMFFKDIEEQYPTSLA
Cat            NGNNDYMDNWARLSDPILNHNFGNGFRTASNKEIKLSEHNIKKSKMLFKDIEERYPTNLA
Dog            NGNSDYMDNWARLSDPISNHSFENGFKTASNKEIKLSENNIRKSKMLFKDIEEHYPTNLA
Mouse          DGNSDCSDKWSEFLDPVLNHNFGGSFRTASNKEIKLSEHNVKKSKMFFKDIEEQYPTRLA
Opossum        RNEDYLGKWAQNFDPDSNKSFGCGFKTASNKEIILSEHNIKKGKLFFKDIEQYYNSS--S

               1044                                                      1098
                 :  .   .  .::: ..        .  :     .    :        ..   .       . *:.
Human          CVEIVNTLALDNQKKLSKP-----QSINTVSAHLQSSVVVSDCKNSHITPQMLFSKQDFN
Cat            CIEIVNT-PLESQEKLSKPHILDPQSINTVSGCVQSSAYVSDSENRHTTPPTLSLKRDFD
Dog            CLEIVNTSSLESQKKPSKSHALDPQSINIISGFVQNSTYVSDSESGHTAPPTLSLKQDFD
Mouse          CIDIVNTLPLANQKKLSEPHIFDLKSVTTVSTQSHNQSSVSH-EDTDTAPQMLSSKQDFH
Opossum        VEVVNSLASDSKKQEKNS-----PSHIISKDVQSNIFVLNEKEIDPALEDLCSEKDLDLN

               1099                                                      1158
                . . : . :      .         *   :*   : :..:          .       .    .
Human          SNHNLTPSQKAEITELSTILEESGSQFEFTQFRKPSYILQKSTFEVPENQMTILKTTSEE
Cat            SNHNLTPSQKAEITELSTILEESGSQFEFTQFRKPSHLKQKNPCEMPEKHLTISNTTPEE
Dog            SNRNLTPSQKAEITELSTILEESGSQFEFTQFRKPSHIIQKNPFEMPENQLTILNSTSKE
Mouse          SN-NLTTSQKAEITELSTILEESGSQFEFTQFRKPSHIAQ-NTSEVPGNQMVVLSTASKE
Opossum        HSLTASQKAEITELSTILEETGSQFEFTQFRKQSSTVQ--TLDISTNQMSNLN-TFE-CR

               1159                                                      1218
                 :  : :       : : ..:       :          .    . .:. .   .    .
Human          CRDADLHVIMNAPSIGQVDSSKQFEGTVEIKRKFAGLLKNDCNKSASGYLTDENEVGFRG
Cat            QKDGHLRLTINALSISQGDSSKKFEGIIGGKQKLACLSKTSCNKSASGHLTGKNEVEFRG
Dog            WKDDDLHLTTNAPSISQVD-SKKSEGIIGGKQKFACLSRTSCNRSASGYSTDKNEVEFRG
Mouse          WKDTDLHLPVD-PSVGQTDHSKQFEGSAGVKQSFPHLLEDTCNKNTSCFLPNINEMEFGG
Opossum        GVELGVILNNRSPVQVDLNVNSEVVINVKQRTVYLPKSNSEQGASTDIFTESE--FKGFC

               1219                                                      1277
                 .   ::.               :  .  .  ...        :. *          :
Human          FYSAHGTKLNVSTEALQKAVKLFSDIENISEETSAEVHPISLSSSKCHDSVVSMFKIENH
Cat            FYSARGTKLNVCSEALQKAKKLFSDLENISEETSVEVD-RSFSSSKCNGSV-SMFKKENC
Dog            FYSARGTKLNVGSEALQKAKKLFSDLENINEETSVEVD-RSFSSSKYNDSV-SMIQIEDC
Mouse          FCSALGTKLSVSNEALRKAMKLFSDIEN-SEEPSAKVGPRGFSSSAHHDSVASVFKIKKQ
Opossum        SALGRKMNVSNEALQKAMKLFSDIEEIGEGTSAKS--RNGPLDRSQKSIVPAFKIANYA-
```

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                 1278                                                    1336
                 *   . .          : : :                : ::.    :    .
Human            N-DKTVSEKNNKCQLILQNNIEMTTGTFVEEITENYKRNTENEDNKYTAASRNSHNL-EF
Cat              NNEKKLNEKNNKYRLILQNNIEMTTGIFVAEDTEGYKRNIENKANKYTDASRNVYNFREA
Dog              N-DKNLNEKNNKCRLILQNNIEMTTDIFVEEYTESYRRNTENEGNQCTDAGRNTCNS-ES
Mouse            NTEKSFDEKSSKCQVTLQNNIEMTTCIFVGRNPEKYIKNTKHEDS-YTSSQRNNLE--NS
Opossum          NKILKEKML-----PQSNAENNTGIFVEENMLNCSRDPENKQSRFISSHKDSSKL-GSVE

                 1337                                                    1396
                  .*          .: : .    ::     .      .:  .:      :       :
Human            DGSDSSKNDTVCIHKDETDLLFTDQHNICLKLSGQFMKEGNTQIKEDLSDLTFLEVAKAQ
Cat              DGSDSSKNDTVYIHKEENGLPYIDQHDIDLKLSSQFIKEGNTQIKEGLSDLTCLEVVKAE
Dog              DGSDSSKNDTVYIHEEENGLPCIDQHNIDLKLFSQFMKEGNTQIKEGLSDLTCLEVMKAE
Mouse            DGSMSSTSGPVYIHKGDSDLP-ADQGSKCPESCTQYAREENTQIKENISDLTCLEIMKAE
Opossum          PDSD-----NSQREKNDLSSIDQQN-YPKMSIQLIRQENYPVKGGLLDLNCLEAVKDEKI

                 1397                                                    1454
                      . ::            :: .       :.          *        :
Human            EACHGNTSNKEQLTATKTEQNIKDFETSDTFFQTASGKNISVAKESFNKIVNFFDQKP--
Cat              ETLHVNTSNKEHLTANTMGRITKDFDIFDVSFQTASGKNIRVSRASLNKVTNLLDQKCTE
Dog              ETSHVTMSNKQQLTAN-TGQNIKDFDTFYLSFQTASRKNIRVSRESLNKARSLLNQKWTE
Mouse            ETC-MKSSDKKQLPSDKMEQNIKEFNI---SFQTASGKNTRVSKESLNKSVNIFNRET--
Opossum          F---ASNIEELVSNQEEQKMRENENSSHLFQTASGRNIMVSKDSFSKVAHLFAEEL--KE

                 1455                                                    1510
                  :      . :         .                .          .         :
Human            EELHNF--SLNSELHSDIRKNKMDILSYEETDIV--KHKILKESVPVGTGNQLVTFQGQP
Cat              EELNNFADSLNSELLSGIDINKADISHHGEMEIL--KKRQMKESDLTGTENKSLTLQQRP
Dog              EELNNFSDSLNSELLPGIDIKKTDISNHEVIENTERKDKITKESDLIGTENILLILQQRP
Mouse            DELTVISDSLNSKILHGINKDKMHTSCHKKAISI---KKVFEDHFPIVTVSQLPA-QQHP
Opossum          LNDF--SLNAKYCS----NKSVESSGKKSENL--AENEIEEMA-VATKKELMPIQKGPKI

                 1511                                                    1569
                 : .  .  : . :   :..   :.  . :  *   : :.         .         :
Human            ERD-EKIKEPTLLGFHTASGKKVKIAKESLDKVKNLFDEKEQGTSEITSFSHQWAKTLKY
Cat              EYEIKKIKEPTILGFHTASGKRIEIAKESLDKVKNLFDEQEQDKSEMTNFSHRGTKMSKG
Dog              ESKIKKIKESAVLGFHTASGKKIEITKESLDKVKNLFEEKEQDNSEITNFSHRGAKMSKD
Mouse            EYEIESTKEPTLLSFHTASGKKVKIMQESLDKVKNLFDET-QYVRKTASFS-QGSKPLKD
Opossum          D-KKWKEYNMVGFHTASGKEVTISKESLTKVKHFFVEESLE-NDVTNIKNLETEFLNERE

                 1570                                                    1627
                  :           . : . : :  :  .        *                     :
Human            REACKD-LELACETIEITAAPKCKEMQNSLNNDKNLVSIETVVP-PKLLSDNLCRQTENL
Cat              REECEGGLRLACKTIEITPASKEEEMQKPLEK--NLVSNEIVVV-PRLLSDNLYKQTENL
Dog              REECKDGRELACGTTEITTTPEYEETHSSLEK-KKLVSNEIAALRPRLLSDNLYKQTENL
Mouse            SK--KE-LTLAYEKIEVT-ASKCEEMQN-------FVSKETEML-PQQ-NYHMYRQTENL
Opossum          INEK-LVQAYEMVKLNNSQVCEEMQSFQDNDEKVLPVRTTDL-PKI-----------LIV

                 1628                                                    1687
                            :::*  :             .     ..  :      .   .  .
Human            KTSKSIFLKVKVHENVEKETAKSPATCYTNQSPYSVIENSALAFYTSCSRKTSVSQTSLL
Cat              KIPNRASLKVKVHENTGKETAKKPTT-CTNQSTYSATENSALSFYTGHGRKISVSQSSIL
Dog              KISDHASQKVDVHENTEKETAKKPTM-YTNQSTYSAIENSPLTFYTGHGRKISVSEASLF
Mouse            KTSNGTSSK--VQENIENNVEKNPRICCICQSSYPVTEDSALAYYTEDSRKTCVRESSLS
Opossum          YYLMNLQIMFCLKKNYLKLKKIVYCHAKQSTGLPVEMSGLGFYTGHGKSVPVSETSLLEA

                                                                       .
                 1688                                                    1733
                 .
Human            EAKKWLRE----------GIFDGQPERINTADYVGNYLYENNSNSTIAENDKNHLSEKQ-
Cat              EVKKWLRGGELDDQPEKT------------------------------------------
Dog              EAKKWLREGEWDDQSERINAAKVNCLKEYPDDYVENPSCGNSSNSAITENDKNHLSEKQ-
Mouse            KGRKWLRE--QGDKLGTRNTIKIECVKEHTEDFAGNASYEHSLVIIRTEIDTNHVSENQV
Opossum          RKWLKEIDLGGKTKFC--------------------------------------------
```

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               1734                                                    1785
                                                      .: : *.:     .
Human          -----DTYLSNSSMSNSYSY-----HSDEVYNDSGYLSKNKLD-SGIEPVLKNVEDQKNT
Cat            ----------------------------VYNISEYLPKSKVDNSGIEPVVRNVGERENT
Dog            ----GSTYLSNSTMSNSYSYHPGFCHSSEVYNKSEYLSRSKIDNSGIEPVIKNIRERKNI
Mouse          STLLSDPNVCHSYLSQSSFC-----HCDDMHNDSGYFLKNKID-SDVPPDMRNAE---GN
Opossum        -------------------------DVKED--YPCEDTSN-NTSSIDDKNISDKQDAFL

               1786                                                    1835
                 *       : .  .:  :   . :    .     .: .:.
Human          SFSKVISNVKDANAYPQTVNEDICVEELVTSSSPCKNKNAAIKLSISNSNNF--------
Cat            SVSEIMFTVREADTDPQSVNEDICVQRLVTNFS-CKKENTAIKVTVSDSNNFDSTQKLNS
Dog            GFSEIMSPGREADTDPQSVNEDICVEKLATNSS-CKNKNTAIKVAISDSNNFNTIQKLNS
Mouse          TISPRVSATKERNLHPQTINEY-CVQKLETNTSPHANKDVAIDPFLLDSRNC--------
Opossum        SNSMSSIKH-NLKHDTEGSDFCHSDDADFFS---EHISDKVMSCL---------------

               1836                                                    1895
                 :    .                 :     . .    :   :.:         ..
Human          --EVGPPAFRIASGKIVCVSHETIKKVKDIFTDSFSKVIKENNENKSKICQTKIMAGCYE
Cat            DSNDAVPVYTTASSERVLVAHET--KVAEGFTENCSMAIKQTTKSKPGK----IVAGYRK
Dog            DSNNSVPAYSTVNSKRVFVAHQT--KVTEGFTDNCSMVTKQNTKSKSDTCHAEIVADYPK
Mouse          --KVGSLVF------ITAHSQET-ERTKEIVTDNCYKIVEQNRQSKPDTCQ----TSCHK
Opossum        KAQPPAFTTASGKTVHISNEAVQKAREMFINNGDKFLKPNIENKSENNQMKNVKDPSKIL

               1896                                                    1954
                 :..       .    : .  . .     :.      * .  :..           .
Human          ALDDSEDIL-HNSLDNDECSTHSHKVFADIQSEEILQHNQNMSGLEKVSKISPCDVSLET
Cat            APDDSEDTICPNSLDGAECSSPSHKDFAETQSEQTPQLNQSISGFKKRSEIPPHQINLKT
Dog            ALDDSEAIF-PNSLGAIECS-PSHKVFADIQSEQTSQLNQSMSGLEKVSETPPCQINSKT
Mouse          VLDDSKDFICPSSSG--DVCINSRKDSFCPHNEQILQHNQSMFGLKKAA---TPPVGLET
Opossum        -ENKDIS-PKSFDGKKRNLSVNEGSFKIYSKK-AQL-ENISALEMDSEVSHCQINSKTSD

               1955                                                    2014
                  .        .:          :...   :. ..     .       :..       :
Human          SDICKCSIGKLHKSVSSANTCGIFSTASGKSVQVSDASLQNARQVFSEIEDSTKQVFSKV
Cat            SDICKLSTGKRLQSISYTNACGIFSTASGKCVQVSDAALQKARQVFSKVEDSAKQPFSKV
Dog            SDRCELPRGKLPKSVSYTNACGIFSTASGKSVQVSDAAIQKAREVFSKLEDSAKQLFPEV
Mouse          WDTSK-SIREPPQAAHPSRTYGIFSTASGKAIQVSDASLEKARQVFSEMDGDAKQLSSMV
Opossum        LYKSTIGKQPKGSSS---VGIFCTANGKPVQVSDNSLKKARQVFSEIANDSEQLLS---I

               2015                                                    2073
                 .  . ..    ..      .                ..   .  :.    :.
Human          LFKSNE-HSDQLTREENTAIRTPEHLISQKGFSYNVVNSSAFSGFSTASGKQVSILESSL
Cat            SFKHNEDHSDKFTREENTMIHTPQNLL-----------SSAFSGFSTASGKQVPVSESAL
Dog            SLKDNEEHSEKFTNEENTVIYTSQNLL-----------SSAFSGFRTASGKQVPVSESAL
Mouse          SLEGNE-KPHHSVKRENSVVHSTQGVLSLPKPLPGNVNSSVFSGFSTAGGKLVTVSESAL
Opossum        KGSE-HPETLIGEENAALC--KYLPAQKDYLSNMQNLYNNSGFNTASGKQVLISESALQK

               2074                                                    2131
                *   : ::    .          . ::*.*  .       .     :*:     . .
Human          HKVKGVLEEFDLIRTEHSLHYSPTSRQNVSKILP--RVDKRNPEHCVNSEMEKTCSKEFK
Cat            CKVKGILEEFDVMRTECGPQRSPTSRQDVSKMPPPSCVENKTPKHSVNSKLEKAYNKEFK
Dog            CKVKGMLEEFNLIRTESCLQHSSTSRQDVSKMPPPSCIGKRTPEHSRNSKLDKACNKEFR
Mouse          HKVKGMLEEFDLIRTEHTLQHSPIP-EDVSKILPQPCAEIRTPEYPVNSKLQKTYNDKSS
Opossum        VKGMLVEFDLMRNEC-------LESIQDVPKGLSRIDSETPKHIVNSKSKEICNKELHFS

               2132                                                    2190
                  * : ..... .  .:.      : .  :       .  .         :     ::
Human          LSNNLNVEGGSSENNHSIKVSPYLSQFQQDK-QQLVLGTKVSLVENIHVLGKEQASPKNV
Cat            LSSNSKIENGSSEN-HSVQVSPYPSQFKQDK--QLIQGNKASLVENIHLLEKEQALPKNI
Dog            LSSNCNNQSGSSENHHSIKVSPCPSQLKRDK-PQLLVGSKGSLVENIHPLGKEQALPKNI
Mouse          LPSNYK-ESGSSGNTQSIEVSLQLSQMERNQDTQLVLGTKVSHSK-ANLLGKEQTLPQNI
Opossum        NNCNVEISSSENSRIIEVSC--AQFKQDMIHPLLETKLTPAKE-ILFLKKGQVGLKDVDM
```

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                    2191                                                      2250
                    : .        :  :  :       :::..    *:  :   *     ::   ::    ::
Human               KMEIGKTETFSDVPVKTNIEVCSTYSKDSENYFETEAVEIAKAFMEDDELTDSKLPSHAT
Cat                 KWKLETEA-FPNLPLKTDTAIHSTDSKDPENYFETETVEIAKAFMEDGELTDADLLSHAR
Dog                 KTEIGKAETFPNLPVKTNIEFCSTYSKDPENYFETETVEIAKAFMEDGELTDSELLSHAK
Mouse               KVKTDEMKTFSDVPVKTNVGEY--YSKESENYFETEAVESAKAFMEDDELTDSEQ-THAK
Opossum             ESSEA--IDGLPVKRNLQVSSPNSKAQETSMEREAVEIAKAFMQDDEFTDSELPHNAKQS

                    2251                                                      2310
                        .  .  .    .   :
Human               HSLFTCPENEEMVLSNSRIGKRRGEPLILVGEPSIKRNLLNEFDRIIENQEKSLKASKST
Cat                 HFLPTCQHSEETLVSNSRRGKRRGV-LVSVGEPPIKRNLLNEFDRIIKNQEKSLKASKST
Dog                 HFVFTCQNTKEMVLLNSRIGKRRGDALVSVGEPPIKRNLLNEFGRIIKNQETSLKASKST
Mouse               CSLFTCPQNE--TLFNSRTRKRGGVTVDAVGQPPIKRSLLNEFDRIIESKGKSLTPSKST
Opossum             FFTYKNNEERILTNSRFGKRRMEERASY--------------------------------

                    2311                                                      2370
Human               PDGTIKDRRLFMHHVSLEPITCVPFRTTKERQEIQNPNFTAPGQEFLSKSHLYEHLTLEK
Cat                 PDGIIKDRSLFMHHISLEPVTCGPFSTTKKRQEIQNPNFTAPGQKFLSKSHFYEHLALEK
Dog                 PDGILKDRSLFMHHISLEPISCGPFRTTEERQEIQNPNFTAPGQEFLPKSHFYEHLASEK
Mouse               PDGTVKDRSLFTHHMSLEPVTCGPFCSSKERQGAQRPHLTSPAQELLSKGHPWRHSALEK
Opossum             ------------------------------------------------------------

                    2371                                                      2429
Human               SSSNLAVSGHPFYQVSATRNEKMRHLITTGRPTKVFVPPFKTKSHFHRVEQCV-RNINLE
Cat                 SSSNVSISGQPFCTVPATRSEKRGHSITPSKPVKVFVPPFKTKSRFLQDEQHISKNTHVE
Dog                 SSSNLSVSRQPFCMVPATGNEKRRHLIAPGKPVKVFVPPFKTKSHFHRDEQCISKNTKLE
Mouse               SPSSPIVSILPAHDVSATRTERTRH---SGKSTKVFVPPFKMKSQFHGDEHFNSKNVNLE
Opossum             ------------------------------------------------------------

                    2430                                                      2488
                                                                        .
Human               ENRQK-QNIDGHGSDDSKNKINDNEIHQFNKNNSNQAAAVTFTKCEEEPLDLITSLQNAR
Cat                 ENKQKPNNIDEHSSGDSKNNINNSEIHQLNKNNSSQAATMVFTKCEKEPLDLIASLQNAR
Dog                 KNKQNSKDIDELGSGDSEKNINDSGIHQLKKNNSNQAATIIFTKNEKEPLDLITNLQNAR
Mouse               GKNQK-------STDGDREDGNDSHVRQFNK-------------------DLMSSLQSAR
Opossum             -----------------------------------------------EMIENLQHAREM

                    2489                                                      2548
                    :   :: ::..: :     .  *   :.:  . . : :         . :..    :*    .
Human               DIQDMRIKKKQRQRVFPQPGSLYLAKTSTLPRISLKAAVGGQVPSACSHKQLYTYGVSKH
Cat                 DIQDMRIREKRKQHIFPQPGSLFLAKTSTVPRISLRVAVEGRVPSACSHKQLYMYGVSKH
Dog                 DIQDMRIKKKQRQHIFPQPGSLYLAKTSTLPRISLREAVEGRVPSACSHKQLYMYGVSKH
Mouse               DLQDMRIKNKERRHLRLQPGSLYLTKSSTLPRISLQAAVGDRAPSACSPKQLYIYGVSKE
Opossum             QDMRIKKKQTQKIHPQAGSLYLRKTSTLPRSSLRVVVEGKVPSTYSSKQLYMYGITKQCL

                    2549                                                      2608
                     :: :..::  *: .      :         :    .      ...     :
Human               CIKINSKNAESFQFHTEDYFGKESLWTGKGIQLADGGWLIPSNDGKAGKEEFYRALCDTP
Cat                 CVKINSKNAESFQFHTQDYFGKEVQWAKEGIQLADGGWLIPSNDGKAGKEEFYRALCDTP
Dog                 CVKINSKNAESFQFHAQDYFGKEGLWSGEGIQLPDGGWLIPSNDGKIGKEEFYRALCDTP
Mouse               CINVNSKNAEYFQFDIQDHFGKEDLCAGKGFQLADGGWLIPSNDGKAGKEEFYRALCDTP
Opossum             RINSKNSESFKFHSEDYFSKEHLLDGNGIQLADGGWLIPTDEGKLGKEEFY---------

                    2609                                                      2667
Human               GVDPKLISRIWVYNHYRWIIWKLAAMECAFPKEFANRCLSPERVLLQLKYR-YDTEIDRS
Cat                 GVDPNLISRIWVYNHYRWIIWKLAAMEFAFPKEFANRCLSPERVLLQLKYR-YDMEIDRS
Dog                 GVDPNCISRVWVYNHYRWIIWKLAAMEFAFPKEFANRCLSPERVLLQLKYR-CDVEIDKS
Mouse               GVDPKLISSIWVANHYRWIVWKLAAMEFAFPKEFANRCLNPERVLLQLKYR-YDVEIDNS
Opossum             -----------------------------------------------------------
```

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            2668                                                      2727
Human       RRSAIKKIMERDDTAAKTLVLCVSDIISLSANISETSSNKTSSADTQKVAIIELTDGWYA
Cat         KRSAIKKIMERDDTAAKTLVLCISETISSSTDLSETSGSKTSGVGTKNVGIVELTDGWYA
Dog         RRSAIKKIMERDDTAAKTLVLCISEIISSSADISETSSSKTSSVGTKKVGIIALTDGWYA
Mouse       RRSALKKILERDDTAAKTLVLCISDIISPSTKVSETSGGKTSGEDANKVDTIELTDGWYA
Opossum     ------------------------------------------------------------

            2728                                                      2787
Human       VKAQLDPPLLAVLKNGRLTVGQKIILHGAELVGSPDACTPLEAPESLMLKISANSTRPAR
Cat         IKAQLDPPLLALVKKGRLTVGHKIIIHGAELAGSPDACTPLEAPESLILKISANSTRPAC
Dog         IKAQLDPPLLALVKNGRLTVGQKITIHGAELVGSPDACTPLEAPESLMLKISANSTRPAC
Mouse       VRAQLDPPLMALVKSGKLTVGQKIITQGAELVGSPDACAPLEAPDSLRLKISANSTRPAR
Opossum     ------------------------------------------------------------

            2788                                                      2847
Human       WYTKLGFFPDPRPFPLPLSSLFSDGGNVGCVDVIIQRAYPIQWMEKTSSGLYIFRNEREE
Cat         WYAKLGFFPDPRPFPLPLSSLFSDGGNVGCVDVVIQRTYPIQWMEKTPSGLCIFRNEREE
Dog         WYTKLGFSPDPRPFPLPLSSLFSDGGNVGCVDVVVQRAYPIQWMERTPSGLCIFRNEREE
Mouse       WHSRLGFFCDPRPFPLPLSSMFSDGGNVGCVDIIVQRVYPLQWVEKTVSGLYIFRSEREE
Opossum     ------------------------------------------------------------

            2848                                                      2907
Human       EKEAAKYVEAQQKRLEALFTKIQEEFEEHEENTTKPYLPSRALTRQQVRALQDGAELYEA
Cat         EREATKYAEAQQKKLEVLFNKIQAEFEKHDENITKRCVPLRALTRQQVCALQDGAELYEA
Dog         EKEATKYAEIQQKKLEVLFNKIQAEFEKNDENITKQCIPSCALTRQQICALQDGAELYEA
Mouse       EKEALRFAEAQQKKLEALFTKVHTEFKDHEEDTTQRCVLSRTLTRQQVHALQDGAELYAA
Opossum     ------------------------------------------------------------

            2908                                                      2967
Human       VKNAADPAYLEGYFSEEQLRALNNHRQMLNDKKQAQIQLEIRKAMESAEQKEQGLSRDVT
Cat         VKNAPDPASLEAYFSEEQIRALNNHRQMLNDKKQAQIQLEFRKAMESAEQGEQMLPRDVT
Dog         VTNAPDPSDLEGYFSEEQLRALNNHRQMLNDKKQAQIQLEFKKAMESAEQGEQILPRDVT
Mouse       VQYASDPDHLEACFSEEQLRALNNYRQMLNDKKQARIQSEFRKALESAEKEE-GLSRDVT
Opossum     ------------------------------------------------------------

            2968                                                      3027
Human       TVWKLRIVSYSKKEKDSVILSIWRPSSDLYSLLTEGKRYRIYHLATSKSKSKSERANIQL
Cat         TVWKMRIISYGKKEKDSVTLSIWRPSSDLYSLLTEGKRYRIYHLATSQSKSKSERAHIQL
Dog         TVWKLRIISYRKKEKDSVTLSIWRPSPDLYSLLIEGKRYRIYHLAASQSKSKSGKANTQL
Mouse       TVWKLRVTSYKKKEK-SALLIIWRPSSDLSSLLTEGKRYRIYLLAVSKSKSKFERPSIQL
Opossum     ------------------------------------------------------------

            3028                                                      3087
                                                                       .
Human       AATKKTQYQQLPVSDEILFQIYQPREPLHFSKFLDPDFQPSCSEVDLIGFVVSVVKKTGL
Cat         TATKKTQYQQLPASDELLFQVYQPREPLYFNKLLDPDFQPPCSEVDLIGFVVSVVKKIGF
Dog         TATKKTQYQQLPASDEILSQVYQPREPLYFNKLLDPDFQPPCSEVDLIGFVVSVVKKIGL
Mouse       TATKRTQYQQLPVSSETLLQVYQPRESLHFSRLSDPAFQPPCSEVDVVGVVVSVVKPIGL
Opossum     ---------------------------------------------------------VAP

            3088                                                      3147
               :  .      : . .  : :    :.    :  : : ...:   :       .   *
Human       APFVYLSDECYNLLAIKFWIDLNEDIIKPHMLIAASNLQWRPESKSGLLTLFAGDFSVFS
Cat         APLVYLSDECHNLLAIKVWTDLNEDIVKPHTLIAASNLQWRPESKSGIPTLFAGDFSRFS
Dog         APVVYLSDECHNLLAIKFWTDFNEDIIKPYTLIAASNLQWRPEAKSGIPTLFAGDFSRFS
Mouse       APLVYLSDECLNLLVVKFGIDLNEDI-KPRVLIAASNLQCQPESTSGVPTLFAGHFSIFS
Opossum     LVYLSDEYYNLLAVKFWIDLNEDVIKLHTLIAASNLQWKTESRAEFPMLFAGEFSVFSAS
```

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                3148                                                    3202
                .. ..   : .  : .
Human           ASPKEGHFQETFNKMKNTVENIDILCNEAENKLMHILHANDPKWSTPTKDCTSGPYT---
Cat             ASPKEGHFQETFHKMKNTIENVETFCNDAENKLVHILNANSPKVSTPMKDYASEPHT---
Dog             ASPKEEHFQETFHKMKNTVENIGMFYNDAENKLVHILNANDPKLSTPTKDYASEPHT---
Mouse           ASPKEAYFQEKVNNLKHAIENIDTFYKEAEKKLIHVLEGDSPKWSTPNKDPTREPHAAST
Opossum         PKQSHFQERFNKLKNSVE------------------------------------------

                3203                                                    3261
                            :       :            :  :   . . . :: .  . : :  .
Human           --AQIIPGTGNKLLMSSPNCEIYYQSPLSLCMAKRKSVSTPVSAQMTSKS-CKGEKEIDD
Cat             --IQTVLGLGNKLSMSSPNSEMNYQSPLSLCKPKAKSVPTPGSAQMTSKSCYKGERELDD
Dog             --AQIVLGIGNKFLMSSPNNEMNYQSPLSLCKPKEKSVPIPGSTQMTSKSYCKEEKEMDD
Mouse           CCASDLLGSGGQFLRISPTGQQSYQSPLSHCTLKGKSMPLAHSAQMAAKS-WSGENEIDD
Opossum         ------------ISPFHRERNHHCP------EGNSGATISSVKISPTS-CRGDRKMDDPK

                3262                                                    3320
                  . ::   :     :* * .     .  :.        . .   :  .     :  .
Human           QKNCKKRRALDFLSRLPLPPPVSPICTFVSPAAQKAFQPPRSCGTKYETPIKKKELNSPQ
Cat             PKTCKKRKALDFLSRLPLPPPVSPICTFVSPAAQKAFQPPRSCGTKYETPI-RRELNSPQ
Dog             PKTCKKRRALDFLSRVPLPPSVSPICTFVSPAAQKAFQPPRSCGTKYETLM-KKELNSPQ
Mouse           PKTCRKRRALDFLSRLPLPSPVSPICTFVSPAAQKGFQPPRSCGTKYATPI-KKKPSSPR
Opossum         ICKKRRSLDFLSRLPLPPPISPIRTFVSPAAQKAFQPPRSCGNKYNVPVKKNTSNSPQM-

                3321                                                    3380
                      . .  :  :  :  :  *   .:     .
Human           M-TPFKKFNEISLLESNSIADEELALINTQALLSGSTGEKQFISVSESTRTAPTSSEDYL
Cat             M-TP-LKFNDTSLVESDSIADEELALINTQALLSGLAGEDQLMSLNDSPRTAPTSSKDYV
Dog             M-TP-RKFNDLSLLESDSIADEELAMINTQALLLGSPGEHQLVSVSDSTRTAPTSSKDYL
Mouse           RKTPFQKTSGVSLPDCDSVADEELALLSTQALTPDSVGGNEQAFPGDSTRNPQPAQRPDQ
Opossum         TI-KTLSGTTMAENDLIADEELALINTQALLPNSSEN-----------------------

                3381                                                    3418
Human           RLKRRCTTSLIKE--QESSQASTEECEKNKQDTITTKKYI--------------------
Cat             RPKSYPTAPGIRDCENPQASTEGGEPDVQDTDTVKRSSMRLQRRQQQT------------
Dog             GLKRHSTAPGVRG--PESPQACTRKREPRVQNTSDLKRTISETAEATNTKMTMNW-----
Mouse           QVGPRSRKESLRDCRGDSSEKLAVES----------------------------------
Opossum         ------------------------------------------------------------
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Vita

Christina J. Ramirez

EDUCATION

2000-2005	Ph.D., Molecular and Cellular Biology Graduate Program University of Washington & Fred Hutchinson Cancer Research Center, Seattle, WA
2000	B.A., Department of Biology Colorado College, Colorado Springs, CO

RESEARCH

06/01-09/05,	Graduate Student Molecular and Cellular Biology Graduate Program Research Advisor: Elaine Ostrander, Ph.D. Comparative analysis of BRCA1 and BRCA2
05/99-01/00	Associated Colleges of the Midwest Minority Scholar Department of Biology Colorado College, Colorado Springs, CO Research Advisor: Ralph Bertrand, Ph.D. DNA as a computational device
06/98-08/98	Howard Hughes Undergraduate Scholar Laboratory of Evolution, Ecology, and Conservation Biology University of Nevada, Reno, Reno, NV Research Advisor: Guy Hoelzer, Ph.D. Microsatellite analysis of Central American howler monkeys (*Alouatta pigra*)
06/95-08/95	Howard Hughes High School Scholar Laboratory of Evolution, Ecology, and Conservation Biology University of Nevada, Reno, Reno, NV Research Advisor: Guy Hoelzer, Ph.D. Genetic variation of cheatgrass (*Bromus tectorum*) populations in Northern Nevada

HONORS AND AWARDS

09/02-09/05	Pre-doctoral fellow Genome Training Grant University of Washington, Seattle

TEACHING AND MENTORSHIP

06/03-08/05 Mentor
Partners in Science Program at the M.J. Murdock Charitable Trust
Provided one-on-one lab experience to a local high school teacher for two summers; provided resources and classroom demonstrations

07/03-09/03 Mentor
Mentored graduate student Leah Scanlin

04/02-08/02 Mentor
Science and Education Partnership, University of Washington & Fred Hutchinson Cancer Research Center, Seattle, WA
Provided structured lectures and one-on-one lab experience to high school teachers; provided resources and classroom demonstrations over the following school year

01/02-03/02 Graduate Teaching Assistant
University of Washington, Seattle
Introductory Genetics Laboratory

SPECIAL COURSES

Basic Linkage Analysis Course, Rockefeller University, New York, NY May 6-10, 2002

ABSTRACTS

E.A. Ostrander, **Ramirez, C.J.**, M.A. Fleming, G.K. Ostrander, J.D. Potter. 2004. Marsupial BRCA1: conserved regions in mammals and the potential effect of missense changes. Poster presentation: American Society of Human Genetics, Toronto, Canada. Submitted

Marsupial BRCA1: conserved regions in mammals and the potential effect of missense changes. *BreastCancer.Net Newsletter.* March 5, 2004. https://www.breastcancer.net

SEMINARS

"Perspectives in evolution: From the evolution of BRCA1 to the evolution of human chromosome 17, " Graduate Student Seminar. Fred Hutchinson Cancer Research Center, Seattle, WA, November 12, 2004

INVITED PRESENTATIONS

"Evolution of Human Chromosome 17," Society for the Advancement of Chicanos and Native Americans in Science (SACNAS), Orange County, CA, September 27-30, 2002

PUBLICATIONS

Fleming, M.A., J.D. Potter, **C.J. Ramirez**, G.K. Ostrander, E.A. Ostrander. 2003. Understanding missense mutations in the *BRCA1* gene: An evolutionary approach. *PNAS* 100(3):1151-1156.

Ramirez, C.J., M.A. Fleming, G.K. Ostrander, J.D. Potter, E.A. Ostrander. 2004. Marsupial BRCA1: conserved regions in mammals and the potential effect of missense changes. *Oncogene* 23:1780-1788.